Chapter 4

Lactation and Breast Milk Composition (excerpt)

In order to successfully pump long term, it is important to have a basic understanding of lactation and the composition of breast milk. While it is not essential to have extensive scientific knowledge, it is helpful to have a general sense of how things happen. There are many books already published that go into great detail about the structures of the breast and the process of lactation, so this *won't* be a master class on the subject. Rather in this chapter we'll look at the basics of lactation and gain an understanding of the key factors in breast milk production which will enable you to make informed decisions when it comes to exclusively pumping. I do encourage you to search out as much information on this topic as you can. The more you know, the better prepared you'll be. When breastfeeding, it is easy to rely on your baby's instincts to manage lactation—when your baby is hungry, you nurse—but when exclusively pumping it is up to you to set the schedule and create the demand so your supply will be sufficient for your baby's needs.

Critical Factors in Milk Production

An understanding of the lactation process is important for all mothers. Understanding how lactation is initiated and regulated can help you establish a strong milk supply, maintain that supply, and make decisions that reduce any potential negative effects on your supply.

Stages of Lactation

Lactogenesis I begins during pregnancy. The mammary glands change from inactive to active preparing for lactation. About half-way through pregnancy, the breasts will begin to produce colostrum. You may or may not experience leaking at this time. Breasts usually enlarge, veins become darker, the areolas enlarge and darken, and the nipples become more erect.

Lactogenesis II begins following the detachment of the placenta. This stage of lactation is triggered by a sharp decline of progesterone following the detachment and subsequent delivery of the placenta. Any retained placenta can greatly affect a mother's ability to establish a full milk supply.

Formula provided during this time (even just once) changes the normal flora of the gut and it can take days for it to return to normal. The gut flora of a breastfed baby is significantly different from that of a formula-fed baby.

Milk production slowly increases over the first few days postpartum. It usually takes two to five days for milk volumes to increase, but it can take longer depending on a variety of factors such as certain birth interventions or medical conditions. First-time mothers will see an increase later than mothers who have already had children.

It is important to realize that lactogenesis II will happen regardless of whether a woman is choosing to nurse her baby, express her breast milk, or formula feed her child since lactogenesis II is a result of hormonal factors.

Stages of Breast Milk

There are three stages of breast milk:

Colostrum is present at birth and is all a baby requires until milk production increases. It is yellow to orange in colour and is very thick and somewhat sticky. Colostrum is high in antibodies and protein and has a laxative effect, which assists a baby in removing meconium from her system. If meconium is not removed from a baby's system, it can lead to jaundice since bilirubin from the meconium will be reabsorbed. Colostrum also coats the gut providing protection from potential pathogens. It's important to realize that a baby's environment is sterile until birth. Once born, a baby is suddenly exposed to a host of dangers. Nature has provided the initial dose of colostrum as an "inoculation" against these many dangers. Since the mother has already been exposed to these dangers in the environment, her colostrum will provide antibodies against those elements specific to her environment.

If pumping, it is important to collect and feed colostrum, not only for the laxative effect, but also its immunological elements that will assist your baby in fighting off infections. While some pumping mothers choose to supplement with formula at birth, this is not always necessary, depending on how long it takes your milk to increase. Colostrum will assist the baby's digestive system to begin its work, rather than being pushed into high gear immediately at birth.

Transitional milk follows colostrum. It can be seen as early as twelve hours after delivery—although usually takes longer—and usually lasts one to two weeks. It is the consistency of mature milk, but it retains some of the colour of colostrum.

Mature milk has a slight bluish tinge to it and is rather thin when compared to formula or whole cow's milk. It contains all the nutrition that a baby needs for at least the first six months of life. Breast milk will continue to change throughout lactation,

responding to the needs of the infant, the mother's exposure to viruses and bacteria, and the mother's diet.

The Hormones Involved

Prolactin

Prolactin is the hormone responsible for triggering milk production. It is also referred to as a "mothering hormone" because it creates nurturing responses. Prolactin levels rise sharply following delivery and fall substantially over the first twenty-four to thirty-six hours post-partum. Prolactin is produced by the anterior pituitary gland and causes a decrease in estrogen levels. It also inhibits the maturing and release of eggs from the ovaries. The absence of menstruation during lactation is known as lactational amenorrhea. Prolactin levels naturally vary throughout the day with the highest levels in the early morning hours between 1a.m. and 5a.m. Once lactation is established, prolactin takes on only a permissive role as opposed to a regulatory role: it no longer drives production but its presence simply allows milk production to continue. While there has been no research showing a correlation between serum prolactin levels and breast milk volume, it is necessary to maintain prolactin levels for its permissive role.[1] Prolactin and dopamine have an inverse relationship. As dopamine levels rise, prolactin will decrease. If you have a condition or take medications that raise dopamine levels, this may cause issues with lactation. Smoking is one common activity that will raise dopamine and smoking has been shown to have a negative effect on lactation.

