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The Breast and the Physiology of Lactation

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Universal breastfeeding is recommended by the American College of Obstetricians and Gynecologists (ACOG), the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the American Academy of Pediatrics (AAP), and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), but recommendations alone are not sufficient to promote breastfeeding. It is the responsibility of every physician to recommend and promote breastfeeding enthusiastically and support the breastfeeding mother-infant dyad with informed, applicable, evidence-based medicine. This is especially true in obstetrics, where a physician's advice can immediately influence a woman's informed decision concerning breastfeeding and create or diminish barriers to successful breastfeeding.

Benefits of Breastfeeding

Breastfeeding provides significant benefits for both the mother and the infant. A number of these benefits are documented in an evidence-based analysis in the Agency for Healthcare Research and Quality (AHRQ) report on breastfeeding in developed countries.[1,2] ACOG and other groups have championed the benefits of breastfeeding and the use of human milk.[3-6] The benefits are so significant that the AAP and ACOG recommend exclusive breastfeeding for the first 6 months of life and continued breastfeeding through 12 months or more.[7] The WHO recommends that mothers initiate breastfeeding within 1 hour of birth and provide exclusive breastfeeding for the first 6 months of life to achieve optimal infant growth, development, and health; subsequently, to meet their evolving nutritional requirements, infants should receive nutritionally adequate and safe complementary foods, while continuing to be breastfed for up to 2 years or beyond.[8]

Breast milk is species specific, made uniquely for the human infant.[9] Protein in breast milk is readily digested and is present in amounts that can be handled by the developing kidney. Various minerals (e.g., iron) and nutrients exist in a form and in conjunction with other components that make them easily absorbed to meet infants' needs during periods of rapid growth.[9,10] Cholesterol and docosahexaenoic acid have been shown to play a role in central nervous system development and may contribute to the enhanced intelligence quotient measurements reported in breastfed infants.[11-14]

Protection against infections, including otitis media, croup, pneumonia, and gastrointestinal infections, is mediated by the over 50 immunologically active components found in breast milk.[9,15-17] These immunologically active components include viable functioning cells (T and B lymphocytes, macrophages), T cell–secreted products, immunoglobulins (especially secretory immunoglobulin A [IgA]), carrier proteins such as lactoferrin and transferrin, enzymes (lysozyme and lipoprotein lipase), and nonspecific factors such as complement, bifidus factor, gangliosides, oligosaccharides, and nucleotides. Other immune factors in breast milk include hormones, hormone-like factors, and growth factors that contribute to the normal maturation of the mucosal barrier of the respiratory and gastrointestinal tracts as well as the developing infant's immune system. Breast milk is a very dynamic fluid, varying with the mother-infant dyad's environment and needs, especially in the face of infection or stress (providing, e.g., leukocytes, nucleotides, oligosaccharides, secretory IgA, interleukin, interferon, and cytokines).[16-21] There is also evidence that breastfeeding provides protection against some noninfectious illnesses such as asthma, eczema, childhood lymphoma, insulin-dependent childhood-onset diabetes, and obesity[16,22-27] in children who are exclusively breastfed for the first 4 to 6 months of life. A cohort study of infants in Australia[28] and a meta-analysis[29] showed lower odds of developing type 1 diabetes and type 2 diabetes, respectively.

Cognitive and psychological benefits for breastfed infants have been suggested, including those for developmental performance,[30] visual acuity,[31-33] school performance,[34] and performance on standardized and intelligence quotient tests.[35] More recent articles continue to support the impact of breastfeeding on intellectual development while fostering debate over the relative contributions of nutrition, genetics, and environment to the intellectual development of infants and the possible influence on the child's or adult's future cognitive abilities as measured by intelligence quotient testing.[13,36,37] The psychological benefits are more difficult to measure but are well described by Newton and Newton[38] and, indeed, by most mothers who have successfully breastfed their infants.[39] One of the most consistent findings of exclusive breastfeeding is its influence on later intelligence, with a few test points' advantage to the breastfed infant.[13] Reports questioning this effect have been based on heterogenous definitions of breastfeeding (any breastfeeding, not exclusive breastfeeding) and may not have controlled for all potential confounders.[40]

Potential benefits to the mother in the short term include improved postpartum recovery,[41] a decreased risk of postpartum hemorrhage,[42] and prolonged amenorrhea in mothers who exclusively or predominantly breastfeed in the first 6 months postpartum, which may increase spacing between births.[43] There are data supporting the psychological benefits of breastfeeding for the mother, but there are also some equivocal studies. The relationship between breastfeeding and postpartum depression is complicated. Prenatal and

TABLE 11.1 Breastfeeding Definitions

	Definition	Amount of Supplementation
Full breastfeeding	Exclusive human breast milk only	Infant ingests no other nutrients, supplements, or liquids
	Almost exclusive	No milk other than human milk; only minimal amounts of other substances such as water, juice, tea, or vitamins
Partial breastfeeding	High partial	Nearly all feeds are human milk (at least 80%)
	Medium partial	A moderate amount of feeds are breast milk, in combination with other nutrient foods and nonhuman milk (20%–80% of nutritional intake is human breast milk)
	Low partial	Almost no feeds are breast milk (less than 20% of intake is breast milk)
Token breastfeeding		Breastfeeding primarily for comfort; nonnutritive, for short periods of time, or infrequent
Never breastfed		Infant never ingested any human milk

Modified from Labbok M, Krasovec K. Toward consistency in breastfeeding definitions. Stud Fam Plan. 1990;21(4):226–230.

postpartum depression are associated with early cessation of breastfeeding.[44] Among women without a prenatal diagnosis of depression, high positive emotions during infant feeding at 2 months were associated with lower depression and anxiety symptoms at 2, 6, and 12 months.[45] In contrast, breastfeeding worries, lower breastfeeding self-efficacy, negative breastfeeding attitudes, breastfeeding challenges, and pain have increased risk of developing postpartum depression.[44]

Long-term benefits of lactation include a reduced incidence of metabolic syndrome, hypertension, type 2 diabetes mellitus, and breast and ovarian cancers.[1,4,6,46-49] Bone metabolism changes during pregnancy and lactation to meet the needs of the mother and infant. Specifically, during lactation, maternal bone resorption occurs to meet the demand for calcium, although these bone losses are reversed over time.[50] Feltner and colleagues reviewed the risk of fractures rather than the risk of bone mass loss.[49] They identified that many variables may contribute to the risk of fractures (age, hormone replacement therapy, physical activity, parity, and body mass index [BMI]) related to lactation. They concluded that no studies demonstrated a significant association between breastfeeding and fracture. Most of the studies described a lower odds of fracture with greater breastfeeding duration that was not statistically significant.[49] Increasing number of pregnancies, longer oral contraceptive use, and increasing duration of lactation are all protective against ovarian cancer.[51-53] The incidence of breast cancer is lower among women who have nursed.[54,55] Newer data show an association between breastfeeding and lower rates of diabetes,[56,57] and for women with gestational diabetes who breastfeed there is lower risk of developing type 2 diabetes in the postpartum period.[58] Endometrial and thyroid cancers have also been reported to be lower in breastfeeding mothers.[59,60] Other benefits include lower cost of providing adequate infant nutrition and lower environmental costs: 6 months of breastfeeding saves between 95 and 153 kg of CO_2 compared with formula feeding.[61,62]

There is a dose-response relationship between the amount of human milk received by an infant and the benefits or immunologic protection gained. The health benefits to the mother from breastfeeding also relate to the dose and duration of breastfeeding. The relative "dose" of breastfeeding has been defined in terms of exclusivity versus the amount of supplementation (Table 11.1).[63] The WHO provides a specific definition of exclusive breastfeeding: "Exclusive breastfeeding means that the infant receives only breast milk. No other liquids or solids are given – not even water – with the exception of oral rehydration solution, or drops/syrups of vitamins, minerals or medicines."[64] The importance of this dose-response relationship is emphasized in the AAP's and ACOG's recommendation for exclusive breastfeeding in the first 6 months of life and the AHRQ report's analysis of the benefits of breastfeeding relative to measured durations of breastfeeding.[1-4,6-8]

It is essential that a discussion of the benefits of breastfeeding for families (fathers and partners included) be presented alongside any potential risks or contraindications. The benefits of breastfeeding are tremendous, and the risks and contraindications are few. Summarized here and in Table 11.2 are the conditions in which the risks of breastfeeding or providing expressed mother's own milk to infants may outweigh its benefits.[65]

- Women who take illicit drugs, abuse legal substances, or do not control their alcohol intake and are not in stable substance abuse treatment.[66,67] Various groups (AAP, ABM, ACOG, NIH/LactMed, WHO) define abuse, use disorders, and excess consumption/lack of control of intake based on the specific substances.[6,68-70]
- A woman who has an infant with classic galactosemia, because both human and cow's milk exacerbate the condition. A lactose-free formula is recommended for these infants. In milder forms of galactosemia, partial breastfeeding is possible.[6]
- Women who are infected with human immunodeficiency virus or human T-cell leukemia virus type I (see Maternal Infections During Breastfeeding in this chapter).
- Women who have active untreated tuberculosis. Because of the increased risk of airborne transmission associated with the close contact that is typical of breastfeeding, women with active tuberculosis should not feed their infant by *any* method until treatment is initiated. However, infected women can provide their pumped milk to their infants (see later).
- Women who are known or suspected to be infected with Ebola virus, Marburg virus, Lassa virus, or dengue virus, when a safe alternative food source is readily available (see later).
- Women who take certain medications (see Medications While Breastfeeding, later).

Medical situations that indicate a potential risk from breastfeeding must be weighed against the potential benefits for both mother and infant.

Some of the contraindications may be permanent or temporary. For those infections with predominantly airborne or contact precautions, expressed milk may still be given to

TABLE 11.2 Contraindications to Breastfeeding and or Feeding of Breast Milk

Mothers should NOT breastfeed or feed expressed breast milk to their infants	• Classic galactosemia in the infant • Mother actively using illicit street drug, such as PCP or cocaine • Mother infected with HIV,[a] human T-cell lymphotropic virus type I or type II • Mother with confirmed or suspected Ebola virus disease

Mothers should temporarily NOT breastfeed or feed expressed breast milk to their infants	• Mother is infected with untreated brucellosis
	• Mother is taking certain medications; e.g., certain chemotherapies
	• Mother is undergoing diagnostic imaging with radiopharmaceuticals
	• Mother has an active herpes simplex virus infection with lesions present on the breast (transmission)
	  ◦ May feed or provide expressed milk from the unaffected breast provided the lesions on the affected breast are covered
	  ◦ May resume feeding or providing expressed milk from the affected breast once the lesions have resolved

Mothers should temporarily NOT breastfeed, but CAN feed expressed breast milk	• Mother has untreated, active tuberculosis ◦ May resume breastfeeding after 2 weeks of appropriate treatment and no longer contagious • Mother has active varicella that developed within 5 days prior or 2 days after delivery

[a]HIV recommendation only applies to the specific countries that have recommended this as a component of their national efforts at perinatal HIV transmission prevention (e.g., United States, Canada, United Kingdom, and Italy, among others).

Data from Centers for Disease Control and Prevention. Contraindications to Breastfeeding or Feeding Expressed Breast Milk to Infants. Updated 2018. https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/contraindications-to-breastfeeding.html.

the infant. When mothers need to temporarily discontinue breastfeeding, instructions should be provided on when and how to resume breastfeeding, and lactation support should be provided to help with maintenance of their supply.

ROLE OF THE OBSTETRICIAN IN PROMOTING BREASTFEEDING

Obstetricians have many responsibilities for breastfeeding, including the following:

- Enthusiastically promoting and supporting breastfeeding, based on the published literature of its benefits advocated by the major pediatric, obstetric, and women's health organizations.[4-6,71,72]
- Imparting clinical information to the lactating mother about the physiology of lactogenesis and lactation, before and after the birth.[73]
- Developing and supporting hospital policies that facilitate breastfeeding and actively remove any barriers to it.
- Supporting community efforts to provide women with adequate information to make an informed decision about breastfeeding, including links to community breastfeeding resources.
- Providing balanced anticipatory guidance and lactation support to mothers and families regarding potential concerns during labor, delivery, the postpartum period, and breastfeeding (e.g., antenatal consultation with a breastfeeding medicine specialist or lactation specialist for anticipated needs such as suspected fetal cleft palate, multiple gestation, prematurity, and prior breast reduction surgery).
- Actively assessing women for potential breastfeeding challenges, especially those with high-risk pregnancies. Be prepared to fully evaluate and manage breastfeeding difficulties mothers encounter, personally or with the assistance of a breastfeeding medicine specialist or lactation specialist. Enabling breastfeeding in this at-risk population may ameliorate cardiometabolic disease trajectories in the mother and child dyads.
- Providing additional breastfeeding support for mothers at increased risk of low or insufficient milk production or other breastfeeding challenges.[74]
- Proactively providing equitable lactation care addressing potential social challenges to initiating and continuing breastfeeding through the individual attention of the obstetrician and the coordinated and collaborative efforts of institutional and community-based lactation support teams.[5]
- Fostering a general acceptance of breastfeeding by promoting a normative portrayal of breastfeeding and supporting the provision of sufficient time and facilities in the workplace.
- Performing breast examinations before and after the birth and emphasizing lactation as the primary function of the breast.
- Participating in breastfeeding education in medical and other health profession schools.[72]
- Supporting breastfeeding within their own medical facilities by instituting the "Ten Steps to Successful Breastfeeding" as outlined by UNICEF/WHO[75] (Box 11.1).

The mother's plan for infant feeding should be addressed early in prenatal care, with counseling, a medical history focused on breast health and breastfeeding, and a physical examination of the breast. An outline for breastfeeding promotion in the prenatal setting is provided in the Academy of Breastfeeding Medicine's Clinical Protocol #19.[76] Counseling can be modeled after "The Best Start Three-Step Counseling Strategy"[77] as suggested by Lazarov and Evans.[78] This strategy advises beginning with open-ended questions about breastfeeding. An acknowledgment that feelings of doubt about the ability to breastfeed successfully are normal is a good place to begin. Education about breastfeeding then continues with discussion of how others have dealt with these concerns. This conversation will elucidate much about the woman's knowledge of breastfeeding, her previous experiences with breastfeeding, and her own attitudes and those of the mother's partner, the extended family, and other potentially supportive persons in the mother's life. To be respectfully inclusive of all parents/families and avoid one example of discrimination and inequity as experienced by the LGBTQ+ community, affirming health care should begin with affirming names, pronouns, and consideration of the experiences and opinions of both parents. The Academy of Breastfeeding Medicine (ABM) provides some guides for providing affirming lactation care to LGBTQ+ patients and families.[79]

To support breastfeeding optimally, the concerns of family and friends must be addressed actively to foster needed support

BOX 11.1 THE TEN STEPS TO SUCCESSFUL BREASTFEEDING

CRITICAL MANAGEMENT PROCEDURES

1a. Comply fully with the *International Code of Marketing of Breast-milk Substitutes* and relevant World Health Assembly resolutions.
1b. Have a written infant feeding policy that is routinely communicated to staff and parents.
1c. Establish ongoing monitoring and data-management systems.
2. Ensure that staff have sufficient knowledge, competence, and skills to support breastfeeding.

