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Human Milk and Childhood Diarrhoea

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Diarrhoea the commonest cause of death in young children in less developed countries (LDCs) is usually due to the effect of intestinal microbial agents e.g., pathogenic, such as *E. coli,* rotaviruses, etc., or to alterations in the balance of bacterial population. Three age groups may be differentiated — the newborn, the infant and the weanling. Especially in LDCs, human milk plays a role in all these because of (i) its inherent resistance factors (humoral and cellular) notably anti-*E. coli,* cholera, and rotaviruses, (ii) its lack of contamination, (iii) its role as a clean water supply, and (iv) its function in promoting optimal nutrition.

Newborn diarrhoea is essentially a "colostrum deficiency" syndrome, similar to conditions seen in domestic animals (c.f. "scours" in calves). It is *not* usually a problem in traditional societies, unless colostrum rejection is, but can flourish when Westernized puerperal practices develop (bottle feeding, separation of neonates in nurseries). As in non-human mammals, colostrum has been administered prophylactically to babies in special care neonatal units.

Infantile diarrhoea (especially in the first 6-9 months of exterogestate life) is commoner in bottle-fed babies, not only because the positive properties of human milk are lacking, but also because cow's milk-based formulas artificially fed by bottles are inevitably heavily contaminated in LDC circumstances. The need for "rehydration centers" is largely a function of a decrease in breast feeding in a community. In later infancy and in the weanling ("transitional") the protective effect of human milk against diarrhoea declines, particularly as inherently contaminated weanling foods are fed to the young child in increasing quantities.

Public health programmes all over the world need to emphasise the significance of breast feeding as a major preventive of diarrhoea in the newborn and infant, as well as for its other nutritional, anti-allergenic, emotional, child-spacing and economic benefits. Such programmes have to be based on a locally appropriate blend of (a) education and information, (b) reorientation of health services (to curricula, antenatal and puerperal procedures), (c) control of harmful promotion by formula companies, and (d) consideration of facilities for mothers working in salaried employment out of the home.

In the past and present cultures, there has been a widespread recognition that infants should not be "weaned" — that is given foods other than human milk — during the summer when diarrhoea is generally more prevalent.

Also, veterinarians who have been much ahead in this field, have long recognised the paramount importance of mother's milk, particularly colostrum in the prevention of "scours", as *Esch. coli* diarrhoea in newborn calves is termed.

It is easier to view the protective effect of human milk against diarrhoea if it is realised that "infant" or

Hunger and Malnutrition in the Third World

"Forty million people — half of them children, die every year from hunger and malnutrition. If we were to decide to observe a minute of silence for every person who died in 1982 owing to hunger-related causes, we would not be able to celebrate the advent of the twenty-first century, because we would still have to remain silent.

"Of the 122 million children born in the International Year of the Child, one out of ten did not live to see the year out and 90% of these were in the developing countries."

"The time has come to measure progress not by growth rates but by the quality of life of the people."

Excerpt from the address to the plenary session of the Seventh Non-Aligned Summit meet in New Delhi on March 7, 1983 by Dr. Fidel Castro, President of Cuba and outgoing Chairman of the Non-Aligned Movement.

"young children" are not a homogenous "at risk" group. Rather, the stages of early human development can be considered according to the classification of Bostock (Bostock, J. Evolutionary approaches to infant care. *Lancet,* i, 1033, 1962. Jelliffe D.B. & Jelliffe, *E.F.P. Human Milk in the Modern World.* Oxford University Press, Oxford. 1978). — that is into the *foetus* (who, as far as known, is not afflicted by diarrhoea), the *exterogestate foetus*, that is the baby in the first 6-9 months of life who is breastfed under normal biological circumstances. During this phase, the breast acts as the external placenta, dependence on the mother is almost complete, and the association between the nursing dyad is very close, with many of the stimuli, such as the sound of the heartbeat similar to those experienced by the uterine foetus. The third stage is the *transitional,* when the young child is in transition from breast milk to the adult diet of the culture.

The exterogestate foetus, especially the newborn, and the transitional have different risks of diarrhoeal disease, and in each of these stages of development, human milk has a different preventive potential in terms of risks of intestinal infection and consequent death from dehydration.

The anti-diarrhoeal significance of human milk is very considerable, but it is plainly greater when risks of intestinal infection are greater because of poor environmental sanitation, and when breast feeding is compared with the alternative of using artificial feeding — that is with formulas given via feeding bottles.

The anti-diarrhoeal properties can be considered under two headings: "indirect" and "direct". *"Indirect"* refers to the need for the child to attain optimal nutrition in early infancy — that is during the exterogestate foetal period (0-6 or 9 months). Plainly, this nutritional component is a very important part of the whole picture, because diarrhoeal disease and its consequences *are the result of interaction between the host's nutrition and the enteral infection* ("infectious diarrhoea"), due to enteroviruses, pathogenic *Esch. coli* and other organisms.

