Adverse Effects of Cow's Milk in Infants

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Abstract

The feeding of cow's milk has adverse effects on iron nutrition in infants and young children. Several different mechanisms have been identified that may act synergistically. Probably most important is the low iron content of cow's milk. It makes it difficult for the infant to obtain the amounts of iron needed for growth. A second mechanism is the occult intestinal blood loss, which occurs in about 40% of normal infants during feeding of cow's milk. Loss of iron in the form of blood diminishes with age and ceases after 1 year of age. A third factor is calcium and casein provided by cow's milk in high amounts. Calcium and casein both inhibit the absorption of dietary nonheme iron. Infants fed cow's milk receive much more protein and minerals than they need. The excess has to be excreted in the urine. The high renal solute load leads to higher urine concentration during the feeding of cow's milk than during the feeding of breast milk or formula. When fluid intakes are low and/or when extrarenal water losses are high, the renal concentrating ability of infants may be insufficient for maintaining water balance in the face of high water use for excretion of the high renal solute. The resulting negative water balance, if prolonged, can lead to serious dehydration. There is strong epidemiological evidence that the feeding of cow's milk or formulas with similarly high potential renal solute load places infants at an increased risk of serious dehydration. The feeding of cow's milk to infants is undesirable because of cow's milk's propensity to lead to iron deficiency and because it unduly increases the risk of severe dehydration.

Introduction

The feeding of cow's milk to infants has undesirable consequences in two unrelated areas. One is iron nutrition, where several characteristics of cow's milk combine to produce a strong propensity to cause iron deficiency. The other area is body water economy, where the unduly high potential renal solute load of cow's milk increases the risk of severe dehydration.
Cow's Milk and Iron Deficiency

There is an extensive body of evidence beginning in the 1970s showing that the feeding of cow's milk to infants (and to young children) is strongly associated with diminished iron stores and an increased probability of iron deficiency. Many of the studies were conducted in the USA [1–6] and Great Britain [7–11], but studies have also been reported from Denmark [12], Australia [13], Ireland [14], Sweden [15], Iceland [16] and a cross section of European countries [17].

The study of Male et al. [17] involved 488 normal infants in 11 different countries. When iron status was assessed at 12 months of age, 7.2% of the subjects had iron deficiency and 2.3% had iron deficiency anemia. Feeding of cow's milk was a strong determinant of iron status, with each month of cow's milk feeding increasing the risk of iron deficiency by 39%. In a study in Iceland [16] involving 180 normal infants, iron status at 12 months of age was found to be strongly negatively associated with cow's milk consumption between 9 and 12 months of age. Infants in the highest quintile of milk consumption were in significantly worse iron status than infants consuming lesser amounts of cow's milk.

In most studies, the iron status of infants fed cow's milk is compared with that of infants fed formula, which is usually fortified with iron. However, in two studies [1, 2] formulas were used that were not fortified with iron. These formulas still led to better iron nutritional status than cow's milk. These studies thus provide evidence that cow's milk affects iron status adversely not just through its low iron content and suggest that additional mechanisms are involved in producing poor iron status. Two such mechanisms are known. One is occult intestinal blood loss. The other is inhibition of absorption of dietary nonheme iron by components of cow's milk. The relative importance of the known mechanisms cannot be determined from existing data. Although it appears that the low iron content of cow's milk is most important, it is likely that all three mechanisms act in concert to produce iron deficiency.

Low Iron Content of Cow's Milk

One reason why cow's milk causes iron deficiency is its low iron content (about 0.5 mg/l). Taking into account the iron endowment at birth, the infant needs to absorb on average about 0.7 mg (0.55–0.75 mg) of iron each day in the first year of life in order to avoid iron deficiency [18]. If 10% of ingested iron is absorbed, the infant needs to ingest about 7 mg of iron each day, and if 30% is absorbed (which is unlikely but possible), the intake still needs to be about 2.3 mg/day. In either case it is obvious that cow's milk can at best make an insignificant contribution to the needed iron intake. (In contrast, formulas with iron concentrations between 6 and 12 mg/l easily meet infants' iron needs.) The infant fed cow's milk thus depends almost entirely on complementary foods to provide the needed iron. If the infant consumes iron-fortified
complementary foods (e.g., cereals) or meat, the iron intake can be high enough to meet needs. But nonfortified complementary foods seldom provide enough iron. Thus, the infant fed cow’s milk is at risk of iron deficiency, even if the efficiency of iron absorption is high, as it is apt to be when iron stores are becoming depleted.

