Breastfeeding expectations

This review describes the basic requirements for a successful lactation and presents evidence-based insights into breastfeeding behaviour. The changes in fat content of the breast milk and fat intake of the infants are also discussed. The intention is to give mothers of infants who are growing within the normal range the confidence to breastfeed their infants on demand and without attention to timing so that their infants will consume as much milk as they need, as often as they need.

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Key points

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1. Most women are physiologically able to exclusively breastfeed.
2. There is a wide range in breastfeeding behaviour of infants who are growing within the normal range.
3. Breastfeeding dyads do not need to conform to average.
4. Breastfeeding at night is normal.
5. Breastfeeding frequency does not influence the daily fat intake of the infant.

Breast milk is the ideal food for the nutrition of the newborn infant and protection from infection, and exclusive breastfeeding is recommended for six months with continuation of breastfeeding into the second year of life.[1] Initiation of breastfeeding is supported by *'Ten steps to successful breastfeeding'*[2] and the high rates of initiation of lactation across cultures[3,4] indicate that the importance of breastfeeding is well understood and accepted. However, expectant and new mothers may be concerned about whether they will be able to breastfeed after birth or after hospital discharge and what can be expected once breastfeeding is established. Common questions are: "How often will my infant breastfeed, for how long and how much milk will be taken during each breastfeed and throughout the day?" This article will provide evidence-based, rather than experience-based, answers to these questions.

Will I be able to breastfeed?

At least 95% of women are able to produce sufficient milk[5] and therefore less than 5% of women will have primary lactation insufficiency. Primary lactation insufficiency may be due to severe maternal illness, hormonal abnormalities, breast surgery, or breast hypoplasia where the breasts show minimal growth during pregnancy or soon after delivery.[5] Maternal illness can include Sheehan's syndrome, where the pituitary gland has been damaged due to severe blood loss at delivery.[6] Hormonal abnormalities can include hypothyroidism,[7] low prolactin,[8] or high progesterone due to retained placental fragments.[9] Adequate breast development does not mean that large breasts are required because up to 54% of the total amount of tissue in the breast can be adipose tissue.[10]

Secondary lactation insufficiency is far more common than primary lactation insufficiency. It is due to modifiable factors such as infrequent or incomplete milk removal.[5]

Milk production in the neonatal period is optimised by breastfeeding within the first hour after birth,[11] followed by frequent breastfeeding[12] allowing the infant unrestricted access to the breasts, day and night.[13] Assessment of the infant is also important to ensure that it is capable of removing sufficient milk to maintain adequate production.[5] Breastfeeding success is also enhanced by support for mothers, particularly those of lower socioeconomic status, from both health professionals and family.[14]

Initiation of lactation

The first secretion from the breasts is colostrum, which is viscous and contains high concentrations of proteins that provide the infant with protection from infection. During the first breastfeed the infant will take up to 5mL of colostrum and in the first 24 hours it receives only 7-123mL of colostrum.[15,16] The onset of copious milk secretion (secretory activation) will occur about three days after delivery of the placenta. After secretory activation, promotion of an adequate milk supply during the first week is critical for successful long-term milk production.[17] If the infant cannot be breastfed within the first hour after birth, breast expression using a hospital-grade electric breast pump[11] or manually[18] should be commenced within the first 6-12 hours after birth. During the first few days,

FIGURE 1 A breastfeeding session can comprise: A) A single feed from one breast. B) A pair of breastfeeds when the infant commences feeding from the second breast within 30 minutes of finishing feeding from the first breast. C) Feeding again from the first breast within 30 minutes of finishing feeding from the second breast.

frequent sucking has a positive effect on subsequent milk production,[12] and skin-to-skin holding of infants can result in a significant increase in milk production.[19]

Definition of a breastfeeding session

A breastfeeding session can be considered as a breastfeed from one breast, or breastfeeds from both breasts with an interval of less than 30 minutes between breasts, or a cluster of breastfeeds when the infant goes back to the first breast within 30 minutes of finishing on the second breast (**FIGURE 1**).[20]

Breastfeeding sessions

The breastfeeding sessions of the majority (57%) of exclusively breastfed infants who are growing within the normal range will sometimes comprise one breastfeed, sometimes a pair of breastfeeds, and occasionally a cluster of breastfeeds.[20] Almost one-third of infants (30%) always have only one breastfeed for every breastfeeding session and only 13% of infants always have a pair of breastfeeds during each breastfeeding session.[20] These data support advice that the infant should be offered the second breast after finishing feeding from the first, but there should be no obligation for the infant to accept the offer.

