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CEREAL BASED ORAL REHYDRATION THERAPY FOR DIARRHOEA



INTERNATIONAL CHILD HEALTH FOUNDATION

Front Cover Photo: Oral rehydration is a family responsibility: a father in Pakistan rehydrating his child. (UNICEF photo)

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CEREAL BASED ORAL REHYDRATION THERAPY FOR DIARRHOEA

Report of the International Symposium
on
Cereal Based Oral Rehydration Therapy

12-14 November 1989

at

The Aga Khan University
Faculty of Health Science
Karachi, Pakistan

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1990

DEDICATION

**To all children who have died of diarrhoea
without benefit of these discoveries.**

ACKNOWLEDGEMENTS

The International Child Health Foundation, the Aga Khan Foundation, and The Aga Khan University are most grateful for the substantial and valued contributions made by the well over 100 participants (see Appendix C) who came from some 25 countries of Asia, Africa, North and South America, Europe and the Pacific.

This report contains a "leading edge" knowledge base of relevance to health and development policy makers and planners, action oriented primary health care, child survival, and diarrhoeal disease control programme managers. Four productive workshops were documented by facilitators and co-facilitators, who also served as co-authors of the main sections of this report:

Workshop 1 on *Biomedical Aspects of Oral Rehydration Therapy – Discovering New Dimensions and Potentials*, by Dr William B Greenough III, Dr A Majid Molla, Dr Norbert Hirschhorn, Dr David Rolston and Dr Nathaniel Pierce;

Workshop 2 on *Integrating Oral Rehydration Therapy and Feeding – Dietary Management of Diarrhoea at the Household Level*, by Dr Ronald Behrens, Dr Mark Nichter, Dr Elizabeth Herman and Dr Kenneth Brown;

Workshop 3 on *Implementing ORT Programmes at Community and District Levels – Reaping the Benefits of Cereal Based ORT*, by Dr Robert Northrup, Dr David Sanders, Dr Carl Taylor, Dr David Werner, Dr Naomi Baumslag and Dr Larry Casazza; and,

Workshop 4 on *Strategic Planning at the Global and National Levels – Strengthening ORT Programmes through a Multiplicity of Approaches*, by Dr John Bryant, Dr Shanti Ghosh, Dr Jon Rohde and Dr Richard Cash.

Optimising productivity of participants, facilitators, co-facilitators and other contributors to an international symposium requires a conducive environment and a sense of shared objectives and common purpose. For providing the latter, we are most grateful for the leadership of Dr William B Greenough III of the International Child Health Foundation, Dr Norbert Hirschhorn of John Snow, Inc. and Dr A Majid Molla of The Aga Khan University. For conference organisation we are extremely grateful to Charlene Dale of the International

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PREFACE

At the turn of the 1980 decade, seminal clinical studies on rice based oral rehydration therapy (ORT), conducted at the International Centre for Diarrhoeal Diseases Research, Bangladesh (ICDDR,B) in Dhaka, and at the Kothari Centre for Gastroenterology in Calcutta, produced clear scientific evidence that rice based ORT – in contrast to ORT using conventional glucose based oral rehydration solution, made from the standard, pre-packaged oral rehydration salts (ORS) promoted by WHO and UNICEF – significantly reduced the duration of diarrhoea, the stool volume and the quantity of rehydration fluid needed by young children with acute diarrhoea. These studies were followed by additional clinical trials of cereal based ORT, using cereal grains such as wheat, maize, millet, and sorghum; and of tubers, such as potato, all of which yielded results similar to those obtained using rice based ORT.

In 1983, ICDDR,B established a large field study in Chandpur, funded by the Aga Khan Foundation (AKF), CIDA and UNICEF, to compare rice based ORT with the conventional glucose based oral rehydration solution made from standard ORS. In 1984, an AKF grant to the Kenya Medical Research Institute (KEMRI) enabled them to launch clinical studies on cereal based ORT, using maize, millet, sorghum and rice with standard electrolytes. This was followed by a clinical study and field study in Kakamega Province in western Kenya to compare maize-salt ORT with the standard glucose based rehydration solution. Other research initiatives by many other investigators followed these earlier studies in Bangladesh, India, and Kenya.

By 1986, the preliminary results were highly promising with respect to a new form of ORT – cereal based ORT – which, in comparison to the standard glucose based ORS solution, appeared to be more effective in terms of reducing the duration of diarrhoea, the stool volume, and the amounts of replacement fluids required. Anthropological studies also confirmed that the cereal based oral rehydration solutions were both palatable and more culturally acceptable than standard ORS in Bangladesh. Researchers were busy establishing the scientific basis for – and improving upon – the “traditional wisdom” of giving rice soup, chicken soup, maize gruels, and other locally prepared solutions to those with diarrhoea.

Health planners and strategists began to recognise the immense social and programmatic implications of a cereal based ORT which could be prepared and given safely by family members, using low cost food available in even the poorest homes.

Cereal based ORT is now recognised as an effective, practical, low cost, culturally acceptable, and highly sensible health intervention, appropriate to primary health care and child survival programmes and one which could have immense benefits, most particularly in the poorest nations where diarrhoea continues to ravage the young and accounts for some four million deaths of children under the age of five each year.

In 1987, the International Child Health Foundation (ICHF), the Aga Khan Foundation and The Aga Khan University began planning an International Symposium and Workshop on Cereal Based Oral Rehydration Therapy. The promising results and powerful social implications of recent research on cereal based ORT suggested a new era in global child survival primary health care and diarrhoeal disease control programmes, because of its increased effectiveness and potential to overcome current problems of availability, access, safety and costs.

Cereal based ORT used at home could substantially reduce the relatively higher costs of producing, transporting, and distributing ORS packets. The “downstream maintenance” costs of cereal based ORT programmes should diminish as knowledge of cereal based ORT pervades the pool of local knowledge and “traditional wisdom”, whilst the costs of maintaining conventional ORT programmes based solely on ORS packets will remain or, more likely, increase over time.

During 1988-89, the Symposium was planned and designed to bring together scientists, physicians and other health professionals from around the world to:

- accumulate and fully assess results of available research and field experience on cereal based ORT, giving particular attention to their implications for action oriented diarrhoeal disease control, primary health care (PHC), and “child survival” programmes

- Identify remaining high priority research issues, including some fundamentals of the intestinal transport physiology on which ORT is based
- Identify and recommend optimal methods of introducing cereal based ORT, including social, anthropological and economic considerations
- Identify and recommend optimal methods of communication, education and training

On 12-14 November 1989, the International Symposium and Workshop on Cereal Based ORT took place at The Aga Khan University in Karachi, Pakistan, with over 100 scientists, physicians and health professionals participating in working groups to explore, deliberate and make recommendations on four major themes:

- biomedical aspects of ORT
- integrating ORT and feeding -- dietary management of diarrhoea at the household level
- implementing ORT programmes at community and district levels
- strategic planning at the national and global levels

The first group addressed and considered the biomedical aspects of rehydration therapy, gaps in current knowledge of the physiology of solutions that might be used effectively, issues surrounding the use of a cereal based solution and its interaction with intestinal digestive and transport mechanisms.

The second group considered what is required to properly integrate the use of cereal based ORT without in any way detracting from the benefits of early feeding in children with diarrhoea.

The third group considered issues surrounding the implementation of oral rehydration programmes at community and district levels, and ways in which it may be possible to introduce improved solutions, or achieve an amicable balance between commercially prepared and distributed solutions and those prepared at home, in order to increase the overall use of ORT.

The fourth group considered problems of scale. What would be the most effective way in which all interested parties, including governments and UN agencies, might proceed to propagate the knowledge available on the treatment of diarrhoea with ORT, including cereal based formulations?

Chapters 2-5 present the issues addressed, and the deliberations, conclusions and recommendations of the four working groups.

The goals of the Symposium were clear, and there was no disagreement among participants about the need to provide the most effective therapy at the earliest time to all those in need.

Realisation of this goal, however, presents a series of ongoing challenges. Lively discussions and debates occurred both in the workshops and the plenary sessions. Major issues were identified and tackled, resulting in agreements in many areas, and some healthy differences of view in others.

Important agreements established at the Symposium were:

- Cereal based ORT is a major and highly significant advance which can substantially reduce diarrhoea-related morbidity and mortality and help sustain and improve the nutritional status of children with diarrhoea.
- Cereal based ORT can be promoted as an appropriate and highly effective form of ORT for application by family members at home, recognising that it is more readily available and less costly than glucose based ORS packets, and that it can help families and communities attain a measure of self-sufficiency in their own home based management of diarrhoea.
- Whatever the form of ORT, breastfeeding and/or the child's normal diet should be continued during and after diarrhoea to speed recovery and prevent malnutrition. Neither glucose based ORT or cereal based ORT alone provide adequate nutrition, and should never be regarded as a substitute for food.
- Cereal based or other proven forms of ORT, as appropriate, should be widely promoted and adopted by all health workers at all levels of health care in all countries, from community health workers in villages to physicians in hospitals, in order to fully legitimise and popularise this practical, life saving technology. This, rather atypically, implies a "reverse technology flow", from the Third World where ORT was developed to the more "technologically advanced" countries, where expensive hospitalisation and sometimes dangerous intravenous infusions and drugs are often used, rather than the safe and more effective ORT.
- Cereal based ORT could be marketed as a commercial product to help drive useless, expensive and sometimes harmful drugs used to treat diarrhoea out of the market.
- Global and national policy on ORT should remain open to a multiplicity of approaches, in order to

achieve high coverage as rapidly as possible. Where appropriate, strategies should use both ORS packets (cereal based or glucose based) and home prepared, cereal based ORT.

- Strategies on ORT and diarrhoeal disease control, whether at local, district, provincial, national, or global level, should be developed and implemented within the context of the health for all strategy, and be based on principles of equity, universal coverage, cultural acceptability, community involvement and self-reliance, affordability and cost-effectiveness (efficiency).

One area of difference in perspective at the Symposium sprang from the strong advocacy of cereal based ORT on the one hand by scientists, physicians, and programme managers who were convinced of its superiority and their conviction that it should be strongly promoted, based on current scientific evidence; and, on the other hand, the attitudes of some policymakers and planners from national level Ministries which already have established national policies and implementation programmes, based on the standard glucose ORS packet. The latter believed that introducing cereal based ORT might confuse health workers and communities and possibly have a counter-productive effect. Others felt that introducing cereal based ORT could augment implementation of ORT. In countries where a firmly established policy does not yet exist, cereal based ORT could be seriously considered as the therapy of choice for use by families and by health workers at all levels of the health care system.

This report, published by the Aga Khan Foundation and the International Child Health Foundation, includes the major contributions, deliberations, results, conclusions and recommendations of the International Symposium on Cereal Based Oral Rehydration Therapy. It is the hope of both contributors and publishers that the reader will use the information to strengthen diarrhoeal disease control, child survival and primary health care programmes; and to empower family and community members to manage acute diarrhoea at home with this effective and practical oral rehydration therapy; and, ultimately, to make community health workers and family members more self-reliant and child survival a reality.

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**MEETING THE CHALLENGE TO IMPROVE
ORAL REHYDRATION THERAPY EFFECTIVENESS,
SAFETY, ACCESS, ACCEPTANCE AND USE**



*The challenge to ORT:
several million young children a year still die from dehydrating diarrhoea and malnutrition.
(Aga Khan Foundation — Kenya)*

MEETING THE CHALLENGE TO IMPROVE ORAL REHYDRATION THERAPY EFFECTIVENESS, SAFETY, ACCESS, ACCEPTANCE AND USE

*Ronald Wilson, William B Greenough III, Norbert Hirschhorn, Katherine Elliott,
Charlene Dale, David Sanders, Kathy Attawell*

ORT and Diarrhoeal Disease Control in the Context of the Global Health For All Strategy

Health strategy and economics

The global Health For All strategy aims to attain a level of health for all the people of the world by the year 2000 that will enable them to lead a socially and economically productive life. This global strategy is based on principles of equity, universal coverage, cultural acceptability, appropriateness and affordability. While substantial progress has been made in the past decade, the fundamental economic and social conditions which led to the Alma Ata Declaration in 1978 persist. In May, 1989, the World Health Organization's report, *The World Economic Situation and the Prospects of Health For All by the Year 2000*, concluded that:

Economic trends since the Declaration of Alma Ata have retarded progress towards health for all in many countries. In developing countries expenditures on health have often fallen while demands have continued to increase.

Health resources are simply inadequate to cope with major health problems. This is true at every level – family, community, district, national and global.

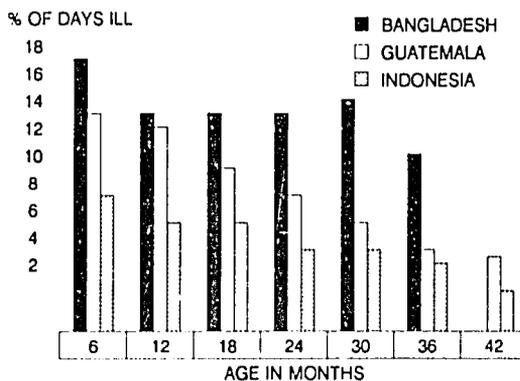
Problems like diarrhoeal diseases and life threatening dehydration caused by diarrhoea, must therefore be tackled in the most effective and efficient (cost-effective) manner. The conventional health care infrastructure cannot hope to reach all who suffer from diarrhoea and other highly prevalent diseases.

