Optimising the provision of human milk for preterm infants

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The benefits of breast milk for preterms can be realised by teaching mothers simple but effective milk expression techniques

As survival rates for preterm infants improve, attention is focused on improving the quality of survival through nutritional management. Necrotising enterocolitis (NEC) remains one of the most critical complications. Although no individual randomised controlled trial (RCT) has been sufficiently powered to examine the true effect of breast milk on the incidence of NEC in preterm babies,¹ a series of observational studies and a meta-analysis suggest a reduced incidence in those fed breast milk.²⁻⁵ There is also evidence that human milk is better tolerated than formula, leading to a faster attainment of enteral feeding.⁶

Mothers of preterm infants experience physiological and emotional challenges, which may adversely affect breast feeding outcome following delivery. Therefore, it is not surprising that these mothers start and sustain breast feeding at lower rates than mothers of term babies.⁷ This is further compounded by the high levels of socioeconomic deprivation common in this population.⁸ Although there is a marked inverse relationship between gestational age and duration of breast feeding, it is not inevitable that lactation should fail, even in mothers of extremely low birthweight infants.⁹ This paper discusses the possible implications of a shortened pregnancy on mammary physiology and the lactating breast, and how to deal with any issues this might pose about the management of milk expression.

PHYSIOLOGY OF PRETERM LACTATION

Preterm delivery adversely affects initiation of lactation for the following reasons:

- mammary growth may be incomplete in a substantially shortened pregnancy, and poor placental function with low levels of placental lactogen may exacerbate this problem further¹⁰;
- the mammary epithelium may not be sufficiently prepared by the hormones

of pregnancy to respond with efficient milk synthesis¹¹;

- lactation may be inhibited by stress, fatigue and anxiety.¹²

Although some mothers lack the capacity to respond to the stimulation of milk expression and have diminished milk production, others seem to achieve compensatory growth by the adoption of a frequent milk expression schedule in the early postpartum period.¹⁰ As the average baseline milk production on days 6–7 is highly predictive of adequate milk volume (defined as greater than 500 ml/day) at six weeks post partum, mothers of extremely preterm infants should be taught effective milk expression techniques as a matter of urgency.¹³

ENCOURAGING MOTHERS TO PRODUCE MILK

A protocol should be in place to ensure the role of expressed breast milk in the care of the premature infant is discussed with all expectant mothers during the antenatal period. This also provides an opportunity for anticipatory guidance about the importance of early, frequent milk expression. It is helpful to reinforce the verbal discussion with written information about the benefits of breast milk and the principles of milk expression.

Following the birth of a preterm infant, the importance of human milk feeding should be discussed with the parents during the first visit to the unit by neonatal staff. Counselling mothers at this stage increases the incidence of lactation initiation and contrary to popular belief does not increase maternal stress or anxiety.^{14 15} When a mother and baby are separated, the health professionals caring for the baby should liaise with staff caring for the mother to ensure that the she has been given support to start a milk supply. The premature charity BLISS has produced a parent information leaflet entitled *Breastfeeding your premature baby*, which is available for distribution in the UK. It

should be given to all mothers of preterm infants at an early stage.¹⁶

OPTIMISING LACTATION SUCCESS

It is important that the first milk expression should take place as soon as possible following delivery.^{8 17} Mothers should be given realistic expectations regarding the initial milk volume because the amount produced can be as little as a few drops of colostrum at each expression for the first 24–48 hours post partum. There may be a considerable delay before more substantial milk production begins. Mothers should be encouraged to express at least eight times in 24 hours, because any break in the frequency of effective milk removal at this time may seriously compromise the potential to maximize milk production.¹⁸ It has been shown that mothers of very low birthweight (VLBW) infants who produce adequate milk volumes at five weeks post partum pump at least 45 times per week (more than six times a day).¹⁹ The goal is to establish a milk supply of at least 750 ml/day by day 10, because milk production, the most powerful determinant of lactation success, typically plateaus by two weeks post partum.²⁰ When the milk supply is low at day 10 (less than 350 ml/day) despite frequent milk expression, it is important to ensure that the milk expression technique is optimal. This includes:

- a supportive environment for the mother;
- regular breast massage using a good technique;
- simultaneous pumping of both breasts;
- use of a high-quality breast pump;
- a properly fitting milk expression shield.