KEY CLINICAL PRACTICES

3. Discuss the importance and management of breastfeeding with pregnant women and their families.
4. Facilitate immediate and uninterrupted skin-to-skin contact and support mothers to initiate breastfeeding as soon as possible after birth.
5. Support mothers to initiate and maintain breastfeeding and manage common difficulties.
6. Do not provide breastfed newborns any food or fluids other than breast milk, unless medically indicated.
7. Enable mothers and their infants to remain together and to practice rooming-in 24 hours a day.
8. Support mothers to recognize and respond to their infants' cues for feeding.
9. Counsel mothers on the use and risks of feeding bottles, teats, and pacifiers.
10. Coordinate discharge so that parents and their infants have timely access to ongoing support and care.

From UNICEF/WHO. The ten steps to successful breastfeeding. https://www.who.int/activities/promoting-baby-friendly-hospitals/ten-steps-to-successful-breastfeeding. Accessed January 28, 2021.

on many levels. Misconceptions and potential barriers must be identified and reasonable solutions developed in partnership with the woman. These often include feelings of responsibility for every unexplained problem the infant displays; conflicts among a woman's several roles as mother, sexual partner, and worker outside the home; and, most commonly, a greater time commitment and fatigue than was expected. It is important to address these and other questions repeatedly throughout pregnancy and not just in the immediate postpartum period, working closely with the infant's pediatrician.[5,74] Dr. Alison Stuebe, a maternal-fetal medicine expert and a member of the Academy of Breastfeeding Medicine, utilizes open-ended questions following a format recommended by Duggan and Street that encompasses relational functions (fostering healing and validating and responding to patient emotions) of provider-patient communication and "task-driven" functions (exchanging and managing information, making treatment decisions, enabling patient self-management, and managing uncertainty) to approach maternal and familial recurring issues and concerns regarding breastfeeding.[80,81]

It is important to be familiar with and in communication with members of the medical team who support breastfeeding throughout the community including lactation consultants, pediatric practices, and support groups. Specific codes from the *International Classification of Diseases*, 10th Revision (ICD-10) commonly used for breastfeeding care and breast abnormalities are listed by ACOG to facilitate billing for the time required for informed medical care and effective communication.[82]

Examination of the Breast

The medical history related to the breasts should include their development, previous experience with breastfeeding, systemic illnesses, infections, breast surgery or trauma, medications, allergies, self–breast examinations and findings, and any anatomic or physical concerns the mother has about her breasts.

The breast examination at prenatal and postpartum visits should include careful inspection and palpation. Inspection of the breasts is most effective in the sitting position, first with the arms overhead and then with the hands on the hips. Skin changes, distortions in shape or contour, and the form and size of the areola and nipple should be noted. Palpation can begin in the sitting position, looking for axillary and supraclavicular adenopathy. Palpation in the supine position is easier for the complete examination of the breast and surrounding anterolateral chest wall. Size, shape, consistency, masses, scars, tenderness, and any abnormalities can be noted in both descriptive and picture form for future comparison. Serial examinations should document maturational changes of pregnancy (size, shape, fullness, enlargement of areola) and nipple position (inversion or eversion).

The changes in the breast during pregnancy provide important prognostic data regarding successful breastfeeding. With the increased frequency of cosmetic breast surgery, it is important to be aware of the nature of any surgery and to examine carefully for the location of the surgical scars. Many women successfully breastfeed after surgery for benign breast disease, breast augmentation, or breast reduction. However, a periareolar incision or "nipple translocation technique" for breast reduction can damage nerves and ducts, making this more difficult. Nipple piercing is another increasingly common procedure, after which breastfeeding can be successful with the jewelry removed. Such surgeries do not preclude successful breastfeeding but rather remind us that additional early support should be provided to these mothers from physicians, nurses, lactation consultants, and peer support groups.

Perinatal Period

The obstetrician can make important contributions to successful breastfeeding through the conduct of the labor, delivery, and puerperium. A stressful or exhausting labor and delivery has been shown to affect lactation adversely.[83] A safe delivery for both mother and infant is, of course, the most important outcome. During the delivery and afterward, any medications used should be compatible with breastfeeding and not interfere with the bonding and first feeding. Immediate skin-to-skin contact between mother and infant and a first feeding within 1 hour of delivery are probably the most important intrapartum steps to increase the likelihood of successful breastfeeding. Having the infant in the mother's room, feeding on demand, and early breastfeeding support (including teaching appropriate techniques) within the first 24 to 36 hours can also help. Supplementation should be avoided unless medically indicated and ordered by the pediatrician.

For the breastfeeding woman, medication choices are very important (see Medications While Breastfeeding in this chapter). Most women and many health professionals assume that no medication can be safely administered to a lactating woman, but the number of contraindicated drugs is in fact quite small. Before assuming a medication is unsafe, expert advice should be consulted, available in texts, websites, or through drug information telephone services. (e.g., LactMed, Infant Risk Center, MotherToBaby Call Center).[69,84,85]

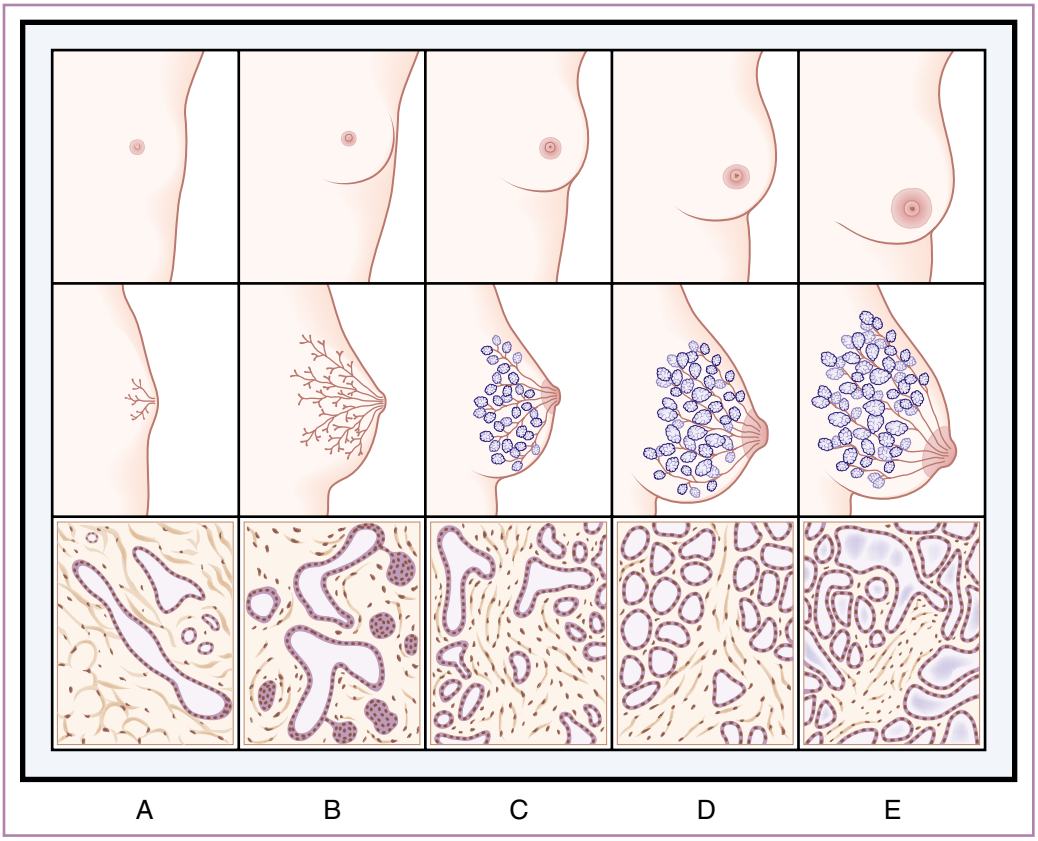

Figure 11.1 Female breast from infancy to lactation, with corresponding duct structure and tissue cross sections. (A–C) Gradual development of the well-differentiated ductular and peripheral lobular-alveolar system. (D) Ductular sprouting and intensified peripheral lobular-alveolar development in pregnancy. Glandular luminal cells begin actively synthesizing milk fat and proteins near term; only small amounts are released into the lumen. (E) With postpartum withdrawal of luteal and placental sex steroids and placental lactogen, prolactin is able to induce full secretory activity of alveolar cells and release of milk into alveoli and smaller ducts. (*From Lawrence RA, Lawrence RM.* Breastfeeding: A Guide for the Medical Profession. *7th ed. St Louis, MO: Mosby; 2010:43.*)

Early follow-up (2 to 4 days after discharge) with the infant's health provider should be arranged for all breastfeeding mothers. Continued support of breastfeeding for the mother should occur through the 6-week postpartum visit. Discussions about breastfeeding should cover techniques to ensure adequate emptying of the breast as well as problems such as nipple soreness or trauma, plugged duct (in the form of a small lump), mastitis, breast abscess, breast masses, and bloody nipple discharge, all of which can usually be treated without stopping breastfeeding.

The Breast

To fully understand the process of lactation, one needs to understand the anatomy and physiology of the breast as it applies to this function. The human mammary gland is the only organ that does not contain all of the rudimentary tissues at birth. It experiences dramatic changes in size, shape, and function from birth through menarche, pregnancy, and lactation and ultimately during involution. The three major phases of growth and development before pregnancy and lactation occur in utero, during the first 2 years of life, and at puberty (Fig. 11.1 and Table 11.3).

EMBRYONIC DEVELOPMENT

The milk streak appears in the fourth week of gestation when the embryo is approximately 2.5 mm long. It becomes the milk line, or milk ridge, during the fifth week of gestation (2.5 to 5.5 mm). The mammary gland itself begins to develop at 6 weeks of embryonic life, and proliferation of the milk ducts continues throughout embryonic growth and again in pregnancy and lactation. The process of forming the nipple in the human embryo begins with a thickened, raised area of ectoderm in the region of the future gland by the fourth week of pregnancy. This thickened ectoderm becomes depressed into the underlying mesoderm and thus the surface of the mammary area soon becomes flat and finally sinks below the level of the surrounding epidermis. The mesoderm that is in contact with the ingrowth of the ectoderm is compressed, and its elements become arranged in concentric layers that at a later stage give rise to the gland's stroma. By dividing and branching, the ingrowing mass of ectodermal cells gives rise to the future lobes and lobules, and much later to the alveoli.

By 16 weeks' gestation in the fetus, the branching stage has produced 15 to 25 epithelial strips that represent the future secretory alveoli. By 28 weeks' gestation, placental sex hormones enter the fetal circulation and induce canalization in the fetal mammary tissue. The lactiferous ducts and their branches are developed from outgrowth in the lumen. They open into a shallow epidermal depression known as the mammary pit. The pit becomes elevated because of mesenchymal proliferation, forming the nipple and areola. An inverted nipple is the failure of this pit to elevate.[86] At 32 weeks' gestation, the lumen has formed in the branching system, and by term there are 4 to 18

TABLE 11.3 Stages of Mammary Development

Developmental Stage	Hormonal Regulation	Local Factors	Description
Embryogenesis	?	Fat pad necessary for ductal extension	Epithelial bud develops in 18- to 19-week-old fetus, extending short distance into mammary fat pad with blind ducts that become canalized; some milk secretion may be present at birth
Mammogenesis			Anatomic development
Puberty			
Before onset of menses	Estrogen, GH	IGF-I, hGF, TGF-β; others?	Ductal extension into mammary fat pad; branching morphogenesis
After onset of menses	Estrogen, progesterone; PRL?		Lobular development with formation of terminal duct lobular unit
Pregnancy	Progesterone, PRL, hPL	HER; others?	Alveolus formation; partial cellular differentiation
Lactogenesis	Progesterone withdrawal, PRL, glucocorticoid	Not known	Onset of milk secretion Stage I: midpregnancy Stage II: parturition
Lactation	PRL, oxytocin	FIL	Ongoing milk secretion
Involution	PRL withdrawal, alpha-lactalbumin dimer	Milk stasis; FIL?	Alveolar epithelium undergoes apoptosis and remodeling; gland reverts to prepregnant state

FIL, Feedback inhibition of lactation; *GH,* growth hormone; *HER,* heregulin; *hGF,* human growth factor; *hPL,* human placental lactogen; *IGF-I,* insulin-like growth factor I; *PRL,* prolactin; *TGF-β,* transforming growth factor-β.
Modified from Neville MC. Mammary gland biology and lactation: a short course. Presented at: International Society for Research on Human Milk and Lactation annual meeting; October 1997; Plymouth, MA.

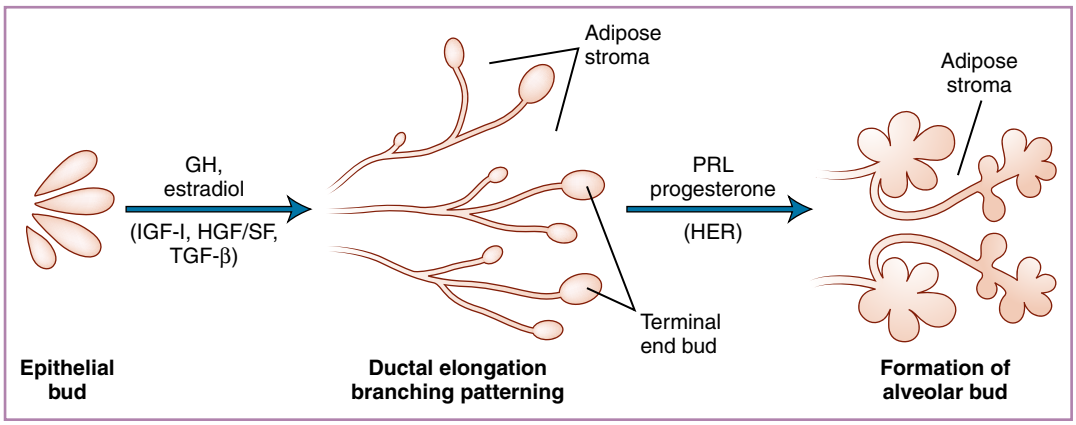

Figure 11.2 Schema for hormonal regulation of mammary development in the mouse. *GH,* Growth hormone; *HER,* heregulin; *HGF/SF,* human growth factor/secretory factor; *IGF-I,* insulin-like growth factor I; *PRL,* prolactin; *TGF-β,* transforming growth factor-β. (*From Neville MC. Mammary gland biology and lactation: a short course. Presented at: International Society for Research on Human Milk and Lactation annual meeting; October 1997; Plymouth, MA.*)

mammary ducts that form the fetal mammary gland.[87] Fig. 11.2 shows the hormonal regulation of mammary development in the mouse.

The nipple, areola, and breast bud are important landmarks for the determination of gestational age in the newborn. At 40 weeks, the nipple and areola are clearly seen and the breast bud is up to 1.0 cm in diameter. In the first weeks after delivery, the breast bud is visible and palpable; however, the gland then regresses to a quiescent stage as maternal hormones in the infant diminish. After this, the gland grows only in proportion to the rest of the body until puberty.

