Handling and storage of expressed breast milk

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Issue

Current guidance on the handling and storage of expressed breast milk (EBM) for healthy infants is unclear and inconsistent. The key concerns are the place of storage, storage times and temperatures, and how this may affect the microbiological status of the milk and its nutritional and the immunological quality. This paper summarises current guidelines, examines factors affecting storage of EBM and highlights some gaps and uncertainties in our current knowledge.

The focus of the paper is on handling and storage of EBM for feeding "healthy" full term infants in the home, and settings other than hospitals (e.g. the work place, day care, child minders and nursery). It does not specifically address 'milk banking' (see www.ukamb.org for more details) or recommended handling and storage practices for breast milk in neo-natal or special care units in the National Health Service.

The paper has attempted to present an overview in relation to the handling and storage of expressed breast milk. Microorganisms are the main hazards associated with poor hygiene and/or inappropriate storage of EBM. Whilst breast milk has been linked with the direct transmission of infections from mother to child, this aspect is not covered in the paper which focuses on the hazards and risks associated with EBM and how these can be managed.

Introduction

Exclusive breastfeeding is recommended for the first six months of an infant's life with continued breastfeeding alongside the introduction of solid foods. Infants are vulnerable to a wide range of infections. With respect to infectious intestinal disease (IID) rates in children under 1 year of age in England were found to be about 3 times higher than across all age (FSA 2000). In the USA the incidence of salmonellosis among infants has been found to be 8 fold greater than the incidence across all age group (CDC 2004). Although incidence rates of IID tend to be higher in infants there is no evidence that this is primarily due to infant feeding either breast milk or breast milk substitutes. Epidemiological studies have provided evidence of a protective effect of breast feeding against gastrointestinal and respiratory infections (FSA 2000; Field 2005; Newburg 2005). Breast milk is known to contain a number of protective factors including specific antibody and anti-adhesion factors and a range of components with antimicrobial activity (Isaacs 2005; Newburg 2005).

Impact of storage on the microbiological status of expressed breast milk

Breast milk is not sterile and microorganisms will be acquired from the skin and nipple as milk is expressed (Ajusi et al. 1989; Rozolen et al. 2006). The levels of bacterial contamination tend to be low and variable although (10^2-10^3/ml) an "acceptable" contamination level and potential for multiplication in EBM has yet to be clearly defined.

Good hygiene is important in preventing contamination of breast milk with harmful microorganisms and careful attention to cleaning and sterilisation of equipment such as breast pumps and storage containers is emphasised in most publications and websites providing advice and guidance in this area.

There is evidence in the literature that breast milk can on occasion act as the source in transmission of pathogens particularly bacteria. Transmission of *Salmonella* via EBM has been reported in a few instances (Quatishat et al. 2003; Chen et al. 2005). Contaminated breast milk was suspected but not proven as the source of a case of *Enterobacter sakazakii* meningitis Brazil (Barreira et al. 2003) although recent work has shown that *E. sakazakii* is capable of growing in EBM (Lenati et al. 2005). In contrast to EBM there have been well documented outbreaks of *Salmonella* and *E. sakazakii* infection linked to powdered formula the microbiological safety of which has recently been the subject of two FAO/WHO consultations (FAO/WHO 2004, 2006).

Many studies have looked at the growth of bacteria in EBM under different storage conditions in both tropical and temperate climates (Larson et al. 1984; Knoop et al. 1985; Pittard et al. 1985; Olowe et al. 1987; Sosa & Barness 1987; Nwankwo et al. 1988; Ajusi et al. 1989; Igumbor et al. 2000; Ogundele 2002; Rechtman et al. 2006). Many of studies in this area are relatively small and are often difficult to compare directly due to design and methodological. However, collectively they provide a reasonable body of evidence in support of the bacteriostatic behaviour of EBM during several hours under ambient conditions and several days at refrigeration temperatures.

Challenge studies with bacteria have demonstrated inhibitory properties of EBM and components (Chen & Allen 2001; Ogundele 2002; Isaacs 2005; Coppa et al. 2006) although as is often the case there can be apparent exceptions to the rule (Lenati et al. 2005)

Although the focus of this paper is EBM, Santiago et al. (2005) examined the effect of human milk fortifiers on bacterial growth in breast milk and Telang et al. (2005) reported that fortifying fresh human milk with commercial powdered human milk fortifiers did not affect bacterial growth during 6 hours at room temperature.