**Occult Intestinal Blood Loss**

Normal infants lose small quantities of blood in their feces at all times. In the past, investigators were able to measure fecal blood loss quantitatively using the radiochromium ($^{51}$Cr) technique. With this technique, erythrocytes are withdrawn from the subject, labeled in vitro with $^{51}$Cr and reinjected. Measurement of radioactivity simultaneously in blood and feces then permits quantitative determination of the amount of blood lost in feces. Using this technique, Elian et al. [19] found that blood loss averaged 0.59 ml/day in infants hospitalized for various nonintestinal infectious illnesses. Each infant had measurable blood loss. In infants with gastroenteritis blood loss averaged 1.85 ml/day. Wilson et al. [20] were the first to recognize that the feeding of cow’s milk can lead to an increase in intestinal blood loss. Studying iron-deficient infants and toddlers with the $^{51}$Cr method, they found that in a sizable number of infants there was a clear and reproducible increase in fecal blood loss caused by the feeding of cow’s milk. In other iron-deficient subjects blood loss occurred sometimes during cow’s milk feeding but not at other times. In infants with consistent cow’s milk-induced blood loss, the amount of blood lost averaged 1.7 ml/day. When the same subjects were fed formula (milk-based or soy-based), blood loss decreased to 0.3 ml/day. Blood loss of 1.7 ml/day is equivalent to iron loss of 0.53 mg/day, which, if it is not causing an outright negative iron balance, makes it at least very difficult for the infant to achieve a net iron gain of 0.7 mg/day as is necessary to prevent iron depletion.

As the studies of Wilson et al. [20] concerned infants and toddlers with iron deficiency, it remained unclear how common cow’s milk-induced blood loss was in infants with normal iron stores. To answer this question, Fomon et al. [21] performed a study in which normal 4-month-old infants were randomly assigned to pasteurized cow’s milk, or heat-treated cow’s milk (heat-treated to the same extent as ready-to-feed infant formula), or iron-fortified ready-to-feed infant formula. Between 112 and 196 days of age, stool specimens were collected weekly and tested for the presence of blood by the guaiac test. During the first 4 weeks of the trial, 39% of infants fed cow’s milk had one or more guaiac-positive stools and 17% of all stools were guaiac positive. In contrast, among infants fed formula or heat-treated cow’s milk, only 9% of infants had one or more guaiac-positive stools ($p < 0.01$) and only 2.4% of all stools were guaiac positive ($p < 0.001$). During month 2 and 3 of the trial, differences between feeding groups were smaller and not statistically significant. There were no differences in iron nutritional status, possibly because iron intake was generous in all groups.
While the study by Fomon et al. [21] showed that a sizable minority of normal infants had intestinal blood loss when fed cow’s milk, it provided no information about the quantity of blood lost during feeding of cow’s milk, and it concerned relatively young infants. A subsequent study [22] of similar design employed a quantitative method for determination of fecal hemoglobin. Also, it initiated the feeding of cow’s milk at a later age (5½ months). There were two feeding groups, one fed cow’s milk and one fed iron-fortified milk-based formula. Infants had initially been breastfed or had been fed milk-based or soy-based formulas, but for at least 1 month before entering the trial all infants were fed a milk-based formula. As in the earlier study, the percentage of guaiac-positive stools rose from a baseline value of 3% to 30% during the first month of the trial (p < 0.01), whereas among infants fed formula the proportion of guaiac-positive stools remained low (5%). The concentration of hemoglobin in stool increased in infants fed cow’s milk from 622 µg/g dry stool before cow’s milk to a mean of 3,598 µg/g (SD 10,479) dry stool during the first month of feeding cow’s milk (as illustrated in fig. 1). In infants fed formula stool hemoglobin concentration did not change from baseline and remained significantly (p < 0.01) lower than in infants fed cow’s milk. Again, a large minority (38%) of infants fed cow’s milk reacted to cow’s milk (‘responders’) and accounted for all the observed increase in mean stool hemoglobin concentration. As before, the majority of infants (‘nonresponders’) were indistinguishable from formula-fed control infants. Among the responders, fecal hemoglobin concentration varied widely, as indicated by the large SD value.