PUBERTAL DEVELOPMENT

With the onset of puberty in the female, further growth of the breast occurs, and the areolae enlarge and become more pigmented. The further development of the breast involves two distinct processes: organogenesis and milk production. The ductal and lobular growth is organogenesis, and this is initiated before and throughout puberty, resulting in the growth of breast parenchyma with its surrounding fat pad. The formation of alveolar buds begins within 1 to 2 years of the onset of menses and continues for several years, producing alveolar lobes. This menarchial stimulus begins with the extension of the ductal tree and the generation of its branching pattern. The existing ducts elongate. The ducts can develop bulbous terminal end buds that are the forerunners of alveoli. The formation of the alveolar bud begins within 1 to 2 years of the onset of menses. During this ductal growth, the alveoli enlarge and the nipple and areola become more pigmented. This growth involves an increase in connective tissue, adipose tissue, and vascular channels and is stimulated by estrogen and progesterone released by the ovary.[88]

BOX 11.2 BREAST ABNORMALITIES

Accessory breast: Any tissue outside the two major glands
Amastia: Congenital absence of breast or nipple
Amazia: Nipple without breast tissue
Hyperadenia: Mammary tissue without nipple
Hypoplasia: Underdevelopment of breast
Polythelia: Supernumerary nipple(s) (also hyperthelia)
Symmastia: Webbing between breasts

From Lawrence RA, Lawrence RM. Breastfeeding: A Guide for the Medical Profession. *8th ed. St Louis, MO: Mosby; 2015:39.*

During the menstrual cycle, there continues to be cyclic microscopic proliferation and regression of ductal breast tissue. The breast continues to enlarge slightly with further division of the ductal system until about the age of 28 unless pregnancy intervenes.

THE MATURE BREAST

The mature breast is located in the superficial fascia between the second and sixth intercostal cartilages and is superficial to the pectoralis muscle. It measures 10 to 12 cm in diameter. It is located horizontally from the parasternal to the midaxillary line. The central thickness of the gland is 5 to 7 cm. In the nonpregnant state, the breast weighs on average 200 g. During pregnancy, however, the size and weight increase to about 400 to 600 g, and to 600 to 800 g during lactation. Early in pregnancy there is a significant increase in ductal expansion and branching attributed to estrogen. Lobular formation increases due to prolactin, progesterone, and chorionic gonadotropin. By the third month of gestation, secretory material like colostrum is present in acini. Prolactin stimulates the secretion of colostrum in the second trimester, but production of milk prior to delivery is limited by the presence of progesterone. A projection of mammary tissue into the axilla is known as the tail of Spence and is connected to the central duct system. The breast is usually dome shaped or conic, becoming more hemispheric in the adult and pendulous in the older parous woman.

ABNORMALITIES

In some women, mammary tissue develops at other sites in the galactic band. This is referred to as *hypermastia*, which is the presence of accessory mammary glands that are phylogenic remnants. These remnants may include accessory nipples or accessory gland tissue located anywhere along the milk line. From 2% to 6% of women have hypermastia. These remnants remain quiet until pregnancy, when they may respond to the hormonal milieu by enlarging and even secreting milk during lactation. If left unstimulated, they will regress after the birth. Major glandular tissue in the axilla may pose a cosmetic or management problem if the tissue enlarges significantly during pregnancy and lactation, secreting milk. It is distinct from the tail of Spence.

Other abnormalities include amastia (absence of the breast or nipple), amazia, hyperadenia, hypoplasia, polythelia, and symmastia (Box 11.2). Abnormalities of the kidneys have been associated with polythelia. Other variations include hyperplasia or hypoplasia in various combinations, as listed in Box 11.3. Gigantomastia is the excessive enlargement of the breasts in pregnancy and lactation, sometimes to life-threatening proportions. This enlargement may occur with the first or any pregnancy and may not recur. The enlargement recedes but rarely back to original size.[9] Breastfeeding has been successful in some cases of gigantomastia with appropriate professional support. In extreme cases, gigantomastia may require heroic measures, including emergency mastectomy.

Mothers with congenital abnormalities of the breast may wish to breastfeed. Not all abnormalities or variations preclude breastfeeding, and the decision is made on a case-by-case basis.

BOX 11.3 TYPES OF BREAST HYPOPLASIA, HYPERPLASIA, AND ACQUIRED ABNORMALITIES

HYPOPLASIA

Unilateral hypoplasia, contralateral breast normal
Unilateral hypoplasia, contralateral breast hyperplasia
Unilateral hypoplasia of breast, thorax, and pectoral muscles (Poland syndrome)
Bilateral hypoplasia with asymmetry

HYPERPLASIA

Unilateral hyperplasia, contralateral breast normal
Bilateral hyperplasia with asymmetry

ACQUIRED ABNORMALITIES

Caused by trauma, burns, radiation treatment for hemangioma or intrathoracic disease, chest tube insertion in infancy, and preadolescent biopsy

From Lawrence RA, Lawrence RM. Breastfeeding: A Guide for the Medical Profession. *8th ed. St Louis, MO: Mosby; 2015:40.*

NIPPLE AND AREOLA

The skin of the breast includes the nipple and areola and the thin, flexible, elastic skin that covers the body of the breast. The nipple is a conic elevation in the center of the areola at the level of about the fourth intercostal space, just below the midline of the breast. The nipple contains smooth muscle fibers and is richly innervated with sensory and pain fibers. It has a verrucous surface and has sebaceous and apocrine sweat glands but not hair.

The areola surrounds the nipple and is also slightly pigmented and becomes deeply pigmented during pregnancy and lactation. The average diameter is 15 to 16 mm, but the range may exceed 5 cm during pregnancy. The sensory innervation is less than that of the nipple. The nipple and areola are very elastic and elongate into a teat when drawn into the mouth by the suckling infant.

The surface of the areola contains Montgomery glands, which hypertrophy during pregnancy and lactation and resemble vesicles. During lactation, they secrete a sebaceous material to lubricate the nipple and areola and protect the tissue while the infant suckles. These glands atrophy after weaning and are not visible to the naked eye except during pregnancy or lactation.

Each nipple contains 4 to 18 lactiferous ducts, of which 5 to 8 are main ducts surrounded by fibromuscular tissue.[89] These ducts end as small orifices at the tip of the nipple from which the milk flows. The corpus mammae is an orderly conglomeration of a number of independent glands known as *lobes*. The morphology of the gland includes parenchyma that contains the ductular-lobular-alveolar structures. It also includes the stroma, which is composed of connective tissue, fat tissue, blood vessels, nerves, and lymphatics.

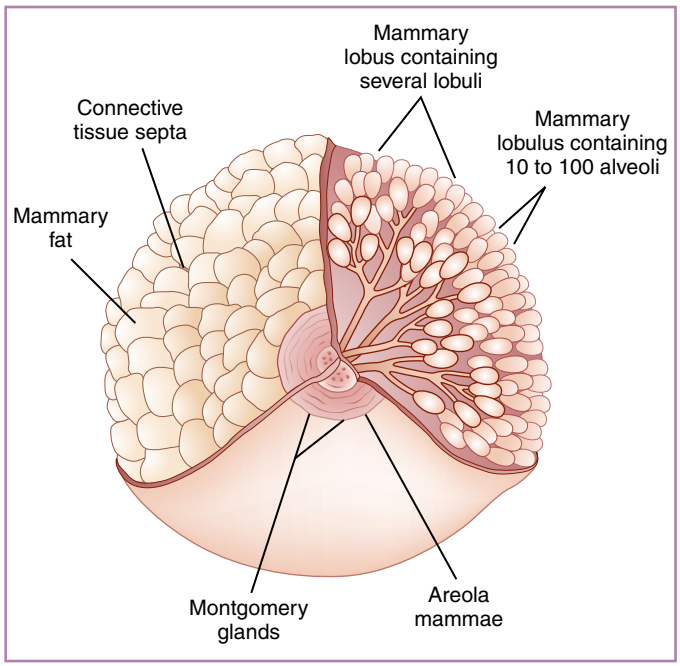

Figure 11.3 Morphology of the mature breast. Diagrammatic dissection reveals mammary fat and duct system. (*Modified from Lawrence RA, Lawrence RM.* Breastfeeding: A Guide for the Medical Profession. *9th ed. St Louis, MO: Mosby; 2021:45.*)

The mass of breast tissue consists of tubuloalveolar glands embedded in adipose tissue, which gives the gland its smooth, rounded contour. The mammary fat pad is essential for the proliferation and differentiation of the ductal arborization (Fig. 11.3). Each lobe is separated from the others by connective tissue and opens into a duct that opens into the nipple. The extension of ducts is orderly and protected by an inhibitory zone into which other ducts cannot penetrate.[90]

Blood is supplied to the breast from branches of the intercostal arteries and perforating branches of the internal thoracic artery. The main blood supply comes from the internal mammary artery and the lateral thoracic artery. The venous supply parallels the arterial supply.

Lymphatic drainage has been thoroughly studied by researchers of breast cancer. The main drainage is to axillary nodes and the parasternal nodes along the thoracic artery within the thorax. The lymphatics of the breast originate in lymph capillaries of the mammary connective tissue and drain through the deep substance of the breast.

The breast is innervated from the branches of the fourth, fifth, and sixth intercostal nerves. The sensory innervation of the nipple and areola is extensive and includes both autonomic and sensory nerves. The innervation of the corpus mammae is meager by comparison and is predominantly autonomic. Neither parasympathetic nor cholinergic fibers supply any part of the breast. The efferent nerves are sympathetic adrenergic. Most of the mammary nerves follow the arteries. A few fibers course along the walls of the ducts. They may be sensory fibers that sense milk pressure. No innervation has been identified to supply the myoepithelial cells. The conclusion is that secretory activities of the acinar epithelium of the ducts depend on hormonal stimulation, such as by oxytocin.

When sensory fibers are stimulated, the release of adenohypophyseal prolactin and neurohypophyseal oxytocin occurs. The areola is most sensitive to the stimulus of suckling and the nipple the least; the skin of the breast is intermediate. The large number of dermal nerve endings results in high responsiveness to suckling. Pain fibers are more numerous in the nipple, with few in the areola. All cutaneous nerves run radially toward the nipple. Breast nerves can influence the mammary blood supply and therefore also influence the transport of oxytocin and prolactin to the myoepithelial cells and the lacteal cells, respectively.

MAMMARY GLAND IN PREGNANCY

During the first trimester, rapid growth and branching from the terminal duct system into the adipose tissue is stimulated by the changing levels of circulating hormones. As epithelial structures proliferate, adipose tissue decreases. There is increased infiltration of the interstitial tissue with lymphatics, plasma cells, and eosinophils. By the third trimester, parenchymal cell growth slows and alveoli become distended with early colostrum. Alveolar proliferation is extensive.

The lactating mammary gland has many alveoli that are made up of cuboidal, epithelial, and myoepithelial cells. Little connective tissue separates the alveoli. Lipid droplets are visible in the cells. By complex interplay of the nervous system and endocrine factors (progesterone, estrogen, thyroid, insulin, and growth factors), the mammary gland begins to function (lactogenesis stage I) and other hormones establish the milk secretion and maintain it (lactogenesis stage II).

Human prolactin has a significant role in both pregnancy and lactation. The levels are high during pregnancy, but the influence of prolactin on the breast itself is inhibited by a hormone produced by the placenta, originally referred to as *prolactin-inhibiting hormone* but believed to be progesterone.

Physiology of Lactation

LACTOGENESIS

Lactation is the physiologic completion of the reproductive cycle. The human infant is the most immature and dependent of all mammals except for marsupials, and thus the breast provides the most physiologically appropriate nutrients required by the human infant at birth. Throughout pregnancy, the breast develops and prepares to take over the role of fully nourishing the infant when the placenta is expelled. The breast is prepared for full lactation after 16 weeks' gestation. The physiologic adaptation of the mammary gland to its role in infant survival is a complex process, only the outline of which is discussed here. There are a number of complete reviews of the newer scientific studies on the physiology of lactation.[89-91] Hormonal control of lactation can be described in relationship to the five major changes in the development of the mammary gland: embryogenesis, mammogenesis or mammary growth, lactogenesis or initiation of milk secretion, lactation or full milk secretion, and involution (see Table 11.3). Detailed explanation of mammary growth is beyond the scope of this discussion. The two most important hormones involved in lactation itself are prolactin and oxytocin, and these are described with respect to their impact on lactogenesis.

Lactogenesis is the initiation of milk secretion, beginning with the changes in the mammary epithelium in early pregnancy and progressing to full lactation. Stage I lactogenesis occurs

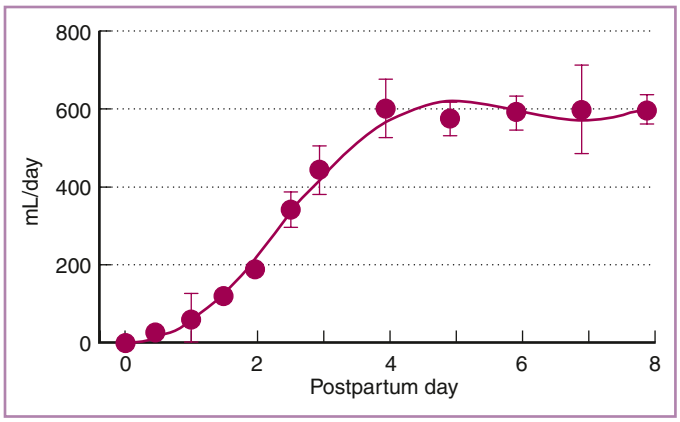

Figure 11.4 Milk volumes during first postpartum week. Mean values from 12 multiparous White women who test-weighed their infants before and after every feeding for the first 7 postpartum days. (*Redrawn from Neville MC, Keller RP, Seacat J, et al. Studies in human lactation: milk volumes in lactating women during the onset of lactation and full lactation.* Am J Clin Nutr. *1988;48:1375–1386.*)

during pregnancy and is achieved when the gland is sufficiently differentiated to secrete milk. It is prevented from doing so by high circulating plasma concentrations of progesterone.[92] Stage II is the onset of copious milk secretion associated with delivery of infant and the placenta.[90] The progesterone level decreases sharply, by 10-fold in the first 4 days. This is accompanied by the programmed transformation of the mammary epithelium.[93] By day 5, the infant has 500 to 750 mL of milk available (Fig. 11.4). The changes in milk composition that occur in the first 10 postpartum days should be viewed as part of a continuum in which the rapid changes of the first 4 days are followed by slower changes in various components of milk throughout lactation.[90] A change in permeability of the paracellular pathways results in a shift from high concentrations of sodium, chloride, and the protective immunoglobulins and lactoferrin, little lactose, and no casein in colostrum to increasing amounts of all milk components.[94]

Lactogenesis stage II results in an increase of milk from 100 mL in the first 24 hours to large volumes (500 to 750 mL/day) by day 4 or 5, gradually leveling off at 600 to 700 mL/day by day 8.[95] These volume changes are associated with a decrease in sodium and chloride concentration and an increase in lactose concentration. The production of lactose drives the production of milk. The early changes in sodium and chloride are a function of the closure of the tight junctions that block the paracellular pathway.[96-98] Secretory IgA and lactoferrin represent 10% by weight of the milk produced in the first 48 hours, and although their amounts remain the same, the increased volume of milk produced decreases their concentration. At 8 days, secretory IgA and lactoferrin are 1% by weight and 2 to 3 g/day.[99]

At 36 postpartum hours (in multiparas) and at up to 72 hours (in primiparas), milk production increases 10-fold (from 50 to 500 mL/day). Women refer to this as their milk "coming in." It reflects a massive increase in synthesis and secretion of the components of mature milk, including lactose, protein, and lipid.[96]

During pregnancy, hormones maintain the pregnancy and produce mammary tissue that is prepared to produce milk but does not do so. Progesterone, prolactin, and possibly placental lactogen are credited with the development of the alveoli. Progesterone has been identified as the major inhibitor of milk production during pregnancy.[100] Prolactin levels in pregnancy are greater than 200 ng/mL. Apparently, the continued high level of prolactin and a decrease in progesterone are necessary for stage II lactogenesis after parturition.[100] The placenta is the main source of progesterone in pregnancy. After the birth, progesterone receptors are lost in the human breast and estrogen levels drop precipitously.

