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Fueling The Future of Science… ISSN: 3048-8397

Bio Vet Innovator Magazine

Volume 2 (Issue 5) MAY 2025

OPEN ACCESS | INTERNATIONAL BIODIVERSITY DAY – 22 MAY | REVIEW ARTICLE

The Art and Science of Breastfeeding: A Comprehensive Review

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DOI: https://doi.org/10.5281/zenodo.15389135

Received: May 05, 2025
Published: May 10, 2025

Introduction:

Breastfeeding (nursing, lactation) is feeding an infant human milk directly from the mother's breast. It is the optimal source of nutrition for newborns – breastmilk contains all the energy, protein, fat, lactose and micronutrients an infant need in the first months, plus live antibodies and growth factors that protect against infection. Major health organizations (WHO, UNICEF, AAP) recommend exclusive breastfeeding for about the first six months of life. In practice, early initiation (within 1 hour of birth) and "on demand" feeding (8–12 times/day or more) are encouraged. Despite its benefits, only ~40–50% of infants worldwide reach six months of exclusive breastfeeding. Breastfeeding is often termed the "gold standard" of infant feeding, given its proven reduction in infant infections (respiratory, gastrointestinal, ear infections, etc.), and its association with long-term child and maternal health gains.

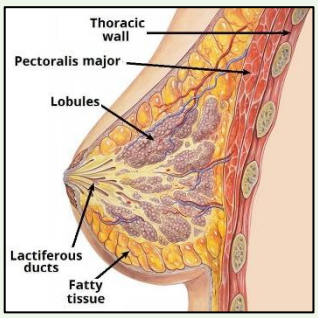
History of Breastfeeding:

Human milk feeding has been practiced since antiquity. Archaeological and textual evidence (e.g. from Egypt, Mesopotamia) indicates breastfeeding has been vital for infant survival since ~3000 BC. In many ancient cultures, wet-nursing (another woman nursing the child) was common when the mother could not breastfeed. For centuries certain myths prevailed – for example, some societies believed colostrum was "old" or even harmful, delaying its use (colostrum feeding was discouraged in some cultures). By the 18th century, medical authorities like Rosen von Rosenstein (1776) recognized colostrum's value in protecting against illness.

In the 19th century the first commercial infant formulas appeared (e.g. Liebig's "Food" in 1865), and urbanization led to more bottle-feeding in some populations. However, this also spurred public health efforts: in the late 1800s, campaigns against contaminated cow's milk and unsafe feeding aimed to reduce infant diarrhoea. In the mid-20th century, formula marketing controversies (notably in the

developing world) prompted WHO/UNICEF to issue the International Code on Breastmilk Substitutes (1981) and to launch the Baby-Friendly Hospital Initiative in 1991. These initiatives codified Ten Steps to Successful Breastfeeding (prenatal education, immediate skin-to-skin contact, exclusive feeding, rooming-in, etc.). In summary, the 150 years since the 19th century have seen alternating declines and resurgences in breastfeeding, influenced by social norms, scientific knowledge and policy interventions.

Anatomy of the Breast:



The breast is a modified sweat gland embedded in fatty tissue. Anatomically, each breast contains about 15–20 lobules (mammary lobes), each made up of many alveoli (milk-secreting sacs). Milk produced in the alveoli drains into a system of ducts: each lobule has a single lactiferous duct, and these ducts converge beneath the nipple like spokes of a wheel. The nipple itself has 5–10 duct openings. In the non-lactating breast, most of the volume is fat and connective tissue; under the influence of pregnancy hormones (estrogen, progesterone, prolactin) the ductal tree and alveoli proliferate markedly preparing for milk production. The areola (pigmented skin around the nipple) contains Montgomery glands which secrete oil to lubricate and protect the nipple during nursing. The microscopic alveoli are lined by milk-producing cuboidal cells and surrounded by contractile myoepithelial cells. When these cells contract (under the influence of oxytocin), they expel milk into the ducts toward the nipple.

