

## Breastfeeding without Nursing Exclusive Pumping



Marsha Walker, RN, IBCLC  
 Marshalact@gmail.com

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### Breastfeeding but not at the breast

- 85% of breastfeeding mothers expressed milk sometime since their infant was born
  - Labiner-Wolfe et al. *Pediatr* 2008;122(suppl 2):S63-S68
- 5.6% of these mothers exclusively expressed
- Pumping without feeding at the breast is associated with shorter breastfeeding durations and earlier introduction of infant formula
  - Keim et al. *Breastfeed Med* 2017;12:422-429
- Also associated with development of high efficiency commercial pumps




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### Why exclusive pumping?

- Latch difficulty
- Pain
- Oral anomaly/cleft/tongue-tie
- Congenital condition
- Infant illness
- Adoption
- Preterm infant
- Multiples
- Maternal choice
- Breast anomalies/surgery
- Employment
- Weight loss strategy
- Sexual abuse history



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### A few things we don't know

- Does exclusive pumping result in:
  - Reducing or increasing the risk of maternal reproductive cancers, Type 2 diabetes, myocardial infarction, metabolic syndrome for the mother
  - Altered nutritional and immunological benefits compared to milk directly from the breast resulting in different infant health outcomes
  - The erosion of societal support for direct breastfeeding

"Accept it, without the advances of medical technology it would be impossible for you to breastfeed your baby!"



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### Much information on exclusive expressing comes from the lay literature

- Internet and social media represent the bulk of advice sources on exclusive pumping
- Are some of these sources promulgating advice that is harmful, anecdotal, or ineffective
- A whole industry has sprung up related to pumping
  - Does this introduce commercial bias rather than expert interventions



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### Many mothers think pumped milk is equivalent to milk directly from the breast

- Pumped milk may be stored between minutes and months
- Pumped milk can experience 5 or more temperature changes
- Pumped milk may come in contact with 2-6 containers before being fed to the infant
- Different bottle systems may contribute to nutrient degradation
- Infant formula may be added to human milk in the same container

Felice et al. Matern Child Nutr 2017;13:e12425

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### Alteration and contamination of pumped breastmilk

- Milk expressed by pumps can have higher levels of bacteria, including pathogenic bacteria, than direct breastfeeding or hand expressing
  - Boo et al. J Hosp Infect 2001;49:274-281
- Bifidobacterium* spp. exist in breastmilk at high levels but are significantly depleted in pumped breastmilk
- A family of bacteria that includes *E. coli* and *salmonella* are more abundant in pumped milk than direct breastmilk
- Pumped milk lacks inoculation by the infant's oral microbiota through retrograde or backwash movement of the milk
  - Moossavi et al. Cell Host & Microbe 2019;25:324-335
- Enterobacteria and other potential pathogens are enriched with indirect breastfeeding. Pump expression increases the abundance of this and other gram-negative bacteria in milk such as *Pseudomonas* and *Stenotrophomonas*
  - Jimenez et al. PLoS One 2017;12:e0181071

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### Infant gut microbiome is altered

- Gut microbiota is crucial in the development and education of the infant immune system
- Lower milk bacterial richness was found in pumped milk
- Pumped milk is enriched with environmental and pump-associated bacteria and lack bacteria from infant oral cavity

Paul Rogers, NY Times

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### Altered infant health outcomes when using pumped breastmilk

- Increased risk for otitis media
  - Boone et al. J Pediatr 2016;174:118-125
- ↑ risk for pediatric respiratory infection and asthma
  - Klopp et al. J Pediatr 2017;190:192-199
- Increased risk of coughing and wheezing
  - Soto-Ramirez et al. J Hum Lact 2013;29:71-80
- ↑ Increased risk of jaundice with *Bifidobacteria* depletion
  - involved in metabolism of bilirubin through galactose metabolic pathway
- Pumped breastmilk fed by bottle increased infants risk of becoming overweight or obese
  - Azad et al. Pediatrics 2018;142(4):e20181092

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### Effects of handling, storage, & transport of expressed breastmilk