Breastfeeding frequency

There is no prescribed frequency of breastfeeding and, as with all measured parameters of breastfeeding, there is a wide range of frequencies between mother-infant dyads.[20] **FIGURE 2** shows two dyads within the range of normal breastfeeding frequency. Normal infants aged one to six months will have between six and 18 breastfeeds in a 24-hour period, in the form of between four and 13 breastfeeding sessions.[20] When the frequency of breastfeeding sessions was recorded twice within three weeks it was found to be reproducible within dyads (coefficient of variation = 13%).[21] However from one to three months of age, the frequency can be expected to decrease by one breastfeeding session per day, after which the frequency is not expected to change significantly until six months of age.[21]

It is important to note that breastfeeding

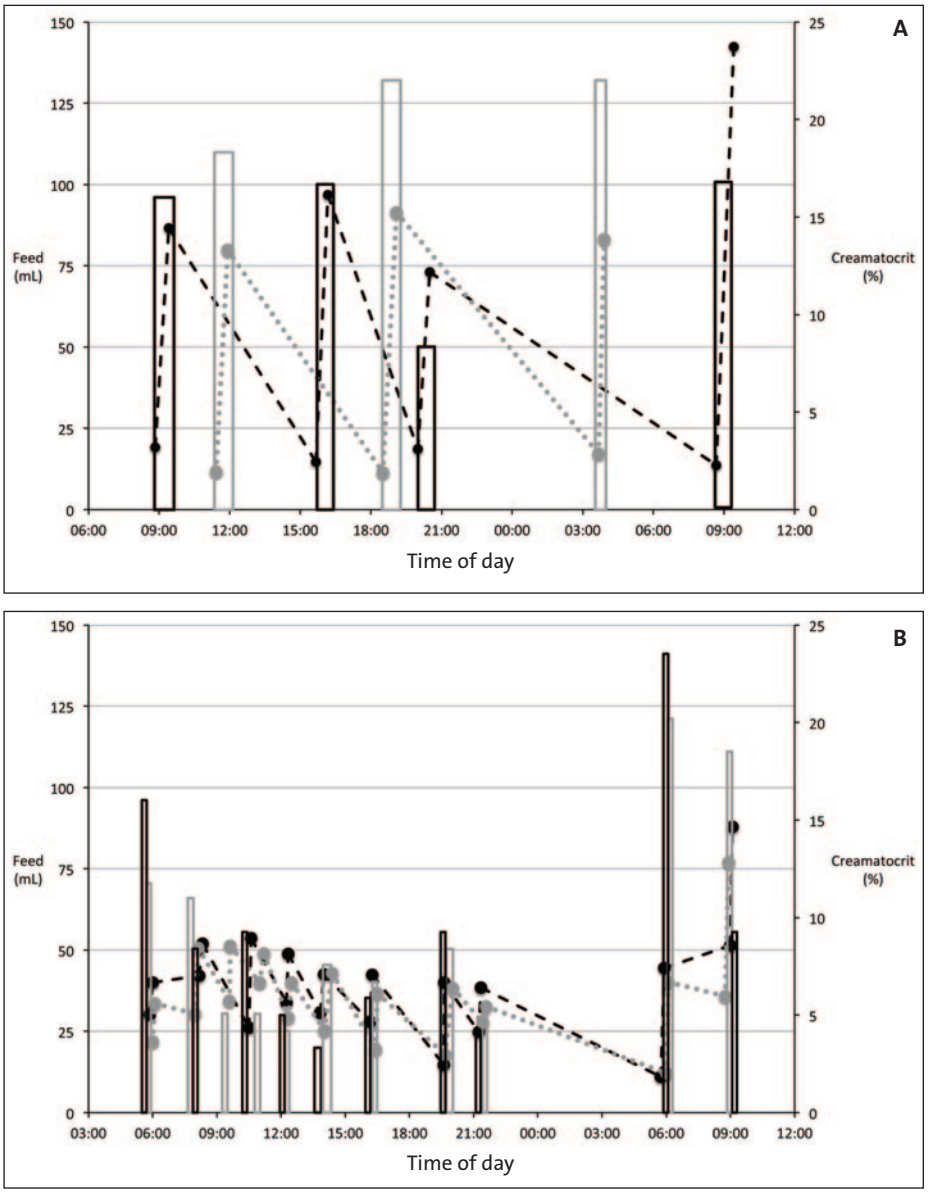

FIGURE 2 Frequent and infrequent breastfeeding patterns. The bars indicate the volume of milk transferred and the width of the bars represents the duration of the breastfeed. The circles indicate the cream content of milk samples collected before and after each breastfeed and the connecting lines indicate the changes in the cream content. Black = data from the left breast, grey = right breast.
A) An infrequent feeding pattern. An infant aged 11 weeks who always had only one breastfeed for every breastfeeding session: milk intake 620mL per day, fat intake 32.1g per day, average feed duration 31 minutes, average breast milk storage capacity 134mL, average percentage of available milk removed 81%.
B) A frequent feeding pattern. An infant aged 22 weeks who usually had a pair of breastfeeds during each breastfeeding session, but occasionally (eg at 9:30am on day 1) had only one breast in the breastfeeding session: milk intake 750mL per day, fat intake 28.7g per day, average feed duration nine minutes, average breast milk storage capacity 252mL, average percentage of available milk removed 33%.

at night is normal, even up to six months of age. The night breastfeeds are larger than the daytime breastfeeds and, on average, contribute 20% of the total daily milk intake.[20]

Breastfeeding amount

The amount of milk that an infant consumes during each breastfeed varies from feed to feed (**FIGURE 2**). It can vary from no milk exchange (when the infant goes to the breast and latches on but removes no milk) to up to 240mL from one breast, or up to 350mL during a breastfeeding session.[20] Generally, one breast will be more productive than the other. If a breastfeeding session is comprised of a pair of breastfeeds and the more productive breast is fed from first, the infant will take more from the first breast than the second. On the other hand, if the less productive breast is fed from first, the infant is likely to take the same amount from the second breast.[20]

There is also a large variability between infants in the median amount of milk consumed during breastfeeds (30-135mL) and breastfeeding sessions (54-234mL) (derived from data published by Kent et al 2006[20]). This is not surprising given the variability between dyads in the frequency of breastfeeding sessions, and the inverse relationship between the frequency of breastfeeding sessions and the median amount of milk consumed during each breastfeeding session.