Recent investigations demonstrate increasingly that there are very many *"direct"* protective effects of human milk as far as infectious diarrhoea is concerned, which can be broadly categorised into passive and active.

The *passive protection* conferred by human milk has been recognised for many years. Breast milk is clean, with, at most, a few organisms present from the mother's skin and nipples; there is no opportunity for bacterial multiplication: it is a clean water supply for the exterogestate foetus. But, in addition, the past 10-15 years has produced a very large amount of new information on the *active protection* afforded by human milk, particularly colostrum, against intestinal infections (notably infectious diarrhoea), and generalised infections, where the portal of entry into the body is through the alimentary canal.

Two forms of active protection can be differentiated — cellular and humoral (anti-infective substances). The cellular composition of human milk has long been recognised, and, in fact, breast milk is a live fluid, so that, in some cultures, it has been termed "white blood". The white cells in colostrum and human milk-macrophages and lymphocytes, are present in similar numbers to those in blood. Their protective effect is not only as far as the baby is concerned, but very probably for the mother as well, in dealing with ascending infections through the terminal lacteals. In addition to direct action, such as phagocytosis by macrophages, milk cells themselves secrete anti-infective substances. For example, lymphocytes produce the antiviral substance — interferon — which has a profound effect on the enteroviruses which are increasingly recognised as a common cause of diarrhoeal infection.

As regards substances present in human milk, there are two forms — general and specific. In breast milk, antibodies and also anti-enterotoxins are present to deal with the organisms which are the commonest cause of diarrhoea, including *Esch. coli, V. cholera* and enteroviruses. Many of these substances are general, in that they are found in all mother's milks; some are specific to a particular mother and her baby.

This dyadic interaction occurs in a remarkable way, via the "gut-mammary axis", in which organisms swallowed by the mother are taken up by Peyer's patches in the wall of the small intestine. Subsequently, lymphocytes are transported in the blood from the intestinal wall to the breast, where antibodies are produced against these specific organisms.

In addition, there is a "mirror-image" aspect of this situation, at least in calves. This is termed "diathelic immunisation" — in which organisms in the infant's mouth can also influence the anti-infective substances which are present in the mother's milk. If this is correct in the human, it would mean that there would be a two-way dyadic interaction in prevention of infection in both mother and baby.

Anti-diarrhoeal substances are highest in colostrum and decline there-after, as was demonstrated with secretory IgA in colostrum and subseqent milk in women in Guatemala (Mata, L. & Lechtig, A. Infection and nutrition of children of a low socio-economic community. *Am. J.Cl. Nut.,* 24,249.1971). It is, then, often stated that the anti-infective properties are only significant with colostrum. This is not the case. Experience proves otherwise in practice; also colostrum is highly concentrated but is in small amounts whereas subsequent milk has a lower content of anti-infective substances, but a very much larger volume.

Health Services. One of the most interesting recent developments is the realisation that breast milk, especially colostrum, can be used as a form of chemoprophylaxis. This has been undertaken in various parts of the world, particularly by Larguia in Buenos Aires (Larguia, A.M. et al. Feeding human colostrum for the prevention of E. coli diarrhoea. *J. Trop. Ped. Env. Child. Hlth.* 23, 287. 1977) where *Esch. coli* diarrhoea of the newborn had become endemic and seemed resistant to all efforts to deal with it. A daily dose of colostrum was given to all babies, and the situation settled completely.

Another important recent development is an increasing tendency to continue breast feeding *during* diarrhoeal disease (Hoyle, B., Yunus, M. & Chen., L.C., Breast Feeding and food intake among children with acute diarrhoea. *Am. J. Clin. Nut.* 33, 2365 1980.) The question of the high lactose content of human milk (seven percent) is often given unwarranted emphasis. In practice, this procedure has been shown to be effective, which is unsurprising, if one thinks of the risks and benefits involved. The child is obtaining additional clean fluid and some nutrients by mouth. The child is receiving protective antibodies in the human milk. The lactose in the breast milk is being diluted in many cases by the other fluids the child will be

receiving during oral rehydration. Also, the lactose present in the human milk is a major substrate on which the protective *Lactobacillus bifidus* live. Finally, it is more important that the mother's breast milk flow be kept going.

The protective effects of human milk will vary with many circumstances — for example, the type and dose of infecting organism, and the nutritional status and age of the child. Blanket statements which will include all young children all the time are obviously too sweeping.