- Vitamin C (ascorbic acid) levels can decrease by 1/3 after 24 hours of refrigeration
  - Buss et al. Acta Paediatr 2001; 90:813-815
- Calorie and fat content decrease with increasing freezing time
- Maximum decrease was seen between 0-7 days
  - Garcia-Lara et al. Breastfeed Med 2012;7:295-301
- ↓ antioxidant capacity with lowest seen at freezing for 7 days

	fresh	4°C (48 hours)	4°C (7 days)	-20°C (48 hours)	-20°C (7 days)
Human milk (n=14)	1.46 (0.04)	1.58 (0.06)	1.48 (0.05)	1.45 (0.05)	1.34 (0.04)
Formula (n=9)	1.07 (0.02)*	1.08 (0.04)*	1.05 (0.02)*	1.05 (0.02)*	1.07 (0.04)*

Data are presented as, Tolic, equivalent antioxidant capacity. \*p < 0.05 compared with human milk.

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### Storage containers and nutrient integrity

- Riboflavin (vitamin B2) and vitamin C can be degraded when exposed to light
- When placed in clear containers, mean levels of breastmilk vitamin C and B2 dropped rapidly
- Riboflavin dropped below 75% by 30 minutes and over 6 hours to <35% of baseline in a clear container
- Ascorbic acid level decreased to <68% of baseline by 30 minutes in a clear container
- Best container is amber colored as compared to clear, green, blue, opaque
- Francis & Dickton. J Nutr Health Food Eng 2015; 2(6):100883

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### Reducing photodegradation

- Feeding bottle covers and sleeves are typically used for insulation or on glass bottles to protect from breakage
- Perhaps the use of a sleeve or cover would help reduce vitamin C loss when feeding expressed breastmilk




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### Where mothers pump and store milk

Geraghty SR. Breastfeeding Medicine 2011;6:433-435



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### Refrigerated in variety of containers and next to assortment of foods



Temperature fluctuation      Months supply of milk in freezers



Microwave exposure      Taken shopping      Transported outside

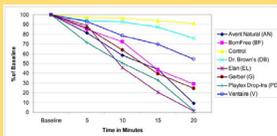


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### Feeding bottles and nutrient integrity

#### Ascorbic acid

- Milk-to-air interface (diameter of the bottle) had the greatest impact on decrease in ascorbic acid
- The larger the surface of milk contacting air, the greater the vitamin reduction
- Vitamin C levels decreased up to 76%
- Bubbles rapidly formed in all bottles except for Dr. Brown's
- Air moving through milk and formation of bubbles on the milk surface impacted levels of ascorbic acid depletion
- Venting of the bottle (no air moving through the milk and no bubbles) should be considered in bottle choice
  - Francis et al. Intl Breastfeed J 2008;3:19
- Bottle systems studied
  - Avent Natural
  - Born Free (glass)
  - Dr. Brown's Natural Flow
  - Evenflo Elan
  - Gerber Classic
  - Playtex Drop-Ins (plastic liner)
  - Playtex Ventaire

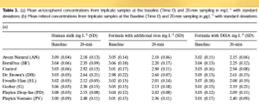
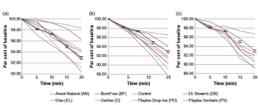


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### Feeding bottles and nutrient integrity

#### Retinol and alpha-tocopherol

- In a 20-minute simulated feeding, retinol (Vitamin A) and alpha-tocopherol (Vitamin E) displayed decreases over time significantly different than that of the Control, which was milk not exposed to bottle feeding.
- The correlation between degradation and bottle feeding systems was dependent upon the formation of bubbles in the milk as the milk was removed from the bottle
- A decrease of up to 12%, in retinol and 35% alpha-tocopherol was seen
  - Francis et al. Matern Child Nutr 2012;8:215-224

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### Marketing to meet a need!!