When the median amount of milk consumed during breastfeeding sessions over a day was recorded twice within three weeks, it was found to be reproducible within dyads (coefficient of variation = 14%).[21] However, from one to three months of age the median amount of milk consumed during a breastfeeding session can be expected to increase by 20mL, after which it is not expected to change significantly until six months of age.[21]

Total milk intake over 24 hours

After secretory activation, milk synthesis is no longer under endocrine control but responds to the demand for milk from the breasts.[22] Exclusively breastfed infants who grow rapidly take more milk than those who grow less rapidly.[23] Just as there is a wide range in growth rates of normal infants, there is a wide range in daily milk intake between infants who are exclusively breastfed and growing within the normal range, from 478-1,356mL.[20] Contrary to popular belief, exclusively breastfed infants do not increase their milk intake between one and six months.[21,24] Infants do not require more energy intake between three and six months because:

1. Their energy needs for growth decrease from 35% of total energy requirement during the first three months to about 17.5% in the next three months
2. Their total daily energy requirement decreases from approximately 500kj/kg/day at one month to approximately 350kj/kg/day at six months.[25]

'Growth spurts' are commonly mentioned in the popular literature, being described as periods of 2-3 days in which infants feed more frequently and are fussier than usual. It is claimed that there is a temporary increase in the infant's milk intake, but there are no published studies that document sudden increases in growth associated with temporary increases in milk intake. It is possible that these 'wonder weeks' when the infant has an increased need for body contact and attention, are associated with major changes in the infant's brain.[26]

Time taken to breastfeed

The median duration for each breastfeed ranges from five to 37 minutes, and for a breastfeeding session ranges from 12 to 67 minutes (derived from data published by Kent et al 2006[20]). The infant illustrated in **FIGURE 2A** showed an average feeding duration of 31 minutes per breast, while the infant illustrated in **FIGURE 2B** fed, on average, for nine minutes per breast. There is no relationship between the duration of a breastfeed and the amount of milk that the infant consumes during that breastfeed. Infants suck at the breast both nutritively and non-nutritively.[27] This will provide at least part of the explanation for the lack of a relationship between duration and milk transfer. Additionally, the rate of milk transfer varies between infants from 0.03-0.5mL per cycle of sucking,[28] so there is a difference between infants in the efficiency of sucking.[29]

Milk ejection

Significant amounts of milk are available to the infant only after a milk ejection, also called the 'let-down'. The milk ejection reflex is stimulated by the infant sucking at the nipple, causing the release of oxytocin from the brain and contraction of the milk-containing alveoli in the breast. The contraction forces the milk down the lactiferous ducts towards the nipple where it is available for removal.[30] The duration of a milk ejection ranges from 35 to 135 seconds and the time between milk ejections during one breastfeed ranges from 45 to 356 seconds.[30] The milk ejection reflex can be detected by differing breast sensations, warmth, nausea or thirst, or may not be sensed by the woman at all.