![Fig. 1. Fecal hemoglobin concentration in infants fed formula and infants fed cow’s milk beginning at 168 days of age (mean ± SE). Drawn from data of Ziegler et al. [22].](image-url)
One responder infant in the study of Ziegler et al. [22] had massive hemoglobin loss during the first month of the study (average iron loss of 2.04 mg/day). This infant developed iron deficiency anemia after just 1 month on cow's milk and was taken out of the study and given iron treatment, to which she responded promptly and completely. The remaining 9 responders lost on average 0.24 mg of iron/day, an amount that is not trivial in infants whose ability to gain 0.7 mg of iron/day is already compromised by low iron intake due to being fed cow's milk. It is of note that intestinal blood loss was clinically silent and that feeding-related behaviors did not differ between responders and nonresponders. Also of note is that infants who were fed milk-based formula from birth were less likely (p = 0.059) to respond to cow's milk with intestinal blood loss than infants who were breastfed from birth.

Subsequent studies [23, 24] answered the question whether cow's milk-induced intestinal blood loss occurs also in older infants. Infants were fed cow's milk for 2 months starting at 7½, 9 and 12 months of age. About half the study participants were initially breastfed for various lengths of time, while the other half of infants were fed formula only (including soy-based formula). During the feeding of cow's milk beginning at 7½ months (224 days) of age, fecal hemoglobin concentration rose significantly (p < 0.05), but the increase was on average less pronounced than at 5½ months of age. Among the 26% of infants who were classified as responders, average fecal hemoglobin was 3,010 µg/g dry stool (fig. 2). Among the responders were 2 infants with persistent high fecal hemoglobin concentration that averaged 7,430 and 8,156 µg/g dry stool, respectively.

When cow's milk was introduced at 9 months (280 days) of age, 29% of infants showed a response and had average stool hemoglobin concentration of 2,711 µg/g (SD 1,732) dry stool, which was significantly (p < 0.01) higher than at baseline when concentration averaged 1,395 µg/g (SD 856) dry stool. In contrast, introduction of cow's milk at 12 months of age produced no increase in fecal hemoglobin above baseline (fig. 2). Two infants (7%) showed a response, but it was quite mild and short-lived. Of note is that baseline fecal hemoglobin concentrations showed a marked increase with age. They averaged 657 µg/g dry stool at 5½ months of age and rose steadily until they reached 1,395 µg/g dry stool at 9 months of age and 1,194 µg/g dry stool at 12 months of age (fig. 2). The increase probably reflects the increasing presence of unabsorbed food heme (e.g. from meat) rather than increased baseline blood loss, but the latter possibility cannot be excluded.

Inhibition of Absorption of Iron by Components of Cow's Milk

In contradistinction to heme iron, the absorption of nonheme iron, which constitutes the bulk of dietary iron, is subject to inhibition by a number of substances that commonly occur in the diet. Cow's milk contains much higher amounts of calcium and casein than, for example, breast milk. It is well established that calcium is a potent inhibitor of iron absorption [25]. In adult
subjects, iron absorption from human milk was 37.3% and from cow’s milk 15.5% [26]. When the calcium concentration of human milk was raised to the same level as in cow’s milk, iron absorption from human milk was only 19.2%. Thus, calcium explained about 70% of the difference in iron bioavailability between human and cow’s milk [26]. No similar studies have been reported for infants. Hurrell et al. [27] showed that casein and other milk proteins strongly inhibit the absorption of iron. Thus it is evident that cow’s milk with its high calcium and casein content is likely to have an adverse impact on the availability of iron which the infant and young child obtains from complementary foods.