Hormonal Control of Lactation:

Lactation is controlled by a neuroendocrine reflex dominated by prolactin and oxytocin. During pregnancy, rising prolactin levels (from the anterior pituitary) stimulate ductal and alveolar growth in the breast, but high levels of estrogen and progesterone (from the placenta) inhibit copious milk secretion. Immediately after birth, placental estrogen/progesterone levels plummet, removing this brake. Consequently, the persistent high prolactin now initiates full milk production (often called *Lactogenesis II*). In the postpartum period, suckling triggers afferent neural signals that cause bursts of prolactin (to make more milk) and release of oxytocin (from the posterior pituitary). Oxytocin causes the myoepithelial cells around alveoli to contract, producing the milk ejection reflex ("let-down") that pushes milk into the ducts and out through the nipple. Thus, frequent emptying of the breast – either by nursing or by pumping – maintains supply via a supply-and-demand feedback loop. (If milk sits unremoved, local feedback inhibitors accumulate and suppress further production.)

Breast Milk Volume and Composition:

Breast milk volume rises rapidly after birth. On day 1, the mother produces only small amounts of colostrum (often ~5–50 mL per feed), rich in immunoglobulins. By day 3–5, "milk comes in" and yields increase to several hundred millilitres per day. For example, one study found that daily output reaches

about 300–400 mL by day 3 and 500–800 mL by day 5. Mature milk volume (days 10+ in an exclusively breastfeeding dyad) typically averages ~600–900 mL/day, although it varies with infant demand. Notably, breast milk is nearly all water (about 88% water by volume); there is no need to give supplemental water to an exclusively breastfed infant.

The macronutrient composition of mature human milk is approximately 1.2 g/dL protein, 3.6 g/dL fat, and 7.4 g/dL lactose (carbohydrate), yielding roughly 65–70 kcal per 100 mL. It therefore provides adequate energy and amino acids for growth. The fat content is the most variable component: "foremilk" (the milk at the beginning of a feed) is thinner with lower fat, while "hindmilk" (later in the feed, after the milk has drained) is creamier and higher in fat. This ensures the infant receives both hydration and high-energy milk. The proteins in breastmilk include caseins (for calcium delivery) and whey proteins (e.g. lactalbumin, lysozyme, lactoferrin, secretory IgA). These proteins aid digestion and immune defence. The carbohydrate is mostly lactose, which supplies energy and promotes calcium absorption, plus about 1 g/dL of human milk oligosaccharides (HMOs). HMOs are not digestible by the infant but serve as prebiotics for the gut microbiome and as decoys to block pathogens.

Human milk also contains hundreds of bioactive factors. These include antibodies (especially secretory IgA) that coat the infant's gut, enzymes, leukocytes, cytokines, hormones (e.g. leptin, ghrelin), growth factors, and beneficial bacteria. Colostrum in particular is very concentrated in immune components – a natural "immune booster" that helps protect the newborn against infections. Over time (weeks to months), the concentrations of many factors gradually adjust to meet the developing baby's needs. For example, sodium and protein content slowly fall while lactose and fat content rise as milk matures. Overall, human milk is uniquely tailored and dynamic, adapting to the infant's age and even to the stage of a single feeding.

Management of Breastfeeding:

Managing breastfeeding involves both medical guidelines and practical support. World health authorities stress early initiation, exclusive breastfeeding for 6 months, and continued breastfeeding into the second year of life (with appropriate complementary foods). The Baby-Friendly Hospital Initiative (BFHI) summarizes key management practices: staff and parents should receive antenatal breastfeeding counselling (Step 3), and after birth the newborn should have immediate skin-to-skin contact and begin nursing ASAP (Step 4). Mothers and infants should room-in together 24 hours, feeding on demand. Unless medically needed, no other foods or fluids (not even water or pacifiers) should be given to breastfed infants in the early weeks.