Squeeze all the air out before storage or feeding to minimize milk oxidation and nutrient degradation

- Nursh silicone bottles with collapsible liner
- 8oz pack of 3
- \$24.99 on Amazon
- 9 pack of silicone pouches
- \$24.99 on Amazon

\$16.99 on Amazon

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### "Off" or rancid flavors and odors of stored breastmilk

- Milk lipolysis is the process of milk lipids (fat) being hydrolyzed by lipase into free fatty acids (FFAs) and glycerol
- Large accumulated amounts of FFAs, especially short and intermediate fatty acids, cause a rancid flavor in the milk
- Milk lipolysis is inhibited when pasteurized or frozen at -70C (-94F) but home freezer temps are ~ -20C (-4F)
- Rancid flavor compounds, FFAs caproic acid and lauric acid, were found to increase with frozen storage time, with highest levels at 30 days compared with 7 days, gradually increasing over storage time
- The flavor of frozen milk may exceed the unacceptable rancid flavor threshold, especially for adults
- Lauric acid has an unclean and soapy flavor and may be the main contributor to rancid flavor of frozen breastmilk

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### Rancid flavors and odors

- Even though rancid-flavor of frozen breastmilk may be described as objectionable (at 7 days) and intolerable (at 30 days) by adults, it may be acceptable by many infants
- As evidenced by some infants accepting the flavor of Nutramigen
- Extreme lipolysis may increase the probability of infant refusal
- If infants refuse thawed milk, mothers could try providing freshly expressed milk or milk frozen for <7 days
  - Hung et al. BMC Pediatrics 2018;18:94
- Try flavoring the milk with vanilla



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### Rancid flavors and odors

- Survey of 84 mothers who stored their milk
- 73% froze milk
- 27% stored milk in refrigerator
- 24.6% had at least 1 episode of infant refusal
- Abnormal odor was noted by 25% of mothers
- 95% of those infants refused the milk with the off smell
- Mothers discarded the milk with the off smell
  - Francis & Dickton. J Nutr Health Food Eng 2018;8:391-392
- Scalded milk = 180F
- Boiled milk = 212F
- Holder pasteurization = 145F (for 30 minutes)
  - Inactivates lipase and decreases vitamin C

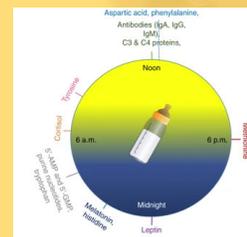


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### Chrononutrition

Hahn-Holbrook et al. Pediatr Research 2019;85:936-942

- Breastmilk is formulated to communicate time of day to infants
- Day milk has ↑ cortisol & activity-promoting amino acids
  - Promote alertness
  - Feeding behavior
  - Catabolic processes
- Night milk has increased melatonin & tryptophan
  - Foster sleep
  - Relax digestion
  - Support cell restoration
- Feeding from the breast matches maternal and other circadian rhythms
- Pumped milk may not be circadian-matched



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### Chrononutrition

- Cortisol levels are 330% higher in morning milk
- Cortisol acts as a modulator of infant circadian clock
- Melatonin levels not detectable during the day but rise in the evening and peak in the early morning hours
- Leptin regulates energy balance by inhibiting hunger, with levels higher in milk collected between 10:00pm and 4:00am
- Daytime milk has higher levels of immune factors
- Circadian clock controls rhythms in sleep-wake cycles, respiratory rate, body temperature, digestion, metabolism
  - Infants with colic have blunted cortisol rhythms with lower morning cortisol and higher evening cortisol

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### Chrononutrition

- Circadian-matched milk may improve infant health
  - Time spent in active feeding during the day
  - Growth rate
  - Sleep consolidation
  - Neurocognitive development
- Infants who are at high risk of infection or currently experiencing infection might benefit from milk collected during the day when immune factors are highest (such as IgA)
- Daytime colostrum and mature milk contain higher levels of phagocytes that engulf and destroy harmful microorganisms
- Mothers may wish to label expressed milk with time of day when it was expressed
- Feed the infant with the stored milk that best corresponds with the current time the infant is being fed

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### Formula companies understand chrononutrition!

- Thickened with rice starch and re-labeled from Enfamil AR
- Taken quickly off the market due to complaints
- Formula companies adding alpha-lactalbumin to formulas to decrease protein content
- Alpha-lactalbumin is a source of tryptophan
- Tryptophan is a precursor of serotonin, a neurotransmitter that may regulate sleep-wake rhythm and the response to stress



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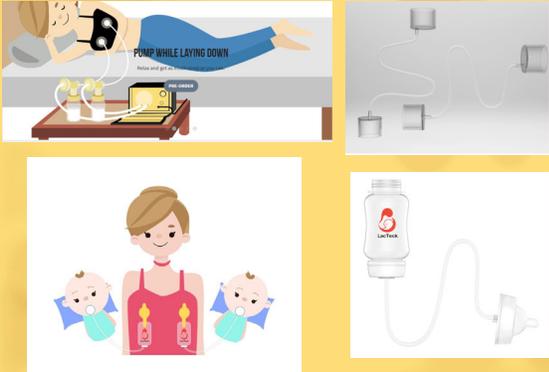
### Which pumps are best?

