Vaginal Seeding After Cesarean Delivery:
Bridging the Microbial Gap

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Background and Significance

Babies born through cesarean section (c-section) do not pass through the birth canal, so they miss out on the exposure to their mother's vaginal microbiota which are the first microbial colonizers that babies receive during a vaginal delivery (Mueller et al., 2023). Having a c-section prevents the growth of essential microbiota due to no exposure from the vaginal microbiota which would be setting up their microbiome. As a result, their microbiome develops differently from babies born vaginally which can have long term impacts, on metabolism, inflammatory, and immune responses. This can increase their risk for future adverse health outcomes including the development of asthma, allergies, type 1 diabetes, and obesity later in life (Mueller et al., 2023).

At birth, a newborns gut is sterile. When a baby is delivered vaginally, they are exposed to their mother's vaginal microbiota. When delivered by c-section, babies are limited to acquiring microbes through physical contact with their mother/environment, for example through skin to skin or while breast feeding (Xanthi Anthoulaki et al., 2023). **Vaginal seeding** is the process in which a newborn's mouth, skin and nose are swabbed with the mother's vaginal secretions immediately after birth to help transfer essential microbes to build a strong immune system. There is concern that vaginal seeding is associated with higher risk of contracting infections such as Group B Streptococcus (GBS), HIV, Chlamydia, and HSV. However, without vaginal seeding the newborn is at higher risk for autoimmune and inflammatory disease when compared to infants delivered by vaginal delivery (Hourigan et al., 2022). The clinical practice of vaginal seeding warrants further research to assess whether it should become the future gold standard for newborns via c-section.

Objectives

- **To explore current research on maternal child microbial seeding to evaluate its effectiveness in restoring the microbiome of cesarean delivered infants.**
- **Determine risk and benefits of vaginal seeding by analyzing evidence from randomized controlled trials and observational studies.**
- **Improve awareness among nursing professionals about the implications of vaginal seeding for patient education, safety, and evidence-based practice.**

Methods and Summary of Search

A systematic literature search was conducted based on the PICOT question below. Databases searched included Google Scholar, PubMed, and Embase. Key search terms used were delivery methods: "Cesarean section or C-section or Cesarean." Microbiota terms and Microbial exposure terms: "Microbiota or Gut microbiota or Microbiome." Newborn health and interventions: "Breast feeding after C-section," "Probiotics given to newborns after C-section", "Microbiota in newborns who do not go through the birth canal," "Fecal Microbiota Transplantation", "Microbiota", and "Vaginal seeding." "Vaginal secretions used after C-section to help improve newborns." The search included experimental studies and randomized control trials that investigated changes in gut microbiota of c-section born infants

PICO

P: In Newborns delivered via cesarean section
I: Vaginal seeding (exposure to maternal vaginal microbiota)
C: No vaginal seeding
O: Development of gut microbiome and immune function
T: The first year of life

Implications for Nursing Practice

Education
- CNL's should encourage evidence-based practice to improve patient care, and education to help in clinical decision making (King et al., 2021). These recommendations should include educating nursing staff and patients on the current benefits of vaginal seeding, limitations from evidenced based research, monitoring ongoing research trials to determine its future safety and efficacy, communicating with the patient about current practices to support early skin to skin contact and to promote breast feeding may increase the infant's microbiome (Wilson et al., 2021).
- Develop patient educational tools such as informational pamphlets and online resources and hold classes to talk about vaginal seeding and promote early breast feeding.

Communication and Collaboration
- Inform mothers who inquire about vaginal seeding, the CNL should communicate openly about risk and safety concerns and the importance of screening for transmittable infections (Hourigan et al., 2022).
- The CNL plays a key role in promoting collaboration with other team members such as obstetricians, neonatologists, infection control teams and researchers to ensure best practices are followed and institutional standards are maintained (King et al., 2021).
- As a lateral integrator of care the CNL bridges the gaps in communication between clinical staff and administration to promote and implement evidenced based practice but also why it can be problematic (King et al., 2021).
- The CNL can help facilitate interdisciplinary meetings about new and upcoming interventions and lead quality improvement projects and studies focused on early microbiome detection, infection control prevention and screening.
- Effective inter professional communication is essential for patient safety.