Change in the sucking rhythm of infants is thought to be associated with the availability of milk during milk ejection. Over one-third of infants will come off the breast when there is a milk ejection at the end of the breastfeed.[30] Women can have between one and nine milk ejections during a breastfeed and it is the number of milk ejections, rather than the time spent at the breast, that is associated with the amount of milk transferred to the infant during a breastfeed.[30]

The milk ejection pattern during breast expression with an electric breast pump has been shown to be characteristic of a particular woman and reproducible within a lactation.[31] The milk ejection pattern can vary from few to many, and some milk ejections can occur after a long quiescent period. Thus, a woman who experiences a late milk ejection (perhaps after 12 minutes of pumping) will always show the same pattern during pumping. It is yet to be demonstrated if the milk ejection pattern during breastfeeding is also reproducible within a dyad.

Breast milk storage capacity

The storage capacity of the breast is the amount of milk available to the infant when the breast is full.[32] There is a wide range between women in the storage capacity from 74-382mL.[20] This is not related to the size of the breasts but may be related to the amount of secretory tissue in the breast, rather than the adipose tissue that can contribute to up to 54% of the breast volume.[10] The storage capacity of the breast may determine the flexibility of frequency of breastfeeding[33] so that a mother with a small storage capacity may need to feed frequently, whereas the infant of a mother with a large storage capacity may choose to feed frequently or infrequently.

Feeding to appetite

The finding that infants cease to feed and detach from the breast when a milk ejection occurs at the end of a feed adds to

the body of evidence demonstrating that infants feed according to appetite[34] and do not stop a breastfeed only when there is no more milk available in the breast.[35] The largest amount of milk transferred from one breast during one breastfeed is 240mL,[20] so an infant could not completely drain a breast when there is more than 240mL available. On average, an infant will take 67% of the milk available in the breast, but this varies from feed-to-feed and from infant-to-infant. Infants who feed frequently will take a lower percentage of the available milk than those who feed infrequently.[20] The average storage capacity of the left and right breasts of the mother illustrated in **FIGURE 2A** was 134mL and her infant, on average, took 81% of the milk available. This infant drained the breasts reasonably effectively during each breastfeed. In contrast, the average storage capacity of the left and right breasts of the mother illustrated in **FIGURE 2B** was 252mL and her infant, on average, took 33% of the milk available. This infant drained the breast effectively during the 9am breastfeed on the second day, and during the remaining feeds consumed only as much as he wanted.

Frequent feeding during the neonatal period is attributed to the limited stomach capacity of the infant[36] and this may determine the maximum breast milk intake during a breastfeeding session. Although there is large variation between infants, on average the maximum breast milk intake increases from 162mL at four weeks to 216mL at 13 weeks,[21] presumably as the stomach capacity of the infant increases.

The gastric emptying rate may also affect frequency of breastfeeding. The half-emptying time for infants 1-6 months old has been measured at 48±15min,[37] so those with a more rapid gastric emptying time will need to feed more often than those with a slower gastric emptying time.

Cream changes

When breastfeeds are large and infrequent the milk expressed before each breastfeed is low in cream and the milk expressed after each breastfeed is high in cream. In the case illustrated in **FIGURE 2A** the average cream content before feeding was 2.5% and the average cream content after feeding was 15.6%. However, when breastfeeds are small and frequent there is a smaller difference between the cream content from before to after a breastfeed, but that does not mean that milk samples collected before and after the breastfeed both have a low cream content. In the case illustrated in **FIGURE 2B** the average cream content before feeding was 4.7% (higher than that for the infrequent feeder) and the average cream content after feeding was 7.8%. The daily fat intake of these two infants was 32.1g and 28.7g, respectively. Analysis of data from 71 exclusively breastfeeding dyads showed that the fat intake of the breastfed infant is independent of the breastfeeding frequency.[20] That is, there is no need to advise the mother to ensure that the infant 'finishes' the first breast before offering the second. Current studies on mothers with normal milk production indicate that infants can be fed as often as they cue to feed, for as long as they choose to stay on the breast, without compromising their fat intake.