Magnitude and complexity of diarrhoeal diseases

Dehydration from diarrhoea remains the largest killer of children in the world – approximately four million

die each year (Snyder and Merson 1982; Rohde 1984; Guerrant and McAuliffe 1986), accounting for between 25% and 50% of child mortality (Scrimshaw et al 1968); it is the single most common cause of death of children. In developing countries, most children have diarrhoea many times each year and those who are malnourished and have low resistance to infection are at highest risk (Chen 1983). Death from diarrhoeal disease is 200 times more common among children in the poorest developing countries (Gordon et al 1964) than it is among children in countries such as Sweden which have a strong health care infrastructure, good environmental sanitation and higher standards of living.

Diarrhoea Prevalence – % of Days Ill by Age



Most small children in developing countries have frequent episodes of diarrhoea. (Rohde J and Northrup R, 1985. Diarrhea is a nutritional disease. ICORT II Proceedings, USAID, Washington, DC)

Diarrhoeal disease morbidity and mortality are the result of the complex and mutually reinforcing interaction between intestinal infection and protein energy malnutrition (Scrimshaw et al 1968). A number of environ-

mental, social, economic and political processes influence the development of undernutrition and intestinal infections. The relative strengths of these contributory factors vary from country to country, and between different socio-economic groups within the same country. These factors act at the family, community, and district levels. Any long term solution for the control and management of diarrhoeal diseases must consider these underlying processes, and the constraints facing poor communities and families.

Oral rehydration solutions and fresh strategies

The discovery that an orally administered glucose and electrolyte solution given to fully replace diarrhoeal losses could prevent or reverse dehydration (Pierce et al 1969; Pierce et al 1968; Cash et al 1970a,b) opened up many new possibilities for reducing mortality and morbidity due to diarrhoeal diseases.

Oral rehydration therapy, if properly practised, can cut infant and child mortality rates by at least half (UNICEF 1985a,b) and obviate the need for countless millions of costly visits to hospitals, health centres, and clinics in all countries. But is this feasible? Packets of oral rehydration salts (ORS) are not universally available (UNICEF 1987) and the simpler sugar-salt solution can have dangerous untoward effects if it is improperly mixed or administered (Molla et al 1982; Molla et al 1985). Cereal based ORT can overcome both of these disadvantages.

Stark health statistics and economic facts underline the need to fashion fresh strategies and interventions to address not only diarrhoea treatment, poor environmental and personal hygiene, and undernutrition, but also underlying poverty and inequity with their root causes. Availability, access, safety and costs remain major issues in current health care strategies. Such health care strategies must necessarily focus on local actions which can, wherever feasible, be taken at the personal and family levels. Health technologies must also be developed and refined for application at these levels, as well as at community and district levels.

Cereal based ORT, which can be prepared and administered by families in their own homes, exemplifies one of the best and most important methods of empowering families to take care of their own health without dependence on expensive and often non-existent or inaccessible health care services.

Implementation of Current ORT Technology: the Challenging Issues

Initially, the promotion of ORT was based on making packets of the glucose and electrolyte formula (ORS) available worldwide through all health care channels, and where ORS packets were not available, home made solutions using sugar and salt which are readily available in many homes were promoted by those responsible for patient care. Neither form of ORT, how-



Health care strategies must focus on actions which can be taken at local level. (WHO/UN photo – Ind'a)

ever, shortens illness or is universally available, or is entirely safe if not properly mixed. Operational issues, such as packet size, maintenance of supply, container size and cost containment, also still need resolution in most countries.

Unsolved problems of ORS packets and home based sugar and salt solutions continue to limit realisation of the full potential of ORT. These might be roughly divided into three main groups: effectiveness and acceptance; logistics to achieve high coverage at reasonable costs; and professional attitudes and practices.

Effectiveness and acceptance

If ORT is taken to mean only use of the pre-packaged standard glucose-electrolyte (ORS) solution, then a major and continuing barrier to universal acceptance of ORT is its failure to stop diarrhoea. Diarrhoea can be annoying or even very frightening to those taking care of the child (whether mother, doctor, or other health professional) all of whom want to stop the loss of fluids as rapidly as possible. Dangerous and inappropriate drugs have been and often still are employed to treat diarrhoea and dehydration, in the hope of controlling the diarrhoea (Portnoy et al 1976; Read 1983).

Dehydration, the consequence of loss of body fluids from diarrhoea, is much less obvious than the diarrhoea itself, especially in the earlier stages. Thus, the urgent need to replace fluids may be overlooked until too late. ORT given early to those with diarrhoea can prevent dehydration from occurring, but, since there is no visible change in the diarrhoea, parents justifiably question its value.

Cereal based ORT has been shown to be effective and acceptable and has obvious advantages over standard ORT. Fluid losses, due both to vomiting and diarrhoea, can be reduced by between 25 and 50%, depending on the food based solution used and the kind of diarrhoea (Patra et al 1982; Molla et al 1985). Suitable starchy foods, familiar to local people and used traditionally for illness, are to be found in virtually every home. The cost of cereal based ORT prepared in the home is minimal. These are all important factors which could lead to greater acceptance and use of ORT.

Logistics, coverage and costs

In March 1989, the Tenth Meeting of the Technical Advisory Group of the World Health Organization's Diarrhoeal Disease Control Programme reported that global production of ORS has more than tripled in the period 1984-87, rising from 100,000,000 litre packets in 1983 to 350,000,000 litre packets in 1987. However, in developing nations there are an estimated 240 million

children aged under three years. If each child requires two to ten packets per year, the 350 million packets produced in 1987, even if effectively distributed to homes and health centres, could cover no more than 58% of the need for ORS for the under three age group alone. In addition, older children, adults and the elderly also need oral replacement therapy for diarrhoea.

Too often, packets do not even reach community health centres, creating problems of access to ORS. The global access rate to a health worker who can dispense ORS has shown little increase in the past two years, remaining slightly under 60% despite the substantial increase in the global production of ORS packets. The actual use rate of ORS packets is *only* 19% of diarrhoea episodes; and only 30% when home based ORT is included.

Even though ORT is intrinsically an inexpensive form of therapy, there is a high cost to governments for the production and distribution of ORS packets. Can governments be expected to allocate sufficient future resources in their budgets for the necessary increases in production, even if this could lead to proportionate increases in ORS access and use rates? Can families, especially those with meagre incomes, afford to pay for ORS packets? Many now cannot afford packets even at subsidised prices. In some countries, packet costs to rehydrate one child come close to a day's wages. There are also costs involved in teaching families effective use of both home based ORT and packeted ORS.

Professional attitudes and practices

UNICEF notes in its 1989 report on the State of the World's Children that:

Advice about health carries special weight when it comes directly from health services. Paradoxically, the great majority of doctors, nurses, pharmacists and other health workers have not yet received adequate training in modern methods of diarrhoea management, including the use of ORT. According to WHO, only 6% of health workers in developing countries have been trained to use ORT (including how to communicate effectively with mothers).

Health care professionals who do know about ORT continue to have anxieties about unsupervised use of packets, fearing incorrect dilution and inadequate dosing of oral rehydration solution for too short a time (Dibley et al 1984; Levine et al 1980; Hutchins et al 1980). They are often even less happy about home made salt-sugar solutions, knowing that too much salt or sugar can cause hypernatremia or increase the diarrhoea, giving ORT a bad name (Harland et al 1981; Snyder et al 1982; Ruccimazza et al 1986).

There is also the crucial issue of whether families can act effectively on their own or must remain entirely dependent on a health care system. When either packets or self-made solutions are available at home, together with knowledge about their preparation and use, then health workers become less necessary to treat diarrhoea in its early or less serious phase. This has important implications for local, national and global programmes.

Cereal Based ORT: the Challenging Issues

Education and training of health workers and families

In the context of primary health care, the dual challenges of packet production and distribution costs, and the need for more effective education and training of health workers and the community, remain formidable barriers to full realisation of the potential acceptance and use of ORT. Home made sugar-salt solutions overcome difficulties of packaging and distribution but increase the educational challenges and perhaps increase the risk of poor practice. No sugar based solution on its own reduces stool loss or shortens duration of diarrhoea. This is possibly the greatest barrier to acceptance and use of ORT.

To look for a more effective and acceptable ORT made obvious sense and there have been continued research efforts to achieve this goal. The most promising results to date, employing sound physiological principles and taking advantage of long-standing traditions, have been achieved by investigating the use of cereals, in the form of gruels and soups, to treat people with diarrhoea.

This approach has been shown to be effective, acceptable and safe, and has the obvious advantage over standard glucose based ORS packets of decreasing severity and duration of diarrhoea. In addition, suitable foods, containing starch and proteins on which to base ORT solutions, are available in every home.

The advent of cereal based ORT heralds a new era in "child survival", primary health care, and diarrhoeal diseases control programmes worldwide.

The potential for packaging cereal based ORS

As a means of rapidly increasing the availability of cereal based ORT, there may be a need to develop packaged cereal based ORS, readily available (at food and/or drug stores), easily prepared (eg by pouring a packet into a measure of water), and acceptable to patients who can afford these packets. The infrastruc-

ture, capabilities and promotional strength for commercial marketing of food manufacturers (and/or pharmaceutical companies) could bolster information about ORT and its effectiveness, and help promote its use. Commercial applications include ease of handling for busy hospitals and clinics, doctors' offices, drug stores, pharmacies (where people often go first for advice), those for whom the appearance of a packaged product is important, and those who are able to afford packages and want something easy and quick to use.

Packaging cereal based ORS is feasible and is a viable approach for areas of the world where access to medicines is not limited and family poverty is not a problem.

In underserved areas where distribution, cost, or other problems will limit the availability of pre-packaged cereal based ORS, emphasis should be placed on cereal based ORT which can be prepared in the home, using home available ingredients. Knowledge about the effectiveness of home made cereal based ORT would need to be provided to health workers and mothers. Home preparations are especially needed for those who live in remote areas, in times of epidemics, for those who want to start ORT right away at home and for those who cannot afford packets. The extent to which pharmaceutical or food companies can support the promotion of widespread use of packaged cereal based ORS needs careful discussion and examination. For example, government regulatory agencies could require that commercial packets of cereal based ORS include instructions on how a cereal based solution can also be prepared at home with local ingredients.

Research issues

The scientific basis for and effectiveness of cereal based ORT are now well established, but a range of issues related to its adaptation and implementation in a variety of settings need to be addressed. These require consideration by all concerned in the improvement of treatment for diarrhoeal diseases. Issues to be addressed, and opportunities to be taken, include:

- Which starchy cereals to select as a local basis for cereal based ORT solution; availability, effectiveness, acceptability, and cost must be considered.
- Home preparation requirements, such as availability and costs of fuel and effort for cooking.
- Discovery of the particular cultural practices that may facilitate adoption and instruction.
- Finding educational channels that can convey information about the correct measurement of cereal, salt and water and the timely administration of adequate quantities of the solution to patients.

- Considering the possibilities of involving commercial marketing techniques to increase access and proper use.
- Further optimisation of cereal based ORT solutions by exploration of types and amounts of proteins that might be added for the best results.

How can this new knowledge be applied, shared, used quickly and to the best advantage? What has been learned through developing and implementing current ORT programmes? Consensus needs to be reached on how to take advantage of these advances and opportunities and what the next steps ought to be.

Meeting Current and Future Challenges: Symposium Keynote Address

ORT prevents death due to fluid loss and is especially effective when administered at the earliest stage of any diarrhoeal illness. The promise that effective early use of oral rehydration can prevent up to four million deaths per year globally (Rohde 1984; Guerrant and McAuliffe 1986) is now being translated into reality through the programmes of the World Health Organization and UNICEF, as well as those of many private and voluntary agencies working together with cooperating governments and agencies around the world.

This translation of the biophysics of salt and water absorption by the human intestine into an inexpensive, lifesaving cure for one of the commonest problems on the planet led an editorial in the *The Lancet* to declare that "the development of oral rehydration therapy is potentially the most important medical advance of this century" (Lancet Editorial 1978). If this is so, then one may very legitimately ask "Why tamper with success?". Why not simply proceed with the excellent glucose based formula that is now in use around the world, propagating it, and ensuring that it will be available at the earliest possible time to everyone with a serious diarrhoeal illness. Already, programmes to accomplish this are in high gear, and some have met with great success. The difficult problems of complex logistics, commercial preparation, quality control, and education of health workers and families are being addressed. Evidence of successful application has been forthcoming from many participating countries. In fact, the only countries that can be considered backward in the use of oral rehydration therapy at the present time are the developed countries – especially the United States and Europe, in which hospitalisation and intravenous fluid therapy, at great cost, still dominate the treatment of dehydrated children with diarrhoea. That this is inferior to early home use of oral rehydration therapy is clear from the deaths of 600 children and 500 million dollars of hospital costs experienced in the USA each

year (Ho et al 1988a, 1988b). Since glucose based ORT is effective and rapidly becoming the global standard for the best treatment of dehydrating diarrhoea, what then, is the added promise of cereal based oral rehydration therapy, and why should we even consider it as an option for the present or the future?

Glucose or sugar based oral rehydration solutions have a singular limitation. Patients are kept hydrated and alive, but their basic vomiting and diarrhoea are not alleviated. When most of us seek a remedy, we expect that it will relieve the symptoms. Thus, there is bound to be disappointment with ORS. For this reason, people still seek a wide variety of drugs to decrease diarrhoea, reduce vomiting and shorten illness. Often, because dehydration is not understood or easily recognised, drugs will be substituted for the replacement of fluids, to the detriment or even death of patients (Read 1983; Portnoy et al 1976).

