Examining the Use and Outcomes of a New Hospital-Grade Breast Pump in Exclusively Pumping NICU Mothers

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ABSTRACT

PURPOSE: To determine whether exclusively pumping mothers of preterm infants could achieve full milk production while using the Ameda Platinum breast pump the first 14 days postpartum.

SUBJECTS: Twenty-six mothers who delivered infants between 26 and 32 weeks' gestation at 2 Intermountain Healthcare hospitals completed the study. Mothers could not take milk-enhancing or milk-reducing substances, feed directly at the breast, have had breast surgery, or use any other breast pump during the study.

DESIGN: Nonexperimental, descriptive study.

METHODS: Mothers were instructed to use the Ameda Platinum breast pump exclusively 8 times daily, for 14 days. They recorded milk volumes, suction pressures, cycle speeds, and time spent pumping. A "Performance Questionnaire" was completed at the end of the study with questions about the ease of use, preferred speed and suction settings, and overall performance of the pump.

MAIN OUTCOME MEASURE: Full milk production was defined as 700 mL/d. Speed and suction settings, as well as average pumping session length, were analyzed in relation to categories of maximum milk volumes expressed.

RESULTS: The average maximum daily milk volume for all mothers was 817 mL/d. Sixteen mothers produced milk volumes more than 700 mL/d and 9 of these mothers were able to express more than 1000 mL/d. Those with daily milk production more than 700 mL/d used lower suction pressure settings to stimulate the milk ejection reflex and to empty the breast. These higher-producing mothers also chose ending speeds of 50 to 60 cycles per minute, similar to the nutritive sucking pattern of a healthy newborn. Mothers producing less than 500 mL/d used higher suction pressures, faster ending cycle speeds, and longer pumping times. Suction pressures varied widely among all of the mothers and were influenced by the mothers' nipple or breast sensitivity, which varied from mother to mother and day to day. Mothers reported liking separate controls for speed and suction and used them to achieve maximum comfort and milk volume.

CONCLUSIONS: The Ameda Platinum breast pump is an effective hospital-grade pump for exclusively pumping mothers to establish full milk production by 14 days postpartum. Separate control of speed and suction allows mothers a wide range of options to achieve greater comfort and multiple milk ejections, both of which contribute to optimal milk expression.

Key Words: cycle speed, electric breast pump, milk ejection, milk production, milk supply, suction pressure

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Mothers who deliver preterm infants are dependent on milk expression to initiate and establish full milk production, which is critical to long-term breast milk feedings and the transition to direct breastfeeding.[1-4] According to research, these mothers are at 3 times greater risk for low milk volume, less than 500 mL/d, when compared with mothers of healthy term breastfeeding infants.[5] In this study, we defined full milk production as 700 mL/d, which is the recommended daily milk output by day 10 for mothers of preterm infants, who are not breastfeeding, and a typical daily milk yield for a healthy term infant.[5,6] To help establish full milk production, hospital-grade breast pumps are the standard of care for exclusively pumping mothers.

Some features of hospital-grade pumps may enhance their effectiveness, ease of use, and comfort. Variations in vacuum strength and cycle speed have been found to affect the milk ejection reflex and expressed milk volumes in some mothers.[7-10] A recent study by Meier and colleagues[11] compared the effects of different vacuum-and-cycling patterns in a programmable breast pump and found that mothers perceived milk expression to be more comfortable when multiphase cycling patterns were used. Comfort is an important consideration for mothers who must pump many times daily over a period of weeks or months.

In 2010, Ameda released an advanced breast pump with a rotating-piston mechanism and independent speed (30-80 cycles per minute) and suction (−30 to −250 mmHg) controls that will replace its SMB and Lact-e hospital-grade breast pumps. The independent suction and speed controls of the Ameda Platinum breast pump make it possible for more than 5000 combinations. Mothers can customize the pump's settings to their own comfort and milk flow, to help maximize the amount of milk obtained while pumping. The purpose of this study was to determine whether exclusively pumping mothers could achieve full milk production, defined as 700 mL/d, while using the Ameda Platinum pump during the first 14 days postpartum.