Research
- Collect data on the current research of vaginal seeding and related pilot programs of maternal-infant microbiome health and incorporate these newer developments for use when speaking to interdisciplinary care professionals, nurses, staff, administration and most importantly patients.
- In summary vaginal seeding is a promising invention but more evidence is needed to promote a process change. The CNL can bridge the gaps between research and practice while upholding patient safety through evidence-based interventions.

Evidence Table

Author, Year of Publication	Results	Level of Evidence	Quality Rasting
Hourigan et al (2022)	Gut microbiome is partially restored in infants who were delivered via c-section and vaginally swabbed. Clinical significance: Having a ratio of Enterobacteriaceae/Bacteroide imbalance at 3 months following a c-section has been implicated in developing obesity later in childhood.	III	B
Liu et al (2023)	Statistical Results: BMI and BMI z-score: showed not significant difference between groups at any time point (P>0.05), Allergy risk: Median allergy score was 1.5 (vaginal seeding) vs. 2.0 (control), but not statistically significantly (P=0.48). Microbiome composition had higher levels of Lactobacillus and Bacteroides in the vaginal seeding group but was not statistically significant. Obesity Risk: Lower at 6 months in the vaginal seeding group (0/57 vs. 6/59; P=0.03), but not significant at later points in time. Clinical significance: Higher microbiome composition= higher beneficial bacteria, no significant effect on BMI or allergy risk. Possible short-term reduction in the risk of obesity but findings are not significant over time. No safety concerns.	I	A
Mueller et al (2023)	Statistical Results: Increase maternal to infant microbiota transmission in vaginal seeding group (P=0.0001), Significant increase in bacterial load in neonatal skin microbiota forearm: 32 copies/uL vs.14 copies/uL, P=-0.033), Reduced stool microbiota in day 1 (P=0.047) and day 30 (P=0.01). Clinical significance: Supports the hypothesis that vaginal seeding enhances maternal bacterial engraftment in infants. Early microbial colonization may be beneficial in reducing pathogenic bacteria. No significant effect on stool microbiota by day 30.	I	A
Wilson et al (2021)	Statistical Results: No-significant difference in gut microbiome composition of infants who received vaginal seeding and those who did not (placebo). 1 month (p= 0.90) and 3 months (p= 0.18). Significant difference in gut microbiome of vaginally born vs. C-section. Vaginally born at 1 month (p= 0.22) and 3 months (p= 0.001) indicating infants delivered vaginally had a higher Bacteroides spp. compared to c-section infants. At 1-month Bacteroides was present in 28% of c-section infants vs 80% in vaginally delivered infants. At 3 months vaginally born infants had higher incidence of other bacteria such as vulgaris, B. dorei, and B. fragilis. C-section infants had more Autopodium, Clostridium, Hemophilus and Streptococcus spp. Vaginal seeding did not significantly affect the gut microbiome composition.	I	A
Xanthi et al (2023)	There was no statistically significant difference in ocular, rectal, ear, and umbilical microbes between infants delivered via cesarean section and those delivered vaginally. Infants delivered vaginally had a lower number of microbes compared to those delivered via c- section with vaginal seeding. Infants delivered via c- section with seeding had significantly higher levels of Staphylococcus epidermidis (P= 0.002), E. coli (P= 0.037), Bifidobacterium (P=0.015), and Lactobacillus (P=0.011) compared to those delivered vaginally. Vaginal seeding done in infants delivered via c-section does not completely replicate the microbiomes of infants delivered vaginally but may restore some beneficial microbiome populations.	I	A

Summary and Conclusions

Limitations
- Vaginal seeding only done on singleton term pregnant women with scheduled c-sections.
- Pregnant women with complications or risk factors for emergency cesarean delivery were excluded.
- Infants born to mothers with sexually transmitted infections or Group B infections were excluded from the study as these factors could interfere with the safety and effectiveness of vaginal seeding.
- Women who delivered outside the treatment facility were excluded.
- Infants with health conditions known to influence gut microbiome development were excluded.