A second constraint is more scientific and technical. Improving the performance of oral rehydration solutions by the use of additional small carrier molecules – such as amino acids – will be expensive and limited in scope (Greenough 1983; Mahalanabis and Patra 1983). Small molecules which have high osmotic activity cannot be added beyond the point at which they create an osmotic force that impedes rather than enhances absorption (Santosham et al 1986; Vesikari and Isolauri 1986). Thus, although improved solutions have been reported, based on alanine (Patra et al 1989), and may in the future be discovered based on other amino acids, their scope will be limited either because of costs or osmotic ceilings. The use of digestible food polymers made up of glucose and amino acids circumvents both cost and the osmotic penalties of their component molecules (Greenough and Molla 1988; Field 1977). Natural sources of such polymers are at once inexpensive and readily available – the commonest polymer of glucose being starch, and starch being the staple of almost all diets around the world. In root vegetables, cereals and starchy fruits, proteins are also present.

In 1978, at the International Centre for Diarrhoeal Diseases Research, Bangladesh, and soon thereafter in Calcutta, the use of rice and rice products as a source of the co-transporting glucose molecule for rehydrating diarrhoea patients was explored. (Greenough 1980) It was apparent almost immediately at the bedside (Patra et al 1982) that rice solutions were well received by the patients and their mothers, and that vomiting was markedly reduced early in treatment (Molla et al 1982; Molla et al 1985). It was also soon apparent that the amount of fluid lost and the duration of diarrhoea was shortened. Subsequently, many have confirmed this result (Kinoti et al 1986; Lepage et al 1989), and two field trials have demonstrated that hospital based clinical studies could be translated into field action with excellent results in Bangladesh and Kenya

(Rahman et al 1985; Ismail et al 1986; Molla et al 1989a, 1989b, 1989c).

At the present time, depending on the type and amount of cereal used in the solution, how it was administered, and other variables, there have been differing reported reductions in fluid loss and shortening of disease. Where patients have been few, variability in degree of fluid loss has, at times, been sufficient to obscure positive results. At present, estimates are of a 30 to 50% improvement (Molla et al 1985; Molla et al 1989b, 1989c). As yet, we lack the basic scientific information to formulate an optimum food polymer based oral rehydration solution. To do this, we must know the optimum mixture of amino acids that should be present in a protein to promote salt and water absorption, and what proportion of that protein should be mixed with starch for best results.

A recent rapidly developing area of knowledge concerns healing of intestinal epithelium injured by diarrhoea causing microbes. We know that glutamine and perhaps other components of food proteins can accelerate regeneration of gut lining cells. We must seek the most optimal mix of food derived substrates that will encourage the most rapid healing of damaged gut epithelium. A rapid return of digestion and absorption ensures early and optimal conversion of available foods.

Thus, from both philosophical and theoretical points of view, it is clear that there are significant further improvements that can be made to the solutions on which oral rehydration therapy is based. Since this form of therapy is at once inexpensive, requires low technology for its



Cereal based ORT is intrinsically safe: adding too much food is not a risk. An Afghan refugee in Pakistan makes wheat based ORS. (Photo by Karen Siener)

administration, and is highly effective, every effort should be made to discover and promote the best solution at the lowest cost to the user.

Although now it can be said that in every household, except under the most extreme condition of famine, the necessary materials to prepare effective oral rehydration solutions exist, the foods available will vary widely from country to country and even within different districts of the same country. Historically, many such starchy foods have been used in what might be called "grandmother solutions" to treat people with upset stomachs and diarrhoea. If these had been effectively made and used, there would have been few deaths from diarrhoea. This has not, however, been the case because composition is critical and often large amounts must be taken. Formidable problems of education, standardisation, and quality control must still be faced in the implementation of effective use of cereal based solutions (Greenough 1987).

This presents a great challenge and opportunity. If one could wave a magic wand and provide every household in the world with the knowledge necessary to prepare an effective oral rehydration solution using the materials available in their homes, and to use such solutions in sufficient amounts to fully repair dehydration, there would be an abrupt decrease in childhood mortality around the world. The difficulties of scaling up programmes based on widely different foods prepared by different methods according to different family, neighbourhood, community and country traditions, has staggered the capacity and imagination of most programmes up to the present time.

Another important problem is that drinkable food solutions could be construed by many users as a substitute for nutrition. It will be important in any educational effort to ensure that use of cereal based solutions is not seen as a replacement for early feeding, which should go on just as with sugar based oral rehydration solutions.

Finally, there are other issues related to cereal based solutions, ranging from the need for cooking using precious fuel, to the complex requirements for preparing stable packaged products that could be distributed where this was felt to be a preferred programmatic strategy.

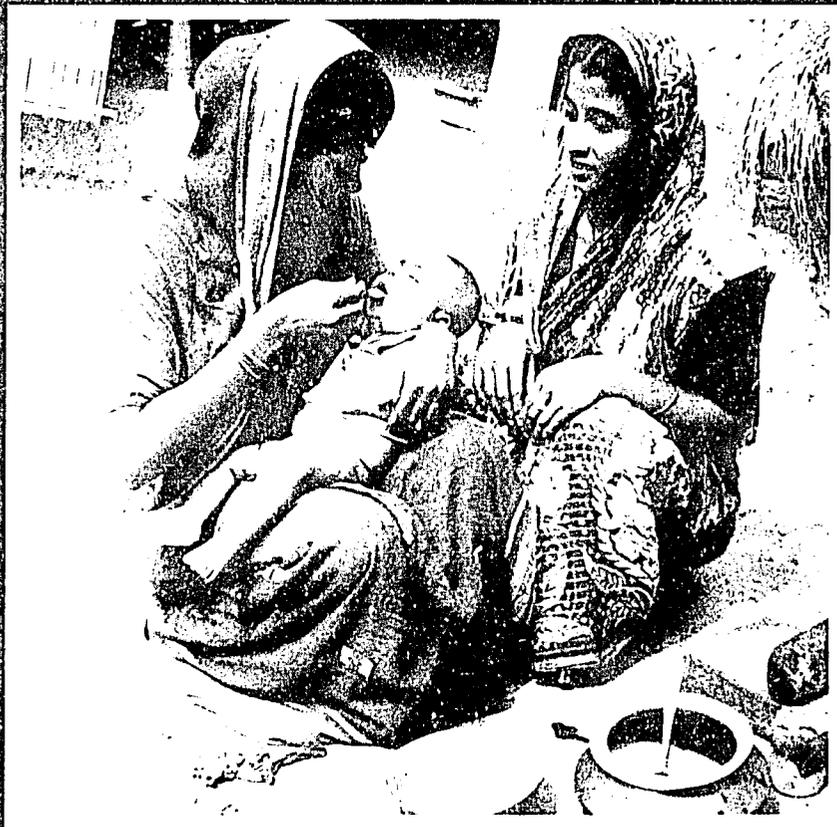
While worrying about the obstacles that must be overcome to attain effective deployment of cereal based oral rehydration therapy, it is important to remember there is an intrinsic safety factor not possessed by glucose or sugar based products. When food polymers are used instead of sugars, there is no hazard of overdosing or using too much of the food in the solution for two reasons (Field 1977; Greenough and Molla 1988). First, no matter how much food is added, it will not excessively raise osmolarity of the solution. The sec-

and is that, if too much food is added, the solution simply becomes too thick to drink! When food polymers are not digested, they pass on through the intestine without producing the dangerous osmotic diarrhoea which characterises malabsorption of sugars.

There are many different strategies and tactical alternatives and options in considering the introduction of new solutions for ORT. This myriad of options can confuse those responsible for designing programmes, in spite of the intrinsic physiological and scientific simplicity of food polymer based oral rehydration solutions.

The International Symposium on Cereal Based ORT was organised to consider and promote clearer understanding of the new opportunities presented by cereal based ORT, which are based solidly on human physiology and the biophysics and chemistry of solutions. One must stand firmly on this platform of scientific knowledge and wisely seek to implement it to the benefit of all those afflicted with diarrhoeal diseases in all countries.

**BIOMEDICAL ASPECTS OF ORAL REHYDRATION THERAPY:
DISCOVERING NEW DIMENSIONS
AND POTENTIALS**



*Rice based ORT reduces the duration and severity of diarrhoea,
and is acceptable to both mothers and children.
(International Centre for Diarrhoeal Diseases Research — Bangladesh)*

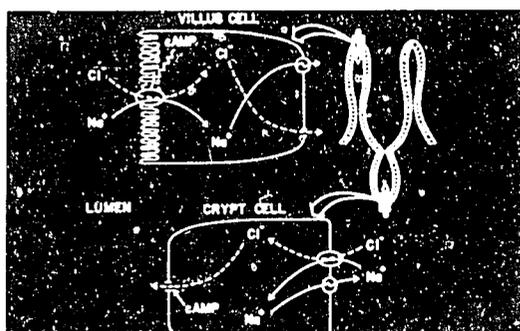
BIOMEDICAL ASPECTS OF ORAL REHYDRATION THERAPY: DISCOVERING NEW DIMENSIONS AND POTENTIALS

Michael Field, William B Greenough III, A Majid Molla, Norbert Hirschhorn, David Rolston, Nathaniel Pierce

Current Knowledge

During normal digestion in the course of a day, we secrete about 12 litres (three gallons) of fluid into our stomach and upper intestine and reabsorb the vast majority of it in the lower intestine. Without this process we would become rapidly dehydrated. The exquisitely controlled and coordinated sequence of secretion, digestion, and absorption at different levels of the gut begins with the earliest sight, smell or anticipation of food, and is governed by the nervous system and internally secreted hormones.

Figure 1



The sodium chloride uptake by the villus cells of the brush border drives the absorption of water. Secretion by the crypt cells is driven by active chloride extrusion into the lumen. (Michael Field)

Diarrhoea occurs when secretion exceeds absorption across the entire digestive tract. Bacteria, viruses and parasites which cause diarrhoea do so either by producing inflammation or through toxic products (enterotoxins) (Guerrant et al 1975). These affect the cellular lining of the intestine to block the channels for sodium chloride absorption, and open the channels for active secretion of chloride (Field 1971, 1975; Moss and

Vaughan 1980; Field et al 1972; Guandalini et al 1982a,b). In general, whenever any molecule or ion is moved in one direction or another, water follows. Secretion and blocking of absorption occur normally and reversibly during eating, but permanently during diarrhoea until new cells are generated (Moss et al 1980; Beckman et al 1974).

Most natural staple foods are made up of small molecules, linked together by chemical bonds into large polymers. Starches and proteins are of primary concern and interest when discussing oral rehydration therapy. The process of digestion splits carbohydrates into molecules of glucose (singly or in pairs) (Gray 1981; McMichael 1975; Reiser and Lewis 1986) and protein into amino acids (singly, in pairs and triplets). These molecules provide the driving force for restoring fluid to the bloodstream, both after eating and in the course of ORT.

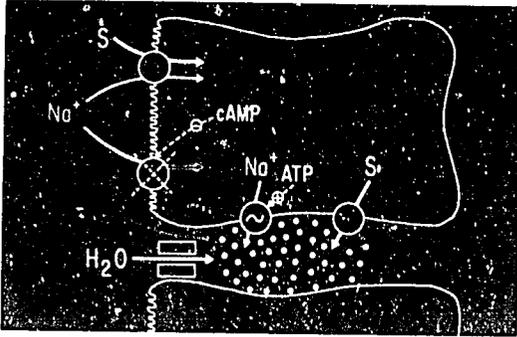
Sodium transport

Nutrient-linked sodium absorption (*Figure 2*) is preserved during normal digestion as well as during most cases of diarrhoea (Field 1971, 1975; Hirschhorn et al 1968; Fondacaro 1986). (Some bacteria and viruses destroy cells together with their nutrient linked sodium absorption, but the damage is usually patchy (Levine, 1987; Kerzner et al 1977; Keljo et al 1985).) Small nutrient molecules (glucose, amino acids and di- and tri-peptides) transit the brush border of the intestinal epithelium acting as specific carriers which transport sodium ions with glucose or amino acids (Hopfer and Groseclose 1980; Kimmich and Randles 1980; Misfeldt and Sanders 1983; Guandalini 1988). (Di- and tri-peptides are accompanied by hydrogen ions. A sodium-hydrogen ion exchange links oligopeptide transport to sodium).

When intracellular cyclic AMP has been increased by diarrhoea causing agents, sodium absorption can only occur via nutrient linked sodium co-transport (Kimmich

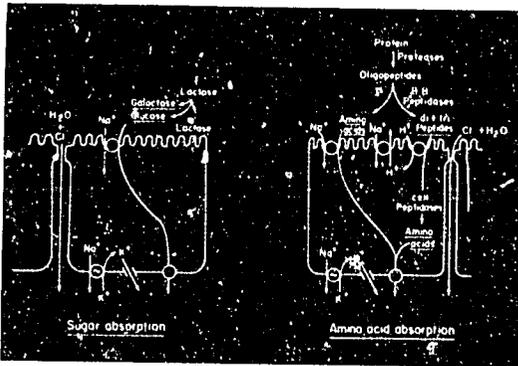
and Randles 1980; Misfeldt and Sanders 1983). When sodium and glucose enter the cell, sodium is extruded by the sodium pump (and glucose by a separate carrier) into the lateral intercellular space (Reiser and Lewis 1986). This generates the osmotic and electrical gradients which result in water and other small solutes entering into this space from the lumen, and subsequently into the bloodstream (Wright et al 1980).