STUDY DESIGN

Subjects

Of the 31 mothers enrolled, 26 mothers completed the study. They were recruited from the population of mothers who delivered infants requiring neonatal intensive care at Utah Valley Regional Medical Center in Provo, Utah, and Intermountain Medical Center in Murray, Utah, between June and December 2010. This study was approved by Intermountain Healthcare's institutional review board. All mothers were provided with information about the study, and written informed consent was obtained. Mothers were included in the study if they met the following criteria: desired to initiate lactation, agreed to double pump 8 to 10 times per day using only the Ameda Platinum breast pump, and spoke English as their primary language. Mothers were excluded from the study if they had a history of breast surgery, any nipple damage at the time of enrollment, fed their baby directly at the breast, took any milk-enhancing or milk-reducing substances, or used any other brand or model of breast pump to express breast milk during the 14-day study period. Mothers were not excluded on the basis of preexisting medical conditions or other lactation-related factors.

Equipment

Two Ameda Platinum breast pumps, inspected by each hospital's biomedical department, were provided for each mother enrolled in the study: one pump to use at home and the other in the hospital at the infant's bedside. The Ameda Platinum breast pump has variable suction strength between −30 and −250 mmHg and a variable cycling speed of 30 to 80 cycles per minute (cpm) that can be manually altered by pushing the soft touch controls on the front panel. The front panel also has an elapsed, digital, back-lit time display.

Instructions

Two neonatal intensive care unit (NICU) lactation consultants at each facility were trained on providing instructions to the mothers in compliance with the study protocol. These lactation consultants provided both verbal and written instructions regarding the function and features of the test pump. After the instructions were received, mothers were observed during a pumping session to ensure the proper use of the pump.

Mothers were enrolled within 12 hours of birth. Participants were asked to use the breast pump according to study guidelines, that is, initiating pumping as soon as possible after birth, pumping both breasts simultaneously for a minimum of 15 minutes using appropriately fitted breast flanges, at least 8 to 10 times in 24 hours. Once, secretory activation (lactogenesis II) occurred, pumping until 2 minutes after the last drop of milk is expressed or for 30 minutes, whichever came first was recommended. To ensure complete breast drainage, 2 techniques were taught. During the first 3 days postpartum, mothers used hand expression after pumping. After lactogenesis II, mothers used hands-on pumping technique, which includes breast massage and compression while pumping.[12] Mothers were encouraged to hold their infants skin to skin as much as possible and to pump at their babies' bedside in the hospital. These instructions were consistent with the information that is given to all of the exclusively pumping mothers who deliver at these 2 medical centers.

Throughout the study period, mothers were instructed to start pumping at the highest comfortable suction pressure and increase the pressure as

tolerated throughout the entire pumping session. Mothers were instructed to adjust the speed according to milk flow, starting with a fast speed setting of 60 to 80 cpm and reducing to a slower speed of 30 to 40 cpm after 2 minutes or once milk started to flow. Stimulating subsequent milk ejections during the pumping session was encouraged by instructing mothers to increase the pump speed for a brief period of time after milk ejection ended. These fast-then-slow cycle settings were repeated as milk flow changed (multiphase pumping) to mimic the breastfeeding baby's fast-then-slow sucking patterns at the breast.[13,14] The mothers were instructed to try to stimulate multiple milk ejections during each pumping session to drain the breast more fully.[15] Mothers were instructed to adjust the pump suction and speed to their own personal comfort level and vary their speed settings to drain the breast more efficiently and to maximize milk production.

EVALUATION METHODS

Pump Logs

Mothers were required to keep a detailed log of their pumping sessions for 14 consecutive days. The daily log included time of day, duration of each pump session, milk volume obtained from each breast, beginning and ending speed and suction settings, and an area to write in comments or changes that occurred during the day along with the time the mother spent in skin-to-skin contact with the baby (Figure 1). Two follow-up visits were made after enrollment in the

FIGURE 1.

SUBJECT PUMPING LOG
(ATTACHMENT 9)

DATE (M/D/Y)		**DAY # (1-14)**	
Subject ID#		**Subject Initials:**	

Session	Time	AM or PM	Length of Time Pumped (Minutes)	Amount (mL) Pumped From Right Breast	Amount (mL) Pumped from Left Breast	Your Starting Settings (Speed/ Suction)	Your Ending Settings (Speed/ Suction)
1						/	/
2						/	/
3						/	/
4						/	/
5						/	/
6						/	/
7						/	/
8						/	/
9						/	/
10						/	/

Comments or Changes Today?

Pump log.

study with the mother and the lactation consultant to ensure compliance with pumping frequency, documentation of pumping sessions, proper flange fit, and the use of the suction and speed settings. These visits were made on days 4 and 8 of the study.