Elegant studies measuring breast volume and cream content of milk before and after every breastfeed for two 24-hour periods demonstrated that the cream content of the milk is dependent on the degree of fullness of the breast. That is, the cream content of the milk will be at its minimum for the day when the breast is at its maximum volume for the day, when it contains the most milk, and the cream content of the milk will be at its maximum for the day when the breast is at its minimum volume for the day and contains the least amount of milk.[38]

The difference in cream content of milk as it is removed from the breast is attributed to the separation of the milk fat globules from the skimmed milk. It is likely that the rate of fat secretion by the lactocytes is constant, unless the alveoli are full and the rate of milk synthesis has slowed. When there is a long interval since the previous removal of milk the fat globules adhere to the wall of the alveoli. Animal studies have shown that the milk ejection reflex that helps to expel milk from the alveoli first forces the low cream milk from the middle of the alveoli down the lactiferous ducts towards the nipple. Then, more and more of the fat globules are dislodged as the alveoli contract and empty.[39] The milk fat globules appear to take some time to partition within the alveoli, so if an infant feeds frequently the milk fat globules have not had time to adhere to the walls of the alveoli and remain in suspension. When a milk ejection occurs, the first milk that is expelled from these alveoli contains more fat globules than that from the full alveoli and there is a smaller difference in cream content between the milk at the beginning and the end of the breastfeed.

Changes throughout lactation

From 1-3 months of age, infants can be expected to drop one breastfeeding session per day but increase the average milk intake during one breastfeeding session by 20mL. From 3-6 months there are no further changes in breastfeeding frequency or amount. From 1-6 months the infants become more efficient in their breastfeeding, with breastfeeding sessions being seven minutes shorter at three months than at one month, and the breastfeeding sessions continuing to take less time up to six months.[21]

There is no significant change in the volume of breast tissue between one and six months while the milk production is also constant. After six months, both milk production and the volume of breast tissue decrease, until the breasts have returned to pre-pregnancy size by 15 months. However, there is an apparent increase in the efficiency of the breast tissue as lactation continues and mothers who are still breastfeeding at 15 months produce up to 315mL of milk per day.[40] Therefore, the decrease in breast volume may be at least partly due to a decrease in the adipose tissue in the breast and mothers can be reassured that a change in breast size does not necessarily mean that they are no longer producing enough milk for their infant.

Tests for normality of breastfeeding

If an infant is showing signs of normal growth and development (**TABLE 1**) and breastfeeding is comfortable, parents and health professionals can be assured that the particular feeding pattern of the infant that is within the normal ranges described in this article, is satisfactory and no further investigations are necessary. However if low milk intake is suspected, assessment of

Consistent weight gain
Alertness
Good skin colour
Good muscle tone
Sufficiently wet and dirty nappies
Contentment

TABLE 1 Signs of normal infant growth and development, based on Neifert, 2001.[5]

the infant is required to ensure that it is capable of removing sufficient milk. The milk production of the mother and milk transfer by the infant also need to be assessed. It has been shown that observation of a breastfeed, even by an experienced clinician, is not an accurate method of determining milk transfer during a breastfeed.[41] Deuterium dilution will provide an accurate measure of daily milk intake by the infant,[42] but it is expensive and not easily undertaken outside a specialist laboratory. Test-weighing is inexpensive and can be performed by mothers in their own homes using accurate integrating digital scales.[11] Given the variability in milk intake from feed-to-feed[20] and the fact that in Western cultures even measurements over a 12-hour period cannot be extrapolated to a whole day[43], it is important that the test-weighing be performed for a full 24-hour period. A lactation specialist can then use the data to provide evidence-based advice to optimise the milk production and/or investigate the infant's ability to transfer milk.

Conclusion

When a woman is concerned about her ability to breastfeed, she can be assured that at least 19 out of 20 mothers can successfully breastfeed. If there are no relevant physical or physiological abnormalities, family and professional support for early breastfeeding will help to ensure an optimal lactation. Those who do have breast or hormonal abnormalities may be able to provide at least some breast milk with appropriate support, particularly early in lactation. This support includes breastfeeding soon after birth, skin-to-skin care and unrestricted breastfeeding day and night.

Once breastfeeding is established, it should be accepted that each dyad is unique and does not need to conform to the average. As long as the infant is showing signs of getting enough breast milk, all those caring for the infant and mother should be comfortable with any feeding pattern that is within the wide range of normal.

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