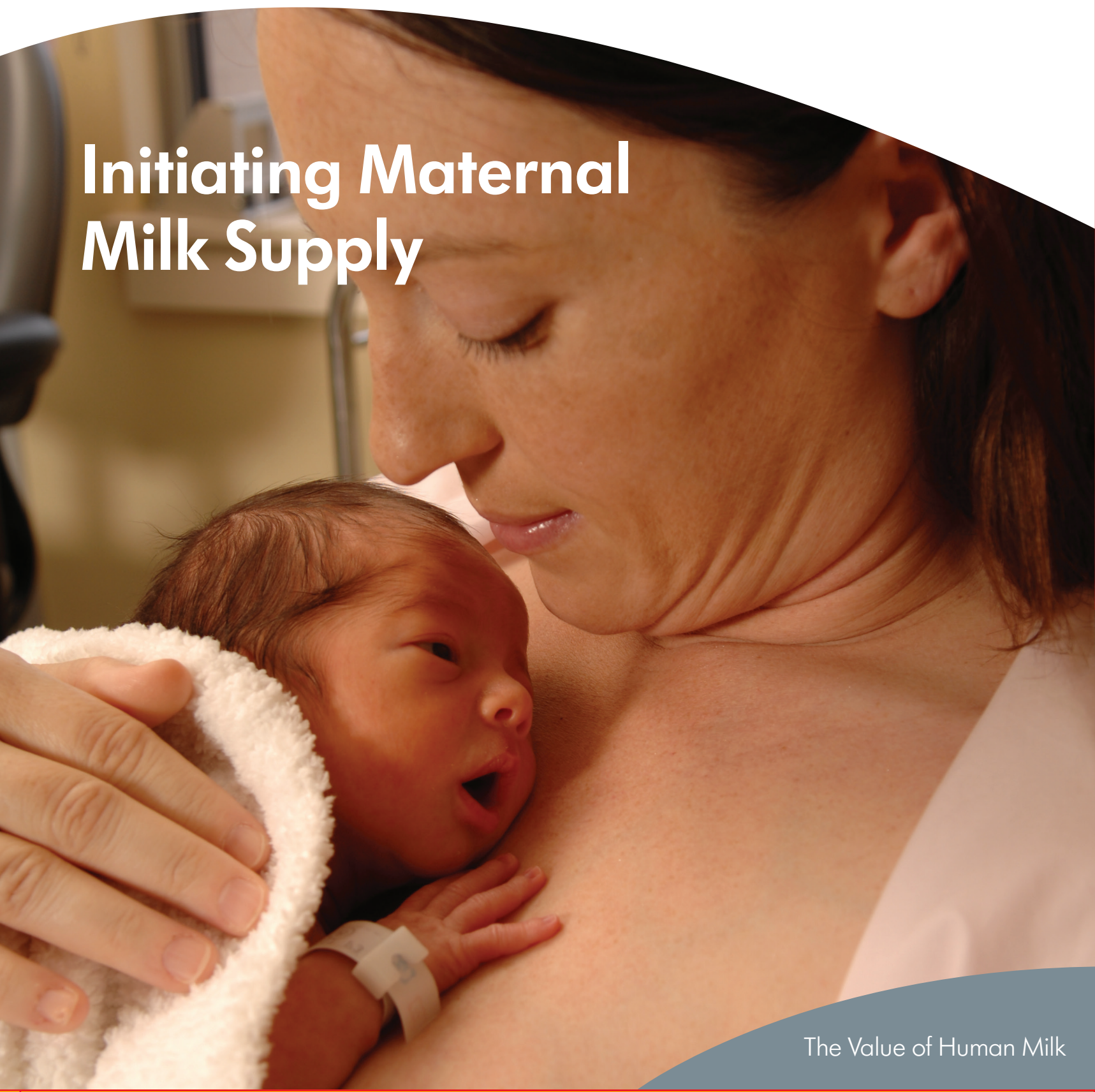




Every Drop Counts®

Initiating Maternal Milk Supply



The Value of Human Milk

Innovating Practice through Research and Evidence: Technological Advances for Initiating Maternal Milk Supply

