

# Applying New Learnings on Human Milk Composition to Clinical Practice in the NICU

## Bibliography

Agostoni C, Buonocore G, Carnielli VP, et al. Enteral nutrient supply for preterm infants: commentary from the European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2010;50(1):85-91. doi:10.1097/MPG.0b013e3181adaee0

Alshaikh B, Abo Zeid M, Yusuf K, Guin M, Fenton T. Effect of enteral zinc supplementation on growth and neurodevelopment of preterm infants: a systematic review and meta-analysis. *J Perinatol.* 2022;42(4):430-439. doi:10.1038/s41372-021-01094-7

American Academy of Pediatrics Committee on Nutrition. *Donor Human Milk for the High-Risk Infant: Preparation, Safety, and Usage Options in the United States.* *Pediatrics.* 2017;139(1):e20163440. doi:10.1542/peds.2016-3440

American College of Obstetricians and Gynecologists' Committee on Obstetric Practice; Breastfeeding Expert Work Group. Committee Opinion No. 658: Optimizing Support for Breastfeeding as Part of Obstetric Practice. *Obstet Gynecol.* 2016;127(2):e86-e92. doi:10.1097/AOG.00000000000001318

Belfort MB, Rifas-Shiman SL, Sullivan T, et al. Infant growth before and after term: effects on neurodevelopment in preterm infants. *Pediatrics.* 2011;128(4):e899-e906. doi:10.1542/peds.2011-0282

Bergner EM, Taylor SN, Gollins LA, Hair AB. *Human Milk Fortification: A Practical Analysis of Current Evidence.* *Clin Perinatol.* 2022;49(2):447-460. doi:10.1016/j.clp.2022.02.010

Bulut O, Coban A, Uzunhan O, Ince Z. *Effects of Targeted Versus Adjustable Protein Fortification of Breast Milk on Early Growth in Very Low-Birth-Weight Preterm Infants: A Randomized Clinical Trial.* *Nutr Clin Pract.* 2020;35(2):335-343. doi:10.1002/ncp.10307

Brown JV, Embleton ND, Harding JE, McGuire W. Multi-nutrient fortification of human milk for preterm infants. *Cochrane Database Syst Rev.* 2016;(5):CD000343. Published 2016 May 8. doi:10.1002/14651858.CD000343.pub3

Claas MJ, de Vries LS, Koopman C, et al. Postnatal growth of preterm born children ≤750g at birth. *Early Hum Dev.* 2011;87(7):495-507. doi:10.1016/j.earlhumdev.2011.04.009

Colaizy TT, et al. NICHD Neonatal Research Network MILK Trial - Results and lessons learned about donor human milk Presented at: Hot Topics in Neonatology 2022. National Harbor, MD; December 4-7, 2022.

de Halleux V, Pieltain C, Senterre T, Rigo J. Use of donor milk in the neonatal intensive care unit. *Semin Fetal Neonatal Med.* 2017;22(1):23-29. doi:10.1016/j.siny.2016.08.003

Ehrenkranz RA, Dusick AM, Vohr BR, Wright LL, Wrage LA, Poole WK. Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infants. *Pediatrics.* 2006;117(4):1253-1261. doi:10.1542/peds.2005-1368

Embleton ND, Moltu SJ, Lapillonne A, et al. *Enteral Nutrition in Preterm Infants (2022): A Position Paper From the ESPGHAN Committee on Nutrition and Invited Experts.* *J Pediatr Gastroenterol Nutr.* 2023;76(2):248-268. doi:10.1097/MPG.0000000000003642

Embleton ND, Sproat T, Uthaya S, et al. Effect of an exclusive human milk diet on the gut microbiome in preterm infants: A randomized clinical trial. *JAMA Netw Open.* 2023;6(3):e231165. Published 2023 Mar 1. doi:10.1001/jamanetworkopen.2023.1165

ESPGHAN Committee on Nutrition, Agostoni C, Braegger C, et al. Breast-feeding: A commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2009;49(1):112-125. doi:10.1097/MPG.0b013e31819f1e05

ESPGHAN Committee on Nutrition, Arslanoglu S, Corpeleijn W, et al. Donor human milk for preterm infants: current evidence and research directions. *J Pediatr Gastroenterol Nutr.* 2013;57(4):535-542. doi:10.1097/MPG.0b013e3182a3af0a