Community Effects. On a community basis, the protective potential is high everywhere, but the *need* depends on the local economic and environmental circumstances. Human milk demonstrates its protective effect against diarrhoeal disease most clearly in poor environmental and social circumstances.

A second factor needing consideration concerns the current feeding practices. Are other foods being given as well as breast feed? Are occasional bottle feedings used? All increase the risk of introducing large doses of enteropathogenic bacteria or viruses.

The nutritional status and age of the young child also influence the outcome — in general, the younger and the worse nourished the more serious the short and long-term ill-effects of diarrhoea. The over-all protective effect of human milk will depend on the interaction of all these different factors, and will vary greatly with the circumstances.

If one looks at past history and various present day situations, there is abundant evidence of the varying protective effect of human milk in different circumstances which may be termed "poor", "medium", and "good" environmental conditions.

For example, in 1903 in poor environmental circumstances, in Derby, England, mortality rates among the breast-fed and the bottle-fed were profoundly different, mostly due to severe diarrhoea or "cholera infantum", as it was termed then (Harworth, W.J. The influence of feeding on the mortality of infants. *Lancet* ii, 210. 1905). In the totally breast-fed, mortality rate was 7, and in the bottle-fed 19.8. Similar figures are available from the Netherlands at about the same period, showing once again, that the difference in mortality rates between the breast-fed and the bottle-fed was very great (Wennen, C.A.M. The decline of breast feeding in Nigeria. *Trop. Geogr. Med.* 21, 93, 1969) What is more, the difference between the well-to-do and the poor were considerable in both groups.

In a study in India, breast-fed babies had 70 episodes of diarrhoea in a twelve-month period, compared with 211 in the formula-fed (Chandra, R. Immunological aspects of human milk. *Nutr. Rev.* 36, 265. 1978.) However, these results are in *infants.* In a sense, this statistical method of reporting tends to blur the issue, because the protective effects of human milk becomes less as other foods (and sources of microbial contamination) are introduced. Ideally, one should look separately at the protective effects during the foetal and the transitional period, which will vary in length and risks with the different circumstances in differing cultures. However, this is not usually feasible. Customarily, mortality in infancy (0-12 months) is considered statistically, although this represents a varying blend of exterogestate foetus and transitional.

If one looks at the figures from the USA in 1934, with "medium" circumstances hygenically, the diarrhoea incidence in the entirely breast-fed was five percent and the artificially-fed 16 percent, as judged by a very large national study (Grulee, C.G. Sanford, S.N. & Schwartz, H. Breast & artificially fed infants. *J.Am. Med. Ass.* 104, 1986. 1935). Data from Canadian Indians seem to give similar results as regard diarrhoea — five percent in breast-fed and 16 percent in bottle-fed (Elleystad-Sayer, J. et al. Breast feeding protects against infection in Indian infants. *Canad. Med. Ass. J.* 120, 295. 1979). However, these results are probably not comparable, as the episodes of illness were probably of less severity than those reported in 1934.

Age and protection. It is the newborn who are especially protected from infections by breast milk. In essence, neonatal diarrhoea—usually due to *Esch. coli* or enteroviruses, can be considered as a "colostrum deprivation syndrome". However, the preventive effect is also very profound during the exterogestate period, but, as other foods are introduced into the diet of the transitional and as human milk becomes a lesser part of the diet, so its protective effect diminishes.

To reiterate, the anti-diarrhoeal effect of breast milk depends, as would be expected, on the local risks —particularly on the environmental circumstances together with levels of education and economics. The protective benefits in a refugee camp or in a tropical slum are obviously very much greater than in a well-to-do, middle class society in any part of the world. The anti-infective potential is universal, but is less obvious when the risks are less.

Nevertheless, recent studies have confirmed that the anti-infective properties of breast milk, including diarrhoeal disease are also significant in "middle-class" communities in industrialised countries, especially as regards to morbidity—that is the number of episodes of diarrhoea. Cunningham has reported the results of his own investigation on Cooperstown, New York state (Cunningham, A.S. Morbidity in breast-fed and bottle-fed infants. *J. Ped.* 90, 726, 1977.) (Table 1), and has reviewed similar literature from identical countries.

Discussion. In considering human milk and breast feeding, one has to take an "unfragmented view" for the infant, the family and the community taking into account the nutritional, the emotional, the anti-infective, the economic, and the child-spacing advantages. One cannot just focus on one aspect, as in the case with much modern paediatric thinking.