Implications for Successful Lactation

Introduction

Although breastfeeding initiation is at an all-time high of 83%, rates of breastfeeding exclusivity and duration lag behind national goals. Women who stop breastfeeding before meeting their goals often report they did not have enough milk. The ability to initiate, build and maintain breast milk volumes sufficient to meet an infant's needs are dependent on complex interwoven factors. Additionally, there are multiple maternal risk factors for delayed milk production and suppressed lactation:

- Primiparity
- Cesarean sections
- Maternal age > 30
- Elevated BMI
- Glucose resistance

Demographic trends in the United States indicate all these risk factors have increased, some quite dramatically, in the last 20 years. Additionally, many women have multiple risk factors and are at significant risk for lactation problems. New evidence suggests babies' feeding behaviors have an important role in determining lactation success. These unique infant sucking patterns in the first few days of life appear to program mothers' breasts for optimal milk production. New breast pump initiation technology that mimics early newborn sucking is a potentially viable and safe intervention to provide at-risk mothers with additional breast stimulation for optimal milk production outcomes.

In many lactation situations, interventions aren't started until a mother reports problems. By identifying mothers who are at risk for delayed or suppressed milk production, especially those mothers with multiple risk factors, clinicians can increase surveillance of infant feeding progress and intervene proactively with breast pump initiation technology.

Key Points

- Initiation of secretory activation (lactogenesis II) begins with a dramatic decline in progesterone after delivery of the placenta followed by hormonal and breast changes resulting in a significant increase in milk production within the first few days postpartum.
- Early mammalian sucking patterns can influence maternal milk production for the duration of lactation.
- Prior to secretory activation, healthy breastfeeding infants suck irregularly: Sucking rates and strength vary and long pauses are interspersed between sucking bursts. This initiation pattern is believed to program mothers' breasts for successful milk production in days, weeks and months to come.
- Once mothers' milk is established, infants suck in a bi-phasic pattern that begins with rapid sucking to elicit milk ejection and is followed by slower, deeper sucking to remove milk.
- A breast pumping initiation pattern that mimics initial term infant sucking, in combination with a bi-phasic pattern after secretory activation, appears to program the breast for optimal milk production. Together, these two patterns create an initial pumping program for optimal milk production.
- Mothers of preterm infants who use the Initiation Program produce milk volumes similar to exclusively breastfeeding mothers of term infants.
- The Initiation Program yields similar milk production results in pump-dependent mothers of term infants with congenital cardiac disease.
- Studies support use of the Initiation Program in pump-dependent mothers with infants born at any gestational age.
- Research demonstrates use of the Initiation Program significantly shortens the time to secretory activation, helping mothers make more milk more quickly.
- The Initiation Program increases the chance of adequate milk production. In one study, 94% of mothers achieved >500mL/day compared to 53% of those using a standard bi-phasic pattern only.
- In two studies, daily milk production is 67% higher in women who used the Initiation Program compared to the standard program.
- Hospitalized infants need mothers' milk as quickly as possible and in sufficient volumes to meet 100% of their needs. The Initiation Program can help them reach this goal.

Meier PP, Engstrom JL, Janes JE, Jegier BJ, Loera F. Breast Pump Suction Patterns that Mimic the Human Infant during Breastfeeding: Greater Milk Output in Less Time Spent Pumping for Breast Pump- Dependent Mothers with Premature Infants. Journal of Perinatology. 2012; 32(2):103-10.