- Current observational and randomized control trials have not shown clear significant improvements in clinical outcomes for c-section born infants, including changes in the gut microbiome, growth, allergy risk or long-term immune health. It is important to note all the studies presented in this paper have shown no safety concerns which support additional investigation to this practice for future research.
- Vaginal seeding caused increased changes in the newborn's microbiota during maternal transmission and increased the variety of microorganisms found on the skin and stool (Mueller et al., 2023).
- Research continues and in the future larger and longer randomized control trials are needed to determine whether vaginal seeding has implicit effects on immune system development, metabolism, and disease prevention. Furthermore, studies should investigate the role of maternal microbiome to help identify the proper composition of vaginal seeding needed to support a c-sectioned infants' development. Research could also explore alternative seeding methods such as focused probiotics or genetically modified microbiota in instances when mothers have infections or co-morbidities that prohibit them from participating in vaginal seeding (Hourigan et al., 2022).
- If evidence demonstrates that vaginal seeding can improve long-term health outcomes for infants born via c-section, it could eventually become a standardized part of the c-section protocol.
- Vaginal seeding, believed to mimic the exposure that naturally occurs during a vaginal birth, can positively influence microbial colonization's pattern in c-sectioned delivered infants.
- Maternal-child microbial seeding, also known as "vaginal seeding," is the practice of swabbing vaginal fluids to transfer the vaginal flora into the mouth, nose or skin of the newborn immediately following a cesarean delivery (Hourigan et al., 2022).
- Vaginal seeding remains under research constraints due to the possibility of transmitting a maternal infection to the newborn, lack of standardized practice and unknown long-term effects (Hourigan et al., 2022).
- Some studies found the gut microbiome of infants delivered by c-section with vaginal seeding were like the gut microbiome of vaginally delivered infants (Xanthi Anthoulaki et al., 2023).

Evidence Summary

Five research articles were used to identified key findings.

- Two articles showed microbiome restoration and engraftment; Mueller et al. (2023) found vaginal seeding partially restores neonatal microbiota to resemble vaginally delivered infants particularly on the skin and in stool. Samples were taken at day one and month one postpartum however long-term maternal strains in the infant's gut were limited.
- Wilson et al. (2021) studied an alternative method of oral administration of maternal vaginal microbes, finding initial engraftment occurred. The continuance of these microbes past infancy were unclear. Two of the studies identified clinical and immune implications; Hourigan et al. (2022) identified vaginal seeding interventions may contribute to better health outcomes, possibly reducing the risk of immune diseases such as allergies, asthma and obesity.
- Liu et al. (2023) reported no significant impact of vaginal seeding on body mass index or allergy risks despite evidence of short-term microbiome alterations.
- Two studies used different methods in vaginal seeding; Xanthi Anthoulaki et al. (2023) indicated c-section delivered neonates with applied vaginal seeding versus vaginal delivery showed differences in gut microbiota.
- Mueller et al. (2023) highlighted bacterial microbiota strains transferred from mother to infant successfully however their presence was not always apparent. This was an indication for further study and research into long-term microbiome reliability needed.
- Three studies had inconsistencies in long term stability of the transfer of microbiomes; Mueller et al. (2023) identified maternal microbiomes did not persist long-term in the infant's gut while Xanthi Anthoulaki et al. (2023) identified infants born via c- section with vaginal seeding as well as vaginally had microbiomes still present later in infancy.
- Some studies showed good clinical outcomes and health benefits; Hourigan et al. (2022) identified potential health benefits which included reduced risk of immune related diseases whereas Liu et al. (2023) found no significant effects on BMI or risk for allergies. Wilson et al. (2021) experimented using oral administration of vaginal microbiota instead of direct seeding on the skin which showed no long-term effects of colonization in comparison to the swabbing methods used in the other studies.
- Consistencies across all studies showed microbiome alterations during vaginal seeding in infants. All studies identified no adverse effects related to vaginal seedings supporting it is safe when used under controlled environments.

References

Acknowledgements

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