Figure 2



A co-transporting solute (glucose) passes into the cell on a specific carrier and one sodium ion travels into the cell with it. The sodium pump translocates sodium out of the cell to the lateral intercellular space, and glucose also enters this space by a separate carrier. The increased osmotic and electrical forces pull water and solutes from the lumen into intercellular spaces and are absorbed into the blood stream. Sodium chloride absorption is temporarily blocked by an increase in cyclic AMP during normal digestion and irreversibly by several types of diarrhoea. (Michael Field)

Figure 3



The separate channels for co-transport of solute molecules linked to sodium are indicated and include glucose, amino acids and oligopeptides. (Michael Field)

If, however, there were a high concentration of osmotically active molecules in the gut lumen, water would tend to be pulled out of the bloodstream and into the lumen, working against fluid absorption stimulated by co-transport. Oral rehydration therapy should be designed to maximise the rate of entry of co-transporting substances into the cells, and minimise luminal osmotic forces (Hirschhorn et al 1968; Lifshitz and Wapnir 1985).

The rate of entry of co-transporting molecules (and thus water) can be increased by using all available separate co-transporting carriers (Lifshitz and Wapnir 1985). These exist for certain sugars (such as glucose), amino acids and oligopeptides (Figure 3).

Glucose and amino acid polymers

As yet, very little investigation has been done to ascertain the optimal mix of oligopeptides and amino acids that, when mixed with starch, could provide the most rapid absorption of salts and water from the lumen. The amino acid, glycine, when added to glucose in ORT solutions slightly improves absorption (Khin-Maung-U 1986; Nalin et al 1970; Santosham et al 1986; Vesikari and Isolaure 1986). It is probable that a food protein rich in amino acids and oligopeptides would be more effective (Mahalanabis and Patra 1983). Some amino acids are more efficiently transported than others.

Current physiological research, therefore, supports the probability that a complex mixture of digestible glucose and amino acid polymers (starches and proteins) will, at low osmotic cost (Ho et al 1982a,b), maximally enhance sodium and water absorption during diarrhoea. Whether ordinary foods will perform as well as commercially tailored starches and proteins can only be determined by further clinical studies. As more is learned about the role of proteins and oligopeptides in ORT, we can expect better ORT solutions.

Issues Addressed by Workshop on Biomedical Aspects of ORT

The main question considered was whether a specially formulated home fluid is necessary for the routine management of children with diarrhoea. It was agreed that fluids made with cooked cereal powder with a defined composition would be appropriate as recommended fluids for home based ORT (Molla et al 1982, 1987, 1989; Rahman et al 1985; Ismail et al 1986; Kinoti et al 1986; Lepage et al 1989; Greenough 1987).

Discussion focused mostly on the problem of acute non-cholera diarrhoea in young children, and considering three topics:

- prevention of dehydration and electrolyte abnormalities
- treatment of dehydration and electrolyte abnormalities
- maintenance of nutrition during the episode

Prevention involves treatment given at home before dehydration occurs (preventive home based ORT), whereas rehydration of severe or moderate dehydration often requires treatment (of dehydration) at a health facility with ORS solution, but occasionally with intravenous fluids. It was agreed that when results of studies are considered, or when needed research is proposed, the outcome variables and comparisons being made should be clearly defined. This is especially true for home based management to prevent dehydration where a variety of fluids and foods may be used.

Appropriate home based management of children with acute diarrhoea

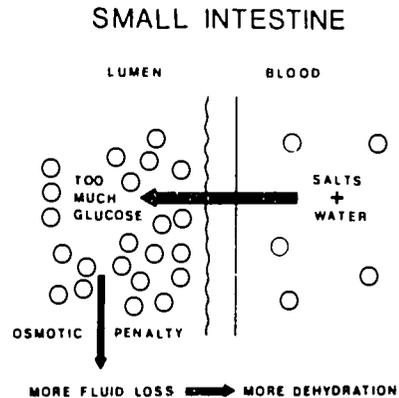
Home based management of acute diarrhoea should involve both ORT and feeding (Greenough and Molla 1988). The objectives of ORT are to minimize the occurrence of dehydration and electrolyte abnormalities, by giving increased fluids as soon as diarrhoea starts, and possibly to facilitate feeding by improving appetite (Finberg 1980). Successful home based ORT requires full replacement of losses of both electrolytes and water.

The objective of feeding is to maintain or improve nutritional status. This requires that feeding be continued during and after diarrhoea with breastmilk (Khin-Maung-U et al 1985), energy rich weaning foods suitable for the age of the child, or artificial milk, if appropriate (Brown and MacLean 1984; Brown et al 1988).

What is the most appropriate and feasible strategy for achieving effective home management of acute diarrhoea?

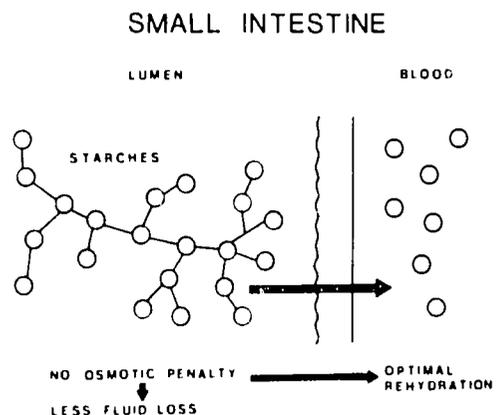
One viewpoint was that the composition of fluids given at the start of diarrhoea should promote maximum absorption of water and sodium. Such fluids would be prepared from specific recipes which contain salt, to provide enough sodium to replace faecal losses, and food rich in starch (usually a cooked cereal) that efficiently promotes sodium absorption. These cereal based fluids, when given with food of adequate caloric density and nutrient balance, would also provide sufficient potassium to replace much of the faecal and urinary potassium losses. The concentration of sodium which could be safely used was thought to be quite wide in range, the required minimum being about

Figure 4



The osmotic effect of too much glucose can worsen diarrhoea and dehydration. (Greenough WB III, 1987. Status of cereal based oral rehydration therapy. In: Dale CB and Northrup RS (eds). Cereal based oral rehydration therapy: theory and practice: ICHF/NIH Symposium Proceedings, ICHF, Columbia MD.)

Figure 5



Starch molecules have no osmotic penalty and provide optimal rehydration. (Greenough WB III, 1987. Status of cereal based oral rehydration therapy. In: Dale CB and Northrup RS (eds). Cereal based oral rehydration therapy: theory and practice: ICHF/NIH Symposium Proceedings, ICHF, Columbia MD.)

30mm/l and the tolerated maximum being about 150mm/l.

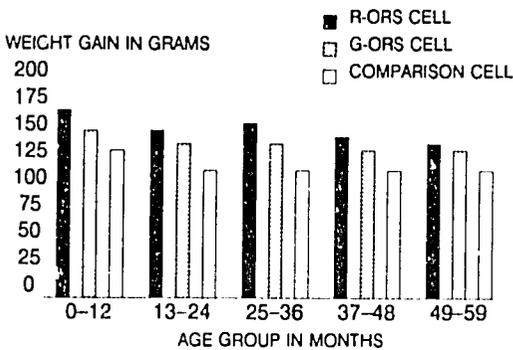
The concomitant use of fluids which have a high sugar content (and therefore osmolarity), such as sweetened tea, lime cordial, or soft drinks, should be discouraged to obviate the risk of hyponatremia.

Cooked cereal powder was the preferred ingredient for use in home prepared, cereal based ORT fluids because of its demonstrated ability to efficiently promote sodium and water absorption and its lack of a significant contribution to the osmolarity of the fluid (Figure 5), which is an important factor leading to hyponatremia.

This approach, combined with continued feeding, would also be especially effective for maintaining nutritional status, as field trials of early home therapy with solutions of glucose ORS and rice based ORS (Rahman et al 1985; Ismail et al 1986) plus feeding (performed in the Philippines and Bangladesh) had shown that such treatment was associated with better weight gain, when compared with children given only existing home management. Presumably, this was due to an effect of water and salt replacement on appetite (Molla et al 1983), leading to improved food intake, or perhaps to more rapid healing of intestinal lining epithelium. (It could not possibly be attributed to the calories contained in the glucose or rice based fluids which are insufficient to sustain nutrition).

This strategy, however, raised concerns about whether a specially formulated fluid may be necessary or practical for routine management of all patients, especially early in the course of acute diarrhoea. The training required to promote such fluids could interfere with efforts to achieve a balanced emphasis on fluid replacement and feeding, and in any event, it is likely to be the total intake of water, salt and food that determines the extent to which home management is effective.

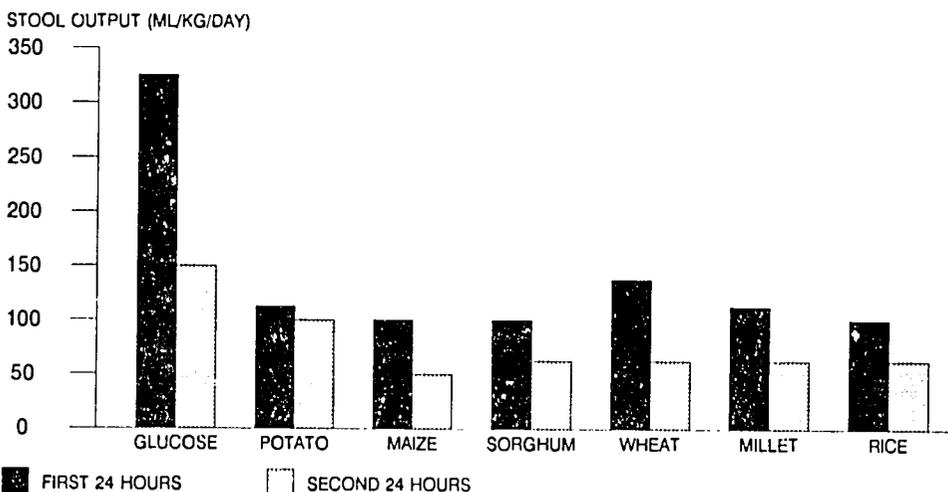
Figure 6
Monthly Mean Weight Gain in Children Given Rice ORS or Glucose ORS by Age Group



children suffering from ≥ 4 diarrhoeal episodes in 2 years

(Bari A et al, 1989. Comparison between rice ORS and glucose ORS in rural Bangladesh: a field based longitudinal study.)

Figure 7
Comparison of Efficacy of Different Food Based ORS and Standard Glucose ORS in Cholera



(Greenough III W, 1987. Status of cereal based oral rehydration therapy, in Cereal based oral rehydration therapy: theory and practice: ICHF/NIH Symposium Proceedings, ICHF, Columbia MD.) (Molla AM, Molla A, Nath S, Khatun M, 1989a. Food-based oral rehydration salt solutions for acute childhood diarrhea.)

On the basis of these concerns, an alternative strategy was proposed which would:

- encourage continued feeding of nutritious, energy dense, well tolerated foods to maximise caloric intake
- promote the liberal use of selected home available fluids, particularly those that are cereal based; such fluids, however, would be those currently used by mothers and not require special formulation or extra salt

Supporters of this strategy believed that during the vast majority of diarrhoeal episodes, adequate water and salt replacement could be achieved for up to three days by promoting the use of common home available foods and fluids, including breastmilk or animal milk, with due consideration for the amounts of water and sodium they would provide. It was also stressed that:

- all episodes of diarrhoea contribute to malnutrition (Black 1985; Thane-Toe et al 1984), unless adequate feeding is maintained, whereas few (about 5%) develop clinically evident dehydration when given usual home management; food intake during diarrhoea is frequently poor (Molla et al 1983; Creed and Graham 1980; Hoyle et al 1980) and vigorous teaching is required if continued feeding with energy rich foods is to be achieved
- most of the benefits of a specially prepared solution could be achieved by giving energy rich foods, which would usually be cereal based, and adequate amounts of available home fluids
- mothers are quite selective in their adherence to recommendations for early home therapy, tending to reserve the use of specially prepared fluids, such as sugar-salt solution, for the episodes that they consider serious

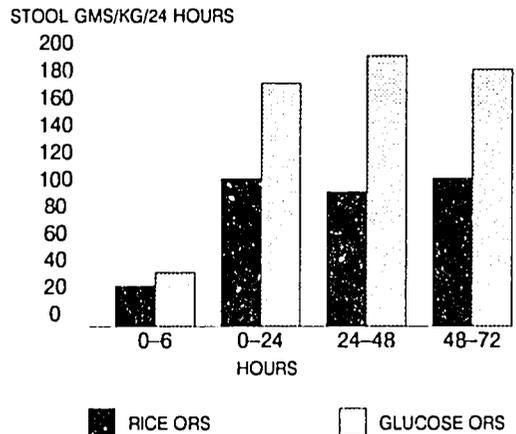
A number of specific advantages and disadvantages of recommending a thick but drinkable fluid of cooked cereal with added salt for routine home management of acute diarrhoea were considered.

Advantages:

- the fluid provides water and salt; glucose, protein and amino acids derived from the digestion of cereal starch are also more available and these efficiently promote water and electrolyte absorption
- the fluid is at least as effective as sugar-salt solution, and perhaps more so, causing reduced stool output and shortened duration of illness (Molla et al 1982, 1985; Mehta and Subramaniam 1986), although the magnitude of this effect requires further exploration

- the fluid is less likely than sugar-salt solution to be dangerously hypertonic, as the cooked cereal starch contributes little to its osmolarity (Field 1977; Greenough and Molla 1988; Ho et al 1982a,b)
- full replacement of sodium losses are assured, provided adequate amounts of fluid are given; this prevents urinary and faecal potassium wasting, which might occur if unreplaced sodium losses caused hypovolemia and consequent aldosterone-mediated excretion of potassium
- the fluid provides starch, protein and sodium together, ensuring optimum absorption of water and sodium even when other foods are not taken

Figure 8
Comparison of Stool Volume
Between Rice ORS & Glucose ORS Group



(Islam A et al, 1989. Comparison of efficacy of rice based ORS and glucose ORS in acute diarrhoea of infants – a preliminary report.)