Background

During pregnancy, progesterone acts to suppress lactation in the presence of high prolactin levels. In the first few days after birth when colostrum is present, term breastfeeding infants demonstrate an irregular sucking pattern consisting of sucking bursts of various lengths interspersed with short and long pauses. On the first postpartum day, infant intake at breast is generally quite low, approximately 15+/- 11 mL,⁹ but sufficient for infants' needs. With secretory activation, breast milk volumes increase dramatically. To accommodate changes in milk volumes and coordination of the milk ejection reflex (let-down), infants alter their sucking patterns. Infants begin to suckle in a rapid, gentle pattern to stimulate mothers' milk ejection reflex. As mother's milk flows rapidly from the alveoli through the ducts to the nipple, infants suck with increased vacuum levels but slower rates, allowing time to swallow and breathe.¹⁰⁻¹³

Mothers of preterm infants who are not nursing have not been exposed to the initial irregular sucking pattern of term infants. Medela Symphony® Breast Pump is a hospital-grade (multi-user) breast pump that contains technology to allow programming of innovative pumping patterns. The original Standard 2.0 pattern was designed to express breast milk with 2-Phase Expression Technology® mimicking term infants at breast as mothers' milk begins to "come in." The authors from Rush University Medical Center hypothesized this early sucking pattern may be a critical phase in establishing an adequate volume of breast milk.

Therefore, the purpose of this study was to evaluate the effectiveness, efficiency, and comfort of new breast pump patterns that simulate term infant sucking in the initiation and maintenance phases of lactation. In collaboration with Medela scientists and engineers, these test patterns were designed and installed in Symphony breast pumps.

Three combinations of pumping patterns were developed and compared in a randomized block design clinical trial. A total of 105 mothers of infants born $\leq$ 34 weeks completed the study. Mothers were blinded as to the pump pattern combination they were using. To insure continuity of study protocols, women took the Symphony pump home at hospital discharge.

All women were instructed to pump for 15 minutes eight times a day, starting with the Initiation Program to which they were assigned. Once they had achieved two consecutive sessions of 20 mL or more, they were to switch to the maintenance program. At this point, secretory activation was beginning (the milk was "coming in") and milk production was increasing.

Women were assigned to one of the following groups:

1. Standard 2.0 program: Subjects used the Medela Standard 2.0 bi-phasic program (stimulation phase followed by expression phase) for both the initiation and maintenance phases.
2. Initiation (Preemie +) program: Subjects used an experimental pattern for milk initiation based on initial term infant sucking, followed by the Standard 2.0 pattern for maintenance.
3. Two experimental patterns in one program: Mothers in this group did not find the suction strength in the maintenance phase comfortable; therefore, study of this program was discontinued.

Research measures focused on three categories of outcomes:

1. **Effectiveness** of the breast pump suction patterns as indicated by:
 - Onset of lactogenesis II as determined by two consecutive pumping sessions of 20 mL or more
 - Daily maternal milk output from mothers' milk pumping diaries
 - Percentage of mothers who reached a total milk output of ≥ 350 mL and ≥ 500 mL per day
2. **Efficiency** of the breast pump suction patterns as indicated by:
 - Number of pumping sessions
 - Number of minutes spent pumping
 - Milk output per minute

Results

Effectiveness

- On day four, the Initiation Program and standard program groups began to show differences in mean daily milk output with mothers in the Initiation Program group pumping 50% more milk. By day seven, women in this group had achieved 67% more milk output with significantly higher milk volumes maintained until the study was concluded on day 14.
- At different time points, a statistically significant greater percentage of women in the Initiation Program group were making at least 350 mL and 500 mL per day.

Efficiency

- There were no statistically significant differences in daily minutes spent pumping or number of pumping sessions between the three groups.
- Milk output per minute was highest for the Initiation Program group, statistically significantly higher from days 8-14.

Conclusions

The authors concluded the combination of the experimental initiation pattern (modeled after term infant irregular sucking) paired with the Medela Standard bi-phasic maintenance pattern after secretory activation was the most effective, efficient and comfortable in initiating, building and maintaining human milk production in mothers of preterm infants.

The authors discussed the early post-birth time as a critical period of cellular proliferation, differentiation and programming of the human breast for successful lactation. By day six, women using the Initiation Program achieved similar average daily milk volumes as women breastfeeding term infants. These milk volumes were maintained until the end of the study on day 14.

Milk volumes achieved by the Initiation Program were higher than those previously reported for pump-dependent women.