In addition to prolactin, insulin and corticoids are essential to milk synthesis.[101] Delayed lactogenesis is seen in women who had retained placenta, cesarean section, diabetes, and stress during delivery.[95,101-103] Many factors contribute to delayed onset of lactogenesis in women with gestational diabetes, including prepregnancy obesity, older maternal age, and insulin requirement for gestational diabetes.[104-106] In the 1940s, Jackson first noted that stressful labors influenced the early breastfeeding experience in the rooming-in unit.[107] Stress alone may be the trigger for delayed lactogenesis in the conditions other than retained placenta.[83,108] It has been observed that high sodium levels in early milk samples are seen in pregnancy, mastitis, involution (weaning), premature birth, and inhibition of prolactin secretion by bromocriptine. These observations suggest that junctional closure depends on adequate suckling or effective milk removal in the first 3 postpartum days. The significance of having a high sodium concentration in breast milk requires further study.[94]

If milk removal does not begin by 72 hours, the changes in milk composition associated with lactogenesis are reversed and the probability that lactation will be successful decreases.[109] Thus clinical efforts that facilitate early suckling by the newborn enhance the probability of lactation success. Early stimulation of the breast by pumping before 72 postpartum hours is essential when the infant is unable to nurse directly. Initiation of milk expression within the first 6 hours after birth has resulted in increased milk volume, greater colostrum production, and sustained milk volumes.[110] This knowledge is important to reinforce with mothers, families, and staff to encourage and facilitate early expression of milk by mothers of premature infants or when infants and mothers are separated for any reason.

LET-DOWN (EJECTION) REFLEX

An effective let-down reflex is key to successful lactation. This reflex, also known as the *ejection reflex*, was first described in humans by Peterson and Ludwick in 1942[111] and was later demonstrated clinically by Newton and Newton to be caused by the release of oxytocin by the pituitary.[38] Since that time, many refinements in the understanding of the process of milk ejection have been published,[112-114] but the fundamental principles are unchanged (Fig. 11.5). A mother may produce milk, but if it is not excreted, further production is eventually suppressed. The reflex is a complex function that depends on hormones, nerves, and glandular response and can be inhibited most easily by psychological influences.[38]

Oxytocin is the hormone responsible for stimulating the myoepithelial cells to contract and eject the milk from the ductal system. The ducts begin at the alveoli, which are surrounded by a basket-like structure of myoepithelial cells that also surround the ducts all the way to the nipple. When the infant stimulates the breast by suckling, impulses sent to the central nervous system and to the posterior pituitary result in the release of oxytocin, which is then carried by the bloodstream to the

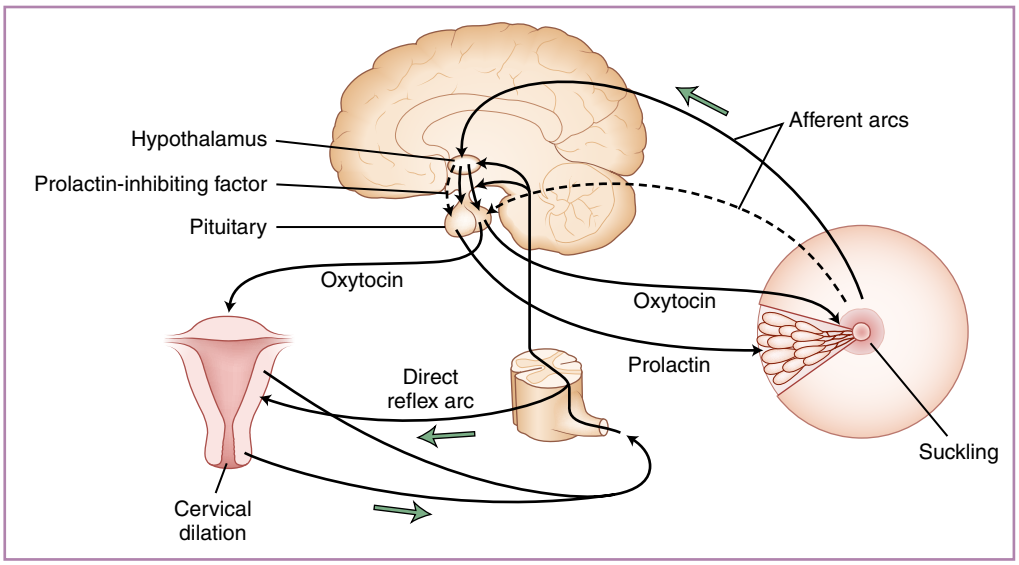

Figure 11.5 Neuroendocrine control of milk ejection. (*Modified from Vorherr H.* The Breast: Morphology, Physiology and Lactation. *New York, NY: Academic Press; 1974.*)

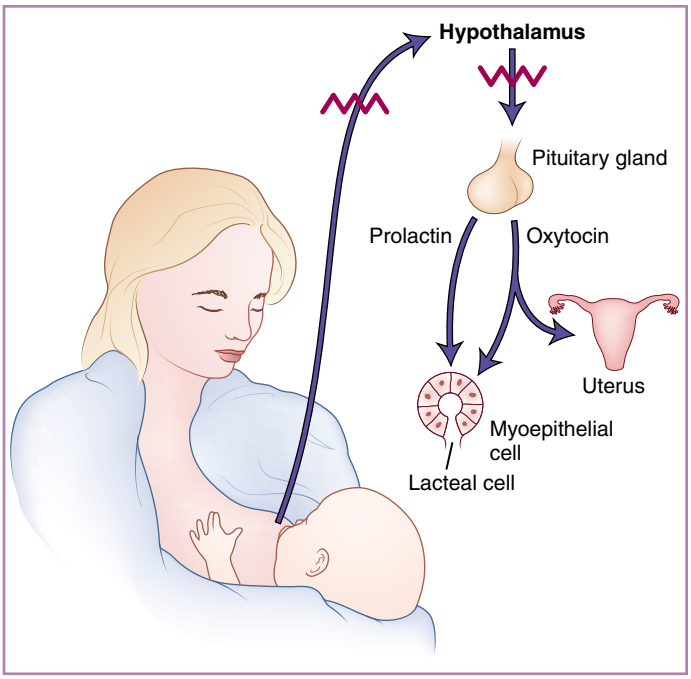

Figure 11.6 Diagram of let-down (ejection) reflex arc. When the infant suckles the breast, mechanoreceptors in the nipple and areola are stimulated, which sends a stimulus along nerve pathways to the hypothalamus, which stimulates the posterior pituitary gland to release oxytocin. Oxytocin is carried via the bloodstream to the breast and uterus. Oxytocin stimulates myoepithelial cells in the breast to contract and eject milk from the alveolus. Prolactin is responsible for milk production in the lacteal cells lining the alveolus. Prolactin is secreted by the anterior pituitary gland in response to suckling. Stress (e.g., pain, anxiety) can inhibit the let-down reflex. Seeing or hearing the cry of the infant can stimulate the release of oxytocin but not prolactin. (*From Lawrence RA, Lawrence RM. Breastfeeding: A Guide for the Medical Profession. 7th ed. St Louis, MO: Mosby; 2010:259.*)

myoepithelial cells. This is a neuroendocrine reflex. Oxytocin release can also be stimulated by other pathways of sight, sound, and smell that represent the infant. Oxytocin also stimulates the myoepithelial cells in the uterus, which are very sensitive to oxytocin during parturition and for a week or so after the birth. This causes the uterus to contract, decreases blood loss, and hastens postpartum involution. The uterus of a mother who breastfeeds returns to a prepregnant state more rapidly. The uterine cramping experienced while breastfeeding is a result of this stimulus (see Fig. 11.6).

Newton and Newton[38] demonstrated that pain and stress interfered with the let-down reflex because it interfered with oxytocin release. In their experimental model, they stimulated stress with pain, loud noises, or pressure to solve mathematical problems. In other species, oxytocin release has been shown to stimulate mothering behaviors.[115] Levels of adrenocorticotropin and plasma cortisol are decreased in lactating women compared with nonlactating women in response to stress.

Prolactin is central to the production of milk and regulates the rate of synthesis. Its release depends on the suckling of the

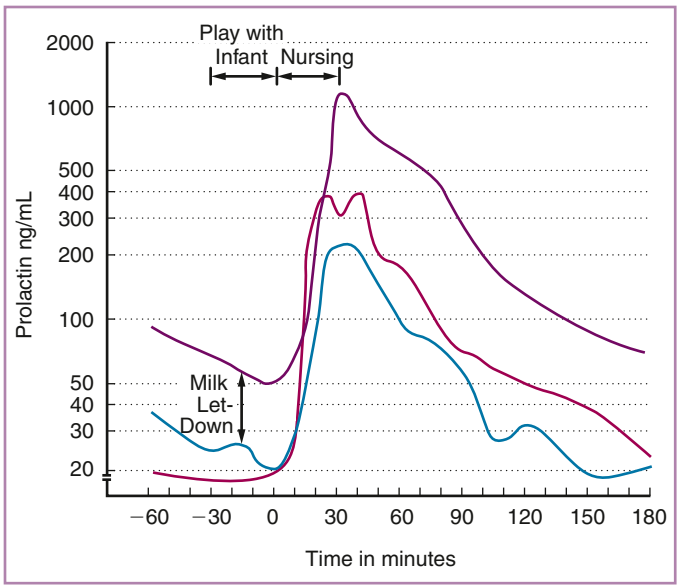

Figure 11.7 Plasma prolactin stimulation. Plasma prolactin levels were measured by radioimmunoassay before, during, and after a period of nursing in three mothers between 22 and 26 days after the birth. The levels rose with suckling but not with infant contact only. (*Modified from Josimovich JB, Reynolds M, Cobo E. Lactogenic hormones, fetal nutrition, and lactation. In: Josimovich JB, Reynolds M, Cobo E, eds.* Problems of Human Reproduction. *Vol 2. New York, NY: John Wiley & Sons; 1974:1.*)

infant or the stimulation of the nipple by mechanical pumping or manual expression. Prolactin is also released through a neuroendocrine reflex. Its influence is modified, however, by the actual release of milk from the alveoli. Local factors in the ductal system or in the accumulated milk can inhibit milk release and thus inhibit further milk production. Prolactin is not released as a result of sound, sight, or smell of the infant, as is the case with oxytocin, but only by suckling (Fig. 11.7).

INITIATION OF LACTATION

Although breastfeeding is a natural process in postpartum women, it is a learned skill, not a reflex. Because the incidence of breastfeeding in developed countries dropped to about 10% in the 1950s and 1960s, there are few experienced role models available to support, encourage, and assist new mothers in feeding their infants at the breast. In the late 1940s, Edith Jackson at Yale, in cooperation with Herbert Thoms, established the first rooming-in unit in the United States, introduced "childbirth without fear," and reestablished breastfeeding as the norm for mothers and infants at the Yale New Haven Hospital.[116] Obstetric and pediatric residents were well schooled in the practical aspects of breastfeeding and human lactation. Jackson and her pediatric colleagues published the classic article on the management of breastfeeding,[117] on which decades of publications, both lay and professional, were based.

The obstetrician and pediatrician have become more involved in the decision to breastfeed and in the practical management of the mother-infant dyad. Medical schools are gradually adding breastfeeding and lactation to their curriculum. Although it is not the physician's role to put the infant to the breast, it is important to understand the process, to recognize problems, and to know how to solve them. Breastfeeding support is a team effort in which the physician works with many health care professionals, including nurses, midwives, doulas, and dietitians, to provide complete care to the perinatal patient. Lactation specialists may be nurses, dietitians, nonmedical individuals with special training, or physicians with specialty designation. The physician should be sure that consultants are licensed and board certified by the International Board of Lactation Consultant Examiners and that other collaborating physicians are recognized as fellows of the Academy of Breastfeeding Medicine.

Except in extreme cases, breast size does not influence milk production. Augmentation mammoplasty does not interfere with lactation unless a periareolar incision was made and nerves were interrupted. If augmentation was done for cosmetic enhancement, the tissue should function well, but if there was little or no palpable breast tissue before surgery, lactation may be improbable.

Reduction mammoplasty is more invasive surgery, and lactation results depend on the technique used. If many ducts were severed and the nipple and areola transplanted, lactation is interfered with. However, if the nipple and areola remained intact on a pedicle of ducts, lactation could be successful. Other incisions (e.g., for lump removal) should be discussed but usually do not interfere with lactation.

During pregnancy, the obstetrician should document the changes in the breasts in response to pregnancy, when the nipple and areola should become more pigmented and enlarged and the breast should enlarge one-half cup size or more. Lack of breast changes should also be communicated to the pediatrician, because this represents a risk for early failure to thrive in the infant because of insufficient milk supply. A breast examination should be conducted late in the pregnancy to check for any new findings of masses, lumps, discharge, or pain. Berens described the role of the obstetrician throughout pregnancy in detail.[118]

Initiating Breastfeeding

The ideal time to initiate breastfeeding is immediately after birth (the Baby-Friendly Initiative recommends within 1 hour of birth). When left on the mother's abdomen to explore, the unmedicated newborn will move toward the breast, latch on, and begin suckling. This usually takes 20 to 30 minutes if unassisted.[119] This has been described as initiating breastfeeding by breast crawl.[120] The infant is ready to feed and has been sucking in utero since about 14 weeks' gestation, consuming amniotic fluid daily (about 1 g protein/kg of fetal weight is received daily from amniotic fluid). The infant at 28 weeks' gestation has already developed coordinated rooting, suckling, and swallowing necessary for breastfeeding. The ability to coordinate suck and swallow while bottle feeding does not occur until 34 weeks.

Holmes and coworkers outlined recommendations for peripartum breastfeeding management for the healthy mother and infant at term.[121] Shortly after delivery, the mother should be offered the opportunity to breastfeed and should be assisted to assume a comfortable position, usually lying on her side. The infant can be placed beside her, tummy to tummy, facing the breast. The mother should support her breast with her hand, keeping her fingers behind the areola so the infant can latch on. The mother should stroke the center of the infant's lower lip with the breast (see Fig. 11.8).[122] The infant should open the mouth wide, extend the tongue, and draw the nipple and areola into the mouth to form a teat. The teat is compressed against the palate by the tongue, and the gums and lips form a seal with the

Figure 11.8 Getting a good latch. (a) Tickle the baby's lips with your nipple to encourage him or her to open wide, (b) pull your baby close so that the baby's chin and lower jaw move in to your breast, and (c) watch the baby's lower lip and aim it as far from the base of the nipple as possible so that the baby takes a large mouthful of breast. (*From Office on Women's Health in the US Department of Health and Human Services. Getting a Good Latch. https://www.womenshealth.gov/breastfeeding/learning-breastfeed/getting-good-latch. Updated August 28, 2018. Accessed January 30, 2021.*)

breast. It is the peristaltic motion of the tongue that stimulates the let-down reflex. The continued peristaltic motion travels to the posterior tongue, the pharynx, and down the esophagus as one coordinated motion so that swallowing is automatically coordinated with suckling during breastfeeding.