Disadvantages:

- preparation of the solution takes some time and requires the use of sometimes scarce and expensive fuel for cooking
- specific training is required to teach mothers to add an optimum amount of salt to the solution; this may consume limited training resources and thus compromise the delivery of other messages, e.g. concerning appropriate feeding
- although rarely the case, salt may not be available in some homes

- as the fluid is often prepared from the same food used in weaning diets, the mother may believe that continued feeding is not required; this could lead to significant under feeding of the child
- the prepared fluid spoils within 8-12 hours (without refrigeration) and, thus, must be made two to three times a day
- if too much salt were added, i.e. more than 150mm/l, the fluid could become dangerous and contribute to hypernatremia
- introduction of this solution would require that national programmes revise their educational messages, which, some felt, could cause some confusion, at least initially

The benefits and potential value of a cereal-salt solution for home based ORT could be better defined by additional research. In the meantime cereal-salt solution could be considered as an option available to national programmes, with any decision on their use being made after review of the advantages and disadvantages cited above, and of local programmatic considerations.

Impact of feeding on the efficacy of glucose based ORS

The question of whether glucose ORS solution given with food, especially cooked rice, would have the same efficacy as rice based ORS solution was considered. Only a few studies provide data related to this question. A study in Burma showed that feeding rice to children with diarrhoea treated with ORS solution caused *increased* stool output compared with those given only ORS solution, suggesting that rice feeding did not improve ORS solution efficacy. However, the same study showed greater weight gain in the rice fed children, indicating significant absorption of nutrients in rice (Khin-Maung-U et al 1986). Another study from Burma showed that breastmilk given with ORS solution to children with diarrhoea was associated with *reduced* stool output when compared with children given ORS solution without breastmilk (Khin-Maung-U et al 1985). Four clinical trials (three in patients with cholera) have shown that the rate of stool loss was substantially lower in patients fed a rice based diet and treated with rice based ORS solution than in those given the same diet and treated with glucose ORS solution (Pierce 1989, Personal Communication). In three of these studies, however, food intake was not reported. In the fourth, children treated with glucose ORS solution were fed cooked rice or rice based formula, but those given rice ORS solution were not given food. It was agreed that the question stated above remains unanswered and that more studies were required on this topic, especially in children with acute non-cholera diarrhoea.

The need for further research to develop an improved ORS solution

Clinical trials with rice based ORS have shown that a solution containing 50 grams(g) of cooked rice powder per litre(l) is more effective than one containing 20 or 30 g per litre (Molla 1989, Personal Communication). A solution with 80 g of rice powder per litre was slightly more effective than one with 50 g/l. This suggests that the major benefit of cooked rice powder was achieved at 50 g/l. Rice contains about 8% protein and 75% carbohydrate. It is not certain whether the greater benefit of the 50 g/l solution resulted entirely from glucose released during the digestion of starch or was due in part to breakdown products of rice protein.

Further research is needed to determine what food elements most efficiently promote sodium and water absorption during diarrhoea; this is especially true for amino acids, some of the most promising of which have not been studied (i.e. arginine, leucine and methionine), and proteins that are rich in these amino acids. Results of such research might guide the development of an ORS formula that would be even more effective than rice or other cereal based ORS and might also indicate foods that would be most suitable for inclusion in home fluids or for feeding during diarrhoea. Such a solution would have significant advantages since it could be promoted as having an anti-diarrhoeal effect. Cost and acceptability of the product would, however, be an important consideration.

Hypernatremia in relation to ORS composition

The hypothetical possibility that an improved ORS formula which enhanced sodium absorption might also lead to hypernatremia was considered. This was thought very unlikely as water absorption from such solutions would also be improved. This view is supported by the failure to observe hypernatremia in any of the reported studies involving rice based ORS, in some of which the rate of stool loss was reduced by 50% compared to patients given glucose ORS (Molla et al 1989b).

Should the concentration of sodium in cereal based ORS be reduced, for example to 60mm/l, if other changes in ORS composition are made? It was recognised that there might be some benefit from the lower osmolarity that would be achieved by reducing the sodium concentration, but it was noted that this would also be achieved by the change from glucose to cereal powder. There was general agreement that the 90mm/l concentration of sodium in ORS had proven to be both safe and effective in extensive clinical experience (Tay et al 1987; Bart and Finberg 1976; Hirschhorn 1975) and should not be changed without persuasive new clinical and experimental results. Finally, evidence from

Egypt suggests that hyperosmolar sugar drinks and incorrect mixing of glucose ORS were largely responsible for hypernatremia seen in hospitals there (Hirschhorn 1989, Personal Communication).

Recommended Research

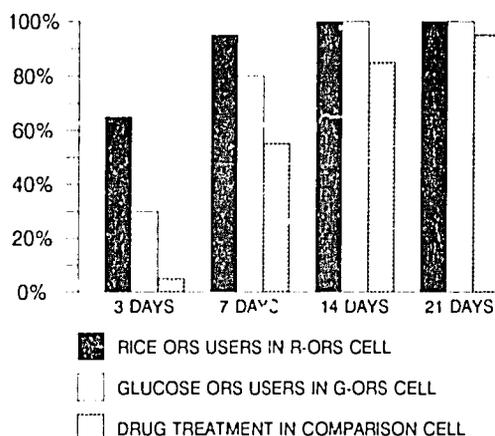
Based on the above considerations a number of areas for further research were proposed:

- *Rice based ORS (50g/l) compared with glucose based ORS.* Additional clinical trials are needed in young children with acute non-cholera diarrhoea. In these trials, children should be fed an energy rich rice based diet from the time rehydration is completed. Breastfeeding should be continued.
- *Safety and efficacy of rice (and other cereal based) ORS in young infants (below four months of age) and severely malnourished children, with acute non-cholera diarrhoea.* Clinical trials are required to determine the safety and efficacy of rice ORS (50g/l) in comparison with glucose ORS in the treatment of infants under four months of age with acute diarrhoea and in severely malnourished children with acute diarrhoea. Some studies on these topics are already underway.
- *Acceptance and use of cereal based ORS compared with glucose ORS.* Field studies are needed to compare the acceptability and current use of cereal based ORS and glucose ORS in children with acute diarrhoea, when the former is promoted as having an anti-diarrhoeal effect. These studies should be carried out in a setting in which packaged ORS is currently used, eg in patients seen at a health facility and given packaged ORS for home use.
- *Effect of food based ORT on feeding.* Field studies are needed to determine whether the promotion of cereal-salt solution, or a food based fluid that does not require a special formula, interferes with concurrent efforts to promote adequate feeding during diarrhoea. There was concern that training needed to promote a specific formulation, especially if it required added salt, would detract from efforts to encourage improved feeding as an essential component of home therapy.
- *Compared efficacy of cereal based ORS, home made cereal-salt solution and recommended home fluids not requiring a special formula.* Field studies are needed to compare the efficacy of rice (and other cereals) powder ORS, an optimally formulated rice (and other cereals) -salt solution, and a home available rice based fluid (not requiring a special

formulation) in children with acute diarrhoea. All study groups should also receive standard messages concerning continued feeding with a cereal based diet.

- *Impact of concurrent feeding on the efficacy of glucose and cereal based ORS.* Additional clinical trials are needed to determine whether cereal based ORS is more effective than glucose ORS when children are concurrently fed a cereal based diet. The studies should be in children with acute non-cholera diarrhoea, including endpoints of hydration and nutritional state. The required information can be obtained from studies described above.

Figure 9
Cumulative Rate of Recovery from Non-dysenteric Diarrhoea using Major Treatment Regimens in Three Cells (excluding outcome unknown)



(Bari A et al, 1989. Comparison between rice ORS and glucose ORS in rural Bangladesh: a field based longitudinal study.)

- *Further improvements to ORS or ORT formulations.* Additional research is needed to identify food elements that most efficiently promote sodium and water absorption. This is especially true for certain amino acids and proteins containing them. Exploratory studies in animal models are likely to be needed to determine which amino acids or oligopeptides to study in clinical trials.

In the above studies, the following outcome measures should be among those obtained:

For clinical trials:

- ORS solution intake (ml/kg) during each 24 hours and the amount of food intake

rate of stool output (ml/kg) in the first 24 hours of treatment and during subsequent 24 hour periods until diarrhoea stops

duration of diarrhoea (in hours)

total stool output (ml/kg)

For field studies:

duration of diarrhoea

weight gain

ORS solution intake

ORS solution acceptance (subjective)

ORS solution use rate

Research to develop an improved, packaged ORS should continue. This should include both cereal based products and those containing appropriate proteins or amino acids. Such a product, if successfully developed, could have important advantages over the present glucose based ORS because it could be promoted as having anti-diarrhoeal properties, thus discouraging the current widespread use of largely ineffective anti-diarrhoeal drugs.

Exploratory studies in animal models are likely to be needed to determine which amino acids or proteins to study in clinical trials.

Conclusions

The main question considered was whether a specially formulated home fluid is necessary for the routine management of children with acute diarrhoea. Also, whether comparable efficacy would be achieved by the combined effects of appropriate feeding and use of selected home fluids that did not require a special formulation or, whether given that optimal salt and water intake and absorption is essential for all episodes of acute diarrhoea, this could only be assured if specially formulated home fluids were used.

One proposed resolution of these differences that may be considered is to present them as options available to national programmes, with the decision to be based on local programmatic considerations, until further research data are available.

It was agreed that the concentration of sodium in the present ORS formulation 90mEq/litre had proved to be both safe and effective and need not be changed, even if an improved ORS were developed. There is no evi-

dence that an improved ORS would lead to hypernatremia by more efficiently promoting sodium absorption as water would be absorbed as well.

Major specific conclusions were:

Fluids made with cooked cereal powder with a defined composition are appropriate as recommendations for home based ORT.

Cooked cereal is the preferred ingredient in home prepared ORT fluids, because of its superior promotion of sodium and water absorption, its lack of a significant contribution to the osmolarity of the fluid, and potential for speeding recovery rate, thereby leading to improved food intake.

Clinical studies have provided evidence that cereal based ORS can reduce stool volume and output, and duration of diarrhoea.

Cereal based ORT, when given with food of adequate calorie density and nutrient balance, would provide sufficient potassium to replace losses.

Further research is required to determine what food elements most efficiently promote sodium and water absorption during diarrhoea, especially in relation to protein content.

Existing data strongly support the safety, efficacy and physiological appropriateness of cereal based ORT as a therapy for dehydration from acute diarrhoea, and suggest that the new cereal based formulations could have important advantages over existing glucose based oral rehydration therapy.

INTEGRATING ORT AND FEEDING:
DIETARY MANAGEMENT OF DIARRHOEA
AT THE HOUSEHOLD LEVEL



*Always the best food for babies,
breastmilk protects nutrition during and after diarrhoea.
(Photo by Steve Maines, UNICEF - Burma)*

INTEGRATING ORT AND FEEDING: DIETARY MANAGEMENT OF DIARRHOEA AT THE HOUSEHOLD LEVEL

Ronald Behrens, Mark Nichter, Elizabeth Herman, Ken Brown

The initial management of diarrhoeal episodes occurs at the level of the household, and mothers or other family members are the primary providers of care. If properly managed at home at the onset and early stages of diarrhoea, at least 90% of diarrhoeal episodes need not require outside treatment or referral (Wheatley 1968; Walker-Smith 1988). In this context, the development of dehydration is only one of several adverse outcomes, if diarrhoea is not properly managed. Strategies for the initial management of diarrhoeal episodes in young children, including the potential effect of promoting cereal based ORT, must consider all of the following objectives:

- 1) to decrease or avoid the adverse nutritional consequences of diarrhoea
- 2) to prevent the development of dehydration
- 3) to minimize the adverse household consequences of the illness (such as time, resource and inconvenience costs to the caretaker)
- 4) to identify children at risk of life threatening consequences of diarrhoea so they can be taken for further treatment

Introduction of cereal based ORT in any locality must also be considered in the context of current breastfeeding and nutritional practices, behaviour related to breastfeeding and the administration of food and fluids during diarrhoea, as well as existing household resources. Although there is evidence that cereal based ORT offers nutritional benefits when given during diarrhoea, national programmes must obtain information on the practices mentioned above, before deciding whether to promote cereal based ORT or being able to judge if it will provide nutritional benefits.

In countries where the nutritional density, quantity or frequency of foods given to young children is insufficient, and resources are limited, programmes should focus on improving feeding practices before, during

and following diarrhoeal episodes, in order to decrease the nutritionally adverse consequences of diarrhoea.

Developing a Family Oriented Strategy for the Replacement of Fluids during Diarrhoea

Two different approaches to developing a household strategy for replacing fluids lost in diarrhoea emerged.

Either, that the primary emphasis should be the administration, during early diarrhoea management, of safe fluids in amounts that are adequate to replace lost fluids, since focusing too much on preparing a physiologically 'correct solution' may have resulted in CDD programmes failing to communicate the concept of giving adequate amounts. Even the most physiologically ideal fluid will be ineffective if only small "meJicinal" doses are administered (Cash 1987). Those favouring this approach argued that it would prevent dehydration in more cases because busy mothers will be more likely to follow the recommendation early in the course of every diarrhoeal episode.