- Best pump depends on the situation and the mother (could even be hand expression!)
- High efficiency double electric pump for preterm and exclusive pumping from the start (Ameda, Medela, Spectra)
- Closed system
- May want or need to rent a pump
- May be able to use a personal use pump if mother has started breastfeeding but switched to exclusive pumping
- May want to use a hands-free pump (Elvie, Willow, Baby Buddha)
- May want a manual pump for backup
- Avoid previously used breast pumps unless they are designated as multi-user
- Insurance-provided pump may or may not be suitable for all mothers
- May want a hands-free bra
- Extra sets of pump parts
- All kinds of gadgets and accessories for exclusive pumping
- Lactalite



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### Gadgets-www.lacteck.com



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### Flange size

- Nipple diameters range from <12 mm at their base to >23 mm at the base
- Nipples swell during pumping
- Mothers with large nipples may find that a standard size flange is too small to accommodate both the large nipple and subsequent swelling
- Wilson-Clay and Hoover (2005) speculate that if a mother has a nipple size of approximately 20.5 mm (or the size of a US nickel) or larger she may benefit from using a larger than standard size pump flange

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### Proper flange fit



**Too Tight**                      **Just Right!**

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### Flange size

- The nipple should be able to elongate without rubbing against the sides of the nipple tunnel
- Too small: areola cannot move into tunnel
  - nipple is sore, tender
  - nipple blanched white on removal of flange
  - skin flakes visible on the nipple tunnel
- Tight fit compresses milk ducts and does not allow for effective milk removal
- Incomplete drainage can lead to low milk supply, plugged ducts and mastitis

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### Pumpin' Pal

- Different sizes of angled flange may help if mothers cannot find a good fit
- Some mothers rotate flange sizes during pumping sessions to account for nipple swelling
- Can apply olive oil for better seal and to prevent abrasion



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### Flange cushions and inserts

- Beaugen Mom flange cushions
- Marketed to customize fit, reduce friction, and replace need for lubrication
- <https://www.beaugen.com/>



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### Maymom shield sizing

- Inner diameter of flange should be 1-2mm larger than diameter of nipple after pumping, or
- 3-5mm larger before a pumping session
- 15, 17, 19,, 21, 24, 25, 26, 27, 29, 30, 34, 36mm and 22 and 28mm inserts



Downloadable caliper for measuring nipples  
[www.maymom.com](http://www.maymom.com)

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### Open system

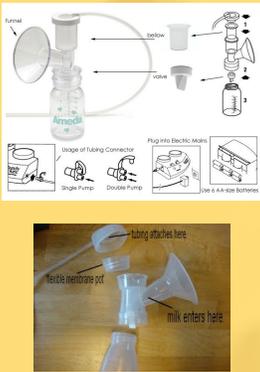
- Multiple use of single-user devices typically invalidates the manufacturer's warranty
- Many single user pumps are open systems and may not have any protective barrier to prevent cross contamination from multiple users



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### Closed system

- Physical separation between air intake and milk
- May be a barrier inside the pump
- Reduces the chance of internal pump contamination and milk contamination from ambient air



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### Used pumps

- A borrowed pump can be ineffective or break, necessitating the purchase of a replacement pump
- Because pumps have a limited lifetime, some mothers who borrow or purchase previously used pumps may put their milk supply at risk because the device cannot operate at its optimum
- The motor may be worn down so much from use that it cannot generate enough vacuum to be effective

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### Cleaning pumps

- First Years pump with *Serratia marcescens*
- Cleaning instructions should include taking apart all of the pieces for washing
- Moisture in Medela tubing should be removed by swinging tubing or leaving just the tubing attached while running the pump for several minutes



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### *S marcescens*

Makes bacterial contamination obvious to the naked eye

Produces a pink pigment called prodigiosin




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### Mold in pumps and pump parts



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### Pumping more effectively