Questionnaire

A maternal questionnaire was completed after the first and last pumping sessions during the study. The 20 questions gathered information on ease of use, preferred speed and suction settings, and overall performance.

RESULTS

Demographics

Of the 31 mothers who were initially enrolled in the study, data were analyzed from 26 mothers who delivered preterm infants between the gestational age of 26 and 32 weeks at Utah Valley Regional Medical Center and Intermountain Medical Center. Of the 26 mothers, 22 had singleton births, 3 had twins, and 1 had triplets. Five of the original participants were excluded from the study results because of infant demise (2), pump malfunction (1), noncompliance with pumping regimen (1), and maternal request to discontinue the study due to low milk production (1). Three of the mothers had used another hospital-grade breast pump prior to the study with a previous delivery.

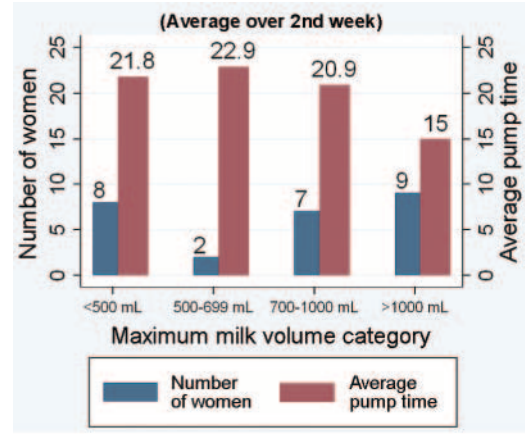
Three mothers completed the study early because their infants were ready to begin nonnutritive feedings at the breast. All of these mothers were yielding at least 700 mL/d when their infants' began nonnutritive feeds. One mother completed the study at day 10, yielding 1016 mL the last complete day of pumping. Two mothers completed the study at day 12, yielding 1359 mL and 877 mL the last day of pumping. No data were collected from these mothers after their date of completion.

Milk Volumes and Duration of Pumping Sessions

Analysis of the pump logs showed that mothers used the pump an average of 7 to 8 times daily. Two of the mothers who were yielding more than 1000 mL at 1 week postpartum reduced their pumping sessions to 5 to 6 times a day on days 9 to 14 of the study. These mothers yielded 1536 and 1425 mL on day 14 of the study.

The average maximum milk production of all 26 mothers was 817 mL/d. Sixteen mothers (62%) were able to express milk volumes over 700 mL/d with more than half of these mothers (9 of the 16) producing volumes more than 1000 mL/d (Figure 2). Eighteen mothers (69%) were able to express more than 500 mL/d, also considered an adequate daily milk volume.[5,16] Five mothers (19%) produced less than 350 mL/d, considered a borderline milk volume.[6]

FIGURE 2.



Number of women and average pump time by maximum milk volume (n = 26).

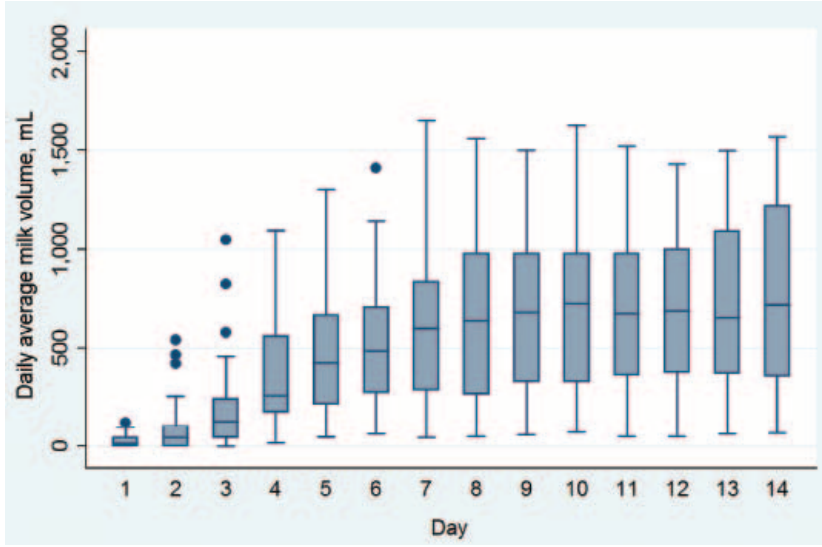
The range of daily milk volumes for all 26 mothers is shown in Figure 3. On days 1 to 4, mean daily milk volume was 28 mL (SD = 36; range = 0–125); 99 mL (SD = 153; range = 0–540); 222 mL (SD = 264; range = 0–1045 mL), and 380 mL (SD = 322; range = 20–1095), respectively. Milk volumes continued to trend upward over the remaining 10 days of the study. On day 5, mean daily volume was 492 mL (SD = 373; range = 49–1300); on day 6, 547 mL (SD = 377; range = 65–1410); on day 7, 627 mL (SD = 432; range = 45–1650); on day 8, 669 mL (SD = 461; range = 52–1560); on day 9, 683 mL (SD = 437; range = 60–1500); and on day 10, 721 mL (SD = 464; range = 72–1626). A slight decrease in mean daily milk volume is seen on day 11, 703 mL (SD = 433; range = 52–1520), the day after a mother who was yielding more than 1000 mL daily exited the study. Milk volume rose again on day 12, 711 mL (SD = 415; range = 52–1430), and again slightly decreased on day 13, 704 mL (SD = 440; range = 67–1497), the day after 2 mothers yielding more than adequate milk volumes exited the study. The 24-hour mean milk volume again increases on day 14, 746 mL (SD = 465; range = 71–1570).