Usually these measures, which are discussed in detail below, will rescue the situation, but if not then the pharmacological enhancement of prolactin secretion may have some value. Domperidone or metoclopramide may increase milk supply in the short term.^{21 22} However, these medications are not licensed to augment lactation and there is no evidence-based protocol for drug timing and dosage.

PRACTICAL MEASURES

The process by which milk is expelled from the alveoli is called the milk ejection reflex and is essential to milk removal from the lactating breast. When this reflex is inhibited, the average milk yield is less than 4% of available milk, and local mechanisms bring about an inhibition in milk secretion.²³ In stressful situations, mothers may have difficulty with milk

ejection when expressing. The early instigation of kangaroo mother care (KMC) is thought to be beneficial in this respect, with mothers experiencing feelings of milk ejection during KMC (fig 1).²⁴ It has been shown that mothers of VLBW infants who practised KMC lactated on average four weeks longer than controls,²⁵ with less chances of discontinuing lactation before discharge.²⁶ In contrast, the use of nasal oxytocin spray does not markedly improve the milk yield during the first five days post partum.²⁷

Milk expression is more likely to be effective using a high-quality electric breast pump with the following characteristics²⁸:

- easy to assemble and disassemble with all parts able to withstand sterilisation methods;
- fully automatic, with a cyclic suction rhythm that mimics infant suckling;
- vacuum strength that does not exceed 250 mm Hg, and is easily regulated;
- separate drive and suction system to ensure that no contamination from milk spillage can enter the pump;
- a system of collection that allows milk to be pumped directly into a storage container with a universal thread, to avoid the need to transfer milk to another container for storage or administration.

Breast massage is a highly effective technique for stimulating milk ejection and should be used before starting to express.²⁹ A good massage technique involves stroking the breast with gentle feather-like movements, or using a hand

action that rolls the knuckles downwards over the breast and working towards the areola. Rolling the nipple gently between the thumb and forefinger or stroking the nipple with the palm of the hand is also beneficial. The massage should be completed by stroking the area under the nipple and areola with flat hands in an upward movement.

Double pumping requires two breast shields and collection sets. A mirror can be used to ensure that the shields are placed with the nipples central. Light pressure is required to obtain a patent seal—firm pressure will inhibit milk flow as the ducts are easily compressed. It is important not to force the rim into a section of the breast and obstruct drainage from the area. A specially adapted bra is available which holds both collection sets securely, allowing the mother to pump hands free.¹⁶

Finally, we have observed that the diameter of the aperture of the milk expression shield can affect milk output, because shields that are too small compress the milk ducts, inhibiting milk flow. As the main culprit for sore nipples during milk expression is the use of an undersized breast shield, a variety of sizes should be available. The most appropriate size is usually determined by comfort.

CONCLUSION

The most common misconception that undermines successful lactation for mothers of preterm infants is that initiation of milk expression can be delayed until an infant is stable. To overcome this problem collaborative guidelines should be in place so that midwives and neonatal nurses can work together to ensure the early establishment of frequent milk expression. Furthermore all healthcare professionals who care for preterm infants should have expert knowledge of mammary physiology and management of milk expression. This requires a comprehensive training programme such as the one currently recommended by the UK Department of Health.³⁰

A mother's commitment to supplying her milk will probably have considerable medical benefit for a VLBW baby, both in the short and long term. If the principles of milk expression outlined above are followed, there will rarely be a need to resort to bank milk. In most instances, successful expression in the early stages will lead to successful preterm breast feeding, which should be the ultimate goal.

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Photograph courtesy of Marc Hardenberg.

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Figure 1 Kangaroo Mother Care (KMC). Informed consent was obtained for publication of this figure.

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Brain imaging in neonates

Optical imaging of the neonatal brain

Topun Austin

Optical systems could be valuable tools for assessing cerebral function at the cotside

The newborn brain is vulnerable to a variety of insults with potentially lifelong consequences. As our understanding of the mechanism of brain injury improves and new therapies are developed to prevent or minimise brain injury, new non-invasive methods are required to assess cerebral function at the cotside.