Fu TT, Schroder PE, Poindexter BB. Macronutrient analysis of target-pooled donor breast milk and corresponding growth in very low birth weight infants. *Nutrients.* 2019;11(8):1884. Published 2019 Aug 13. doi:10.3390/nu11081884

## Applying New Learnings on Human Milk Composition to Clinical Practice in the NICU

Gates A, Marin T, De Leo G, Waller JL, Stansfield BK. Nutrient composition of preterm mother's milk and factors that influence nutrient content. *Am J Clin Nutr.* 2021;114(5):1719-1728. doi:10.1093/ajcn/nqab226

Gates A, Marin T, Leo G, Stansfield BK. Review of preterm human-milk nutrient composition. *Nutr Clin Pract.* 2021;36(6):1163-1172. doi:10.1002/ncp.10570

German KR, Vu PT, Comstock BA, et al. Enteral iron supplementation in infants born extremely preterm and its positive correlation with neurodevelopment; post hoc analysis of the preterm erythropoietin neuroprotection trial randomized controlled trial. *J Pediatr.* 2021;238:102-109.e8. doi:10.1016/j.jpeds.2021.07.019

Granger CL, Embleton ND, Palmer JM, Lamb CA, Berrington JE, Stewart CJ. Maternal breastmilk, infant gut microbiome and the impact on preterm infant health. *Acta Paediatr.* 2021;110(2):450-457. doi:10.1111/apa.15534

Guellec I, Lapillonne A, Marret S, et al. Effect of intra- and extrauterine growth on long-term neurologic outcomes of very preterm infants [published correction appears in *J Pediatr.* 2017 Jun;185:255]. *J Pediatr.* 2016;175:93-99.e1. doi:10.1016/j.jpeds.2016.05.027

Hair AB, Blanco CL, Moreira AG, et al. Randomized trial of human milk cream as a supplement to standard fortification of an exclusive human milk-based diet in infants 750-1250 g birth weight. *J Pediatr.* 2014;165(5):915-920. doi:10.1016/j.jpeds.2014.07.005

Hair AB, Scottoline B, Good M. Dilemmas in human milk fortification. *J Perinatol.* 2023;43(1):103-107. doi:10.1038/s41372-022-01502-6

Han SM, Derraik JGB, Binia A, Sprenger N, Vickers MH, Cutfield WS. Maternal and infant factors influencing human milk oligosaccharide composition: Beyond maternal genetics. *J Nutr.* 2021;151(6):1383-1393. doi:10.1093/jn/nxab028

Hård AL, Nilsson AK, Lund AM, Hansen-Pupp I, Smith LEH, Hellström A. Review shows that donor milk does not promote the growth and development of preterm infants as well as maternal milk. *Acta Paediatr.* 2019;108(6):998-1007. doi:10.1111/apa.14702

Hay WW Jr. Nutritional support strategies for the preterm infant in the neonatal intensive care unit. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21(4):234-247. doi:10.5223/pghn.2018.21.4.234

Hellström A, Ley D, Hansen-Pupp I, et al. New insights into the development of retinopathy of prematurity--importance of early weight gain. *Acta Paediatr.* 2010;99(4):502-508. doi:10.1111/j.1651-2227.2009.01568.x

Hopperton KE, O'Connor DL, Bando N, et al. Nutrient enrichment of human milk with human and bovine milk-based fortifiers for infants born <1250 g: 18-month neurodevelopment follow-up of a randomized clinical trial. *Curr Dev Nutr.* 2019;3(12):nzz129. Published 2019 Nov 12. doi:10.1093/cdn/nzz129

Isaacs EB, Morley R, Lucas A. Early diet and general cognitive outcome at adolescence in children born at or below 30 weeks gestation. *J Pediatr.* 2009;155(2):229-234. doi:10.1016/j.jpeds.2009.02.030

Kim JH, Chan G, Schanler R, et al. Growth and tolerance of preterm infants fed a new extensively hydrolyzed liquid human milk fortifier [published correction appears in *J Pediatr Gastroenterol Nutr.* 2016 Jan;62(1):188-9]. *J Pediatr Gastroenterol Nutr.* 2015;61(6):665-671. doi:10.1097/MPG.0000000000001010

Kim SY, Yi DY. Components of human breast milk: from macronutrient to microbiome and microRNA. *Clin Exp Pediatr.* 2020;63(8):301-309. doi:10.3345/cep.2020.00059

Kleinman RE, Greer FR, eds. *Pediatric Nutrition*, 8th ed. American Academy of Pediatrics; 2020.