**Cow’s Milk and Renal Solute Load**

Waste substances of endogenous and dietary origin that require excretion by the kidneys are collectively referred to as renal solute load (RSL). Most of the RSL is of dietary origin and is related to the protein and electrolyte
content of the diet. Potential renal solute load (PRSL) refers to solutes of dietary origin that need to be excreted in the urine except for a small proportion that is used for synthesis of new tissues and that is lost through nonrenal routes. Solutes are expressed in milliosmols and the concentration of the urine (osmolality) is expressed in milliosmols per kilogram of water.

Excretion of the RSL requires water and the minimum amount of water needed to excrete a given amount of RSL depends on the concentrating ability of the kidneys. When an infant is well and feeding ad libitum, his ability to excrete unneeded solutes and maintain water balance is more than adequate, even if the feeding has a high PRSL, for example cow’s milk. However, there are circumstances in which the PRSL of the feeding is an important factor in maintaining water balance. In acute illnesses, food intake and hence fluid intake is generally decreased while evaporative loss of water is increased if there is fever. Water loss is further increased if there is diarrhea. In these circumstances the size of the PRSL determines whether or not water balance can be maintained.

**Calculation of PRSL of the Diet**

Nitrogenous compounds (mostly urea), the three electrolytes and phosphate make up the bulk of the RSL of infants. Therefore, an approximation of PRSL may be obtained as follows:

\[ \text{PRSL} = \frac{N}{28} + \text{Na} + \text{Cl} + \text{K} + \text{P}, \]

where the units are in millimoles (or milliosmols), except for N, which is total nitrogen in milligrams, and the term, N/28, represents nitrogenous solutes. The PRSL provided by various milks and formulas is presented in table 1. The value for mature human milk is 93 mosm/l (14 mosm/100 kcal). The value of 135 mosm/l (20 mosm/100 kcal) for the PRSL provided by milk-based formulas is representative and is somewhat lower than the PRSL of

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**Table 1.** PRSL of various milks and formulas [modified from 29]

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<th>Feeding</th>
<th>Components of PRSL</th>
<th>PRSL</th>
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<td>Na mmol/l</td>
<td>Cl mmol/l</td>
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<tr>
<td>Human milk</td>
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<tr>
<td>Milk-based formula</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Soy-based formula</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Two thirds cow’s milk</td>
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<td>Whole cow’s milk</td>
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soy-based formulas (160 mosm/l; 24 mosm/100 kcal). The PRSL of whole cow's milk is 308 mosm/l (46 mosm/100 kcal) [28, 29].

Water Balance

As reviewed by Ziegler and Fomon [28] and Fomon and Ziegler [29], the physiological and clinical significance of the RSL rests on the impact it can have on body water economy. Water is ingested with milk, formula and other foods. At the caloric concentration of 67 kcal/100 ml, breast milk, cow's milk and formula provide about 90 ml of preformed water plus about 5 ml of water derived from the oxidation of fat and carbohydrate, for a total of 95 ml of water for each 100 ml of feeding. Water is inevitably lost from the body by evaporation and in feces. Evaporative water loss is increased considerably by fever and by elevated environmental temperature. Fecal water loss, which normally amounts to about 10 ml/kg/day, is greatly increased in diarrhea. Water not lost via feces or evaporation is available to the kidneys for urine formation. The amount of water available is diminished when evaporative and/or fecal water losses are increased. The capacity of infants to concentrate urine is not fully developed and is generally limited to 900–1,000 mosm/kg of water, with some normal infants being unable to achieve even 900 mosm/kg water [30–33].

Relation of PRSL to Urine Osmolality and Water Balance

An understanding of the PRSL of the infant's diet is of practical importance, as is evident from theoretically based calculations and from epidemiological data. Urine osmolality of infants may be predicted from the PRSL. The actual RSL is the PRSL minus the portions used for growth and lost through nonrenal routes. The latter losses, except during episodes of diarrhea, are small and may be ignored. The RSL may be estimated by subtracting from the PRSL solutes used for growth, i.e. 0.9 mmol (or mosm)/g of weight gain. An estimate of the RSL may therefore be calculated as RSL = PRSL − (0.9 × gain). Urine volume may be estimated from intake of milk or formula minus evaporative water loss. Urine osmolality can then be calculated. The data in table 2 show that predicted urine concentrations of hypothetical infants agree reasonably well with observed urine concentrations. Therefore, predictions of urine osmolality can be used to model urine osmolality and water balance in situations where the water balance is under stress.

