Breastfeeding without Nursing
Exclusive Pumping

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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
- Also associated with development of high efficiency commercial pumps

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

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

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
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

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

Effects of handling, storage, & transport of expressed breastmilk

- Vitamin C (ascorbic acid) levels can decrease by 1/3 after 24 hours of refrigeration
- Calorie and fat content decrease with increasing freezing time
  - Maximum decrease was seen between 0-7 days
- Antioxidant capacity with lowest seen at freezing for 7 days

Altered infant health outcomes when using pumped breastmilk

- Increased risk for otitis media
- Increased risk for pediatric respiratory infection and asthma
- Increased risk of coughing and wheezing
- 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

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
  - Sun & Dobson. J Nutr Health Food Eng 2018;5(4):00083
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.

Where mothers pump and store milk

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

Reducing photodegradation

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

Marketing to meet a need!!

- 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

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
“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 -70°C (-94°F) but home freezer temps are ~ -20°C (-4°F).
- 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.

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.
- Try flavoring the milk with vanilla.

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.
- Scalded milk = 180°F.
- Boiled milk = 212°F.
- Holder pasteurization = 145°F (for 30 minutes).

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.

Chrononutrition

- Breastmilk is formulated to communicate time of day to infants.
- Day milk has 1 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.

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.

Chrononutrition

- Inactivates lipase and decreases vitamin C.

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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

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

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

Proper flange fit

- 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

Gadgets-www.lacteck.com

- Extra sets of pump parts
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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.

Beaugen Mom flange cushions are marketed to customize fit, reduce friction, and replace need for lubrication. Visit https://www.beaugen.com/ for more information.

Inner diameter of flange should be 1-2mm larger than diameter of nipple after pumping, or 3-5mm larger before a pumping session. Maymom shield sizing includes sizes 15, 17, 19, 21, 24, 25, 26, 27, 29, 30, 34, 36mm and 22 and 28mm inserts. Downloadable caliper for measuring nipples is available at www.maymom.com.

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.

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.

A borrowed pump can be ineffective or break, necessitating the purchase of a replacement pump. Many single user pumps are open systems and may not have any protective barrier to prevent cross contamination from multiple users. The motor may be worn down so much from use that it cannot generate enough vacuum to be effective.
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

*S marcescens*

- Produces a pink pigment called prodigiosin
- Makes bacterial contamination obvious to the naked eye

Mold in pumps and pump parts

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

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

- 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).
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 (> 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.

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.

Warmth

- Kent et al. (2011) found that warmed pump flanges resulted in a larger amount of available milk removal.
- 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.

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.
Acupressure


- 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 1st and 2nd metacarpal bones), and acupoint SI1 (1 cun posterior to the corner of the nail on the upper side of the little finger)

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

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

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.
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.

Hang in there Mama-- you got this!