Impact of storage on the chemical status of expressed milk

Maintenance of the chemical composition of expressed breast milk is important and it is known that chilled and frozen storage will impact to varying degrees on a wide range of nutrient constituents, vitamins, antioxidants, cellular and immunological components (Garza & Nichols 1984; Bank et al. 1985; Hamosh et al. 1996; Jocson et al 1997; Eteng et al. 2001; Miranda et al. 2004; Field 2005; Isaacs 2005).

Chemical parameter may behave differently depending on the storage conditions. Hanna et al. (2004) examined the effect of storage on breast milk antioxidant activity and observed that refrigeration was preferable to freezing for preserving activity. Miranda et al. (2004) examined the lipid peroxidation in

breast milk during frozen storage (-20°C for 10 days) and refrigeration (4-6°C for 48 hours) and found that frozen storage was better for preserving the quality of the milk.

Current advice on the handling and storage of expressed breast milk

To continue breastfeeding mothers frequently express and store their milk for use during periods of separation where they leave their baby with someone else to feed, most notably when returning to work following maternity leave. For example breast milk may be expressed, stored and or thawed for use in the home, the work place, day care, at child minders or nurseries.

There is a wide range of advice available to consumers and health professionals in the UK and elsewhere on the handling and storage of EBM in the home and it is generally applicable to the other settings mentioned above. Table 1 shows a collation of current guidelines available for EBM under ambient, chilled or frozen storage. This is not an exhaustive list although even within this sample recommendations varied from "use almost immediately" to 24 hours at ambient temperature, 24 hours to 8 days in the fridge and 3 months to 12 months in the deep freeze. The evidence base underpinning these guidelines is often not available but likely reflects the wide ranging findings in a diverse range of studies on the microbiological and chemical changes in EBM that have been conducted over the years.

Some of this advice is produced by Government Departments or Agencies, but a wide range of other organisations and support groups also offer guidance via books, leaflets and or websites. The advice currently available has led to confusion about which advice is appropriate to follow as "best practice". Hands (2003) reviewed five research-based and 10 simplified guidelines for safe storage of expressed breast milk in the home and her findings are similar to those here. On the basis of her findings key points for storing breast milk were identified covering good hygiene, accurate fridge temperature control, suggested storage times and guidance on defrosting and warming milk.

Good hygiene is a key consideration irrespective of the subsequent method of storage. There appears to be clear consistent guidance and advice on hygiene, particularly the importance of thorough cleansing and sterilisation of equipment and storage containers or using disposable containers for expressing breast milk. Handling and storage of EBM will usually involve the use of equipment and surfaces in the kitchen. It is important therefore to also recognise the food safety 4Cs message (cleaning, cooking, chilling and avoiding cross contamination) cross-contamination being a particular risk in this situation.

Table 1. Guidelines on ambient, chilled or frozen storage of expressed breast milk (EBM). (Updated from Hands 2003)

Guidance	Ambient	Fridge	Freezer compartment of fridge	Freezer
Department of Health Birth to Five (2006)		24 hours	1 week	3 months
Breastfeeding Network (2004)	6 hours	3 days at 5-10°C; 8 days at 0-4°C	2weeks (-15°C)	6 months if –18°C or lower
Academy of Breastfeeding Medicine (2004)	6-8 hrs (25°C)	5 days at 4°C	2 weeks	3-6 months at -18°C; 6-12 months at -20°C
La Leche League (2003)	24 hrs 15°C; 10 hrs at 19-22°C; 4-6 hrs at 25°C	8 days at 0-4°C	2 weeks	Frequently used domestic freezer 3-4 months, separate deep freeze at –19°C for more than 6 months
Health Education Board for Scotland (2003)		5 days at 2-4°C	6 months	6 months
Health Promotion Agency NI (2003)		2 days at 2-4°C		3 months at -18°C
Lang (2002)	6 hrs	1-2 days at 4°C days		3 months at -20°C
UK Association for Milk Banking (2001)	6 hrs	2 days at 2-4°C	-4°C 2 weeks	-20°C 3 months
Lawrence & Lawrence (1999)	6-8 hrs at 25°C or lower	3-5 days at 4°C or lower 2 days in a domestic fridge	2 weeks	3 months in frequently used domestic freezer (back not bottom) 6-12 months in separate deep freeze –20°C or lower

Renfrew *et al.* (2000)	Use almost immediately	2-3 days	2 weeks	1 month
Newman & Pitman (2000)	10 hrs	Up to 5 days	2-4 months	6 months or longer
UNICEF (1998)		3 days at 2-4°C 3 days 24 hrs if domestic fridge with no thermometer	1 week	3 months in domestic freezer
Moody *et al* (1998)		24 hrs at 4°C or below At back or bottom of fridge		3 months
National Health and Medical Research Council (1996) Australia	6-8 hrs (25°C)	3 – 5 days at 4°C or lower	2 weeks	3 months 6-12 months if at –15°C

Refrigerator and Freezer Temperatures

Refrigerators have an important food safety role in keeping foods chilled within the home and other settings and if operated correctly will reduce the risk from bacterial growth in foodstuffs that are stored correctly within them including EBM. If guidelines for storage of EBM are "risk based" then an understanding of the temperatures in domestic refrigerators and freezers will help in accessing the likelihood of compliance.