Mothers were able to complete pumping sessions in 15 to 23 minutes. The average pumping session for mothers achieving full production was 18 minutes and for mothers producing less than 700 mL/d, 21 minutes (Figure 2). Mothers who produced more than 1000 mL/d were pumping, on average, only 15 minutes at each session.

Speed and Suction Settings

Comparisons were done of the speed and suction settings that mothers used within the categories of maximum daily milk volume to see whether any

FIGURE 3.

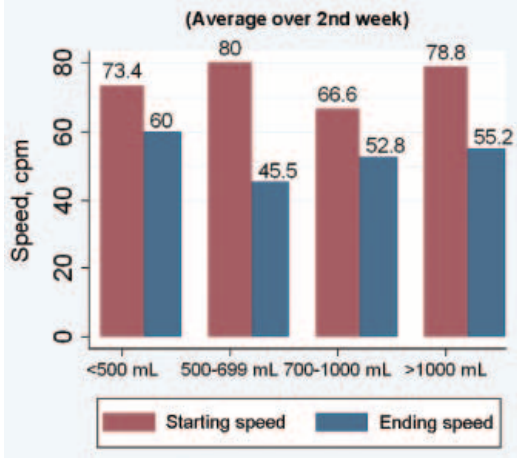


Range of daily milk volume over days of study (n = 26). The boxes in the above boxplots show the 25th percentile, the median (50th percentile), and the 75th percentile of the data. The whiskers show the minimum and maximum of the data that are not outliers. Individual points are suggested outliners. Milk volume is the daily average for each mother.

patterns emerged in the use of the pump to explain milk production levels (Figures 4 and 5). All mothers used a rapid starting speed between 67 and 80 cpm to stimulate let-down. All mothers had a slower preferred ending speed, between 46 and 60 cpm, over the second week of the study. The slower speed is similar to the nutritive sucking rate seen in healthy newborn infants of 50 and 60 sucks per minute[9] (see Figure 4).

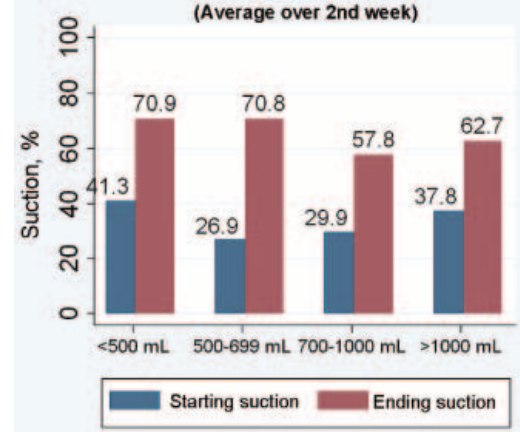
For mothers with adequate milk supply (>700 mL), the average starting suction between days 8 and 14 ranged between 29.9% and 37.8% (−96 to −113 mmHg). Mothers, with adequate milk supply (>700 mL/d), finished their pumping session with an

FIGURE 4.