In normal infants consuming commonly fed diets, water balance is easily maintained because, even with the infant's limited renal concentrating ability, the quantity of water is sufficient to excrete all the RSL. Figure 3 depicts urine osmolality (predicted) of a hypothetical infant. The strong effect of PRSL of the infant's diet on urine osmolality is evident. The effect of complementary foods (data not shown) is to increase urine osmolality except in the case of cow's milk, where the effect is to decrease predicted urine osmolality. If the child experiences a febrile illness, the amount of water available for
urine formation is diminished and urine osmolality increases dramatically, as the right panel of figure 3 illustrates. In the latter scenario it is assumed that the volume of intake from all sources is decreased by 25% and that evaporative water loss is increased by 33%. Even with these rather modest deviations from normal, there is a marked effect on urine osmolality. And now the PRSL of the infant’s feeding makes a crucial difference. With human milk or formula,
the osmolality is still well within the infant’s concentrating ability. But with cow’s milk, the urine osmolality will be close to the infant’s urinary concentrating ability. If the osmolality that would be necessary to excrete all renal solutes exceeds the infant’s concentrating ability, maximally concentrated urine will be excreted and the infant will go into negative water balance. If the decrease in intake and/or the increase in evaporative water loss are higher than assumed in the example, the infant fed cow’s milk will be in more strongly negative water balance. Persistent negative water balance leads to dehydration. Infants fed cow’s milk are therefore at greater risk of significant dehydration than infants fed human milk or formula.

**Epidemiological Evidence**

Epidemiological data indicate that infants fed formulas providing PRSL of 39 mosm/100 kcal or more are at much greater risk of hypertonic dehydration during illness than are breastfed infants (average PRSL of human milk is about 14 mosm/l) or those fed currently marketed formulas (PRSL about 20–24 mosm/100 kcal). In the United Kingdom, whole cow’s milk and formulas with only slightly lower PRSL were widely fed to infants until 1974, when health authorities recommended feedings with lower PRSL. This recommendation was widely followed and the use of feedings with high PRSL declined sharply. A number of reports documented a decrease in the incidence of hypernatremic dehydration occurring in the years following the change [34–37]. The close temporal relation between changes in feeding practices and the decline in the incidence of hypernatremic dehydration strongly suggests that hypernatremic dehydration occurs more frequently when feedings provide an unduly high PRSL. In the United States, the change in feeding practices that led to the use of formulas with relatively modest PRSL occurred more gradually, and epidemiological data comparable to those for the United Kingdom are not available. Nevertheless, there is little doubt that the incidence of hypernatremic dehydration has decreased as formulas with more modest PRSLs replaced evaporated milk formulas in the 1970s. In hospitals in the Bronx, diarrhea with dehydration was reported to account for about 12% of infant admissions from the 1960s through the 1980s. The dehydration was hypernatremic in 19.5% of these infants in 1963–1972, 9.3% in 1973–1980, and 4.5% in the 1980s [38].

**Recommended Upper Limit for PRSL of the Infant’s Diet**

Thus, as discussed in more detail by Ziegler and Fomon [28], both theoretically based calculations and epidemiological evidence suggest that a PRSL of about 39 mosm/100 kcal or greater places the infant at risk of hypernatremic dehydration, whereas feedings providing 20–24 mosm/100 kcal appear to offer a satisfactory margin of safety with respect to water balance. It seems reasonable to limit the PRSL of feedings for infants to 30–35 mosm/100 kcal. RSL considerations entered prominently into the recommendation in 1992 of the Committee on Nutrition of the American Academy of Pediatrics [39] that
infants should be breastfed or fed formulas rather than whole cow's milk (PRSL 46 mosm/100 kcal) during the first year of life.