Koletzko B et al, eds. *Nutritional Care of Preterm Infants. Scientific Basis and Practical Guidelines*, 2nd ed. Karger; 2021.

Kumbhare SV, Jones WD, Fast S, et al. Source of human milk (mother or donor) is more important than fortifier type (human or bovine) in shaping the preterm infant microbiome. *Cell Rep Med.* 2022;3(9):100712. doi:10.1016/j.xcrm.2022.100712

Lessen R, Kavanagh K. Position of the academy of nutrition and dietetics: promoting and supporting breastfeeding. *J Acad Nutr Diet.* 2015;115(3):444-449. doi:10.1016/j.jand.2014.12.014

## Applying New Learnings on Human Milk Composition to Clinical Practice in the NICU

Manapurath RM, Kumar M, Pathak BG, et al. Enteral low-dose vitamin A supplementation in preterm or low birth weight infants to prevent morbidity and mortality: a systematic review and meta-analysis. *Pediatrics*. 2022;150(Suppl 1):e2022057092L. doi:10.1542/peds.2022-057092L

McGee M, Unger S, Hamilton J, et al. Adiposity and fat-free mass of children born with very low birth weight do not differ in children fed supplemental donor milk compared with those fed preterm formula. *J Nutr*. 2020;150(2):331-339. doi:10.1093/jn/nxz234

McGuire MK, Meehan CL, McGuire MA, et al. What's normal? Oligosaccharide concentrations and profiles in milk produced by healthy women vary geographically. *Am J Clin Nutr*. 2017;105(5):1086-1100. doi:10.3945/ajcn.116.139980

Meek JY, Noble L; Section on Breastfeeding. *Policy Statement: Breastfeeding and the Use of Human Milk*. *Pediatrics*. 2022;150(1):e2022057988. doi:10.1542/peds.2022-057988

Meinzen-Derr J, Poindexter B, Wrage L, Morrow AL, Stoll B, Donovan EF. Role of human milk in extremely low birth weight infants' risk of necrotizing enterocolitis or death. *J Perinatol*. 2009;29(1):57-62. doi:10.1038/jp.2008.117

Miller M, Vaidya R, Rastogi D, Bhutada A, Rastogi S. From parenteral to enteral nutrition: a nutrition-based approach for evaluating postnatal growth failure in preterm infants. *JPEN J Parenter Enteral Nutr*. 2014;38(4):489-497. doi:10.1177/0148607113487926

Moya F, Sisk PM, Walsh KR, Berseth CL. A new liquid human milk fortifier and linear growth in preterm infants. *Pediatrics*. 2012;130(4):e928-e935. doi:10.1542/peds.2011-3120

Mun JG, Legette LL, Ikonte CJ, Mitmesser SH. Choline and DHA in Maternal and Infant Nutrition: Synergistic Implications in Brain and Eye Health. *Nutrients*. 2019;11(5):1125. doi:10.3390/nu11051125

O'Connor DL, Gibbins S, Kiss A, et al. Effect of supplemental donor human milk compared with preterm formula on neurodevelopment of very low-birth-weight infants at 18 months: A randomized clinical trial. *JAMA*. 2016;316(18):1897-1905. doi:10.1001/jama.2016.16144

O'Connor DL, Kiss A, Tomlinson C, et al. Nutrient enrichment of human milk with human and bovine milk-based fortifiers for infants born weighing <1250 g: a randomized clinical trial. *Am J Clin Nutr*. 2018;108(1):108-116. doi:10.1093/ajcn/nqy067

Peila C, Moro GE, Bertino E, et al. The effect of holder pasteurization on nutrients and biologically-active components in donor human milk: A review. *Nutrients*. 2016;8(8):477. Published 2016 Aug 2. doi:10.3390/nu8080477

Quigley M, Embleton ND, McGuire W. Formula versus donor breast milk for feeding preterm or low birth weight infants. *Cochrane Database Syst Rev*. 2019;7(7):CD002971. doi:10.1002/14651858.CD002971.pub5