Clinically, management includes teaching correct latch and positioning to avoid nipple injury, monitoring infant weight gain, and scheduling regular lactation support (from nurses or IBCLCs). If direct breastfeeding is temporarily not possible (e.g. infant in NICU or mother returns to work), expressing and

properly storing breastmilk can maintain supply. Workplaces and communities are urged to provide lactation breaks and facilities. Importantly, continuity of care through pregnancy and postpartum – including prompt attention to any breastfeeding problems – greatly improves success. In essence, management means encouraging "breastfeeding on demand," protecting against unnecessary supplementation, and addressing difficulties quickly through skilled support.

How to Breastfeed: Holding Your Baby:

A comfortable latch begins with a good position. One gentle approach is the "laid-back" or biological nurturing hold: the mother reclines (with pillows for support) and places the infant prone on her chest. The baby's body is turned belly-down toward the mother, with the chin finding the breast first and the mouth opening wide. The baby's mouth should then encompass most of the areola (not just the nipple) so that the tongue can draw milk from deep in the breast. In any position, the infant should be held close and well-supported so that ear, shoulder and hip are in a straight line, allowing easy swallowing. The mother's body should not strain her back or arms; pillows can be used under the baby or mother's elbows to achieve nipple level without awkward leaning.

Other common holds include:

- **Cradle hold:** The infant lies across the mother's lap with head in the crook of her arm and tummy against hers. The mother supports her breast with the other hand (using a "C" or "U" hold) if needed. Pillows under the baby can help raise them to nipple level. When properly positioned, the baby's mouth should cover a large part of the areola, and the baby's ear, shoulder and hip should form a straight line.
- **Cross-cradle hold:** As above, but the baby is supported by the arm opposite the feeding breast (so the mother's hand free supports the breast). This hold gives extra control of the baby's head during latching, which can be useful in the first weeks.
- **Football (clutch) hold:** The baby is tucked under the mother's arm (as if holding a football) on the same side as the breast being used. The baby faces the mother, and the mother's hand supports the baby's neck and shoulders while the baby's legs extend behind her (often important after a C-section or when nursing twins). This position can make it easier for the baby to handle a strong let-down reflex.
- **Side-lying:** Mother and baby lie on their sides facing each other (ideal for night feeds or tired mothers). Pillows between the mother's knees and behind her back add comfort. The mother supports the baby's head and brings the baby onto her breast. As in other holds, body alignment (hips flexed, ear-shoulder-hip in line) helps the infant latch effectively.

In all positions, a deep latch is key: the baby's mouth should cover most of the areola with lips flanged out, nose slightly away from the breast, and chin touching the breast first. If the latch is painful, the

mother can gently insert a finger in the baby's mouth to break suction and re-latch. With practice and support, most mothers and infants learn a comfortable hold that allows effective nursing without pain.

Problems in Breastfeeding:

Breastfeeding problems are common but often manageable with proper support. Typical issues include:

- **Nipple and latch issues:** Sore, cracked or bleeding nipples usually result from an incorrect latch or positioning. Many mothers experience some pain during the first week, but persistent severe pain indicates a problem. Correction of latch (ensuring the baby takes a large mouthful of breast) usually resolves nipple trauma. Lanolin-based nipple creams or hydrogel pads can soothe damaged skin and are safe for baby. Importantly, mothers are advised *not* to stop breastfeeding due to sore nipples – continuing to feed and heal is crucial.
- **Breast engorgement:** When milk "comes in" (usually days 3–5 postpartum), breasts may become very firm, hot and tender. Engorgement makes it harder for the baby to latch and can reduce milk flow. Relief comes from frequent breast emptying: feed or pump often (at least every 2–3 hours initially). Warm compresses or showers before feeding help soften the breast, and gentle massage can move milk towards the nipple. After feeds, applying cold packs (or chilled cabbage leaves) for 15–20 minutes between feedings reduces swelling. Adequate bra support (not too tight) also alleviates discomfort.
- **Mastitis and blocked ducts:** If a duct becomes blocked, a tender, localized breast lump can form, sometimes leading to mastitis – a breast infection often with fever, chills and malaise. Mastitis is common: risk factors include oversupply, skipped feeds or nipple injury. Treatment involves continued milk removal (to clear blockage), warm compresses, and if bacterial infection is suspected, appropriate antibiotics (compatible with breastfeeding). Mothers are encouraged to keep breastfeeding or pumping during treatment. (Untreated mastitis can rarely progress to abscess.)
- **Low milk supply (perceived or real):** Many mothers worry their supply is inadequate. In true hypogalactia (rare), endocrine causes or major breast surgery may be involved. More often, "low supply" is a misperception or related to infrequent feeding. Ensuring proper latch, feeding on demand, and pumping after feeds can increase milk production. Inadequate nipple stimulation (e.g. skipping night feeds or using pacifiers) is a common cause of milk supply issues.
- **Infant-related difficulties:** Some infants have trouble latching due to conditions like tongue-tie, prematurity, or hypotonia. In the first day of life up to ~50% of babies may initially struggle to latch. Skin-to-skin contact and dedicated latch support in the hospital often overcome this.