Likewise, it is important to note that progesterone may interfere with normal prolactin production and its interaction with cell receptors.[2] Progestin-only (mini-pills) birth control is the best oral contraceptive to use while lactating; however, due to the possibility that it may interfere with the establishment of the milk supply, it is usually recommended that you wait until your

supply is well established before starting even progestin-only birth control. Oral contraceptives containing estrogen are not recommended for lactating women. Seek the advice of a knowledgeable physician who is experienced with lactation and the possible effects of birth control. If you do take hormonal birth control and find that your supply is starting to decline, stop immediately and use a different form of birth control.

Oxytocin

Oxytocin is vital during both the birthing process (contractions) and lactation (milk ejection reflex). It is also a "loving hormone" assisting in creating affection and social bonds with others. Oxytocin can help to create a relaxed, calm, and euphoric feeling, which both the mother and the baby experience when breastfeeding. Oxytocin is important to the bonding of mother and baby and, in the presence of prolactin and its influence on mothering responses, oxytocin helps to create a strong bond between mom and baby. Oxytocin levels in the brain soar immediately after delivery—this is one reason why immediate and uninterrupted one-on-one time following a baby's birth is so important. Unfortunately, when pumping, the release of oxytocin is not associated with the connection between mom and baby. However, oxytocin is not only released during breastfeeding (or pumping) but also when we share meals together, hug or kiss, or share close connections, and so you can still build a strong bond with your child, even when not directly breastfeeding.[3]

Oxytocin receptors in the breast increase during pregnancy and also increase in the uterus prior to delivery. The uterus uses oxytocin to prevent post-partum hemorrhages by contracting the uterus. Oxytocin is released from the pituitary gland when the nipple is stimulated. Just as with breastfeeding, mothers may experience after-pains when pumping in the days following delivery.

Oxytocin acts upon the smooth muscles of the breast and causes contractions which push the milk into the ducts and to the nipple. The milk ejection reflex, or let-down, takes place multiple times during a feeding or pumping session since the oxytocin is released in waves as stimulation continues. As a new wave of oxytocin is released, a new let-down will occur. This knowledge is important for the mother who is exclusively pumping. Many women will stop pumping once their milk flow has slowed, having been told they should pump only a few minutes after the flow of milk has stopped. However, since the milk ejection reflex is initiated by waves of oxytocin being released, the flow of milk will also come in waves. It may take two or more let-downs in order to remove a sufficient amount of milk from your breasts.

Once lactogenesis II has begun, milk production is largely controlled by the baby, or in the case of a woman exclusively pumping, controlled by the pump and frequency of pumping sessions.

Endocrine and Autocrine Control

The production of breast milk is dynamic and active, and the control of production changes over the first few weeks post-partum. The breast responds to the stimulation of an infant or pump with a series of events that release hormones, which in turn stimulate a milk ejection reflex, or let-down, and prompt further production or signal the breast to decrease production if, for some reason, the milk is not removed from the breast.

Endocrine control refers to the hormonally driven stage of lactation—lactogenesis II—which will happen regardless of whether a baby is nursing or not (with rare exceptions such as Sheehan's Syndrome or physiological conditions such as hypo-plasia) and which lasts for a few weeks after a baby's birth. During this time, lactation is established and supply is set. Milk production will vary depending on the amount of stimulation to

the breasts, nipples, and areolas, and the frequency of stimulation. This is an amazing aspect of nature since the variation in frequency helps a mother regulate her milk supply depending on the number of babies she has. So milk supply will be different for the mother of a single baby as opposed to the mother of twins, and when exclusively pumping this must be taken into consideration. For this reason, it is vitally important that when pumping you pump frequently.

Autocrine (local) control is also referred to as lactogenesis III and is the maintenance stage of lactation. This relies on the principle of supply and demand, and it is both interesting and important to know that milk synthesis is controlled at the breast and independently in each breast.

So there are then three things necessary to maintain breast milk supply:

- there must be the required hormones present and they must successfully travel to the breast (known as endocrine control);
- there must be stimulation to the nipple, areola, and breast; and
- the milk within the breast must be removed (known as autocrine control).

Two Key Processes Controlling Milk Production

Milk removal is the primary control mechanism for milk supply. In other words, milk removed from the breast initiates more production of milk in the breast. As the scientific community continues to research lactation, the understanding of milk production continues to develop. One of the most important things to understand about lactation and milk production is this: milk production slows as the breast fills. This is a central tenet of milk production.