Commentary

This study is an excellent example of insightful research based on observations of real-life phenomena: initial term infant sucking behaviors are natural and purposeful in establishing successful lactation. The results clearly normalize early infant behaviors as non-pathologic and support other research related to skin-to-skin time, prolonged maternal-infant contact and breastfeeding positions that maximize expression of primitive neonatal reflexes and unscheduled breastfeeding.¹⁴⁻¹⁷ Furthermore, the results indicate that mothers who miss the experience of breastfeeding can be supported with pumping technology to initiate and build higher milk volumes within the brief period of milk coming to volume.

This study supports previous work in animals and humans that mammalian breasts are programmed for milk production in the early days after delivery.^{3,18,19} During pregnancy, alveolar epithelial cells differentiate under the influence of estrogen, progesterone, prolactin, growth hormone and glucocorticoids into milk-secreting lactocytes although copious milk production is suppressed by the action of progesterone on prolactin. After delivery of the placenta, progesterone withdrawal in the presence of high circulating levels of prolactin ($\sim 200\text{ng/mL}$)¹³ triggers secretory activation (lactogenesis II). This process occurs approximately 30-40 hours after giving birth in postpartum women.¹⁰ Under the influence of glucocorticoids, tight junctions between the lactocytes close and concentrations of milk components change. Increasing lactose concentrations draw water into the milk compartment of the alveoli causing the onset of copious milk production.¹⁰ Prior to this time, breastfeeding infants exhibit an intermittent sucking pattern of rapid sucking bursts of varying lengths followed by long pauses, obtaining the colostrum they need in very small amounts. Once secretory activation begins, milk volumes increase in response to prolactin from less than 100 mL per day¹³ to approximately 600 mL by day six.²⁰ Milk ejection reflexes (MER) stimulated by oxytocin release large quantities of milk into the ductal system, making mother's milk available to the sucking infant. In response, infant sucking patterns change to a bi-phasic pattern of rapid, lower amplitude sucking for MER stimulation to slower deeper sucking for milk expression.^{11,21-24}

After initial endocrine system regulation of lactation, autocrine factors begin to influence production; sustaining milk volumes is dependent on successful and timely milk removal. This is not to say prolactin and oxytocin cease to influence the breasts, but rather, the primary regulator of milk production maintenance is how well the breasts are drained.¹⁰

In the context of breastfeeding initiation, an erratic sucking pattern may stimulate enhanced development of prolactin receptors and maintain high levels of prolactin necessary for lactation initiation. Additionally, oxytocin release as a result of nipple/breast stimulation increases prolactin levels, increases blood flow to the chest and nipple, reduces maternal stress response and raises pain threshold.²⁵ In Meier et al,⁴ the intervention that made the most difference was the initial sucking pattern paired with the Medela Standard 2.0 pattern to express milk once secretory activation begins. This pumping program is commercially available. This study also demonstrates mothers of preterm infants have the ability to produce, via pumping with this Initiation Program, volumes of milk equal to those of mothers of breastfeeding term infants. Given these results, clinicians have asked what impact this program might have on pump-dependent mothers with term infants.

The next section will examine a study of mothers of term infants with congenital cardiac disease cared for at the Children's Hospital of Philadelphia. In this hospital, the majority of mothers used the Initiation Program to initiate breast pumping.

Torowicz DL, Seelhorst A, Froh EB, Spatz DL. Human milk and breastfeeding outcomes in infants with congenital heart disease. *Breastfeeding Medicine*. 2015;10:31-37.

Background

Infants with congenital heart disease (CHD) require highly specialized pediatric cardiac intensive care immediately after birth. For parents, the experience is similar to that of having an extremely preterm baby - unpredictable and stressful. Like mothers of preterm infants, these mothers are encouraged to express milk for their babies, however, human milk feeding opportunities are often disrupted by surgical interventions. Many studies describe maternal pumping experiences and outcomes in the NICU, but limited information is available regarding human milk production and feeding practices for cardiac mother-infant dyads.

Therefore, the purpose of this prospective cohort study conducted at Children's Hospital of Philadelphia (CHOP) was to describe breast pumping protocols for human milk feeding practices of infants born with congenital heart disease.