**Conclusion**

Because of its adverse effects on iron status and because it increases the risk of severe dehydration, unmodified cow's milk should not be fed to infants. One of the main objections to the feeding of cow's milk, its negative effect on iron status, could be overcome by the use of iron-fortified cow's milk or by providing iron supplements. The dehydration risk can be reduced by lowering the PRSL to less than 35 mosm/100 kcal. That can be accomplished by simply diluting cow's milk and by adding a source of energy (e.g., carbohydrate), i.e. making it into a formula. But the feeding of unmodified pasteurized cow's milk places infants and toddlers at high risk of iron deficiency and increases the risk of severe dehydration.

**References**


Discussions

Dr. Fisberg: I think there is no doubt that cow's milk is not suited for children especially at very young ages. One of the main concerns, especially in developing countries where the prices are not subsidized, is the high cost of the formulas. So what would be an alternative to this situation in those countries?
**Dr. Ziegler:** On the iron side cow's milk could be fortified with iron. Chile is doing it and I think Argentina is also doing it. It is not expensive. On the renal solute load side, a formula can be made out of cow's milk by diluting it with water and adding a source of energy, preferably also a source of iron. That would improve the ratio of renal solute load to water. I suspect that is done in Brazil widely, cow's milk is not fed as straight cow's milk, it is fed as a formula. Of course the ultimate answer is to breastfeed because, besides all other advantages, the economics of breastfeeding are highly favorable.

**Dr. Gailing:** What are your considerations on renal solute load and the eventual dehydration and iron losses with the consumption of dairy products? After 6 months a lot of babies are switched from a part of the milk or the infant formula to normal fresh dairy products based on cow's milk. Do you have the same conclusion when the babies are eating this type of product in a large amount?

**Dr. Ziegler:** If you are asking me about cheese, would cheese cause blood loss? I suspect not, but I don't know, I have not studied any dairy products other than whole pasteurized cow's milk. The concern about the lack of iron is the same with all dairy foods. But I must emphasize that a low iron content is only a concern when a food is the predominant source of energy, as would be the case in a 6-month-old infant fed cow's milk.

**Dr. Domellöf:** What do you think is the mechanism behind the cow's milk-induced blood loss; is it related to cow's milk allergy?

**Dr. Ziegler:** I told you that babies who were exposed to modified cow's milk antigens from birth had a low incidence of blood loss. This suggests perhaps that there is tolerance that develops in those babies who are exposed to cow's milk antigens from early on.

**Dr. Shahkhalili:** Could the different effects of sterilized cow's milk (heat treated at 115°C) and pasteurized milk be due to a lack of live bacteria in sterile milk?

**Dr. Ziegler:** Although pasteurized milk is not completely sterile whereas milk treated to 115°C is, neither form of milk is a source of bacteria for the infant.

**Dr. Agostoni:** I am always very curious about these unknown compounds. Do you have any information whether it is from whey or casein, or do you know whether by supplying yogurt or fermented milk you have the same effect?

**Dr. Ziegler:** A colleague of ours in Russia has studied fermented milk. The name of it is kefir, and he found that there is blood loss when it is given to young infants.

**Dr. Simell:** If I am not totally mistaken, if children who are receiving cow's milk are properly supplemented with iron, the bleeding to the gut is stopped. There are some adult studies looking at the same phenomenon and clearly it looks as though this is happening. Do you know anything more?

**Dr. Ziegler:** I know which study you are referring to, it was done in the 1960s, but there is an alternative interpretation. The study concluded that if you are anemic you lose blood. I think the alternative interpretation, that you lose blood and therefore you are anemic, is just as viable and fits the data. So I don't believe that anemia makes you lose blood, I think it is the other way round.

**Dr. Pazvakavambwa:** I want to know if the high UHT milk, the long-life milk, is different from ordinary cow's milk?

**Dr. Ziegler:** I don't know the answer, I have not studied UHT milk. How high is the temperature in UHT? 115°C, that would suggest that it does not induce bleeding.