There is little recent data on the temperatures of domestic refrigerators. The last comprehensive domestic refrigerator survey in the UK was carried out in 1990 (Evans *et al.* 1991). The mean temperature found ranged from -1°C to 11°C over a 7 day period, and the overall mean temperature was 6.6°C, with nearly 70% of fridges operating at more than 5°C Variation was found in performance between fridges, and within each fridge over time. Different temperatures were also recorded in different parts of single fridges.

In a more recent study of domestic refrigerator temperatures in the UK Johnson et al (1998) found temperatures ranging from -2°C to 13°C with a mean of 7°C and with 70% of fridges operating at more than 5°C. In a small survey in Ireland Kennedy *et al.* (2005) found a wide range of temperatures in domestic fridges (range -7.9°C to 20.7°C) with a mean of 5.4°C and 59% operating at more than 5°C.

There is less information concerning the temperature of domestic freezers or freezer compartments. As with refrigerators freezers are likely to vary to some extent depending on the age and maintenance of the equipment. Since

microorganisms will not multiply at freezer temperatures unless there is a partial thawing, fluctuations are more likely to impact on the chemical composition and organoleptic properties of EBM.

Defrosting expressed breast milk

Particular care is needed when defrosting EBM. A range of approaches are suggested and used for defrosting and warming EBM but the preferred method is to defrost in the fridge (Hands 2003). This does take longer than defrosting at ambient or in tepid or hot water or under running cold water so there are practical considerations. Using microwave ovens for defrosting or heating breast milk is not recommended (Hands 2003). EBM which has been thawed needs to be handled with particular care to minimise opportunities for bacterial growth and enzymic changes which will affect acceptability. Once defrosted, EBM should not be refrozen as this is likely to result in a deterioration in quality and introduces another step where there is potential for microbial growth if thawing is not properly controlled. However, Rechtman et al. (2006) have suggested that EBM thawed in the refrigerator for up to 8 hours may be safely refrozen and perhaps could even be mixed with fresh milk before doing so. No studies were found which examined the effect of repeated freeze/thawing cycles on microbial growth. The volume of EMB stored frozen in individual units is a consideration as larger volumes of EBM will take longer to defrost in the fridge.

Other aspects

Guidelines on handling and storing EMB often neglect to mention the need to label the milk. This is an important consideration, particularly if the milk is being sent to a setting outside the home. Transport of fresh EBM raises practical issues of storage, maintaining temperature control (e.g. use of cool bags, freezer blocks) and avoiding cross-contamination.

Most studies on handling and storage of breast milk focus on the microbiological and chemical changes that occur during storage and there appears to be a lack of published information on practices, attitudes and beliefs concerning the handling and storage of EMB in the home and other settings. Such studies would help assess the likelihood of compliance with recommended guidelines.

Conclusions

- EBM is not sterile. Whilst a number of studies have demonstrated bacteriostatic activity during ambient for several hours and refrigerated storage for several days, attention to hygienic preparation and storage is crucial.

- There is significant variation in published guidelines for the storage of EBM under ambient, refrigerated and frozen conditions Chemical composition of EBM can be influenced by the mode of storage and consideration needs to be given defining how optimum storage conditions can be achieved for composition without compromising food safety.

- The temperature of domestic fridges can vary considerably and EBM should be kept in the body of the fridge and not in the door where pasteurised drinking milk is often stored. Use of a fridge thermometer should be encouraged if the fridge is not provided with one.

- Clear labelling of EBM is important particularly for settings outside the home (e.g. nurseries).

- To encourage compliance EBM handling and storage instructions need to be kept simple and clear for the home and other settings where it will be used.

Areas for further research

- There is scope for further work to establish the effect of initial bacterial load in fresh EBM on the nature and extent of bacterial growth under different storage conditions and the role of intrinsic preservation factors.

- The availability of structured microbiological data on EBM could form the basis of predictive models to assess the behaviour (growth, survival) of bacteria under different preparation and storage scenarios.

- A better understanding of attitudes and behaviours to the handling and storage of EBM in different settings is needed so that guidance and be formulated and targeted in the most effective way.

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