Ultrasound imaging of milk ejection in the breasts of lactating women has provided a more detailed description of the process compared with the traditional serial sampling of plasma oxytocin levels and measurements of intraductal pressure. A significant increase in milk-duct diameter can be observed during milk ejection. Multiple milk ejections occur during the process and are correlated with milk flow and with the changes in milk-duct diameter, although they are not sensed by the mother.[114,123] The number of milk ejections influences the amount of milk available to the infant.

Sucking an artificial nipple is a quite different tongue motion that is not coordinated with swallow. A newborn should not be given a bottle to test his or her feeding ability before breastfeeding. It is wise to avoid all artificial nipples (bottles or pacifiers) in the early weeks of breastfeeding. If, for medical reasons, the infant requires donor human milk or a breast milk substitute, it can be given by medicine cup (cup feeding), spoon, dropper, or supplemental feeder.[124-126]

The initial contact may be limited to exploration of the breast by the infant, with licking and nuzzling of the nipple, or the infant may latch on and suck for minutes. Timing is not necessary because the infant will interrupt him- or herself. In the first hour after birth, the term unmedicated infant will be quietly alert. It is an opportunity for the mother, father/partner, and infant to get acquainted.

Ideally, mother and infant recover in the same room together. The infant is fed on awakening, and the mother learns the early signs of hunger. Crying is a late sign of hunger in the infant. The mother also learns about caring for her healthy term infant. There should be no schedules and no intervention unless an infant does not feed for over 6 hours. A normal feeding pattern for breastfeeding in early infancy is 8 to 12 feeds every 24 hours until satiety. The nursing staff and lactation consultants ensure that the infant latches on well and the mother's questions are answered. Breastfeeding should not hurt; when it does, the process should be observed and adjusted. The obstetrician should be involved if needed in the evaluation of breast pain and can review frequent and effective feeding prior to the mother's discharge. The physician should observe a feeding as part of the infant's discharge examination. If there is persistent breast or nipple pain with breastfeeding additional evaluation will be needed as outlined by the Academy of Breastfeeding Medicine's Clinical Protocol #26: Persistent Pain with Breastfeeding or ACOG Committee #820 on Breastfeeding Challenges.[127] The mother should be aware of the milk letting down by tingling in the breast or dripping from the opposite breast. During the feeding session the infant should be observed in coordinated sucking, swallowing, and breathing to effect adequate milk transfer while breastfeeding. Breastfeeding infants use primarily negative pressure to remove milk from the breast. Vacuum is created by the downward movement of the anterior portion of the tongue parallel to the hard palate. The infant does not suck-swallow-breathe in a 1:1:1 ratio but in variable combinations of the three actions during breastfeeding.[128]

The infant's weight is measured daily and again just before discharge. A weight loss of greater than 5% in the first 48 hours should be assessed by checking the feeding process and reviewing voidings and stoolings. Maximum weight loss should not exceed 7% in a breastfed infant by 72 hours. The weight should plateau after 72 to 96 hours and start to rise with adequate feedings. Birth weight should be regained by 7 days or, at the latest, 10 days by a breastfeeding infant. Flaherman and colleagues have developed nomograms to track such weight loss after vaginal or cesarean births. There is also an online tool for calculating percent weight loss over time since birth at Penn State Health, The NEWT Newborn Weight Tool.[129,130]

A healthy infant voids at least once and stools at least once in the first 24 hours, both at least twice in the second 24 hours, and both at least three times in the third 24 hours. From then on voiding should occur at least six times daily. An infant should stool at least once (and preferably three times) every day in the first month of life. After 3 to 4 months of age, a perfectly healthy breastfed infant may go a week without stooling and then pass a soft yellow stool, but this should not occur under 1 month of age.

Early discharge from the hospital has increased the need for newborn care visits within a few days after discharge and as required thereafter at 2- to 4-week intervals for assessment. A follow-up visit at 48 to 72 hours after discharge, or at 3 to 5 days of age for infants discharged at 48 hours or less, is recommended for reassessment of latch, efficacy of feeding, feeding pattern(8

to 12 feeds every 24 hours), hydration status, and frequency of urination and stooling.[6,8]

The transition from hospital to home is a stressful time for all families, but when an infant is premature, small for gestational age, or even near term, transition can be extremely difficult. The stress can be reduced by appropriate detailed discharge planning. The presence of effective, coordinated sucking, swallowing, and breathing should be pointed out to the parents and documented in the chart. Mothers/parents should receive adequate assistance in the days before discharge; positioning, latch, and milk transfer should be perfected, or gavage feeding, supplementation, and fortification should be managed by the parents prior to discharge. The AAP Committee on Fetus and Newborn has delineated the following three competencies of infants that are recognized as essential before hospital discharge of the preterm infant: the ability to maintain body temperature in a home environment, sufficiently mature respiratory control, and oral feeding with or without gavage feeding sufficient to support appropriate growth.[131,132]

Issues in the Postpartum Period

BREAST ENGORGEMENT AND NIPPLE TENDERNESS

A little engorgement of the breast in the first 24 hours is physiologically normal as the vascular supply shifts from the once-gravid uterus to the breasts. Absence of any engorgement, such as absence of breast growth during pregnancy, is cause for concern. Not only is excess engorgement painful but the increased vascular pressure compresses the alveoli and ducts and interferes with milk production and release.[74,133] Prevention of excessive engorgement is the best treatment and involves the following: (1) wearing a well-fitting nursing brassiere, even before the breasts are engorged, and around the clock; (2) frequent feedings for the infant, being sure to balance the use of both breasts; (3) gentle massage and softening of the areola before offering the breast to the infant, so that proper latch-on can be accomplished; (4) if necessary, applying cold packs or cold compresses after a feeding; and (5) taking acetaminophen or ibuprofen, which may be safely used by the mother for discomfort. Therapeutic breast massage during lactation is a recently studied intervention that is being recommended.[134]

Peak engorgement usually occurs between 72 and 96 postpartum hours when the mother has arrived home and is on her own. At the peak of discomfort, standing in a warm shower to let milk drip or applying warm compresses before pumping to relieve the pressure and stimulate flow provides relief before the phenomenon subsides. Although a variety of remedies have been recommended for engorgement, there is insufficient published evidence to recommend one individual treatment over others.[135-137]

Sore nipples are a common complaint when early lactation has gone unassisted. It should not hurt to breastfeed. When it does hurt, the infant should be taken off the breast by breaking the suction with a finger and reattaching the infant carefully, following the steps previously described. The major cause of sore nipples is inadequate latch-on. It is not caused by breastfeeding too long or too frequently. A newborn usually feeds about every 2 hours in the first few weeks of life. Persistent sore nipples, cracks, or oozing may require the assistance of a licensed certified lactation consultant or breastfeeding medicine specialist who can take the time and has the experience to work with the mother to identify the cause, determine effective treatment, and assist the dyad in maintaining pain-free breastfeeding.[127,138]

A clinically defined phenomenon has recently been described in which breastfeeding mothers become acutely saddened, tearful, and depressed with milk ejection. This picture has been described as a dysphoric milk-ejection reflex (D-MER). A clinical case study and a descriptive study by Ureno and colleagues have related this picture to a severe drop in maternal dopamine and described ameliorating factors including distraction, chocolate ice cream, herbals, smoking cigarettes, pseudoephedrine, and bupropion.[139,140] Management of this condition should begin with "normalization," as the experience is often accompanied by significant maternal guilt for feeling negatively toward the supposedly positive experience of bonding, and can include various distraction interventions. The physician should assist the mother in deciding whether continued breastfeeding or weaning is best for her and her child.

FAILING MILK SUPPLY

Many misconceptions lead to the impression that a failing milk supply is a common occurrence. Many women discontinue breastfeeding before 3 postpartum months, believing their milk is diminishing because their breasts are no longer engorged. A very common question for all breastfeeding mothers is "Am I making enough milk?" There is a legitimate question regarding whether this is just the mother's perception or actual insufficient milk production for appropriate infant growth.[141] Once supply and demand have equilibrated and the breast makes what the infant needs, the breasts are soft and do not constantly drip. The emptying time of the stomach of the infant fed human milk is 90 minutes, that of the infant fed formula is 3 to 4 hours, and that of the infant fed cow's milk is 6 hours. Continuing to feed every 3 hours is a testimony to the breast milk's digestibility, not its inadequacy. Weight gain in the infant is the better barometer of success. ACOG and AAP recommend that exclusive breastfeeding should continue for 6 months, with continued breastfeeding while adding weaning foods for the next 6 months and then as long thereafter as mutually desired by mother and child.[74,142]

Genuine failure to produce enough milk may result from infant causes, such as increased need, increased fluid losses, or lack of adequate suckling, or from maternal causes, such as failure to let down or failure of production. Each case should be carefully reviewed because most situations are remediable. There is a long list of conditions associated with low or insufficient milk supply in ACOG's Committee Opinion #820 on Breastfeeding Challenges.[74] Ideally, both the obstetrician and the pediatrician are experienced in lactation management or have a staff member who is. Working together with a licensed certified lactation consultant, the issues can be resolved, and breastfeeding can continue successfully. There are common situations where the evaluation of breastfeeding is appropriate but supplementation with breast milk substitutes is not. Donor human milk should be considered if it is available. There are few situations when supplementation in healthy term infants is indicated, and some examples include asymptomatic hypoglycemia, signs and symptoms indicative of inadequate milk intake (especially infant weight loss or insufficient gain), hyperbilirubinemia, or the infant is ill, necessitating select macronutrients. Some maternal indications for supplementation may include delayed

secretory activation (with inadequate intake by the infant), primary glandular insufficiency, breast pathology or previous surgery resulting in poor milk production, situations requiring temporary cessation of breastfeeding (maternal chemotherapy), and intolerable breast pain during feedings unimproved by interventions.[143] In certain situations, galactogogues may be recommended to maintain the milk supply. Published reviews of the use of galactogogues are available.[144-148]

BREASTFEEDING AFTER PREMATURE OR MULTIPLE BIRTHS

Human milk is beneficial in the management of the premature infant, according to the policy statement of the AAP.[6] This can be mother's own milk (MOM) or donor human milk (DHM).[149,150] The benefits include infection protection; improvement in gastrointestinal function, digestion, and absorption of nutrients; and improvement in neurodevelopmental outcome. The psychological well-being of the mother is enhanced when she provides her milk for her compromised infant.[151] Meeting the intrauterine rates of growth and nutrient accretion requires attention. Although human milk satisfies these needs for larger premature infants, it can be carefully supplemented for smaller infants and still preserve the benefits of human milk. Factors related to the infants, the mothers, and clinical practice clearly affect exclusive breastfeeding of premature infants.[152-155] There is a commercial product created with 100% human milk developed to enhance mother's milk and replace supplementation made with cow's milk.[156]

Twins and triplets present problems of time management for the mother.[157] The mother will make enough milk, as supply will meet demand. Twins learn quickly to nurse simultaneously and will continue to do so for months or years. Breastfeeding ensures a mother's interaction with her infants. Helpful friends and relatives can perform the other household duties. The mother can also provide enough milk for triplets. Some mothers prefer to nurse two at a feeding, giving the third a bottle but rotating the three, feeding by feeding. Any breast milk is valuable in this situation. Mothers of singleton infants may need help, but mothers of multiples especially need help. It may be necessary for the physician to prescribe help and careful attention to proper rest. Mothers have also breastfed quadruplets and higher numbers of infants. The mother can nurse several infants at each feeding and rotate bottle feeding. Exclusive breastfeeding of quadruplets for the first year has been reported by Berlin.[158]

Contraception

Open-ended questioning is appropriate to support maternal and familial decision making about breastfeeding, sexuality, birth spacing, and contraception. Appropriate information sharing should include (1) there are improved maternal and infant outcomes in subsequent pregnancies if the interpregnancy interval is greater than 18 months, (2) exclusive and frequent breastfeeding can be highly effective in birth spacing, and (3) there are a number of options for contraception which are both effective and safe during breastfeeding.[159] The Centers for Disease Control and Prevention (CDC) and WHO Medical Eligibility Criteria for Contraception include the lactational amenorrhea method for birth spacing. The published risk of pregnancy is less than 2% when women meet three situational variables: amenorrhea, fully or nearly fully breastfeeding with frequent feedings and no periods of >4–6 hours between breastfeeds, and less than 6 months since the most recent delivery.[160,161] Women should be aware that these variables need to be met to provide protection against pregnancy. Hormonal methods of contraception are offered over nonhormonal/barrier methods due to their higher efficacy. Estrogen or combination products are usually avoided before 6 weeks postpartum. Progestin-only contraceptives, such as the mini-pill tablet, injectable medroxyprogesterone acetate (Depo-Provera), and levonorgestrel implants, are the hormonal methods of choice in this period. There remain theoretical concerns regarding whether exogenous progesterone disrupts milk synthesis; however, some limited studies present data that progestin-only methods are safe even in the first 6 weeks postpartum. This theoretical risk of diminished breastfeeding with immediate postpartum progestin-only contraception should be communicated to mothers and families to promote and support autonomous informed decision making.[162]

Recommendations for addressing contraception during lactation are available from the Academy of Breastfeeding Medicine and from ACOG.[163,164] ACOG maintains an online resource for patients as well.[165]

Maternal Infections During Breastfeeding

Although often a mother is concerned about the risk to a breastfeeding infant when she has an infectious illness, maternal infection is not a contraindication to breastfeeding in most cases. Proscribing breastfeeding out of fear of infection deprives infants of significant immunologic, nutritional, and emotional benefits of breastfeeding when they are most needed.[9]

The decision-making process to breastfeed despite maternal infection should involve discussion of the usual route of infection transmission, reasonable infection control precautions, potential severity of infection in the infant or child, medications to treat the mother that are compatible with breastfeeding, the potential of prophylaxis for the infant, the protective effect of breast milk, and the acceptability of using expressed breast milk temporarily. The discussion should involve the mother and family, weighing the known and potential risks of the infection against the known benefits of breastfeeding.[9]

For example, diphtheria and active pulmonary tuberculosis in the mother are commonly transmitted via the respiratory route, so contact between infant and mother should be proscribed regardless of how the infant is being fed. Diphtheria and tuberculosis are not transmitted in the milk, except in the case of cutaneous diphtheria involving the nipple and breast or tuberculosis mastitis. As long as there are no lesions on the breast, expressed breast milk can be given to the infant during the initial treatment of the mother (probable infectious periods are 5 days for diphtheria and 14 days or until the sputum is negative for acid-fast tuberculous bacilli). Prophylactic antibiotics for the infant are appropriate in each case—penicillin or erythromycin for diphtheria and isoniazid for tuberculosis.[9,166,167]

Brucellosis is known to be transmitted via unpasteurized milk of animals. There are case reports of transmission of brucella from mothers to infants via breast milk, but human-to-human transmission is rare overall. In the case of suspected maternal brucellosis, first confirm the diagnosis by culture and serology and then treat the mother during pregnancy between 12 and 36 weeks of gestation with rifampicin and trimethoprim/

sulfamethoxazole to avoid disrupting organogenesis prior to 12 weeks or causing neonatal kernicterus after 36 weeks. If the mother has been effectively treated the infant can breastfeed, or the infant can be given rifampicin beginning at birth with trimethoprim/sulfamethoxazole added after 4 weeks of age as prophylaxis while continuing breastfeeding.[168]