Or, the second, alternative approach which emphasises that any fluid recommended for home therapy of diarrhoea should contain some sodium, even if this requires the teaching of specific recipes or the use of packets. Although not required by most children, the promotion of a physiologically correct fluid would act as a "safety net" to catch the few cases of dehydration not recognised by mothers, or cases occurring in children without access to health facilities. Whilst severe cases of diarrhoea would most likely be taken to a health facility, moderate cases might be missed, with serious consequences.

The case fatality rate of children developing dehydration may not be significantly different between the two approaches, because mothers without access to ORS are also unlikely to have access to the type of teaching and the frequency of reinforcement needed for the

appropriate preparation and effective use of a physiologically correct substitute.

The most appropriate strategy employed will depend on the ability of mothers to recognise dehydration and understand its significance. Success in teaching mothers about dehydration has varied from one country to another (Rahaman et al 1979; Thane-Toe et al 1984; Kielman and McCord 1977); depending on which signs of dehydration are culturally familiar, what signs are included in training materials, and what degree of dehydration it is necessary for mothers to be able to distinguish.

Developing Recommendations for the Dietary Management of Diarrhoea

In addition to fluid replacement, priority should be given in home management of diarrhoea to nutrition before, during and after diarrhoeal episodes. Foods should be identified that are acceptable in all of these phases.

Recommendations for appropriate feeding should include:

- the composition of the recommended diet
- the quantity and frequency of feedings



In addition to ORT, feeding should continue during diarrhoea, extra food is needed during recovery. (WHO/UNRWA photo — Jordan)

- the timing of dietary therapy in acute illness and convalescence, taking into account the existing practices of the family and community

In general, the ability to digest and tolerate the diet will be improved during illness if feeding is more frequent than normal. A small proportion of children, particularly those with fever or vomiting, may suffer from anorexia during the early stage of diarrhoea (Creed and Graham 1980; Hoyle et al 1980). Studies show, however, that breastmilk consumption generally remains unaltered during illness, thereby partially protecting the breastfed child from greatly reduced intakes (Bentley 1988; Armenili and Gonzalez 1979). Breastfeeding is central in the prevention of diarrhoea (Feachem and Koblinsky 1984; Victora et al 1987; Brown et al 1988), and human milk also provides critical components of dietary, fluid and electrolyte therapy (Hoyle et al 1980).

Although there is no specific treatment for anorexia, the family should be urged to continue encouraging the child to eat so that adequate intake will be resumed once anorexia resolves. Where food intake has been reduced during illness, guidelines for increased feeding afterwards should be developed.

Weaning diets and practices

Before developing recommendations for appropriate feeding during diarrhoea, it is necessary to find out if existing weaning practices are nutritionally adequate, and whether these practices are considered by the household to be appropriate for use during diarrhoea and other illnesses.

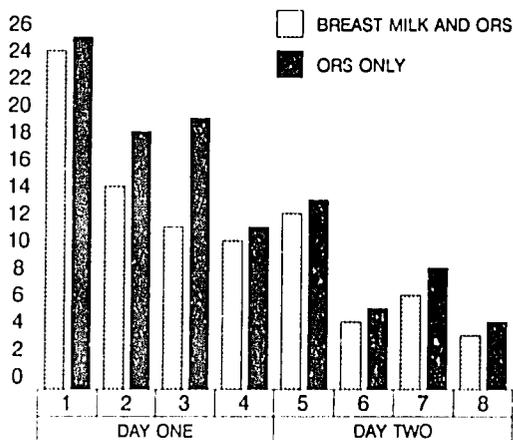
- If the weaning food normally given is nutritionally adequate and acceptable for use during diarrhoea, there should be no need for special instructions, other than to continue feeding the current diet, perhaps with greater frequency.
- If the weaning food is nutritionally adequate, but not considered appropriate for diarrhoea, it is necessary to determine if the food could be modified in such a way as to make it more acceptable, or whether it may be possible to influence present beliefs with regard to feeding during illness.
- If current weaning practices are not nutritionally adequate, efforts should focus on enhancing the diet in a way that will improve its nutritional value and also make it acceptable for use during diarrhoea.

There are many advantages to focusing efforts on the identification, enrichment (if necessary), and promotion of weaning/illness foods as a strategy for decreasing the nutritional consequences of diarrhoea (Ashworth and Feachem 1985). In particular:

- It reduces the number of messages directed at mothers and can therefore act in the child's best interests during other illness episodes, and when the child is well
- If anorexia occurs and intake is reduced, the use of weaning/illness food of high nutrient density will maximise caloric intake

Severity of Diarrhoea among Breastfed Infants Who Received Breast Milk and ORS or ORS Only During First Day of Therapy

MEAN ± SE FAECAL EXCRETION (ML/KG) PER 6 HR PERIOD



(Adapted from Khin-Maung-U, et al, 1985 Br Med J 290:597-589.)

Considerations in the Development of an Enhanced Weaning Diet

The development of an improved weaning diet requires that:

- There is initial understanding of current feeding practices and attention to age-related nutrient needs and stages of physical and behavioural development (including the central importance of exclusive breastfeeding for at least the initial four months of life, followed by prolonged partial breastfeeding if possible at least until the second year.
- The diet be composed of readily available foods. Food availability is determined in part by the household's geographic region, urban/rural location, direct involvement in subsistence food production or in the market economy, and the season of the year. In many cases, these available foods are al-

ready included in the child's diet, although not necessarily in a nutritionally optimal manner.

- The recommended diets must be of low direct cost, and low indirect costs — examples of indirect costs include: the time required for obtaining food and water, fuel required for special food preparation and intensified feeding. An enhanced weaning diet should therefore be simple to prepare, and preferably use techniques that are already well known to the child caretakers of the household.
- Mixed diets be compatible with local cultural beliefs about what is appropriate for particular stages in child growth and development, and for the child who is deemed weak, or ill. Importantly, in most cultures the same special foods are considered appropriate both for the very young and for individuals who are ill.
- The mixed diet (including breastmilk) must provide enough nutrients for nutritional requirements, without needing an impracticable frequency of meals or unreasonably large volumes to be consumed.
- The diet must be acceptable to the child and to the household. Specific considerations include flavour, smell, appearance and viscosity.
- The diet must be protected against microbiological contamination as far as possible, by the use of special food processing techniques (such as fermentation), frequent cooking, and limited storage times under unhygienic conditions. Families should be informed of the minimum required hygiene techniques, such as handwashing with soap before preparing, serving and consuming the diet.

Taking all these considerations into account need not be too complex a process, and does not necessarily require extensive preliminary research. Once background information has been obtained about available foods and current feeding practices, sample recipes can be developed with the participation of mothers, and can then be assessed for their nutritional quality and acceptability to the child. Maternal participation in developing the recipes ensures that the diet will be more likely to be acceptable in terms of cultural norms, cost and time needed for preparation.

Social and Cultural Factors Influencing Feeding as a Strategy in Early Diarrhoea Management

As stated earlier, dietary options should be considered within the cultural and socio-economic context, and dietary advice should take account of and build upon

existing dietary behaviour including breastfeeding, supplementary feeding, weaning, and diet during illness. Concern was expressed that data on household management of diet and cultural aspects of dietary choice should be given due consideration; in some instances, even when it is available, this information only receives lip service and is not appreciated.

All dietary advice should stress the central role of breastfeeding. Positive and neutral aspects of existing dietary behaviour should be supported. Where appropriate, modifications which maximise existing low cost resources should also be supported. Possible modifications might include increasing the duration or frequency of breastfeeding, the amounts of foods usually eaten, frequency of feeding, or the content of foods given to those who are ill.

Some examples, showing variations in socio-cultural contexts, were given. In many regions of South Asia, special diets given during diarrhoea were quite similar to diets given to children considered to have a weak or still developing digestive capacity, and to the elderly. The main concern influencing food choice was the easy digestibility of foods perceived to be light as opposed to heavy, and neutral as opposed to hot or cold.

Other examples cited from Papua New Guinea and parts of Africa reported that mothers in many areas did not alter diet during diarrhoea, but continued to feed as usual. In Nigeria, it was pointed out that mothers' time demands were such that preparing a special diet for a sick child might not be popular if it involved significant time outlay. In Pakistan, the weaning diet is prepared with rice, lentils and cooking oil. Yoghurt is added to it if a child has diarrhoea.

In some areas there is a complementarily existing between foods used as breastmilk supplements, as weaning foods, as illness foods, and for feeding during diarrhoea in particular. Where this is the case with weaning and illness foods, it is feasible to develop a consistent dietary message based on and maximising existing health beliefs and behaviours (and possibly to promote a modified version for ORT, if cereal based).

Some predisposing and enabling factors were identified during workshop discussions.

Predisposing cultural factors influencing dietary choice and the feasibility of modification (including for cereal based ORT):

- [1] *The cultural availability of foods:* established patterns of folk dietetics based on folk medical traditions; cultural concerns such as worm load or digestibility; taste in relation to cultural preferences; concepts of which foods constituted "meal" substitutes as opposed to snack supplements. (The

latter point may be relevant in considering when a cereal based oral rehydration solution might be misinterpreted as a meal substitute). Also cultural perceptions regarding the addition of salt, sugar or oil to children's food during both weaning and illness; ideas relating to the appropriate consistency and density of children's foods and concerns relating to making them thicker and thinner, especially during illness; and cultural perceptions regarding the feeding of children at night (in some cultures night feeding to satiation is deemed dangerous). Also important to consider are cultural patterns of fluid consumption prior to, during and subsequent to feeding.

- [2] *The social availability of foods:* issues of social status related to the use of different food sources; social identity influencing perceptions of modernity and tradition about foods within the community; considerations of who is responsible for providing different food sources – males or females.
- [3] *The psychological availability of foods:* associations of caring and identification, of what constitutes illness connected to different types of foods. Support of a modified traditional diet would add legitimacy to home care, especially if this support were given by medical professionals. This would increase mothers' confidence in their ability to positively affect their child's health at a time when many commercial 'special foods' as well as medicines are being marketed as 'health promoting'. An example of this is advertising for supplementary foods which begins by stating that breast is best, but then presents women with strong statements associating health and strength with formula use.

Enabling factors influencing dietary choice and the feasibility of modification included factors related to physical availability and cost:

- [4] *The physical availability of food:* by season, in what form the foodstuff is stored, storage life and contamination; forms of home food technology known and practised, requirements of such technology; the availability of additional vessels needed for special food preparation and the storage of these foods for the duration of the illness.
- [5] *The costs:* direct costs of food items to be used in modifications of the traditional diet (e.g. oil, gur) and indirect costs, particularly mothers' time costs. Where competing demands on a mother's time are great, household composition and sharing of workload, especially in relation to childcare, need to be considered. Who is available in the home to carry out additional tasks, and what tasks would not be done if a mother devotes extra time to new feeding and food preparation activities? Such tasks range

from gathering of fuel and water needed, to additional time required by more frequent feedings, and finally, opportunity costs of, for example, altering child care patterns where mothers are in full time employment which has a high priority for reasons of household economics or personal gain.

Pre-packaged foods: issues and options

Advantages, disadvantages and some potential dangers of packaged foods (and packaged cereal based ORS) for the treatment of diarrhoea are outlined below.

Advantages include:

- ☐ attractiveness to families
- ☐ greater convenience, particularly for some busy mothers
- ☐ a preferable alternative to existing behaviour regarding purchase of dangerous and ineffective anti-diarrhoeal drugs
- ☐ convenience in urban settings where mothers work, and younger children are left in the care of older siblings, and family meals are cooked only in the morning and evening

Disadvantages include:

- ☐ costs in proportion to the income of poor households
- ☐ the potential "medicalisation" of food when used therapeutically
- ☐ increasing the dependency of caretakers on commercial products with the tendency towards profiteering and exploitation through false claims by companies
- ☐ detracting from or leading to deviation from existing good cultural practices

The most favoured approach is the promotion of development of cottage industries to prepare weaning food ingredients or mixtures in the community. This would have obvious advantages, not only for nutrition, but also for community participation in health and development, and would require only seed funding, since it should become self-sustaining and self-financing. In addition, such approaches could be self-replicating and spread to other communities. There is a need to bear in mind issues of quality control with such proposed community based production. It would also be important to ensure that the easy availability of ready prepared foods does not have an adverse effect on frequency and duration of breastfeeding.



An enhanced weaning diet should be simple to prepare using familiar techniques. (The Gambia)

In Nigeria, for example, pap saleswomen already exist as a cultural institution and are popular among busy mothers. A possibility being investigated is the enrichment of pap with cow peas by these saleswomen.

One alternative view is that centrally produced packets might prove valuable because doctors may be more willing to prescribe them than to give dietary advice. It is also possible that such a food might be attractive to urban mothers who already have a highly medicalised view of illness and doubt the efficacy of household remedies.

However, introduction of such packets would need to be carefully implemented to avoid undermining national and local initiatives encouraging self-reliance and home treatment.

Consistent and targeted messages

Emphasis should be placed on a consistent set of messages about feeding at all levels of the health care system, from hospital to doctor to outreach worker to mother. Practical difficulties in accomplishing this may arise where a large percentage of health care is delivered via the private sector.