- Increasing the frequency of pumping beyond a certain number of times or lengthening the duration of pumping sessions may be less effective than increasing the degree of emptying of the breast



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### Pumping more effectively

- Amount and rate of milk a mother expresses each time she pumps is highly variable
  - individual rate of milk production
  - vacuum pattern generated by the pump
  - the amount of milk stored in the breast when the mother begins a pumping session
  - time since she last pumped or breastfed
- Rate of milk expression changes over the first 5 minute expression period
- Rate of milk removal remains constant over the first 2.5 minutes, but decreases by 5 minutes
- First 2 milk ejections make the most amount of milk available for removal

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### Pumping more effectively

- Combining milk expression techniques may result in greater milk output (Morton et al. 2009).
- Found that in pump-dependent preterm mothers, those that used hand expression greater than 5 times/day and an electric pump 5 times/day during the first 3 days postpartum produced significantly larger volumes of milk than mothers who only used an electric pump.
- Massaging each breast while using an electric breast pump significantly increased the amount of milk pumped at each session.
- Over the 8 week study, mothers who combined early hand expression of colostrum in the first 3 days following birth and who used breast massage and compression while pumping and hand expression if needed, produced more milk than term mothers (average 955 mL per day).

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### Pumping more effectively

- Once mature milk came in, mothers who used breast massage/compression/hand expression in addition to pumping were most likely removing a greater percentage of milk per expression, which allowed greater milk production with less frequent expression.
- The authors found that the use of high frequency pumping ( $\geq 7$  times/day) was more important for the establishment of lactation than its maintenance.
- Some mothers in the study who used the hand techniques concurrently with the breast pump were able to maintain and increase milk volume despite less frequent pumping.

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### Pumping more effectively

- Timing of when breastmilk expression is begun relative to delivery can have an important influence on pumped milk volume.
- Parker et al (2012) studied effects of early initiation of milk expression on the onset of lactogenesis stage II and milk volume in mothers of very low birthweight infants.
- 20 women randomized to initiate milk expression within 60 min of birth (group 1) or 1 to 6 h after birth (group 2).
- Milk volume and timing of lactogenesis stage II was compared between the two groups.
- Group 1 produced significantly more milk than group two during the first 7 days and at week 3.
- Group one also demonstrated a significantly earlier lactogenesis stage II.
- Clinicians may wish to recommend that mothers of preterm or ill infants start milk expression within an hour of birth

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### Pumping more effectively

- Ohyama et al. (2010) found that manual expression yielded twice as much colostrum as did electric pumping during the first 48 hours following delivery in mothers who delivered between 29 and 39 weeks.
- Net milk yield was 2 mL (range 0 to 12.6 mL) in the hand expression group and 0.6 mL (range 0 to 7.2 mL) in the pump group.
- Mothers in this study alternated between manual expression and using a double electric pump every three hours, such that every other expression session was done by hand.

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### Warmth

- The warming of tissues is a known therapeutic intervention that has the effect of increasing local blood flow and metabolism in tissues, facilitating excretion of tissue waste materials and phagocytosis, and enhancing tissue nutrition
- Warm compresses placed on the breasts have long been recommended to aid the let down reflex.
- Kent et al(2011) found that warmed pump flanges resulted in a larger amount of available milk removal.

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### Warmth

- Yigit et al (2012) studied if warming the breast prior to pumping would increase the volume of milk expressed from a warmed breast compared with the other breast which was not warmed.
- Mothers placed a warm compress (40.5C/104.9F) on one breast prior to pumping with an electric breast pump.
- The amount of milk obtained from the warmed breasts was significantly higher than that obtained from the non-warmed breasts.
- Warming probably has an enhancing effect on the milk ducts or milk flow, allowing more milk to be pumped, rather than increasing actual breastmilk production.