Study questions included:

- What is the pumping initiation rate of mothers of cardiac intensive care unit (CICU) infants?
- What is the mother's ability to maintain an adequate milk supply throughout the infant's initial hospitalization?
- Of the babies receiving mother's milk, what is the infant's dose and exposure to human milk throughout the hospitalization?
- How are infants fed – by gavage, bottle or breastfeeding?

Results

Potential subjects assessed for eligibility included 153 infants admitted to the Children's Hospital of Philadelphia CICU. 62 mother-infant dyads were enrolled.

Breast pumping initiation

- Seven mothers (11% of subjects) planned to use formula and did not initiate pumping.
- Full data was collected on 52 mothers (89% of the total) who planned to express breast milk and/or breastfeed. All of these mothers had term infants. 75% percent initiated pumping on the day of delivery.
- 96% percent of the mothers of infants hospitalized in the CICU at CHOP initiated pumping using the Initiation Program used in the Meier et al study⁴ during the first 3-5 days postpartum.
- 67% of mothers who delivered at outside facilities initiated breast pumping. Pump brands/models were not given.
- The average number of pumping sessions per 24 hours was 5-6 with maternal milk volumes, ~500 mL/day by day seven, and over 600 mL/day by day 14.

Infant exposure to human milk and method of feeding in infants receiving human milk

- The average percentage of mother's own milk received per infant per day was 53.6%.
- When the authors subtracted data from the days infants were not fed, the average percent of mother's own milk /day was 70.2%.
- 63% of all feeds were by bottle; 30.5% by gavage; 13% by breast.

Conclusions

Prenatal preparation of parents for an infant with CHD and delivering at a hospital with a CICU can influence a mother's decision to provide milk for her infant.

The authors concluded mothers of infants with congenital heart defects can successfully initiate and establish their milk supply when supported and encouraged. However, due to the short length of hospital stay for this population of babies, many of these infants were not feeding directly at breast upon discharge.

The authors also concluded the Initiation Program facilitated adequate and timely milk production in mothers of term infants who are separated from their mothers.

Commentary

Despite stressors associated with delivery of an infant with congenital cardiac disease, this study suggests mothers of term, hospitalized infants respond in a similar manner as preterm mothers to the Initiation Program. Additionally, results support other interventions to enhance human milk delivery to critical care neonates; prenatal education regarding the benefits of lactation and a supportive institutional culture were vital components of the CHOP program.

Early breast pump initiation is strongly encouraged at CHOP. 75% percent of study mothers began pumping within 24 hours of delivery; however, more detailed information was not available. The 2018 Unicef/WHO document, "Implementation Guidance: Protecting, Promoting and Supporting Breastfeeding in Facilities Providing Maternity and Newborn Services - The Revised Baby-Friendly Hospital Initiative" and Evaluation Criteria for Facilities Seeking Baby-Friendly Designation²⁶ specifies mothers should be supported to initiate breastfeeding as soon as possible after birth, within the first hour after delivery or, if separated from their infants, mothers should be assisted to express milk within one to two hours. Human Milk Banking Association of North America (HMBANA) 2019 guidelines⁷ recommend pumping within six hours of birth. In 2012, Parker et al⁵ conducted a randomized study of mothers of very low birth weight infants that suggested pumping within the first hour produces more milk and leads to an earlier onset of secretory activation than pumping one to six hours after delivery. At three weeks postpartum, milk volumes were also higher. Early breast pumping is consistent with World Health Organization recommendations to initiate breastfeeding within one hour of birth. Both practices provide breast and nipple stimulation, contributing to the cascade of physiologic and hormonal events that stimulate milk production.

Initiating and establishing milk production for a hospitalized infant can be fraught with anxiety and stress. In both of the articles summarized thus far mothers, despite their infants' tenuous situations, were able to establish milk supply volumes with the Initiation Program that were similar to those of breastfeeding mothers.

Research supports the use of the Initiation Program when mothers deliver a preterm baby or one with cardiac disease. In the final article for review, the Initiation Program is compared to the standard bi-phasic program in pump-dependent mothers of preterm, late preterm and term hospitalized infants.