In many cultures diarrhoea is not recognised as an illness, but constitutes a symptom for some time unless accompanied by an explosive stool, vomiting, or fever. Such cases of diarrhoea are not treated specially until they are recognised as an illness; and hence, might not be given a special diet even where one exists in that cultural context. A consistent feeding message aimed at weaning and all cases of "digestive sensitivity" might reach a large number of children presently not being treated as ill. As such a feeding message would constitute a measure of preventive not curative health care.



Advice about feeding during diarrhoea must consider local customs and food availability. (World Health Organization photo by E Schwab)

Finally, in some cultures there are gender specific differences in home care and health care seeking, the latter often favouring male children. It is suggested that a clear feeding message might benefit female children if it fostered habituasi early response and diarrhoea treatment which did not require the purchase of additional foods and/or medicines.

Research Recommendations

The following recommendations were made for areas of priority research:

- Investigation of socio-economic and cultural factors influencing dietary behaviour, before dietary advice is developed. Research on these factors should be practical and be undertaken to produce action alternatives which should be field tested.
- Identification of current practices related to and appropriateness of household fluids in early stages of diarrhoea. What environmental, social and cultural variables, if any, are associated with the risk of progression to dehydration, and to persistent diarrhoea?
- Investigation of the social and handling practices which may increase risk of contamination of solutions prepared or used in the household.
- The impact on total food intake in children provided with cereal based ORT?
- Research to ascertain whether or not messages and instructions concerning the preparation of cereal based ORT affect the feeding practices or nutrient intakes of children with diarrhoea.
- Further investigation of methods of adapting currently practised food processing techniques i.e. fermentation and germination, to improve organoleptic and antimicrobial properties of food for nutritional supplementation in diarrhoea.
- Identification of ways in which it would be possible to increase the amounts of food given, the frequency of feedings, and possible enrichment of foods traditionally given to young children and the sick.
- Finally, the mother-child relationship and cultural notions about feeding related to the child as an active or passive recipient; do caregivers feed in response to demand, on the basis of perceived need or in response to specific ideas related to management of illness?

Conclusions

The group concluded that:

- The choice of fluid therapy for early home management of diarrhoea be based on (1) administering adequate quantities of safe, home available fluids or (2) administration of the most physiologically appropriate fluid, be it a specially taught home ORS recipe (including cereal based) or a glucose ORS packet solution. Choice will depend on family circumstances, cultural practices and feasibility, as well as usage and effectiveness.
- Home management of diarrhoea includes feeding in addition to fluid replacement, in order to minimise or avoid adverse nutritional consequences of diarrhoea.
- The possibility of introducing cereal based ORT must be considered in the context of current feeding beliefs and practices, including breastfeeding practices, foods and fluids given during diarrhoea, and weaning food practices.
- Recommendations concerning appropriate feeding during diarrhoea and appropriate weaning foods be developed on the basis of understanding of existing weaning practices and the suitability of currently used weaning foods for use during diarrhoea and other illnesses.
- In developing recommendations about an improved weaning diet, considerations should include availability, cultural acceptability, costs, contamination issues, nutritional adequacy and feasibility.

The nutritional status of children and diarrhoea are closely interlinked. The well nourished child will get less frequent and less severe episodes of diarrhoea, and the reverse is true in the case of a malnourished child (Gordon et al 1964; Palmer et al 1976; Chen 1983). Diarrhoea is particularly common during the weaning period, primarily because pathogens are introduced through unhygienic methods of preparation, storage and administering the weaning foods (Black et al 1982). Additionally, in some cultures, the traditional use of thin gruels and paps which are nutritionally inadequate as weaning diets, contributes to malnutrition in combination with diarrhoea.

Nutrition should therefore be protected to prevent both the occurrence of diarrhoea and its adverse nutritional consequences. At the same time it is essential to initiate early treatment for diarrhoea at home to replace lost fluids, using the most effective therapy made with the most suitable ingredients available to the family.

It should be emphasised that food and rehydration fluids are not substitutes for each other, and a cereal based ORT should never be seen as replacing the need to give food.

In some cultures cereal based weaning or illness diets may have the potential to be used as a cereal based oral rehydration therapy; but more research is required on the behavioural and cultural aspects of weaning diets and community perceptions of early management of diarrhoea.

Messages about fluids and feeding must be carefully developed, so that fluid replacement and protection of nutritional status through appropriate feeding are integrated and are both perceived as part of early diarrhoea management in the home.

**IMPLEMENTING ORT PROGRAMMES
AT COMMUNITY AND DISTRICT LEVELS:
REAPING THE BENEFITS OF CEREAL BASED ORT**



*Choice of the form of ORT to be used must be made
with the informed participation of the local community.
(Photo by Ruth Angove)*

IMPLEMENTING ORT PROGRAMMES AT COMMUNITY AND DISTRICT LEVELS: REAPING THE BENEFITS OF CEREAL BASED ORT

Robert Northrup, David Saunders, Carl Taylor, David Werner, Naomi Baumslag, Larry Casazza

Considerations for Judging Cereal Based ORT and Other Options in Diarrhoea Case Management

The discussion concentrated on aspects of the implementation of fluid therapy for diarrhoea at the local level, emphasising the concerns of the mother and community. Choice of any particular treatment approach demands consideration of numerous objectives, about which there may be limited, incomplete or even contradictory information available. Deciding whether or not to adopt cereal based ORT as a replacement for current treatment approaches will usually require the collection of additional information. The issues are listed below.

Rehydration ability

Is the new approach more efficacious under controlled clinical circumstances in promoting absorption of orally administered fluid? Is it efficacious when used early in diarrhoea, in homes, to prevent dehydration in mild diarrhoea with slow purging rates, as well as in more severe diarrhoea and dehydrated patients? In children under three months, neonates, and malnourished children with diarrhoea?

Data from several studies indicate that many forms of cereal based ORT are effective in reducing the duration of diarrhoea in mild cases, many without dehydration, as well as in more severely purging patients. Some data were available to show that cereal based ORT was effective in malnourished children, and in those aged under 4 months; but further research was recommended (Patra et al 1982).

Nutritional influence

To what extent does a cereal based ORT approach directly contribute to the nutritional management of the diarrhoea patient? Does it contribute to, or interfere with, efforts to maintain or increase feeding during

diarrhoea, or efforts to improve basic weaning diets, for example by possibly confusing mothers into thinking that giving food based fluids fulfills feeding needs as well as fluid replacement needs?

In Nigeria, there is only a single basic weaning food, maize pap (gruel), often used in overly-dilute form causing malnutrition. Workers there were concerned that promoting use of a more dilute pap as a rehydration fluid would encourage mothers to give only the thin, poorly nutritious pap, and interfere with the use of a fortified weaning product more ideal both for a food during diarrhoea and as a basic weaning food. A parallel was drawn with the example of mothers often continuing to follow recommendations to dilute milk formula during diarrhoea long after the diarrhoea has subsided, resulting in acute onset of malnutrition. No research data, however, exist to substantiate this fear that the use of cereal based ORT could undermine good weaning practices. It was suggested that improved weaning foods eg by addition of oil, amylase rich flour (to reduce viscosity of thicker pap), with salt added, might possibly be used as cereal based ORT. In places where a greater variety of weaning foods are used, interference with feeding by cereal based ORT is less likely. Research on the possibility of cereal based ORT use interfering with feeding practices should be given priority

Stopping or reducing diarrhoea

How effectively does cereal based ORT inhibit progression of acute diarrhoea to persistent or chronic diarrhoea? Does it reduce the severity of dehydration seen in clinics when used in communities as the recommended early home treatment for diarrhoea? Will this effect be sufficiently dramatic to be noticed by mothers, and thus lead to greater acceptance and use compared to glucose ORS solution combined with feeding?

Studies from Bangladesh (Rahman et al 1985; Ismail et al 1986; Chowdhury et al 1988) have shown that a

home-prepared rice based solution led to a significant reduction in duration of diarrhoea, both in mild cases without dehydration, and in more severe cases, and decreased the proportion of cases becoming persistent (duration 14 days). In Sri Lanka, home use of rice congee (water in which rice has been boiled) for diarrhoea led to a dramatic fall in the number of dehydrated patients coming to health centres, resulting in large stocks of unused glucose ORS packets gathering dust in those facilities. The answer to the first two questions therefore appears to be yes; the answer to the third is, as yet, unclear.

Acceptance and usage by mothers and care providers

How would adoption of cereal based ORT affect acceptance of correct diarrhoea case management practices by mothers and health care providers? Would it lead to earlier use of enhanced fluid administration at home, in comparison to an approach based on glucose ORS packets, or SSS? Would doctors be more or less likely to treat diarrhoea patients correctly, if they were encouraged to simply teach mothers how to prepare and give home based fluids, rather than to prescribe packets of ORS? Would the ability of cereal based ORT to reduce the quantity and frequency of stools passed lead to a reduction in inappropriate provision of drugs by doctors and pharmacists, as well as reduce the demand for such drugs by mothers?

In some circumstances, the availability of standard ORS packets seems to undermine the use of home treatment more easily affordable by poor people, because the latter is perceived as "second best" compared to the "high-technology" appearing and more expensive packets. Many poor people do, however, spend heavily on diarrhoea remedies of all sorts (Read 1983; Portnoy et al 1976), and one view was that a cereal based ORS packet product, particularly if available commercially, would lead to higher rather than lower ORT usage rates. Such higher rates may, however, arise from greater use by wealthier families, rather than by the poorest families who have the most diarrhoea and the most severe and potentially fatal cases. Such families may be cut off from functional access to treatment by any policy which stresses use of a product which has to be bought or which is not available in the home.

Physicians may be less satisfied with the "home remedy" characteristic of the home-prepared cereal based ORT approach, since they are often reluctant to give only advice rather than a prescription; as may those families who want the "magic" of a drug or technological-appearing remedy. The majority view expressed was that the primary objective should be to promote rational therapy, rather than cater to the expectations of (especially private) doctors, who in any

case deal with only a small percentage of patients in most developing countries.

Safety

Is the cereal based ORT approach safer than a packet or SSS approach? Will it be less likely to result in errors in preparation (eg use of too little water, production of a hyperosmolar solution) or administration (eg use of inadequate amounts to replace losses)? Would cereal based ORS be more susceptible to bacterial contamination, fermentation or spoilage than current approaches?

The lower osmolarity of cereal compared to glucose solutions should enhance safety; because of this, variations in salt concentration may matter less. Some reports indicated that more salt tends to be added to cereal based ORT, while others indicate the opposite. An example from Ethiopia suggested that wheat based ORT can be successfully and safely used by mothers (Mazumder et al 1987).

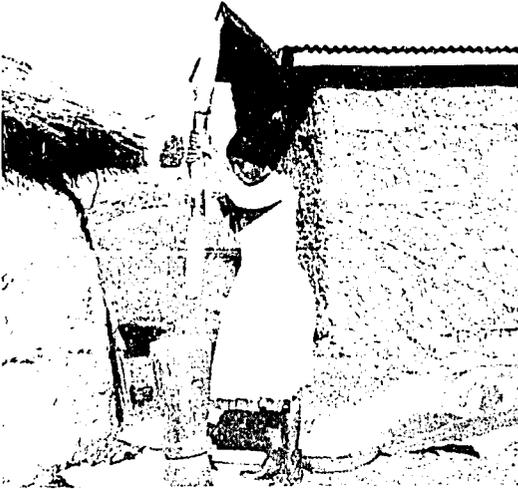
It was noted that both food based preparations and glucose or sucrose preparations appeared to spoil after 8 hours in warm, humid climates, and after 10-14 hours in the cold season. From this perspective there seemed to be no specific advantage to either. However, in many societies fermented porridges are traditionally used both as weaning foods and for treatment of diarrhoea. These fermented gruels can last for up to a week without spoiling.

Empowerment and promotion of self-reliance of families

When diarrhoea occurs, does the cereal based ORT approach lead to greater self-reliance of families and decreased dependence on medical providers?

When recommendations as to the choice and preparation of a food based solution in the home are based on local conditions, including (seasonal) availability of ingredients, of suitable containers, and cultural feeding responses to diarrhoea, a cereal based ORT approach can substantially enhance the ability of families to manage diarrhoea at home. The Sri Lanka example of the use of rice congee illustrates this. But, this consideration should not be overemphasised to the point that leads families to fail to seek medical help when the condition of the child with diarrhoea requires it.

The slightly higher costs of a packet of cereal based ORS (when it becomes available) compared to the costs of the current glucose ORS packet could result in a decreased potential for self-reliance, at least for the poorest families. It was recognised, however, that for



An ORT which can be made with the local staple grain can promote family self-reliance. (World Health Organization photo by J Bland – Ethiopia)

hard-working women, packaged glucose ORS or cereal based ORS could relieve some of their burden. As such, consideration should be given to promoting low cost locally produced packets, as a cottage industry.

Costs, both direct and indirect

How would a shift to cereal based ORT affect the cost of treating a child with diarrhoea, the cost of the treatment itself (eg ingredients of a packet of ORS), the costs of obtaining treatment (eg transport to a clinic, a clinic fee) and the indirect costs to the mother?

The cost to a family of a home cereal based ORT approach would be minimal: the ingredients are already available and cost less than purchasing an ORS packet, especially if the packet has to be obtained from a clinic or shop, requiring time and transport. Some suggested that the increased cost to the mother of the time, work, and fuel needed to prepare the home cereal based solution, compared to the convenience of the more easily and rapidly prepared SSS or ORS packet, might be significant, leading to a preference for the "cheaper" sugar or glucose based fluids or packets of cereal based ORS. It was recognised, however, that in many households cereal porridge may already be prepared and could be easily modified to yield a suitable fluid for ORT. Nevertheless, some mothers may still prefer to pay for increased convenience. More research data on this point are required, which take into account marketing and media influences.

