‘White blood’: dose benefits of human milk

Suzanne Colson explains aspects of the science behind human milk and looks at some dose-related implications of exclusive breastfeeding

Human milk, like blood, is a living, vital substance. Because it is considered similar to the placental blood of intrauterine life, Riordan and Auerbach (1997) coined the term “white blood” to describe human milk. It could be said that ‘white blood’ takes over from cord blood and that the mammary gland takes over from the placenta to nourish the offspring; this switch represents a potential nutritional continuum from fetus to neonate.

Metaphorically, human milk nourishes the infant’s blood – the supposed seat of passion, temperament and mettle. Traditionally, human milk has offered succour, comfort, nutrition, warmth and peace.

Biologically, breastfeeding is a blueprint for enhanced health. Although the constituents of mammalian milks are roughly similar, the type and amount of proteins, fats, sugars, minerals and vitamins varies from mammal to mammal to meet the changing nutritional and developmental needs of the offspring for each species (Lawrence 1997). This is called bio-specificity. Many of the components are multifunctional. For example, the proteins in human milk prevent infection and inflammation, promote growth, transport trace minerals, catalyse reactions and synthesize nutrients (Institute of Medicine 1991). Lawrence (1997) highlights that the constituents of human milk represent a ‘delicate balance of macro nutrients and micro nutrients, each in proper proportion to enhance absorption’. This is termed bio-availability.

Mammalian milk is easily obtained, produced in species-appropriate quantities, at body temperature. No preparation is needed. It is delivered fresh, warm and alive when ingested by the offspring. What is unique to mammalian milk is a biological design that promotes nutritional efficacy.

What is nutrition?

In simple terms, nutrition is a three-way relationship between food, the body and health. It consists of five parts:

- Ingestion
- Digestion
- Absorption
- Metabolism
- Excretion

Efficient nutrition concerns the ease with which food is obtained (ingestion), and how complete and accessible the nutrients are for digestion and absorption (bio-availability) so that they can be converted to use as building blocks or for energy to meet the body’s needs (metabolism). Efficient nutrition is also reflected in the percentage of food ingested that cannot be utilised and is therefore excreted.

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For nutrition to be effective, the right nutrient needs to be available in a usable form, in the right amount, at the right time. For example, human milk and sea fish are unique as they are the only foods for human consumption that contain pre-formed very long chain polyunsaturated fatty acids such as docosahexaenoic acid (DHA 22:6) in the omega 3 family (Lawrence 1997). Because they are building blocks for the central nervous system and the human brain, these have been called the “neural fatty acids” (Crawford and Marsh 1989).

This is an eloquent example of bio-specificity and bio-availability. In the first year of life, the infant’s brain triples in size. According to nature’s blueprint, pre-formed DHA (the right nutrient) is easily and rapidly absorbed into the brain in just the right quantities, at just the right time, throughout baby’s first year. In contrast, DHA is not normally found in bovine milk. The process of adding medium chain fatty acids one by one – such as alpha linolenic acid, the parent omega 3 molecule – which the body can then convert into DHA, results in an artificial milk feed that only mimics human milk. This guarantees neither digestion nor absorption (Lawrence 1997). It is an educated guess that informs how much DHA should be added to enrich bovine milk to feed the brains of human infants. Too much or too little at any one time could have negative consequences.

After weaning, milk from any species is no longer a large part of the mammalian diet. It is only in recent human history that children and adults have drunk large quantities of another mammal’s milk. Encouraging massive ingestion of bovine milk was probably an expedient public health measure initiated when dietary habits were poor and a range of foodstuffs was either scarce or expensive. Bovine milk provides many essential nutrients and there was always at least one cow available in each village. At best, bovine milk can be thought of as a human convenience food.

Getting the best from the breast

Successful nutritional postnatal adaptation relies on two conditions. First, to ensure unlimited access to the mammary gland, the baby needs to remain close to the mother’s body contour. I call this biological nurturing, and preliminary results of research examining the mechanisms involved suggest that biological nurturing positions trigger ingestion.

The second condition concerns exclusivity of breastfeeding. Exclusive breastfeeding from birth is defined as giving the baby no other food or liquid but human milk (World Health Organization 2001). That means no sugar water or plain water, no juice, no teas, no honey, no cereals.

Problems in consistency of breastfeeding definitions and poor research design have misled many health professionals to believe that supplementation with artificial milks is a ▶

reasonable response to common breastfeeding problems if the mother chooses, or is in agreement, to do so. Recent feeding statistics show that 28 per cent of breastfeeding babies are given at least one bottle of artificial milk feed while in hospital (Hamlyn et al 2002). This early supplementation is highly associated with unintended breastfeeding cessation during the first two weeks (Hamlyn et al 2002). On the postnatal ward the slogan 'breast is best' often appears to be an unattainable ideal.

Raisler et al (1999) point out that, throughout this health debate, little attention has been paid to breastmilk dose. In its usual context, dose quantifies the amount, the frequency and the duration of any treatment.

In relation to feeding, dose response can be interpreted in two ways. The first concerns the amount of human milk or the amount of infant formula ingested; the latter weakens the 'combination event' effect or nutrient to nutrient interaction that characterises species specificity and bio-availability (Lawrence, 1997). Furthermore, foreign protein (cow, goat, soy, etc), non-lactose disaccharides and vegetal fats are basic constituents of human milk substitutes. Any dose or amount ingested, even one bottle, sensitises the baby's system to non-human components and may decrease potential health benefits. The effects may be irreversible.