Ramel SE, Gray HL, Christiansen E, Boys C, Georgieff MK, Demerath EW. Greater early gains in fat-free mass, but not fat mass, are associated with improved neurodevelopment at 1 year corrected age for prematurity in very low birth weight preterm infants. *J Pediatr*. 2016;173:108-115. doi:10.1016/j.jpeds.2016.03.003

Rochow N, Fusch G, Ali A, et al. Individualized target fortification of breast milk with protein, carbohydrates, and fat for preterm infants: A double-blind randomized controlled trial. *Clin Nutr*. 2021;40(1):54-63. doi:10.1016/j.clnu.2020.04.031

Rossholt ME, Bratlie M, Wendel K, et al. A standardized feeding protocol ensured recommended nutrient intakes and prevented growth faltering in preterm infants < 29 weeks gestation. *Clin Nutr ESPEN*. 2023;53:251-259. doi:10.1016/j.clnesp.2022.12.024

Sammallahti S, Pyhälä R, Lahti M, et al. Infant growth after preterm birth and neurocognitive abilities in young adulthood. *J Pediatr*. 2014;165(6):1109-1115.e3. doi:10.1016/j.jpeds.2014.08.028

Samuel TM, Zhou Q, Giuffrida F, Munblit D, Verhasselt V, Thakkar SK. Nutritional and non-nutritional composition of human milk is modulated by maternal, infant, and methodological factors. *Front Nutr*. 2020;7:576133. Published 2020 Sep 16. doi:10.3389/fnut.2020.576133

## Applying New Learnings on Human Milk Composition to Clinical Practice in the NICU

Schanler RJ, Groh-Wargo SL, Barrett-Reis B, et al. Improved outcomes in preterm infants fed a nonacidified liquid human milk fortifier: A prospective randomized clinical trial. *J Pediatr.* 2018;202:31-37.e2. doi:10.1016/j.jpeds.2018.07.005

Shah SD, Dereddy N, Jones TL, Dhanireddy R, Talati AJ. Early versus delayed human milk fortification in very low birth weight infants-A randomized controlled trial. *J Pediatr.* 2016;174:126-131.e1. doi:10.1016/j.jpeds.2016.03.056

Spatz DL, Edwards TM. *The Use of Human Milk and Breastfeeding in the Neonatal Intensive Care Unit: Position Statement* 3065. *Adv Neonatal Care.* 2016;16(4):254. doi:10.1097/ANC.0000000000000313

Staub E, Evers K, Askie LM. Enteral zinc supplementation for prevention of morbidity and mortality in preterm neonates. *Cochrane Database Syst Rev.* 2021;3(3):CD012797. doi:10.1002/14651858.CD012797.pub2

Sullivan S, Schanler RJ, Kim JH, et al. An exclusively human milk-based diet is associated with a lower rate of necrotizing enterocolitis than a diet of human milk and bovine milk-based products. *J Pediatr.* 2010;156(4):562-7.e1. doi:10.1016/j.jpeds.2009.10.040

Sun R, Maillart LM, Valeva S, Schaefer AJ, Starks S. *Optimal Pooling, Batching, and Pasteurizing of Donor Human Milk.* *Serv Sci.* 2022;14(1):13-34.

Thanigainathan S, Abiramalatha T. Early fortification of human milk versus late fortification to promote growth in preterm infants. *Cochrane Database Syst Rev.* 2020;7(7):CD013392. doi:10.1002/14651858.CD013392.pub2

US Department of Agriculture (USDA). *Dietary Guidelines for Americans, 2020-2025. December 2020.* Accessed February 9, 2023. [www.DietaryGuidelines.gov](http://www.DietaryGuidelines.gov)

US Department of Health & Human Services. *The Surgeon General's Call to Action to Support Breastfeeding. Office of the Surgeon General; 2011.*

Vieira AA, Soares FV, Pimenta HP, Abrantes AD, Moreira ME. Analysis of the influence of pasteurization, freezing/thawing, and offer processes on human milk's macronutrient concentrations. *Early Hum Dev.* 2011;87(8):577-580. doi:10.1016/j.earlhumdev.2011.04.016

World Health Organization (WHO). *WHO Recommendations on Maternal and Newborn Care for a Positive Postnatal Experience.* March 30, 2022. Accessed February 9, 2023. <https://www.who.int/publications/i/item/9789240045989>



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