Far too often I read or hear women telling other women that perhaps they are not waiting long enough for their breasts to "fill up" again in between pumping sessions and this is why they don't have enough milk. This well-meaning advice goes against everything science teaches us about the process of lactation. If you want to produce enough milk you must pump frequently and remove as much milk as possible from the breast. Milk left sitting in the breast slows production. There are two reasons for this:

> 1) A mother's milk contains a protein called Feedback Inhibitor of Lactation (FIL). As the breast fills, naturally more FIL is present and production will begin to slow. Think of this process as a grocery conveyor belt. As you put groceries onto the belt, you have less and less room to add more groceries and eventually you must stop adding items because you have run out of room. In order to allow more groceries to be added—or breast milk to be produced—you must remove some of the groceries—or milk. Anyone who has ever suffered from engorgement will appreciate this little protein. It is important to have some limits on production or else engorgement, plugged ducts, and mastitis would be far more prevalent than they already are.[4]
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> 2) When the alveoli (small sacs that contain milk-producing cells) are full of milk, their walls expand and the shape of the prolactin receptors changes. (You'll remember that prolactin is the hormone that both initiates lactation and allows lactation to continue.) This prevents prolactin from entering at these sites and, as a result, slows milk production. As the alveoli empty, the receptors return to their normal shape, allowing prolactin to enter again and milk production to increase.[5]

These two processes are key to understanding milk production. Both frequency and efficiency of milk removal are primary in the initiation and continuation of production. Anything that interferes with these two aspects has the potential to interfere with or harm the continuing lactation.[6] It is clear that when milk is removed more frequently, then production will increase.[7]

The Prolactin Receptor Theory

The prolactin receptor theory is another important idea in lactation and has implications for all pumping moms. The basic idea of the prolactin receptor theory is that milk production is "set" during the first few days and weeks post-partum. Frequent stimulation increases the number of prolactin receptors in the breast, allowing the body to utilize prolactin more effectively. This sets milk production for the rest of the lactation period. Newborns naturally feed for short periods but feed very frequently. This encourages the increase of prolactin receptors and the establishment of a strong milk supply. For mothers who are using a breast pump to initiate their milk supply, it is important to understand the prolactin receptor theory and to follow a pumping schedule that provides frequent stimulation and removal of milk.

The most important aspect of the prolactin receptor theory is that the newborn's seeming desire to breastfeed all the time is biology's way of ensuring the mother's milk supply is ample five months or more down the road. Even though it may seem that there is no milk in the breast and that a baby is getting "nothing", a newborn who is nursing frequently is getting exactly what is needed and ensuring that will continue as he or she grows and develops. Hospital practices that separate mom and baby, birth interventions that prevent a baby from nursing within the first hour following delivery, or early bottle supplementation all have an impact on this natural process and inter-

fere with the normal development of prolactin receptors that are critical to long-term breastfeeding. As a pumping mom, this means that you also want to pump frequently and follow nature's plan as closely as possible.

Storage Capacity and Milk Production

Storage capacity is the amount of milk the breast can hold between nursing or pumping sessions. Storage capacity is *not* directly related to the size of the breast and can differ between breasts; in fact the right and left breast rarely produce the same amount of milk.[8] Storage capacity also has been shown to change during lactation.[9] Storage capacity of the breast affects the rate of milk production.[10] A large storage capacity will allow milk production to continue for a greater length of time before slowing since the receptors will not "stretch" until full. Think of this concept as a cup: you can drink a large amount of water throughout the day using any size of cup. If you use a small cup you will simply have to refill more often.[11] This is not an indication that a woman with a larger storage capacity can produce more milk, only that a woman with a smaller storage capacity will need to nurse, or pump, more frequently.

For a breastfeeding mom, storage capacity may affect a baby's feeding pattern. Mothers who have a smaller storage capacity will likely have babies that nurse more frequently. This is important for both the mom's milk supply and for the baby's sufficient intake. Mothers who have a larger storage capacity may have babies who go a little longer between nursing sessions, depending on the amount of milk a baby wants when nursing. A baby whose mother has a large storage capacity will more likely feed from only one breast when nursing as opposed to nursing from both breasts during each feeding.

And what does this mean for a mom who is exclusively pumping? Just like a nursing mom who will need to nurse more

or less frequently depending on her storage capacity, moms who are pumping will also be lead by their individual storage capacity to some extent with regards to how frequently they need to pump. Although when initiating supply it is important to pump frequently, once milk supply has been established a mother with a larger storage capacity can often drop to fewer pumping sessions than a mother with a smaller storage capacity and still maintain her supply. Unfortunately, there is little you can do to thwart nature and you're stuck with the storage capacity you've been given.

Research has shown, however, that the storage capacity of breasts increases between one month and four months post-partum.[12] This is particularly heartening for women who have struggled with production in the early weeks. Many women do find that production will continue to increase with good pumping habits over the first two to three months post-partum and perhaps this increasing storage capacity plays a role in that. While milk production is not dependent on breast volume (i.e. the amount of breast tissue), the study does suggest that both do naturally decrease over time. Apoptosis, which is a process of cell death that is programmed to occur, begins to happen around six months and breast tissue begins to involute; however, milk production continues. Decreased prolactin plays a role in apoptosis, and decreased frequency of milk removal, which results in milk left sitting in the breast, can also encourage apoptosis. For this reason, frequent expression should be continued for as long as possible when long-term pumping is your goal. The good news is that while storage capacity is related to milk production, there is no such connection between breast volume and milk production.[13] Whether A cup or DD cup, it doesn't matter.