In certain highly contagious and serious infections such as the hemorrhagic fevers—specifically with Ebola, Marburg, or Lassa virus—the risk of transmission from any contact with the infected mother is high. The CDC and WHO recommend that, if there are safe alternatives to breastfeeding and care of the infant by another unexposed, uninfected adult, then mothers with probable or confirmed Ebola virus disease should be separated from the infant until recovery.[169,170] A safe, feasible alternative source of feeding is essential before considering withholding breast milk. If feasible, pasteurized mother's milk (via routine pasteurization, Pretoria pasteurization, or flash heating) may be utilized in special circumstances when alternative feeding is not available.[170,171]

There have been few case reports on transmission of dengue virus or other flaviviruses to infants via breast milk. It has been recommended to suspend breastfeeding once the diagnosis is made in a mother, maintain the milk supply by pumping and discarding the milk, and reinitiate breastfeeding when the mother is well. This may not be feasible if an alternative source of infant feeding is not available.[172,173]

Possible West Nile virus (WNV) transmission to an infant through breastfeeding has been reported,[174] but the data on this infection in pregnant or breastfeeding women and their infants are limited. Hinckley and coworkers reported 10 instances of maternal or infant WNV-related illness while breastfeeding. In five cases, the transmission of WNV through breast milk could not be confirmed or ruled out, and in the other five cases, there was no evidence of vertical transmission. They concluded that the information they presented does not support a change in breastfeeding practices after infection with WNV, and that more information is needed.[175]

In the case of infections at specific sites in the mother, the management varies with the specific etiologic organism. For example, with mastitis, continued effective milk removal is the essential first step along with supportive measures (rest, adequate fluids and nutrition, and breast massage) and analgesia. If the obstruction to milk flow and inflammation progress in the next 24 hours, antibiotics are indicated. Empiric antibiotics for acute lactational infectious mastitis include dicloxacillin, flucloxacillin, or a first-generation cephalosporin. For methicillin-resistant *Staphylococcus aureus* coverage, local resistance patterns should be reviewed; clindamycin, trimethoprim/sulfamethoxazole, or vancomycin are options. Alternative therapy for penicillin allergy includes erythromycin, clindamycin, or trimethoprim/sulfamethoxazole. Close follow-up for improvement of symptoms and for potential abscess formation are appropriate. Physical exam should be adequate to diagnose an abscess, but an ultrasound can help on occasion and can guide aspiration/drainage.[176] Cytomegalovirus (CMV) is transmitted from the mother to the infant via breast milk.[177-179] In the full-term well infant this does not produce disease in the infant and is considered "natural immunization." There is considerable debate concerning the risks of CMV infection in premature or very-low-birth-weight infants. There are conflicting data regarding the rates of symptomatic disease in CMV acquired via breast milk in premature infants and the occurrence of long-term sequelae in these infants.[178,180] The risk of transmission and long-term sequelae may be more significant for extremely premature infants less than 28 weeks' gestational age. Because of the concern for significant short-term and possible long-term effects of postnatal infection with CMV via breast milk, the Red Book Committee of the AAP has issued some guidance. They recommend considering screening mothers of premature infants less than 32 weeks' gestational age and short-term pasteurization of breast milk prior to administration to the infant.[181] Use of CMV-negative donor human milk is another alternative. Across nurseries worldwide there is no consensus practice because pasteurization also inactivates many beneficiary components of fresh breast milk. There is ongoing research on flash heating, freezing, and irradiation for inactivation of CMV in breast milk without inactivation of various biologically active components. Until there is a broadly accepted consensus opinion, the conservative approach would be to follow the AAP recommendation from the Red Book Committee.

In mothers with hepatitis, identification of the etiologic agent is required before the appropriate management can be determined. Before the etiologic agent is identified, care must include precautions for all potential organisms. Consultation with an infectious disease specialist is often appropriate. For hepatitis A virus, infection in the newborn or young infant is uncommon and not associated with severe illness. Breastfeeding can continue, and if the diagnosis is made within 2 to 3 weeks of the infant's initial exposure to the infected mother, immune serum globulin and hepatitis A virus vaccine given simultaneously can decrease infection in the infant. With hepatitis B virus, the risk of chronic infection and its serious complications are high (up to 90%) when infection occurs perinatally or in early infancy. Hepatitis B immune globulin and hepatitis B virus vaccine given simultaneously prevent hepatitis B virus transmission in over 95% of cases, regardless of whether the infant is fed by breast or bottle. Therefore it is very appropriate to continue breastfeeding along with provision of effective immune therapy.[181]

With hepatitis C virus (HCV) the rate of mother-to-child transmission (MTCT) is about 6%. Several cohort studies suggest that most infants acquire HCV infection in utero or in the peripartum period. HCV has been detected in colostrum and breast milk at low levels. Large cohort studies, including 1854 mother-infant pairs, have not shown a significant difference in acquisition of HCV infection between breastfed and formula-fed infants.[182] Guidelines from the CDC and AAP state that maternal HCV infection is not a contraindication to breastfeeding.[183] HCV and human immunodeficiency virus (HIV) coinfection in the mother is a contraindication to breastfeeding in high-income countries. Because HCV is a blood-borne virus, the CDC recommends avoiding breastfeeding from the affected breast, at least temporarily, if an HCV-infected mother experiences nipples that are cracked or bleeding.[183]

No clear data indicate HCV transmission via breast milk in HIV-negative mothers.[184] There is evidence of inactivation of HCV by breast milk.[185] However, given the multiple issues involved—low risk of HCV transmission via breast milk, increased risk of transmission in association with HIV infection or high levels of HCV RNA in maternal serum, lack of effective preventive treatments (vaccines or immune serum globulin), and the risk of chronic HCV infection and serious liver disease—it

is essential to educate the parents about the possible low risks of continued breastfeeding and the many benefits of breastfeeding in order to facilitate autonomous informed decision making.

Maternal retroviral infection and breastfeeding is a highly controversial issue that continues to be evaluated and debated. HIV type 1 (HIV-1) is transmissible via breastfeeding and can significantly increase the risk of HIV infection in infants born to HIV-positive mothers. One meta-analysis of five studies of infants born to HIV-infected mothers reported the risk of HIV transmission to infants strictly from breastfeeding as 14% (95% confidence interval [CI], 7% to 22%).[186] Among the many concerns about HIV and breastfeeding are the risk of transmission related to the duration of breastfeeding, the relative risks of exclusive versus nonexclusive breastfeeding, the risk of mortality and morbidity resulting from other infections and malnutrition associated with *not* breastfeeding, the significance of HIV viral loads and $CD4^+$ T-cell counts in the mother relative to transmission from breast milk, the potential protective effects of breast milk against HIV infection, and the degree to which antiretroviral therapy for the mother or infant will be protective against HIV infection. Social issues involved in this debate include the right of the mother to make choices for herself and her infant, the social stigma of not breastfeeding in certain cultures and communities, and the possibility that breastfeeding rates in HIV-negative mothers will be adversely affected by the advice given to HIV-positive mothers. In many countries, neither choice is optimal: breastfeeding risks HIV infection in the infant, but not breastfeeding increases the risks of other infections and malnutrition. The lack of adequate data from controlled trials about the various factors contributing to infection adds to the difficulty of making straightforward recommendations applicable to diverse situations around the world. In the United States, it is appropriate to advise no breastfeeding for infants of HIV-infected mothers to decrease the risk of HIV transmission to the infant.[187]

In resource-poor settings, more recent review of the available data on providing antiretroviral prophylaxis to either the mother or the infant during pregnancy and lactation has led to new recommendations from the WHO.[188,189] These include specific recommendations for the use of antiretroviral therapy in women who need treatment for their own health, the continuation of which beyond the postpartum period provides additional protection against MTCT at the same time as allowing the other benefits to the infant from breastfeeding. The criteria for initiating antiretroviral therapy for pregnant women are the same as those for nonpregnant women. All HIV-infected women who are not in need of antiretroviral therapy for their own health should receive an effective antiretroviral prophylaxis regimen to prevent MTCT. Effective antiretroviral therapy for the mother can be continued through the period of lactation to protect the infant. Additionally, the infant can receive antiretroviral therapy to prevent against HIV infection via breastfeeding. HIV-infected women should still receive education concerning the choices of infant feeding, with emphasis on the benefits of breastfeeding in combination with antiretroviral prophylaxis provided to the mother or infant for the duration of breast milk consumption. Education, support, and medical care throughout lactation for both mother and infant should be provided to achieve the goals of 100% prevention of MTCT, optimal maternal health and survival, and long-term infant health and survival.

There are limited reports that deal with the risk of HIV type 2 (HIV-2) transmission via breastfeeding. Studies suggest that HIV-2 transmission via breast milk is less common than HIV-1 transmission.[190] However, until adequate information is available, it is appropriate to use the same guidelines as for HIV-1.

Transmission of human T-cell leukemia virus type I (HTLV-I) infection is associated with breastfeeding, although short-term breastfeeding (less than 6 months) may pose no greater risk than the risk for formula-fed infants.[191-193] In Japan, where high rates of infection with this virus occur, proscription of breastfeeding is common. In the United States, when the mother has documented HTLV-I infection, it is appropriate to discuss the options, risks, and benefits of breastfeeding and to consider short-term breastfeeding. There are many uncertainties concerning HTLV type II, related to the diseases associated with infection and to whether transmission occurs via breast milk. Here again, it is appropriate to discuss the available data with the parents and to include an infectious disease consultant in the discussion to facilitate an autonomous informed decision.[9]

Complications of the Breast

There are a variety of conditions that can manifest as palpable breast masses during lactation. Some are lactation-specific and some non-lactation-specific (see Table 11.4). Some of these lactation-specific masses are more likely to require imaging for diagnosis and management, such as galactocele, phlegmon, abscess, lactating adenoma, and lactiferous sinus, among other less common masses.[74,194,195]

ACCESSORY BREAST TISSUE

Accessory tissue occurs in approximately 2% to 6% of women. It often first manifests during the breast enlargement during pregnancy. The tissue is frequently in the axilla and bilateral in approximately one-third of women. Its presence can be acutely obvious during engorgement of the breast.

PLUGGED DUCTS

Tender lumps in the breast in a mother who is otherwise well are probably caused by plugging of a collecting duct. The best treatment is to continue nursing while manually massaging the area to initiate and ensure complete drainage. Holding the infant in a different position may encourage flow, as may application of hot packs before a feeding. If repeated plugging occurs, a check should be made for possible obstruction from a brassiere strap or other external forces. Some women can actually see small plugs ejected when they massage. For some, reducing polyunsaturated fats in the diet and adding lecithin provides relief.

GALACTOCELE

Milk-retention cysts are uncommon and are usually associated with lactation. The swelling is smooth, rounded, and nontender. The cyst may be aspirated to confirm the diagnosis and to avoid surgery, but it will fill up again. The cyst can be removed with local anesthesia without interruption of the breastfeeding routine. The diagnosis can also be confirmed by ultrasound, by which the cyst and milk look similar but tumor is distinguishable.[9]

TABLE 11.4 Breast Masses

Lactation-Specific	Clinical Findings	Non-lactation-Specific	Clinical Findings
Accessory breast tissue	Common in axilla, bilateral in one-third of cases, noticed most often during pregnancy enlargement	Fibroadenoma	Mobile rubbery smooth mass, asymptomatic or tender
Plugged ducts	Occur in areas of milk stasis	Phyllodes tumor	Fibroepithelial lesion similar to fibroadenoma
Galactocele	Common, "milk retention cyst," fluid filled	Cysts	With fibrocystic disease or simple or complex
Phlegmon	Poorly defined collection of fluid	Intramammary lymph nodes	Uncommonly palpated but usually identified by the patient
Abscess	Usually well-defined, inflamed fluid collection	Fat necrosis	Irregular palpable mass, tender or not
Lactating adenoma	Rubbery or firm mass, fairly well-circumscribed	Hematoma	Tender mass, usually + history of obvious trauma
Lactiferous sinuses	Subareolar mass	Periductal mastitis	Squamous metaplasia of lactiferous ducts, most commonly in smokers
		Idiopathic granulomatous mastitis	Evolving inflammatory swellings
		Breast cancer	Variable presentations

Data from Mitchell KB, Johnson HM. Breast conditions in the breastfeeding mother. In: Lawrence RA, Lawrence RM, eds. Breastfeeding: A Guide for the Medical Profession. 9th ed. St. Louis, MO: Elsevier; 2021 [chapter 16]; and Mitchell KB, Johnson HM, Eglash A, Academy of Breastfeeding Medicine Clinical Protocol #30: Breast Masses, Breast Complaints, and Diagnostic Breast Imaging in the Lactating Woman. Breastfeed Med. 2019;14(4):208–214. https://doi.org/10.1089/bfm.2019.29124.kjm.

TABLE 11.5 Comparison of Engorgement, Plugged Duct, and Mastitis

			Symptom			
	Onset	Site	Swelling and Heat	Pain	Body Temperature	Systemic Symptoms
Engorgement	Gradual, immediately after birth	Bilateral	Generalized	Generalized	<38.4°C (101°F)	Feels well
Plugged duct	Gradual, after feedings	Unilateral	May shift; little or no heat	Mild but localized	<38.4°C	Feels well
Mastitis	Sudden, after 10 days	Usually unilateral	Localized, red, hot, swollen	Intense but localized	>38.4°C	Flulike symptoms

From Lawrence RA, Lawrence RM. Breastfeeding: A Guide for the Medical Profession. 8th ed. St Louis, MO: Mosby; 2015:568.

MASTITIS

Mastitis is an infectious process in the breast producing localized tenderness, redness, and heat, together with systemic symptoms of a flulike illness with fever and malaise. It can be distinguished from engorgement and plugged duct (Table 11.5). Usually a red, tender, hot, swollen, wedge-shaped area of the breast is visible, and it corresponds to a lobe (Fig. 11.9). The common organisms are *Staphylococcus aureus, Escherichia coli,* and, rarely, *Streptococcus.* An approach to managing mastitis in the breastfeeding mother is outlined by the Academy of Breastfeeding Medicine Protocol Committee; the major points of management are as follows:

- Breastfeeding should continue on both breasts, optimizing effective milk removal.
- Analgesia is appropriate and necessary to facilitate let-down and effective milk removal.
- Supportive measures, including rest, fluids, adequate nutrition, heat for let-down and cold for pain after milk expression, and home care support for the infant and the mother are the first line of management.
- If the mastitis is not improving with conservative supportive measures, antibiotics appropriate to the probable cause and relevant sensitivities should be prescribed.
- Antibiotics are recommended by most practitioners for 10 to 14 days, but there are no controlled trials for the effective duration of antibiotics. The antibiotic should be safe for the infant (see Mastitis under Maternal Infections).

The most common cause of recurrent mastitis is delayed or inadequate treatment of the initial disease. Mastitis can evolve into formation of a phlegmon and/or an abscess, sometimes necessitating drainage and/or imaging. In most situations of mastitis, laboratory or diagnostic procedures are unnecessary. Recommended exceptions to this include no response to antibiotic therapy within 2 days, recurrence of mastitis, hospital-acquired mastitis, medication allergies to the standard antibiotics for mastitis, and severe cases of mastitis.[176] On recurrence, cultures of a midstream flow of milk should be sent and antibiotics chosen according to the results.