**Dr. Solomons:** I was interested in your initial run through of requirements for absorption. I am always interested in something that doesn't have the standard deviation. So you were giving some single numbers, is this an average number, is this a maximum number that is the highest number in the range of what children need? First of all I don't believe it is a single number, I believe that infants have a range to be
absorbed and that range also is dependent on other things, for instance on their difference in growth rates and tissue requirements for iron. This has been illustrated by some recent studies on mice at Davis California [1]. To interpret it, we must acknowledge all of the caveats in extrapolating from a rodent to a human in terms of maturation equivalency. Nevertheless, the observation suggested that iron adsorption is more sensitive to interference from zinc in early life. I think what we are learning from both experiments in animal and human research is that there are a number of intricate factors beyond calcium and the gut that might texture, produce more nuances in requirements from infant to infant for iron. I am skeptical about a single number that you multiply by another number and get another number and call that number universal for all humanity.

Dr. Ziegler: I agree with your point that there has to be a range and that which I showed is at best an average. But I used it mainly to illustrate the fact that there is a substantial requirement for iron that cannot be met by cow's milk. Now that 170-mg increase from birth obviously has a large range because we know that some babies are born with low iron stores and some are born with high iron stores. So if you want you can calculate from the lowest possible iron content at birth to the highest possible iron content at 1 year and you come up with a large number. Then you could do the converse and assume a baby with large iron stores will end up with a low iron content at 1 year. They will obviously have very different increments.

Dr. Morelli: I don’t know if I remember well, but whey protein could be negatively affected by the UHT process, especially if it is real UHT and not UHST. There are two methods for this kind of heat treatment. The old one was UHT and now we have UHST, which takes a very short time; in a couple of seconds steam is injected into the milk, and this treatment is very soft for casein, but not for globulin. So this could be a tool to isolate and identify unknown components.

Dr. Ziegler: Since we don’t know what the offending agent is, the only way to find out whether UHT-treated milk causes blood loss is to do a test.

Dr. Giovannini: Do you have any data on the consumption of whole cow’s milk and its incidence in obesity? We talked about obesity and breastfeeding, but in Western countries whole milk is still used today, not only for economic reasons. Are there any data which could explain to our colleagues who are sometimes the first not to believe too much in breastfeeding and don’t believe too much in formulas?

Dr. Ziegler: I don’t think that anyone has done long-term follow-up studies to see what the incidence of obesity is in childhood or adulthood. I know Dr. Michaelsen has data on the relationship of milk consumption to obesity or adiposity at 4 years. There is adult literature that says if weight-loss diets include a large amount of dairy foods, there is a more pronounced loss of percent body fat, but that is only in the situation of weight loss. For children nothing of that sort is known. But that is current intake of cow’s milk, and you are asking if consuming cow’s milk during infancy has anything to do with obesity later on, and I don’t think anyone knows.

Dr. Cardoso: Could you comment on parasitic infections and blood loss in the developing countries?

Dr. Ziegler: If you have parasitic infections then obviously there are some that can cause substantial blood loss, but I can’t comment.

Dr. Solomons: Intestinal parasites are unlikely to establish adult worms within the first 6 months in the life of an infant; it takes longer for the parasitic egg to develop into a worm than it takes the child to develop into an older infant. Hookworm comes to the skin and if a baby is left lying around, it might get infected. Hookworm causes bleeding and is contacted by the fecal oral route. The child has to be crawling, so this a disease that is well above the infant period.
Dr. Barclay: I would just like to come back to the relationship between calcium and iron absorption. The studies done by Hallberg and Rossander [2] were acute absorption studies. Acute single meal studies show a dramatic effect of calcium intake on iron absorption. However, more recent data from longer term studies, over several weeks or months, show that the effect of calcium intake on iron absorption actually disappears. Is there now a consensus on this relationship between calcium intake and iron absorption?

Dr. Ziegler: Cow’s milk causes iron deficiency. If we dismiss blood loss and dismiss inhibition of iron absorption, we are left with the low iron content of cow’s milk as the mechanism. But something is causing infants fed cow’s milk to be iron deficient, there is no question.

Dr. Michaelsen: We made an intervention study with calcium in pubertal girls in order to look at bone metabolism and iron status [3]. We asked them to take calcium with the evening meal to increase compliance, and there was absolutely no effect on iron status after 1 year.

References