The application of near-infrared spectroscopy (NIRS) for continuous monitoring of cerebral haemodynamics and oxygenation non-invasively was first reported by Jobsis in 1977.¹ Since that time NIRS has become an effective research tool for studying infant cerebral haemodynamics and oxygenation.^{2–3} NIRS exploits the relative transparency of biological tissue to near-infrared light (700–1000 nm), and the wavelength-dependent absorption characteristics of haemoglobin, which vary with oxygenation. By monitoring the intensity of light passing through brain tissue at two or more wavelengths, observed changes in attenuation can be converted into changes in the cerebral concentrations of oxyhaemoglobin and deoxyhaemoglobin.

FUNCTIONAL NIRS

An obvious application of NIRS is the investigation of localised changes in oxyhaemoglobin and deoxyhaemoglobin resulting from functional activation of the cerebral cortex. Increases in local cerebral blood flow (CBF) are manifested by a rise in oxyhaemoglobin and a fall in deoxyhaemoglobin whereas oxygen consumption during activation results in a decrease in oxyhaemoglobin and an

increase in deoxyhaemoglobin. The balance between local perfusion and consumption can be investigated with NIRS.

The first functional studies in the newborn with optical techniques used conventional single source-detector systems to measure overall changes in oxygenation over a particular area of the head. Meek *et al* reported that, in response to a visual stimulus, there was an increase in both oxyhaemoglobin and deoxyhaemoglobin over the occipital lobe.⁴ This finding was consistent with those of studies in infants using functional MRI and contrasted with the response in adults, in whom the increase in regional perfusion greatly exceeds the increase in local consumption, resulting in an increase in oxyhaemoglobin and decrease in deoxyhaemoglobin.⁵ The maturation of this response seems to depend on the type of stimulus and the state of wakefulness of the infant as well as their age, and it is currently an area of active research using optical topography.^{6–10}

Bartocci *et al* investigated the response to olfactory stimuli in the newborn: they found a significant increase in oxyhaemoglobin measured over the frontal cortex in response to colostrum which was inversely related to postnatal age.¹¹ Neonates were also able to differentiate between pleasant and unpleasant odours.¹² Recently the haemodynamic response to pain has been investigated using NIRS.^{13–14} Slater *et al* found that preterm infants as young as 25 weeks' gestation show a cortical response following a heel lance. The response was markedly greater in

infants who were awake, indicating the importance of behavioural state in the response to pain.

OPTICAL TOPOGRAPHY

The single source-detector pair studies outlined above obtain measurements over a relatively large volume of the brain and are therefore susceptible to inaccuracies in both localisation and quantification of the response. Optical imaging is therefore a natural extension of efforts to address these issues.

The most straightforward approach is optical topography, which involves acquiring multiple reflectance measurements at small source-detector separations from the surface of the head simultaneously or in rapid succession (fig 1A). By keeping the separations small it is possible to make measurements of rapid changes in haemodynamics associated with functional activation. The penetration of light is limited and so will reflect changes in oxygenation within the cerebral cortex. Several groups have developed custom-built multichannel topographic imaging systems demonstrating the potential of this technique to assess brain function at the cotside.^{15–16} A commercially available optical topography system (Hitachi ETG-100 optical topography system, Hitachi Medical Corporation, Tokyo, Japan) has been used to investigate the response of neonates to a variety of stimuli, including visual, auditory and somatosensory.^{8–9–17–18} Pena *et al* investigated the response of neonates to speech in the first few days of life.¹⁸ They found the greatest change in regional blood volume, over the left temporal lobe, was in response to the mother's speech, compared with "reversed speech", illustrating the remarkable ability of the human brain for complex neural processing in the first days of life.

OPTICAL TOMOGRAPHY

In contrast to optical topography, the aim of optical tomography is to obtain a two-dimensional slice or a three-dimensional image of the whole brain. The sensitivity to deep tissue requires measurements across the head, and consequently