LACTATING ADENOMAS

These are benign painless masses most frequently observed in the upper outer quadrant of the breast. They seem to present spontaneously, are presumed to be due to hormonal secretion, and often resolve after lactation ends. Biopsy is sometimes

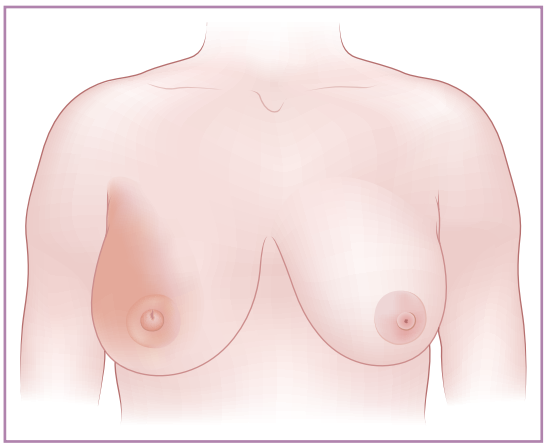

Figure 11.9 Mastitis of right breast, upper outer quadrant. (*From Lawrence RA, Lawrence RM.* Breastfeeding: A Guide for the Medical Profession. *7th ed. St. Louis, MO: Mosby; 2010:554.*)

recommended to confirm the diagnosis but breastfeeding can continue.

LACTIFEROUS SINUSES

These are relatively "dilated" lactiferous sinuses palpable beneath the areola. They are more noticeable in breastfeeding women than in those who have stopped breastfeeding.

CANDIDIASIS OF NIPPLE AND BREAST

Candidiasis of the breast is frequently overdiagnosed because there are several causes for the breast pain that is described by mothers as feeling like "a stab with a hot poker." On examination, there may be little to see except a pinkish hue or slight darkening to the nipple and central areola. Rarely are white plaques seen on the nipple. If the mother has a history of vaginal candidiasis, the infant's mouth may have become colonized, and this could have resulted in inoculation of the nipples. The infant should also be examined for both thrush and diaper rash and treated simultaneously with the mother for a full 2 weeks. Nystatin ointment is applied after each feeding to nipples and areolae, and the infant receives nystatin drops orally to the oral mucous membranes after each feeding. For a recurrent episode, the mother can be treated with 200 mg oral fluconazole systemically once daily for 7 to 14 days. The infant can be given 6 mg/kg on day 1 and then 3 mg/kg per dose every 24 hours orally. Pacifiers and bottle nipples that are put in the mouth should be discarded and new ones sterilized daily. Persistent thrush requires a complete evaluation of the mother and may require treatment for vaginal thrush, decreased sugar in the diet, and colonization with lactobacillus by capsule or yogurt. Persistent pain (longer than 2 weeks) with breastfeeding is an important situation necessitating evaluation and management. Berens and colleagues provide an approach to management and detailed discussion of potential causes of persistent pain.[127]

Medications While Breastfeeding

Questions about medication during breastfeeding are very common. The transfer of maternal drugs to the infant during lactation is different from transfer to the fetus during pregnancy. Although it is almost always better to breastfeed, the mother must weigh the potential benefits and risks of a medication for herself and her infant against the substantial benefit of being breastfed for the infant. The risk-benefit ratio differs for each drug and clinical setting. Both scientific information and experienced clinical judgment are required to assess the risks and benefits and to determine the therapeutic choice.

The AAP Committee on Drugs has published a list of commonly used drugs and chemicals that may transfer into human milk.[196] The categories from the AAP list[196] are as follows:

1. Cytotoxic drugs that may interfere with cellular metabolism of the nursing infant
2. Drugs of abuse for which adverse effects on the infant during breastfeeding have been reported
3. Radioactive compounds that require temporary cessation of breastfeeding
4. Drugs for which the effect on nursing infants is unknown but that may be of concern—for example, bromocriptine, ergotamine compounds, and lithium
5. Drugs that have been associated with significant effects on some nursing infants and should be given to nursing mothers with caution
6. Maternal medication usually compatible with breastfeeding
7. Food and environmental agents that might have an effect on the breastfeeding infant

There are various printed and online resources which can be consulted concerning the use of medications in lactation.[69,84,85,197] A readily available and frequently updated handbook by Thomas Hale, *Medications and Mothers' Milk*, provides a scale that is roughly the reverse of the long-established classification system developed by the AAP.[198] The basic definitions from Hale's text are as follows:

- L1: safest
- L2: safer
- L3: moderately safe
- L4: possibly hazardous
- L5: contraindicated

A lack of information about a drug does not necessarily require cessation of breastfeeding. Understanding the pharmacology of a drug, the dosing schedule, and the stage of growth and development of the infant inform the decision about whether it would affect the infant. Characteristics of the drug that influence its passage into milk include the size of the molecule, its solubility in lipid or water, whether it binds to protein, the pH, and the diffusion rates (Box 11.4). The route of administration influences the blood levels and therefore the milk levels. Passive diffusion is the principal transport mechanism. How the drug is metabolized influences whether it is present in the milk in its active form or as an inactive metabolite (Fig. 11.10).

The infant's ability to absorb, digest, metabolize, store, and excrete a drug must be considered when choosing a medication for a nursing mother. A drug that is not orally bioavailable will not be absorbed from the milk by the infant. The ability to absorb and metabolize a drug depends on the infant's developmental and chronologic age. An 18-month-old who nurses briefly about four times a day for comfort will get little medication, has a substantial diet other than mother's milk, and can metabolize and excrete more efficiently than a newborn. In the first weeks of life, the maturation or gestational age should be considered when determining the safety of a medication, because the less mature the infant is, the less mature are the liver and kidneys.

BOX 11.4 THE PASSAGE OF DRUGS INTO BREAST MILK

1. Mammary alveolar epithelium represents a lipid barrier with water-filled pores and is most permeable for drugs during the colostral phase of milk secretion (first postpartum week).
2. Drug excretion into milk depends on the drug's degree of ionization, molecular weight, solubility in fat and water, and relationship of pH of plasma (7.4) to pH of milk (7.0).
3. Drugs enter mammary cells basally in the nonionized, non-protein-bound form by diffusion or active transport.
4. Water-soluble drugs of molecular weight less than 200 pass through water-filled membranous pores.
5. Drugs leave mammary alveolar cells by diffusion or active transport.
6. Drugs may enter milk via spaces between mammary alveolar cells.
7. Most ingested drugs appear in milk; drug amounts in milk usually do not exceed 1% of ingested dosage, and levels in the milk are independent of milk volume.
8. Drugs are bound much less to milk proteins than to plasma proteins.
9. The drug-metabolizing capacity of mammary epithelium is not understood.

Data from Lawrence RM, Lawrence RA. Medications, herbal preparations, and natural products in breast milk. In: Lawrence RA, Lawrence RM. Breastfeeding: A Guide for the Medical Profession. *9th ed. St. Louis, MO: Elsevier; 2021;332.*

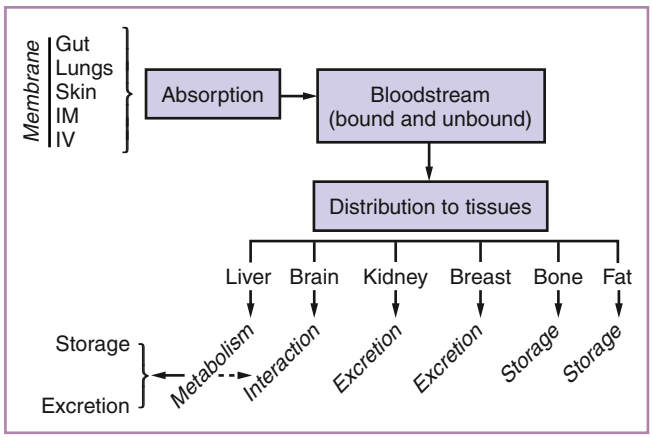

Figure 11.10 Distribution pathways for drugs. Distribution pathways vary with the drug and are relevant to advising the lactating mother about breastfeeding when drugs have been prescribed. *IM,* Intramuscular; *IV,* intravenous. (*Modified from Rivera-Calimlim L. Distribution pathways for drugs, once absorbed during lactation.* Clin Perinatol. *1976;14:51.*)

With the exception of radioactive compounds such as iodine 131, there is no drug whose possible presence in the milk would require immediate withholding of breastfeeding because the physician does not know the data. The American College of Radiology has produced a manual for contrast agents; based on reports from their analysis of the data, less than 1% of the maternal dose is excreted in the breast milk, and less than 1% of the contrast in breast milk reaching the infant's gastrointestinal tract is absorbed.[199] Box 11.5 provides some salient points for the use of radiologic and nuclear medicine studies during lactation. Therefore arbitrary interference with breastfeeding until information can be obtained is not justified. Ample references and information lines are available to resolve the issue. For medications used once or for a short time (e.g., anesthesia), the time required for the drug to clear the mother's system and her milk can be determined. The mother can pump and discard her milk for that period if deemed necessary using evidence-based resources and return to breastfeeding (usually in a few hours or days, not weeks).

MILK-TO-PLASMA RATIO

The *milk-to-plasma ratio,* a term applied to drugs being used by a lactating mother, indicates the level of the drug in the milk compared with the level in the plasma at a given time. The dosage of the drug, including time and route of dosing, must be known to interpret the milk-to-plasma ratio. If there is a very low level in the plasma and the same very low level in the milk, the ratio is close to or equal to 1. A ratio of 1 suggests that the level is of concern; however, the actual level in milk is low and therefore the risk to the infant is likely to be low. Most drugs have a milk-to-plasma ratio of less than 1. It is important to know peak plasma and peak milk levels, and peak plasma and peak milk times, to make appropriate recommendations to avoid feeding the infant when transfer of the drug would be greatest.

ANALGESIA AND ANESTHESIA FOR THE BREASTFEEDING MOTHER

The appropriate use of analgesia and anesthesia during labor and delivery and in the peripartum period, as well as at other times for the breastfeeding mother, is a skill that every obstetrician should master. The use of pharmacologic agents for pain relief during labor and in the postpartum period is appropriate and may improve outcomes for the infant and mother. Their use may influence the course of labor, the neurobehavioral status of the infant, and the initiation of breastfeeding. The effects of such analgesic or anesthetic medications on lactation will depend of various factors, such as the age and size of the infant, the ability of the infant to clear the quantity of medication he or she is exposed to, and the stage of lactation. Pain, suffering, fear, and anxiety during labor can affect delivery and have a negative effect on breastfeeding. These issues may necessitate pharmacologic treatment, but continuous support in labor and nonpharmacologic management of pain may decrease the need for medications and facilitate early skin-to-skin contact and initiation of breastfeeding. Appropriately referenced guidelines for analgesia and anesthesia use in lactating women are available from the Academy of Breastfeeding Medicine.[200] Box 11.6 presents a few salient points from these guidelines.

Ongoing Breastfeeding Support

The duration of lactation will vary significantly by mother-infant dyad. Support should be given to every mother and family to maintain her milk supply, continue breastfeeding, and meet her breastfeeding goals. This is especially important when the mother and infant are separated for longer periods of time, as might occur with maternal hospitalization, surgery, or return to work or school, some of the more common examples of separation. One of the more effective practices that can assist mothers in maintaining their milk supply involves creating a "breastfeeding-friendly physician's office."[201] Overall, this involves providing an office environment that is supportive of breastfeeding, which

BOX 11.5 USE OF RADIOLOGY AND NUCLEAR MEDICINE STUDIES DURING LACTATION

1. Various organizations have made recommendations regarding breast imaging in pregnant and lactating women (American College of Radiology [ACR], National Comprehensive Cancer Network [NCCN], *Journal of Radiographics*, Academy of Breastfeeding Medicine [ABM], among others).
2. Screening mammography should be done based on the woman's individual risk and expected duration of lactation. Ultrasound can be used as a supplemental screening test with mammography. Magenetic resonance imaging (MRI) can be used in high-risk women breastfeeding for short periods of time, 3 months after cessation of lactation.
3. Diagnostic breast imaging during lactation is the same as for nonlactating women. Breast imaging by screening or diagnostic mammography, ultrasound, or MRI with gadolinium-based intravenous contrast does not require interruption of breastfeeding.
4. "Pump and dump" after imaging studies is not appropriate. No breastfeeding interruption is necessary for noncontrast radiographs, nonvascular administration of iodinated contrast, computed tomography (CT) with iodinated intravenous contrast, MRI with gadolinium-based intravenous contrast, nuclear medicine imaging (positron emission tomography [PET] scan or bone scan).
5. The calculated dose of an infant's systemic exposure due to a CT scan with iodinated intravenous contrast given to the mother is <0.01% of the mother's intravenous dose (less than 1 % of the dose administered to the mother reaches the breast milk and <1% of the contrast ingested by the infant in the milk is absorbed by the gastrointestinal tract). Similarly, the calculated dose of an infant's systemic exposure when a mother undergoes an MRI with gadolinium-based intravenous contrast is <0.0004% of the mother's dose (less than 0.04% of the maternal dose is excreted in breast milk and <1% of the ingested contrast is absorbed form the infant's gastrointestinal tract).
6. Thyroid imaging with I-131 necessitates cessation of breastfeeding for this child due to high gamma energy, high beta emission, and long half-life (8.04 days). Thyroid imaging with I-123 is accompanied by recommendations for cessation of breastfeeding varying up to 3 weeks (half-life 13 hours). Technetium-99m pertechnetate with its shorter half-life (6 hours) may necessitate interruption of breastfeeding for 4 hours up to 12 to 24 hours depending on the dose and the recommendation of the local nuclear medicine specialist.[a]
7. Renal imaging utilizing Tc-99m DTPA, Tc-99m MAG3, Tc-99m DMSA, or Tc-99m glucoheptonate usually do not require cessation of breastfeeding,[b] although the International Atomic Energy Administration (IAEA) recommends withholding breastfeeding for 4 hours for the possibility of any external radiation and free Tc-99m pertechnetate in the imaging product.[b]
8. Cardiac imaging with Tc-99m Sestamibi or Tc-99m Tetrofosmin usually do not require cessation of breastfeeding.[b] Multigated acquisition scan (MUGA) with Tc-99m labeled RBCs can be used to assess left ventricular ejection fraction. No interruption of breastfeeding is necessary for in vitro labeling, but a 6- to 12-hour interruption is recommended for in vivo labeling of the RBCs.[a,b] An echocardiogram is an alternative method of assessing ventricular ejection fraction.
9. VQ scan is used to evaluate for pulmonary embolism. No breastfeeding interruption is needed for the ventilation agents of the scan, although a 12-hour interruption is recommended for the perfusion agent Tc-99m macroaggregated albumin.[a]
10. Mothers exposed to an accidental, unexpected radiation exposure should be assessed by the institutional radiology safety officer (RSO), and recommendations can be sought from other expert sources (Infantrisk.com or MotherToBaby.org).

[a]Expressed milk obtained during that period of interruption of breastfeeding can be stored, refrigerated, and given to the infant later after 10 physical half-lives or ~60 hours, which will lead to the elimination of the radiation.