Other challenges include nipple yeast infections (thrush), oversupply (causing forceful let-down and choking), and psychosocial factors. For example, maternal stress, lack of family support, early return to

work, or postpartum depression can lead to early weaning. Addressing these requires a team approach (health professionals, lactation consultants, support groups) to help the mother overcome hurdles.

Advantages of Breastfeeding:

Breastfeeding confers broad advantages to infants, mothers and society. For the baby, breastmilk's immunologic components significantly lower infection rates: breastfed infants have fewer respiratory and gastrointestinal infections, ear infections, and a lower risk of sudden infant death syndrome (SIDS). Data also show modest cognitive benefits – breastfed children tend to score slightly higher on intelligence tests. Long-term, breastfeeding is associated with reduced risks of childhood obesity, type 1 diabetes and certain paediatric cancers. Breastmilk's unique composition (e.g. essential fatty acids, lactose, oligosaccharides) supports optimal gut development and neurodevelopment in infancy.

For the mother, lactation aids postpartum recovery: oxytocin released during nursing contracts the uterus and reduces bleeding, and calories used for milk help with weight loss. Over the long run, breastfeeding is linked to lower rates of breast and ovarian cancer, and lower incidence of maternal hypertension and type 2 diabetes. Breastfeeding also provides natural spacing of pregnancies via lactational amenorrhea. Psychologically, skin-to-skin contact and nursing can enhance mother–baby bonding through release of maternal oxytocin. Economically and environmentally, breastfeeding saves families the cost of formula and reduces medical expenses by preventing disease. In summary, both WHO and the medical community regard breastfeeding as "one of the most effective ways to ensure child health and survival", and a practice to be universally supported.

Breast Care:

Proper breast care during lactation is straightforward. In general, wash the breasts daily with warm water (no special soaps or sterilization needed) and gently pat nipples dry. Allow nipples to air-dry after feeds if possible – the natural breastmilk residue actually helps protect and heal skin. If nipples become sore or cracked, applying pure lanolin ointment or even a few drops of breastmilk can soothe the area; these are harmless to the infant.

Supportive clothing is important: wear a well-fitting, non-restrictive bra (preferably without underwire) that accommodates fullness and engorgement. Tight or underwired bras can compress ducts and potentially contribute to plugged ducts or mastitis. Many women find a nursing bra or stretchy sleep bra helpful in the early weeks. If leaking occurs (common before milk "settles"), absorbent nursing pads can be used. Remember not to let pads stay wet too long, as trapped moisture can cause irritation.

For engorgement or clogged ducts: apply warm compresses or take a warm shower before feeding to soften the breast and promote let-down. Hand or pump expression before nursing can also ease fullness. After feeds, applying cold packs (or chilled cabbage leaves inside the bra) for 15–20 minutes can reduce swelling. Gentle massage from the chest wall toward the nipple while feeding or pumping can

help clear any blockages. If a firm lump persists, empty the breast more frequently and seek guidance from a lactation consultant.

Throughout breastfeeding, the mother should maintain good hydration and nutrition (an extra ~500 kcal/day is recommended) to support milk production. With simple care measures and prompt attention to problems (e.g. a plugged duct or nipple trauma), most mothers can continue breastfeeding comfortably.

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