Post ED, Stam G, Tromp E. Milk production after preterm, late preterm and term delivery; effects of different breast pump suction patterns. J Perinatol. Nov 5 2015.

Background

The purpose of this study was to compare lactation outcomes of the Initiation versus Standard breast pump Programs in pump-dependent mothers regardless of infant gestational age at birth.

Only mothers who were pump-dependent for at least seven days and pumped for seven or more times a day were included in the study. Pump effectiveness and milk output were collected for 14 days from 130 new mothers - 66 in the Initiation Pattern group and 64 in the Standard Pattern group. Mothers were instructed to pump simultaneously within 4 to 6 hours of birth for 15 minutes at least seven times in 24 hours. This research included mothers with medical conditions, lactation risk factors and perinatal complications.

Of the 51 mothers with NICU infants all but one did not have access to pumps with the Initiation Program, thus their data was included in the standard 2-Phase pumping group. This group contained a few mothers with term or late preterm babies but the majority of women had infants less than 34 weeks at birth.

Mothers with non-NICU infants were randomized to either the Initiation Program group or the Standard Program group. Per protocol, mothers using the Initiation Program switched to the Standard Pattern with the onset of secretory activation, defined in this study as a total milk yield of at least 50 mL/day.

Results

Time to secretory activation

Mothers who used the Initiation Program attained secretory activation on average 1.2 days faster than mothers using the standard pattern alone (3.3 days vs. 4.5 days, $P < 0.001$). Of interest, mothers with preterm infants had the greatest difference between the two groups.

Time to adequate milk production (> 500 mL/day)

On average, mothers in the Initiation Program group produced an adequate milk supply (> 500 mL/day) almost two days quicker than the standard group (7.7 days vs. 9.5, $P < 0.001$). The greatest difference was in the mothers of preterm infants (8.0 vs. 9.9 days).

Adequate milk production (> 500 mL/day)

Significantly more mothers in the Initiation Program group (94%) achieved adequate milk production within 14 days compared to mothers (53%) in the Standard Program group ($P < 0.001$).

Daily milk production was significantly higher in the Initiation Program group at each time point from day three until day 14 ($P < 0.001$). At two weeks postpartum, mothers in this group produced on average ~67% more milk (~750 mL/day compared to ~500/day in the Standard Program group).

Conclusions

Using the Initiation Program to initiate breast pumping significantly improves human milk production in pump-dependent mothers with term, late preterm or preterm infants.

Effects of the Initiation Program extend beyond the first few days such that mothers who use this program not only come to volume quicker but also obtain significantly higher milk volumes for at least two weeks. It is speculated that the Initiation Program may alter breast physiology in favor of optimal milk production by mimicking the initial sucking pattern of healthy breastfeeding infants.

Commentary

In light of previous study results, this third study provides further evidence that a pump Initiation Program that mimics normal infant sucking behavior assists mothers with infants of any gestational age to produce more milk in less time. Study results were statistically significant for every outcome category, with mothers of preterm infants receiving the greatest benefit. Of note, both this study²⁷ and the study on mothers of preterm infants by Meier et al⁴ report a 67% increase in milk production with the Initiation Program.

This study instructed mothers to pump their breasts simultaneously. Whereas most women pump simultaneously, others pump sequentially due to unavailability of double pumps, inexperience with pumping or maternal choice. In the previous studies by Meier et al⁴ and Torowicz et al⁸ mothers most likely pumped simultaneously, but this recommendation was not explicitly mentioned. Simultaneous pumping is an important strategy to enhance milk expression. Prime et al²⁷ reports simultaneous pumping is more efficient and efficacious by increasing the number of milk ejections and yielding milk with a higher fat content.

Concluding Remarks

Breast pump technology has advanced to the ability to customize pumping programs based on specific maternal needs. With the innovative use of computer technology, pump-dependent mothers can now experience a pump program designed to explicitly mimic natural infant behavior. The three studies highlighted above present compelling evidence this Initiation Program helps more mothers produce more milk faster than previous breast pump programs.

Notes

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Notes

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