[b]Although the International Atomic Energy Administration (IAEA) recommends withholding breastfeeding for 4 hours for the possibility of any external radiation and free Tc-99m pertechnetate in the imaging product.

Data from Mitchell KB, Fleming MM, Anderson PO, Giesbrandt JG, and Academy of Breastfeeding Medicine. ABM Clinical Protocol #31: Radiology and Nuclear Medicine Studies in Lactating Women. Breastfeed Med. *2019;14(5):290–294.* https://doi.org/10.1089/bfm.2019.29128.kbm. *Epub 2019 May 20. Accessed January 9, 2021; and American College of Radiology Committee on Drugs and Contrast Media. American College of Radiology Manual on Contrast Media. 2020.* https://www.acr.org/-/media/ACR/files/clinical-resources/contrast_media.pdf *Updated 2020. Accessed January 31, 2021.*

can include such specific practices as providing appropriate written and audiovisual breastfeeding materials in the office, providing a private lactation room, offering prenatal and postnatal visits with an emphasis on breastfeeding, ensuring access to a lactation consultant, and providing positive feedback for breastfeeding from the staff and clinicians. Of note, some of the same factors that contribute to successful breastfeeding will facilitate the maintenance of the milk supply during times of separation: early skin-to-skin contact and suckling within the first hour of life, emphasis on early feeding cues and correct technique, encouraging "instinctual breastfeeding behaviors" for both the mother and infant,[202] and encouraging exclusive and unrestricted (on-demand) breastfeeding. Mothers should be instructed on how to express their milk, appropriately store it for home use, and maintain lactation. Not every woman needs a pump. Every woman should be trained how to manually express her breasts before she leaves the hospital because this will facilitate her managing common problems such as a plugged duct or engorgement. Patient information on hand expression of milk and a demonstration video are available online.[203,204] Hand pumps, battery-powered pumps, and electrical pumps are available. The most effective expression of milk will vary from woman to woman, but the expression should be comfortable and meet the infant's and mother's needs.

As part of the normal discussion of ongoing lactation, the mother should be asked about potential periods of separation from her infant and in particular about her plans for return to work or school as an introduction to the topics of human milk storage for home use and the maintenance of lactation. Box 11.7 provides recommendations concerning human milk home storage and use.[205]

ONGOING BREASTFEEDING SUPPORT WITH SOCIAL CHALLENGES

Substantial inequities exist in breastfeeding initiation and duration by age, race/ethnicity, and socioeconomic status.[5] Reviewing CDC breastfeeding data by race/ethnicity, Black non-Hispanic mothers had the lowest breastfeeding rates in 2017 across all parameters (Table 11.6).[206] Breastfeeding rates assessing initiation, duration, and exclusivity were lower among women who were less educated, were younger, were unmarried, had lower household incomes, and received WIC. Obstetricians

BOX 11.6 ANESTHESIA FOR SURGERY IN BREASTFEEDING MOTHERS

1. Mothers who have received general anesthesia with healthy term or older infants can generally resume breastfeeding as soon as they are awake, stable, and alert.
2. Infants at risk for apnea, hypotension, or hypotonia may benefit from a brief interruption of breastfeeding (6–12 hours) after maternal anesthesia. In this situation, mothers can express and store milk in small amounts to be used when the infant is older, or it can be mixed with fresh milk containing no medications to dilute the medications present.
3. The most concerning class of medications used for anesthesia and analgesia in breastfeeding mothers is opioids, as these medications transfer into breast milk and may cause infant sedation or apnea. Judicious use of opioids for short periods is likely to be safe for most breastfeeding mothers and infants.
4. Drugs used for induction, such as propofol, midazolam, etomidate, or thiopental, enter the milk compartment only minimally due to their extraordinarily brief plasma distribution, and hence their transport to milk is low to nil.
5. Little has been reported on the use of anesthetic gases in breastfeeding mothers, but they also have brief plasma distribution phases and milk levels are likely to be nil.
6. Neuromuscular blocking agents are safe for the breastfeeding infant, as they have low lipid solubility and are largely distributed in the extracellular fluid volume. There is little or no data on the pharmacokinetics of these drugs in breast milk, but based on their physical characteristics and their poor oral availability, they are considered safe for use in the breastfeeding mother.
7. For women undergoing postpartum tubal ligation, interrupting breastfeeding is not indicated because the volume of colostrum an infant would receive is small.
8. Women who receive single doses of medication for sedation and analgesia for short procedures can breastfeed as soon as they are awake and stable.
9. Local anesthetics such as lidocaine, bupivacaine, and ropivacaine can be safely used in breastfeeding mothers. These and other local anesthetics are poorly absorbed orally and the large, polarized molecules do not easily transfer into milk.
10. Regional anesthesia (spinal, epidural, or peripheral nerve block) should be considered whenever possible for intraoperative anesthesia or postoperative analgesia. It reduces the need for intraoperative medications and may also decrease the amount of pain medication needed postoperatively. This may leave the mother more awake and alert in the immediate postoperative period, and she will therefore be more likely to resume breastfeeding sooner.
11. Antiemetics are used commonly in the perioperative period, and most of these medications are considered safe during breastfeeding. Ondansetron, dexamethasone, and metoclopramide may be preferred because of their lack of sedating side effects. Prochlorperazine, promethazine, and scopolamine are likely safe, but may lead to maternal sedation. Promethazine and scopolamine have been noted to affect milk supply if given repeatedly.

Modified from Reece-Stremtan S, Campos M, Kokajko L, and the Academy of Breastfeeding Medicine. ABM Clinical Protocol #15: Analgesia and Anesthesia for the Breastfeeding Mother, Revised 2017. Breastfeeding Medicine. 2017;12(9):1–7. https://doi.org/10.1089/bfm.2017.29054.srt.

BOX 11.7 INFORMATION ON STORAGE OF HUMAN MILK FOR HOME USE WITH FULL-TERM INFANTS

PREPARATION FOR HUMAN MILK STORAGE

1. Women should wash their hands before expressing breast milk (using soap and water or a waterless hand cleanser).
2. Milk expression can be done by hand or by a pump. A variety of pumps are available, and selection can be based on cost, availability, frequency and duration of expression, time constraints, and comfort, etc. Appropriate cleaning of hands and cleaning of pump parts (per manufacturer's instructions) is adequate to limit milk contamination during expression and storage. The CDC has guidelines for pump cleaning available on their website.[a]
3. Only food-grade plastic containers should be used for human milk storage. There are a variety of studies concerning storage containers and their effects on fat, carbohydrate, protein IgA, and white blood cell content of the milk after storage. Glass and polypropylene containers are frequently used. The plastic bags used for human milk storage should be sturdy, easily and effectively sealed, and readily labeled (name of child and date of milk expression). The bags should be stored in an area of the freezer to minimize damage to the bag. Containers made with bisphenol A or S should be avoided due to the potential effect the containers have on the milk during storage. Human milk should not be stored in hospital plastic specimen storage containers used for other bodily fluids.
4. Containers for human milk storage do not have to be sterilized. Washing in hot soapy water with careful rinsing and thoroughly drying (by air or paper towels) is sufficient. If soap is not readily available or water is limited, boiling them in water and cooling prior to use may be the preferred method of preparation. Chemical disinfection is not recommended.
5. There is no need to discard the first few drops of milk at the beginning of milk expression.
6. The mother's breasts and nipples do not need to be washed prior to milk expression.

MILK STORAGE GUIDELINES

Location of Storage	Temperature	Maximum Recommended Storage Duration
Room temperature	16–29°C (60–85°F)	4 hours optimal 6–8 hours acceptable under very clean conditions
Refrigerator	~4°C (39.2°F)	4 days optimal 5–8 days under very clean conditions
Freezer	<−4°C (24.8°F)	6 months optimal 12 months acceptable

USING STORED HUMAN MILK

1. Fresh milk is better than frozen milk; use the oldest milk first from the refrigerator or freezer.
2. Avoid using containers that have leaked or been rewarmed and recooled or refrozen.
3. Stored milk may have altered smell and taste due to enzymatic breakdown. This breakdown of fats can aid in digestion and is not harmful; however, some infants may refuse to drink it. Milk that appears stringy, foul, or purulent should not be fed to the infant.
4. The infant may drink the milk cool, at room temperature, or warmed, and infants may demonstrate a preference.
5. Defrost the stored milk in the refrigerator overnight, in running warm water, or by setting it in a container of warm water. Do not microwave the milk.
6. Previously frozen human milk, thawed in the refrigerator for 24 hours, should be used within a few hours at room temperature.
7. Avoid refreezing thawed human milk, due to lack of safety information on its reuse.

Continued

BOX 11.7 INFORMATION ON STORAGE OF HUMAN MILK FOR HOME USE WITH FULL-TERM INFANTS—cont'd

8. It is reasonable to discard milk leftover from a feeding within 1–2 hours (based on limited information). Storing milk in small volume increments (15, 20, or 60 mL) may limit wasting or discarding unfed amounts of milk.
9. Expressed human milk does not require special handling (e.g., universal precautions) as is recommended for other bodily fluids (such as blood, urine). It can be stored in any refrigerator with other stored foods, labeled and dated, although mothers may prefer to store their milk in a personal container.
10. Uncontaminated human milk naturally contains nonpathogenic bacteria, which is important to establishing normal neonatal intestinal flora. There is no evidence that stored milk from a mother with breast pain due to infection needs to be discarded.

[a]Centers for Disease Control and Prevention. How to Keep Your Breast Pump Kit Clean: The Essentials. https://www.cdc.gov/healthywater/hygiene/healthychildcare/infantfeeding/breastpump.html Reviewed July 8, 2020. Accessed January 9, 2021.

Data from Eglash A, Simon L, and the Academy of Breastfeeding Medicine Protocol Committee. ABM Clinical Protocol #8: Human Milk Storage Information for Home Use for Full-Term Infants. Revised 2017. Breastfeeding Med. *2017;12(7):390–395.* https://doi.org/10.1089/bfm.2017.29047.aje.

TABLE 11.6 Rates of Any and Exclusive Breastfeeding by Sociodemographic Status Among Children Born in 2017

	ANY BREASTFEEDING (BF) (%)			EXCLUSIVE BREASTFEEDING (EBF) (%)	
	Ever BF	BF at 6 months	BF at 12 months	EBF through 3 months	EBF through 6 months
RACE/ETHNICITY					
Hispanic	84.1	55.4	33.9	41.5	21.5
Non-Hispanic White	86.7	61.9	38.2	52.4	28.7
Non-Hispanic Black	73.7	47.8	26.1	38.7	21.2
Non-Hispanic Asian	90.0	73.5	50.0	47.7	26.8
Non-Hispanic Hawaiian/Pacific Islander	85.2	NA	NA	NA	NA
Non-Hispanic American Indian/Alaska Native	80.7	NA	NA	NA	NA
2 or more races	83.7	56.5	31.0	43.9	26.6
MATERNAL EDUCATION					
Less than high school	73.6	49.0	28.9	30.8	17.1
High school graduate	75.6	44.1	25.7	41.7	21.5
Some college/ technical school	84.7	53.6	31.1	45.4	23.3
College graduate	93.3	74.0	46.6	57.2	32.8
AGE					
Younger than age 20	74.0	NA	NA	NA	18.7
20–29	82.4	50.9	28.6	45.4	24.2
30 or older	85.2	62.7	39.2	47.8	26.5
MARITAL STATUS					
Married	89.7	68.2	43.7	53.7	30.6
Unmarried	75.1	42.5	21.8	36.1	17.6
RECEIVING WIC					
Yes	77.0	45.4	24.8	37.3	19.0
No, but eligible	82.1	61.3	43.4	53.8	31.1
Ineligible	92.1	71.4	44.8	55.7	31.3

From Centers for Disease Control and Prevention. Rates of Any and Exclusive Breastfeeding by Socio-demographics among Children Born in 2017 [updated 08/01/2019]. https://www.cdc.gov/breastfeeding/data/nis_data/rates-any-exclusive-bf-socio-dem-2017.htm.

need to understand and address structural determinants of health such as transportation, access to lactation/postpartum support, and paid family leave in order to eliminate breastfeeding inequities. For example, in 2012, 23% of women living in the US returned to work as early as 10 days postpartum,[207] making mental wellness, maternal-infant bonding, and establishment of breastfeeding extremely challenging in that short time frame. To address the health care inequities associated with breastfeeding, the obstetrician should understand the varied causes of health disparities and recognize that the solutions must occur at the patient level, practitioner level, health care system level, institution level, and at the level of policy and programs.[208,209] Antiracism health care is paramount to demolish the negative impact of racism, not race, on health care outcomes.

The social challenges in health care and the threats to equitable, nondiscriminatory health care facing mothers and families extend into the lesbian, gay, bisexual, transgender, queer/questioning, plus (+) (LGBTQ+) community.[79,210] Individuals from this community have experienced stigma, misunderstanding, and inadequate care due to prejudice and lack of understanding of individual needs. Here also there are tremendous opportunities to provide affirming, respectful health care. These can begin with the respectful use of language and terms, education of health care providers, providing gender-neutral bathrooms, displaying inclusive signage in the health care facility, and understanding the significance of gender-affirming medical and surgical treatments on pregnancy and breastfeeding/chestfeeding. (For example, chestfeeding

describes the action of a masculine-identified trans person in feeding their baby at the chest with or without previous surgery to affect existing mammary tissue.) Options regarding fertility (childbearing) and contraception should be explored with both parents, as should expressing or pumping breast milk, inducing lactation, sharing of infant feeding, colactation of an infant by two or more parents, bonding of the infant with each parent, use of donor milk and informal milk sharing, and the plans for parenting and support for the parents/family at home with or without breastfeeding. Some of these opportunities for creating and expanding respectful health care during pregnancy and lactation are reviewed by the Academy of Breastfeeding Medicine in their clinical protocol on lactation care for LGBTQ+ patients.[79] There remains a tremendous amount of work for each of us and all of us to do in collaboration with our patients to combat prejudices and institutional racism and create equitable, respectful lactation care for all mothers, partners, and all families.

Key Points

- Mother's milk is the most appropriate feeding for the infant in the first 6 months of life. It is ideal to continue mother's milk, while adding weaning foods, for the next 6 months and as long as mother and baby wish.
- There are very few true contraindications to the use of the mother's own milk for her infant. Maternal use of drugs of abuse should be limited if possible and breastfeeding continued considering the individual medications and the actual maternal doses. Specific maternal infections can be a contraindication to breastfeeding: HIV; HTLV-I; Ebola, Marburg, Lassa, and dengue viruses; and active pulmonary tuberculosis. Most maternal infections can be treated without interrupting breastfeeding. If the infant has the severe form of galactosemia, that can be a contraindication to breastfeeding.
- The obstetrician plays an important role in support of breastfeeding, beginning with the first prenatal visit, through pregnancy, at delivery, during the hospital stay, and as long as the mother requires assistance.
- A good understanding of the anatomy and physiology of the breast and the physiology of lactation is essential to guiding and assisting lactating mothers to achieve their breastfeeding goals.
- Establishing a breastfeeding-friendly office and hospital environment is essential to breastfeeding success.
- Obstetricians, pediatricians, and lactation professionals should work together to establish a knowledgeable and skilled environment for successful breastfeeding. There are numerous current resources of information, readily available to practitioners, to optimize the care of breastfeeding mothers and infants.

SUGGESTED READINGS

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A full reference list is available online at ExpertConsult.com.

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