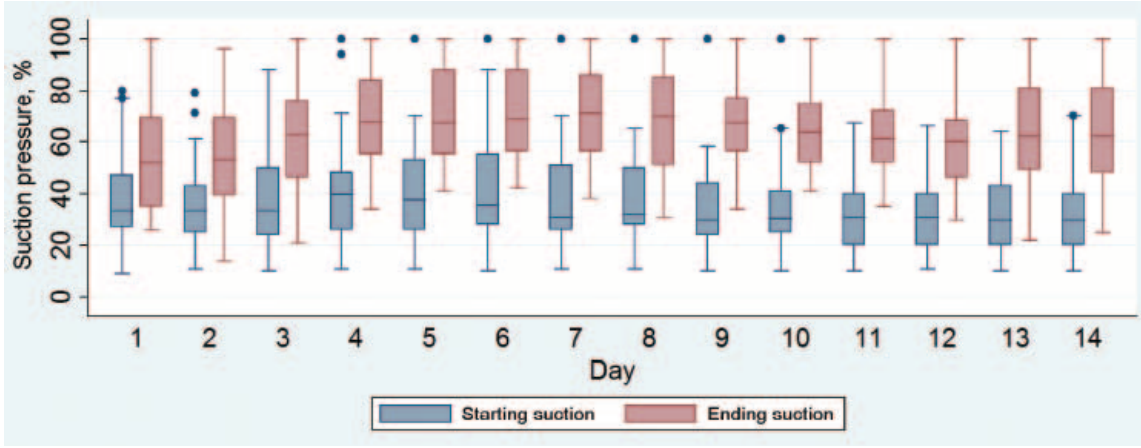
Average start and end speed by maximum milk volume (n = 26). Abbreviation: cpm, cycles per minute.

FIGURE 5.



Average starting and ending suction by maximum volume (n = 26).

FIGURE 6.



Range of starting and ending suction pressure over days of study (n = 26). The boxes in the above boxplots show the 25th percentile, the median (50th percentile), and the 75th percentile of the data. The whiskers show the minimum and maximum of the data that are not outliers. Individual points are suggested outliners.

average suction pressure between 57.8 and 62.7% (−157 to −168 mmHg). The mothers in the lowest milk production category (<500 mL) used the highest average starting suction pressure of 41.3% (−121 mmHg) and average ending suction pressures of 70.9% (−186 mmHg) (Figure 5).

Maximum comfortable suction pressure is widely variable among all mothers and all days of the study as shown in Figure 6. Throughout the study, the range of starting suction pressure was between 10% and 100% (−52 mmHg to −250 mmHg). On average, each mother varied her suction pressures by 114 mmHg over the course of the study.

Maternal Perceptions

All of the mothers (100%) were satisfied with the overall performance of the Ameda Platinum pump, giving an average score of 4.8 on a Likert scale of 1 to 5. Most mothers (96%) said that they would recommend the Ameda Platinum pump to a friend or family member. They reported liking the ability to control the speed and suction pressure independently and felt that this control gave them more comfort in their pumping. Seven mothers (27%) commented on the difficulty in adjusting the settings, while holding the flanges in place during the first day or 2 they used the pump.

The timer on the front panel was mentioned frequently as a well-liked benefit on the performance questionnaire. Mothers reported using the timer not only to measure the length of their pumping session but to time when milk ejection occurred and to gauge when to make adjustments to the settings.

DISCUSSION

The results of this study suggest that a majority of mothers of preterm infants can achieve full milk production (>700 mL/d) by 14 days postpartum using the Ameda Platinum breast pump. Although the main focus of this study was milk supply, examining factors that promote long-term milk expression, such as comfort and efficiency, is important. How the mothers used the pump settings to achieve their maximum milk expression was examined. In this study, mothers producing more than 700 mL/d used lower suction pressures during initiation and throughout their pumping session than mothers who produced less than 500 mL/d and who used higher suction pressures. Lower suction pressures were able to effectively stimulate milk ejection reflex and milk removal. This is an important finding as many mothers think that pumping is like drinking out of a straw and will use high initial suction pressures in an attempt to express more milk. Mitoulas et al[17] concluded a similar study finding indicating that greater suction pressure was not related to greater milk volume, but simply maternal comfort.

Pumping milk is a time-consuming endeavor, especially for mothers who are pump-dependent. The rate of milk flow during pumping is dependent on milk ejection and maximum comfortable vacuum as soon as milk ejection occurs.[7] Because mothers could change the speed and suction pressure as soon as milk flow increased, they were able to take advantage of milk availability during the first milk ejection. Shorter pump sessions can also be attributed to the mothers'

ability to stimulate additional milk ejections more quickly using the speed and suction controls.