It is illuminating to estimate the significance of the current ill-effects of breast feeding. Such figures are, of course, very approximate, but, by looking at WHO's world estimates of young children with severe protein-energy malnutrition (Bengoa, J.M. The problem of undernutrition. *WHO Chron,* 28, 3. 1974.) and infants with diarrhoea, it can be concluded as a gross under-estimate, that *currently* over ten million cases of marasmus and/or diarrhoea could be avoided by breast feeding. If one then hypothesises a ten percent mortality — this would mean a million deaths. Financially, if $ 100 per child were required for treatment for the ten million affected, this means a total expenditure of one billion dollars.

The WHO-UNICEF Alma Alta Conference (WHO/UNICEF. Primary Health Care. Alma Alta Conference. October 1978. 1979.) emphasized priorities in primary health care—insuring good nutrition, the promotion of locally available food supplies, the prevention of infections, the supply of safe water, and the encouragement of

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Significant episodes of illness according to feeding mode at onset of illness in Cooperstown, New York State, U.S.A. (Cunningham, 1980) (Cunningham, A.S. Morbidity in breast-fed and bottle-fed infants, *J.Ped.* 90, 726. 1977)

Illness	Breast	Artificial
Otitis media	3.7*	9.1
Lower respiratory infection	1.1	5.6
Diarrhoea, vomiting	3.5	6.9
Hospital admissions	1.0	3.0
Total episodes of illness	8.2	21.1

**Episodes per 1000 patient-weeks.*

family planning. A comparison of bottle-feeding and breast-feeding can be made in the light of Alma Alta primary health care priorities, and it is apparent that breast-feeding and human milk has clearcut advantages in all categories (Jelliffe, D.B. & Jelliffe, E.F.P. Feeding in early infancy and primary health care. A post Alma Alta comment. *Ecol. Fd. Nutr.* 9, 189. 1980.

Out of this review, two sets of practical "aphorisms" may be suggested:

Aphorisms I:

Human Milk and Protection from Diarrhoea in Early Childhood

- Human milk is a clean water supply in early infancy.
- Human milk actively protects almost completely from infectious diarrhoea in early infancy.
- Protection is highest in the newborn via the colostrum.
- All other foods, including animal milks and formulas are bacterially contaminated in developing countries' circumstances.
- Introduction of foods other than human milk should be avoided in early infancy, until really indicated.
- Bottle-feeding with cow's milk based formulas is especially dangerous, because of cleaning problems, the role of clotted milk as a culture medium.

Aphorisms II:

Practical Action to Insure Human Milk Protection Against Diarrhoea in Early Childhood

- Use colostrum in newborn.
- Breast-feed alone in early infancy.
- Introduce other foods *only when benefits outweigh risks.*
- Positively avoid bottle-feeding as hospital policy.
- Support breast-feeding and minimise bottle-feeding as a part of national nutrition, health and development policies.

Conclusions. The development of a locally logical infant nutrition programme or policy should depend on community analysis. Results always indicate that education-information emphasis is needed. Health services require modifications, which will make breast-feeding easier rather than more difficult. Such a policy needs governmental consideration concerning legislation for women who have to go out to work and who breast-feed. Not enough attention has been given to this last matter. Lastly, the question of monitoring and control of marketing practices of infant food industry and its dominant role in making choices regarding infant feeding needs emphasis.

Human milk and breast-feeding are not, of course, the complete answer to the prevention of diarrhoeal diseases in infancy, even early infancy. Their importance is greatest in this regard in the newborn and the exterogestate foetus, but gradually declining thereafter as the amount of milk becomes less and the other foods introduced increase. Nevertheless there is no protective measure which is so biologically and economically sound, nor with such other valuable community consequences.

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NUTRITION NEWS

The Chandigarh Chapter of the Nutrition Society held a meeting of the members of the Chapter at P.G.I. — Chandigarh on February 12 in celebration of the completion of the tenth year of its formation. Besides the members, a large number of scientists attended and participated in the scientific session. The meeting was organised by Dr. Saroj Mehta, convenor of the Chapter. Dr. S. Varadarajan, President of the Society was present.

The Delhi Chapter of the Nutrition Society held a meeting of the members of its Chapter at the Institute of Home Economics, New Delhi on March 5 to discuss its annual programme and the arrangements for the forthcoming Annual Meeting of the Nutrition Society at New Delhi in October this year. The meeting was convened by Dr. S. Malhan; Dr. S. Varadarajan, President, Dr. Asok Mitra, Past President and Dr. C. Gopalan, Founder President of the Society were present.

Under the auspices of **the Coimbatore Chapter of the Nutrition Society,** Dr. Rajammal P. Devadas delivered a lecture on "Nutritional Profile in Kampuchea" at the Sri Avinashilingam Home Science (Autonomous) College for Women, Coimbatore.

We congratulate **the National Institute of Nutrition** on its being awarded the annual Federation of India Chambers of Commerce (FICCI) award for Science & Technology.