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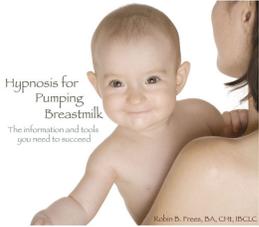
### Music

- Keith et al (2012) found that pump dependent mothers who listened to music while pumping produced significantly more milk with a higher fat content



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[http://www.newbornconcepts.com/products#pumping\\_cd](http://www.newbornconcepts.com/products#pumping_cd)



**Hypnosis For Pumping Breastmilk**

1. Welcome
2. What is Hypnosis?
3. Information for Successful Pumping
4. Guided Imagery for Pumping -20 minutes
5. Guided Imagery for Pumping - 10 minutes
6. Music Only - 20 minutes

Voice: Robin B. Frees, BA, CH, IBCLC  
 Cover design: Josh Frees  
 Photo: Grafissimo  
 Music: Soothe by Spinn Lynn

Disclaimer: This CD is designed to help you improve your pumping techniques so that you can provide breastmilk for your child when you cannot breastfeed and also if needed, increase your milk supply. It is not a substitute for a board certified lactation consultant or medical advice. If you have painful nipples, low milk supply latch problems or general questions, please contact your doctor or local board certified lactation consultant for further help and information. To find an LC in your area, go to [www.lca.org](http://www.lca.org) and click on "find a lactation consultant".

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### Acupressure

Esfahani et al. 2015. Iran J Nurs Midwifery Res, 20:7-11.

- Acupressure for enhanced milk production
- Can be applied by the mother
- GB20 (in a depression between the upper portion of the sternocleidomastoid muscle and the trapezius on the same level with GV16), acupoint LI4 (on the dorsum of the hand, between 1<sup>st</sup> and 2<sup>nd</sup> metacarpal bones), and acupoint SI1 (1 cun posterior to the corner of the nail on the upper side of the little finger)



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### Acupuncture for insufficient milk



- Clavey (1996) reported 90% effectiveness for insufficient milk when started within 20 days of delivery
- American Journal of Acupuncture 1996; 24:35-46
- Wei et al (2008) described electro-acupuncture at Shaoze (SI 1) as effective for insufficient milk
- Wei, et al. (2008). Journal of Traditional Chinese Medicine 28:168-172

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### Pump mechanics

- Have the mother try a different pump. A different suction curve may provide a boost to milk output.
- Check the mother's expectations of the pump.
- The mother may think a small electric pump should behave in the same manner as a hospital-grade pump.
- The small pump may be working correctly based on its capabilities, but not in an effective enough manner to support an abundant milk supply



**Figure 2.** Water pump circa 1940. Courtesy Queen Charlotte's and Chelsea Hospital Milk Bank.

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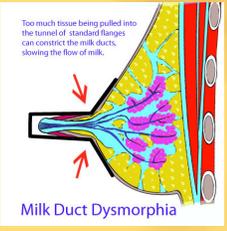
### Sore nipples

- Avoid using a pump that cycles less than 40 times/min. Such a pump holds vacuum on the nipple for prolonged periods of time during each suction phase.
- Use a properly fitting flange.
- Some mothers start out a pumping session with a standard size flange and switch to a larger one midway through as the nipples swell. Mothers may need to change flange sizes during the pumping experience if the nipples become sore from pumping.
- Use a larger flange or a different pump if the nipple turns purple while pumping. This may indicate that the vacuum curve is not allowing venous blood to leave the nipple and is blocking oxygen rich blood from entering. Mothers may need a larger flange or a different pump, with a suction curve better suited to the mother.

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### Sore nipples

- Pumping has an impact on nipple and areolar tissue
- Structural difference between left and right breast
- The nipple/areola stretched to twice its resting length with direct breastfeeding and quickly returns once infant is unlatched
- Pumping can cause swelling, erythema, pain
- Abnormal enlargement of nipple diameter and length can persist after pumping sessions
  - Francis & Dickton. Breastfeed Med 2019; <https://doi.org/10.1089/bfm.2019.0008>
- These symptoms may indicate soft tissue injury
- May need different flanges and or different pump



Too much tissue being pulled into the tunnel of standard flanges can constrict the milk ducts, slowing the flow of milk.

**Milk Duct Dysmorphia**

<https://pumpingpal.com/milk-duct-dysmorphia/>

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### Sore nipples

- Elicit milk ejection prior to the start of pumping to decrease the time vacuum is applied to the breast when milk is not flowing.
- Pump for shorter periods of time, but more frequently.
- May need different size flange for each breast
- Lubricate the flange with a little olive oil.
- Temporarily reduce the amount of vacuum until the nipples feel better.
- Consider hand expression

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Hang in there Mama--  
you got this!



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