Close monitoring of milk-volume targets in the first week allows early intervention to correct factors that may impede reaching full milk production, such as improperly fitting breast flanges, infrequent pump use, and a misunderstanding of how to adjust the breast pump to completely empty the breasts. Other studies have noted that successful lactation depends on mothers tracking their milk production[3] and receiving consistent lactation support,[18] which were integral parts of this study. On days 1 to 3, a few mothers did not yield any measurable milk volume, but all did by day 4. It is not unusual for some mothers to report no yield the first few days of pumping as milk volume rapidly increases from 36 to 96 hours postpartum.[19] With the Ameda Platinum pump, more than half of the mothers who reached full milk supply were effectively using the pump to express more than 1000 mL/d of milk.

The comments obtained from the daily pumping records provided additional insight on how mothers adjusted the speed and suction settings in a variety of ways to achieve comfort while pumping and to maximize milk production. Two mothers felt that the pump helped "mimic the sucking of a baby" and to "copy what a baby would do." Rapid sucking patterns at the beginning of a breastfeeding that stimulate milk ejection can be simulated with the pump. Ramsay et al[15] found the average number of milk ejections occurring during a breastfeeding to be between 3 and 4. One mother commented on how she could stimulate multiple milk ejections using a higher speed stating, "When I change the setting to have the machine help stimulate for another let-down, there is a lot less work on my part. I don't have to massage as much."

The amount of nipple or breast tenderness affected the speed and suction settings chosen. One mother could tolerate only 11% starting suction pressure but was able to produce a full milk production by day 8. Comments on the daily logs frequently addressed nipple soreness and the ability to adjust the pressure to a comfortable level, "I really enjoy being able to personalize the settings. The day my milk came in it was nice to set the settings low due to sensitivity." Another mother reported, "My breasts were tender some days more than others so it was very nice to be able to control the settings depending on how I felt at the time."

Being able to control the settings based on comfort and efficiency at each pumping session allows mothers a wide range of options. Having "too many choices" was mentioned by one mother. Another mother used the exact same settings over the second week of the study and wrote, "I liked the speed and suction control separate so I could get the settings exactly as I wanted."

On the basis of the results of this study, after delivery, we instruct mothers to start pumping sessions with a fast speed (80 cpm) and a light suction pressure (<50%) that is comfortable to the mother to stimulate let-down. Within 2 minutes of initiation of pumping as evidenced by let-down or milk dripping, mothers are instructed to change to an expression pattern, which is slower (50-60 cpm) and stronger (>50%). Mothers should adjust the suction to reach their maximum comfortable suction pressure.

Barriers

The critical pumping period after birth coincides with a physically and emotionally complex period for mothers delivering prematurely. In this study, participants were not excluded on the basis of health conditions of the mother, previous lactation history, parity, or other demographic features that could contribute to low milk production. All of the mothers experienced premature delivery, which itself may predispose some mothers to low milk production.[2] In future studies, additional information on medical conditions that adversely affect milk volume such as nipple yeast, smoking, anemia, infertility, pregnancy-induced hypertension, labetalol use, polycystic ovarian syndrome, and obesity should be consistently collected from all participants.[20-22] A 14-day trial may have been limiting since some mothers of preterm infants experience delayed lactogenesis and take longer to develop a full milk supply.[4]

CONCLUSIONS

The Ameda Platinum breast pump is an effective hospital-grade pump in exclusively pumping mothers to establish a full milk supply by 14 days postpartum. Mothers like having the ability to control pump suction and speed separately and consider this an important component of achieving comfortable and efficient pumping. Control of pump suction pressure and speed allowed mothers to customize their adjustment on the basis of personal comfort and the timing of their milk ejections. A variety of patterns in suction and speed were observed, depending on the mother and the day. It is imperative that mothers of preterm infants have access to appropriate equipment and receive adequate instruction in its use to establish frequent and effective pumping. Implementing strategies should include evidence-based practices, state-of-the-art breast pump technology, and adequate lactation support to meet the unique needs of exclusively pumping mothers.

Future Research

Future research is recommended to examine the effects of specific suction strength and speed variations on expression of colostrum, milk volumes, and efficiency of milk expression. A side-by-side

comparison between this pump and other available hospital-grade breast pumps could also be considered for future research.

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