The second interpretation of breastmilk dose concerns the amount of milk ingested over a period of time. Exclusive breastfeeding as opposed to mix-feeding over any number of months increases the dose, the amount of human specific milk that a baby ingests and as a result enhances breastfeeding health benefits.

The early days

Human milk and infant formula are not metabolised in the same way. When healthy babies are breastfed, they generate ketone bodies. These result from the beta oxidation of fats (from human milk and from adipose tissue stores) and are now recognised to be an alternative fuel for the neonatal brain during the first three postnatal days (Hawdon et al 1992). This is called suckling ketosis and is recognised as a protective and counter-regulatory mechanism that offers an alternative brain fuel when neonatal blood glucose (BG) concentrations are in the lower ranges (Hawdon 1999). Recent research has shown that suckling ketosis does not occur when infants are formula fed (DeRooy and Hawdon 2002). There is a clear dose response: any supplementation of breastfed infants reduces ketone body concentrations in an inverse relationship to the amount of artificial formula feed given (Hawdon et al 2000).

Some would argue that underpinning practice with the physiology associated with non-human milks should remain the gold standard because it has been 'good enough'. Yet, in the short term, we know that giving bottles of infant formula does not always raise BG concentrations (Hawdon and DeRooy 2002). When healthy infants who are at risk of neonatal hypoglycaemia are given artificial milk feeds, no alternative fuel supply is synthesised when their BG concentrations are borderline. These babies often require intravenous glucose and are admitted to special care.

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Breastmilk dose and diabetes

The incidence of early onset insulin dependent diabetes (IDD) among children up to the age of four doubled over a 10-year study period in Oxford (Gardner et al 1997). Although causes are unknown, the researchers postulated that factors associated with early postnatal life may be responsible. Five to six children per thousand may be born with this genetic predisposition (Tarn and Thomas 1988); unless there is a family history of diabetes, it is impossible to know which babies could be affected. The British Paediatric Association highlights a reduction in juvenile IDD associated with breastfeeding (British Paediatric Association 1994). This appeared to be a dose response. Other studies have identified associations between the early introduction of bovine milk protein and IDD in genetically predisposed children (Akerblom et al 1993; Gerstein 1994). And as early as 1996, Henshel and Inch wrote that giving just one bottle of artificial milk feed may increase the risk for those babies who are genetically susceptible.

Bigger is not always better...

Childhood obesity in Britain has reached epidemic proportions (Chinn and Rona 2001). Fat babies appear to have an increased risk of becoming obese teens and adults (Kramer 1981). One study revealed an association between exclusive breastfeeding for three to five months and a 35 per cent reduction of obesity or being overweight in school-aged children (Von Kries et al 1999). A clear dose response effect for the duration of breastfeeding was demonstrated; this protective effect was not attributable to differences in social class or lifestyle. A protective programming effect was theorised: babies fed artificial milk from birth have significantly higher plasma concentrations of insulin (Lucas et al 1980). These higher concentrations would be expected to stimulate fat deposition (Von Kries et al 1999).

There is evidence that, even though they grow more rapidly during the first two months, breastfed (BF) babies gain less weight, on average, during the first year than formula fed (FF) babies, even after solids are introduced (Dewey 1998). There is also evidence that BF infants self-regulate their energy intake at a lower level than FF infants (Dewey 1998). Although the mechanisms are unclear, Dewey (1998) poses a key question: why do FF infants consume more energy than BF infants? Body temperature and minimal observable metabolic rate have been reported as lower in BF than FF babies (Butte 1996). Although this may be part of the explanation, it cannot explain these differences in fatness (Dewey 1998). These adverse consequences may be caused by the excessive protein intake found in infant formulae (Dewey 1998) – yet another dose response.

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Other dose benefits

In the long term, some important health differences have been found that may be associated with breastmilk dose. A retrospective study examining health risks for cardiovascular disease compared method of feeding during the first postnatal week. Subjects who were formula fed had significantly higher glucose tolerance test results at 120 minutes and higher prevalence of impaired glucose tolerance than those who were exclusively breastfed. Formula-fed subjects also had higher fasting insulin concentrations (Ravelli et al 2000).

There is an increasing body of scientific evidence that demonstrates other dose risks associated with formula feeding, even in industrialised countries (MIDIRS 2002). For babies, exclusive breastfeeding confers dose protection against gastroenteritis, respiratory infection and urinary tract infections (Lawrence 1997). For mothers, exclusive breastfeeding is strongly associated with a reduction in pre-menopausal breast, ovarian and endometrial cancers. Exclusive breastfeeding is now advised for the first six months of life (WHO 2001).

Conclusion

Taken together, the above evidence suggests the following practice recommendations to support exclusive breastfeeding:

- Inform mothers concerning dose risks associated with formula feeding
- Carry out risk/benefit assessments before offering any artificial milk supplements to breastfeeding mothers experiencing difficulties
- Sharpen clinical skills associated with breastfeeding assessments, and in particular criteria concerning breastmilk transfer (ie, clinical indications that the baby is getting enough milk)
- Underpin feeding practices with an entirely human nutritional continuum from fetus to neonate.

Diseases of civilisation such as obesity, diabetes and cardiovascular disease are increasing at endemic proportions. Although they seem remote from giving birth and breastfeeding, there is an increasing need to understand and to promote the biological blueprint to enhance health. **TPM**

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