For a national programme, would the costs of a cereal based ORT approach be more or less than current costs? Again, both direct costs (eg the cost of an ORS packet times the number needed), and indirect costs (eg greater or lesser time needed for instructing mothers), must be included in calculations.

Effect on integration of diarrhoea treatment with other child survival activities

Would a cereal based ORT approach facilitate or interfere with other related child health activities? One theoretical concern would be whether promotion of cereal based ORT is likely to interfere with efforts to deal with malnutrition, by encouraging mothers to give diluted food based solutions for long periods. A cereal based ORT approach is, however, unlikely to impede other child survival activities and may in fact enhance them by stimulating greater self-reliance.

Potential problems related to switching to the new approach

Would adoption of either a home cereal based ORT approach or shifting to packets of cereal based ORS lead to significant problems and costs to national programmes? Are the benefits sufficient to justify switching from current programmes, which in many cases already recommend the use of food based home solutions for early home treatment?

Potentially, promotion of an "improved" (cereal based) packeted ORS could make the current glucose ORS seem inferior, leading to distrust of government diarrhoea control efforts. The glucose ORS product may be viewed as treatment for the poor. Among physicians, a lack of agreement among experts about ORT might lead to their viewing ORT as a treatment for which solid proof of effectiveness is lacking. Cereal based ORT should therefore be introduced in a manner which does not imply that earlier methods were wrong, but rather that research has led to improved approaches.

The costs of retraining and of developing revised or new educational materials, as well as the potential difficulties in establishing local manufacturing and quality control procedures for a new packeted cereal based ORS product, should also be considered.

Strategic Programme Options

Based on the above considerations, CDD programme managers must choose among a range of possible options for an optimal strategy to implement fluid therapy of diarrhoea. These options include:

- Glucose based ORS packets alone (G ORS), for use both at home and in facilities
- Fluids available for use at home which do not require a special recipe or preparation, including everything from water to rice water to tea; combined with the provision of G ORS packets at health facilities
- Specially prepared home ORS solutions (including cereal based and sugar-salt based) prepared according to a recipe, with G ORS again available from health facilities
- CBORT at all levels, prepared whenever needed by mothers at home, and by health facilities
- Commercial packets of cereal based ORS, for use both at home and at health facilities

Any of the above strategies should of course be combined with appropriate feeding, antibiotics when appropriate, intravenous fluid therapy for severely dehydrated patients or when oral fluids fail, and other additional components of good diarrhoea case management.

The first and most important principle to consider when choosing an option is that conditions vary widely in different locales. Hence, the choice of option must be made based on local conditions, rather than imposed from national or international levels. For example, the first option, ORS packets for use both at home and at facilities, might be appropriate for Egypt, but would not be appropriate for a country or area where access to health facilities is difficult, either for geographic, economic, or educational reasons, or packets are not widely available. The cost of such a programme is very high and unsustainable in most situations. Furthermore, a majority of the working group felt that glucose ORS packets were not necessary at home level or for children with mild diarrhoea (not dehydrated) at health facilities.

Two diverse views emerged on the issue of whether or not programmes should use packet glucose ORS or packet cereal based ORS. The first was that any approach emphasising the use of packets at home was undesirable, because it made people dependent on the health care system, and was bound to make care less accessible to the poorest of the poor. Some even recommended that ORS packets should not be used even at health facilities, because such use gives people the impression that home fluids are somehow second best, and thereby discourages families from using home options.

The alternative view emphasised that the complete ORS formula — which contains citrate to combat acidosis; potassium to combat hypokalemia; and glucose,

which has been shown to be slightly more effective in stimulating salt and water absorption during diarrhoea than sucrose — was needed for maximal efficacy in more severe diarrhoea cases. It was recognised, however, that CBORS has been shown at ICDDR,B to be more efficacious than G ORS, even in severe diarrhoea (Molla et al 1982, 1985, 1989b,c; Chowdhury et al 1988).

Examples of various country experiences with different ORT strategies (see table page 47) provided the basis for discussion of considerations for the introduction of CBORT.

A major concern was the possibility of confusion between efforts to promote CBORT and to improve child feeding practices, as described in the Nigerian experience. Little objective research data exists on this point, and the need for further research was stated. The decision about whether CBORT is a feasible option may therefore depend on traditional practices, especially weaning food practice; some believed the possible "confusion" issue insufficiently important to prevent aggressive pursuit of the CBORT approach, others disagreed.

Increased emphasis on breastfeeding as most important in rehydration approaches was unanimously and forcefully urged, noting the efficacy of exclusive breastfeeding in preventing diarrhoea.

Methods for Determining Policy

Local determination of fluid therapy policy was strongly recommended. The approach suggested includes gathering information in collaboration with the community to determine current feeding and fluid administration practices, both during diarrhoea and in general during weaning. Fluids found to be in use or acceptable should then be judged for their quality and appropriateness as part of diarrhoea management, considering at the same time the accompanying feeding recommendations to be used. Candidate recommendations should then be tried in homes and communities, to determine whether they are truly feasible.

The basic principle should be to *ask the mother*. She knows that sugar is often unavailable, or that the need to go long distances to fetch water or fuel for cooking, or the time required to prepare a solution, will constitute a major barrier to use. Asking mothers will make such problems evident. A solution which is a better rehydrant may not be better as a measure supporting good nutrition, or better if there are barriers to usage by mothers.

EXPERIENCES WITH DIFFERENT ORT APPROACHES

SSS

Nigeria

It is national policy to use SSS in homes and health facilities; G ORS packets are used only in cases of severe dehydration, at the discretion of a physician.
Discussion: There was concern that in Nigeria, where thin maize gruel is the traditional weaning food, that promotion of cereal based ORT would lead to confusion with messages about improving the weaning food, and might lead mothers to use the diluted gruel during and after diarrhoea, leading to malnutrition. It was suggested that in Nigeria continued use of SSS and other non-food based fluids plus food/improved weaning food would be most appropriate.

Zimbabwe

SSS is the basis of the ORT programme, where great strides have been made in reducing diarrhoea mortality. A single SSS formula is promoted, even in many health facilities, in order to reinforce this approach at home. Dehydrated children are given G ORS, but not from packets.

Bangladesh

The Bangladesh Rural Advancement Committee (BRAC) has been promoting lobon-gur solution (an SSS) to 2.5 million households; home cereal (rice) ORT taught in one area had a lower usage rate than lobon-gur solution, the latter being perceived as easier to prepare by mothers.

SSS & G ORS packets

Brazil

In Brazil both SSS and G ORS packets have been promoted, SSS for preparation in a glass of water, G ORS in one litre of water. In the north east of the country SSS is promoted through traditional healers as the recommended home fluid to prevent dehydration; spoons for measuring salt and sugar have been distributed. Nationally G ORS packets are used chiefly for rehydration in medical facilities, not for prevention of dehydration.
Discussion: These conflicting messages have possibly been responsible for a high level of errors in preparation of solutions, mostly errors in the volume of water used. Salt and sugar are commonly available in every home in the north east; this is not the case with any particular cereal - rice is uncommon in the region and cassava, the staple starch has not been studied to see whether it is a more effective rehydrant than sucrose. A CBORT approach would need to vary from region to region, depending on the local staples.

CBORT or CBORS

Kenya

Research and field studies have shown that maize or millet based ORS are feasible, efficacious and acceptable to care providers. A small scale study where pre-measured packets of maize flour were distributed with packets of pre-measured salt, prepared by local cottage industry, showed high acceptance and use rates, and preparation errors were very low.
Discussion: SSS is not feasible for home use because of the wide variety of spoons and containers available in homes, and the difficulties in providing a uniform understanding of how to prepare a safe solution.

Bangladesh

Studies at ICDDR,B (clinical and field) have showed that a rice based ORT is efficacious and well accepted by mothers, more so than lobon-gur, in contrast to the BRAC study.

Ethiopia

Wheat based ORT has been successfully used by refugee mothers, using wheat flour and a two finger pinch of salt in a litre of water. This approach was acceptable to mothers and, 2 years after teaching, 89% could prepare the solution correctly, 100% with safe sodium content.

Sri Lanka

Widespread use of rice congee, a traditional dish, at home for prevention of diarrhoea has meant a fall off in diarrhoea cases presenting at health facilities and G ORS packets in these facilities remaining unused.

Pakistan

Use of khitchri (a traditional rice/lentil mixture) is widespread.
Discussion: This culturally acceptable, and widely available traditional 'fluid' could form the basis for a cereal ORT for use in diarrhoea as the khitchri is perceived to be a 'cold' food, and diarrhoea to be a 'hot' illness.

G ORS packets

Egypt

G ORS packets are used in Egypt for the prevention and treatment of dehydration. The national programme recommends that every home keep packets of ORS available, like other household staples (eg tea). If the child needs more than 4 packets of ORS a day or for more than 3 days, the advice is to take the child to a health facility.
Discussion: This approach has been successful in Egypt due to the completeness of the health facility system and ease of access to ORS packets by all families. G ORS packets have been widely promoted in Egypt. This approach is unlikely to be feasible logistically or appropriate in terms of cost in many other countries.

Planners should develop approaches which recognise the differences between the three stages of care: prevention of diarrhoea, early treatment by mothers in the home, and treatment in facilities. These should be coordinated, so that one does not interfere with or inhibit the success of the other.

The management of the patient with diarrhoea but no dehydration brought to a health facility for care was considered. A minority wanted to allow the doctor or health worker to give packets under such circumstances. The majority supported the opinion that the patient should be sent home and the mother given advice on how to manage the child with home fluids and feeding; or favoured a third option -- showing the mother how to make and give home cereal based ORT at the facility.

The potential availability of packets of CBORS led to two widely different points of view. The first was that doctors needed something to prescribe and the availability of a CBORS packet, with its potential for reducing stool output, would allow them to prescribe an effective and appropriate treatment, rather than useless drugs; and that CBORS packets would be an improvement over currently available G ORS packets, which did not

have the potential for reducing stool output. The other was that commercial packets reduced self-reliance and should be generally discouraged, even for prescription by doctors. For the same reasons, it was also felt that current ORS packets should not ever be used in health facilities. Instead SSS plus a course of potassium, or facility prepared solutions (either glucose or food based) should be used when more intensive oral rehydration was needed, so that mothers would be encouraged to replicate this approach at home.

The process of switching to a cereal based ORT approach was felt to be a critical matter. For some countries, changing from the current programme would not be feasible at present. It was, however, noted that current approaches did not always appear to be working.

Decision Making with the Community

The discussion focussed almost exclusively on interaction with the "community" because this was seen as the real area of difficulty. Decision making is usually regarded as a "top down" activity with little attention to the perceived and real needs of mothers.

Mechanisms to enhance community participation

The widespread failure of ORT to meet its hoped for goals could, at least in part, be attributed to decisions made by top level planners influenced by international pressure from donors more than by the real needs and constraints of mothers or other child caretakers living in marginal conditions. The easy acceptance by planners of commercialised ORS packets, with a failure to realise how this often prices ORT out of the reach of the poorest families, is an important example. As in many other cases of health and development planning, too often the needs of the 'haves' take precedence over those of the 'have nots'.

Mechanisms facilitating more effective response to the needs of the community and family include:

- [] The existing medical infrastructure should pay more attention to the needs, frustrations, and suggestions of frontline health workers.
- [] Improving communications with other community based institutions; for example, input from the Catholic Church in Brazil strengthens grassroots representation to the Health Ministry.
- [] Political groups which can express local needs and reactions; for example, revolutionary groups in Cuba and Uganda.



In this area of Kenya maize based solution is used in health facilities and homes, thus keeping the ORT message consistent. (Aga Khan Foundation photo by Jean-Luc Ray)

- Local associations; for example, those of dwellers in shanty towns in Brazil.
- Dialogue with traditional healers and TBAs; for example, as in Mozambique, Brazil, and Malawi.
- Direct dialogue of health planners with mothers; for example, in Mozambique, when the packet based ORS approach failed to significantly reduce the high diarrhoeal disease related mortality in most of the country, the Minister of Health met with a group of 40 mothers in Inhambane, where diarrhoeal disease mortality was remarkably low. The Ministry of Health learned that the mothers had stopped using ORS packets and returned to their traditional treatments for diarrhoea – which were essentially cereal based ORT (using rice, maize, or wheat flour). As a result the Ministry of Health began a process of rediscussing their diarrhoeal diseases control strategy, based on the input from mothers.
- Meetings with community representatives in villages.

Problem areas in establishing communication

There are several obstacles to effective communication between those at the 'top' and those at the 'bottom'. They include:

- lack of receptivity by planners to community input
- reluctance on the part of mothers to talk, allowing men and mothers-in-law to speak for them
- barriers between nurses and physicians because of the professional hierarchy
- overload of health professionals with clinical activities, leaving little time for patient interaction
- lack of training for health professionals in communications skills; seminars and personal communication can help
- a falling off of enthusiasm among volunteers over time, as in Bangladesh, where the need to earn a living interfered with continued participation
- the time required for communication with mothers; this process is time-consuming, but in the long run the most successful
- lack of financial backing which results in programmes collapsing

How and when to reach high risk groups

The concept of "high risk" is frustrating and useless when the prevalence of a risk factor is found in over 20% of a target population. Furthermore, the significance of a genuine high risk factor, when this is commonly found can be lost and dismissed as "normal". Programmes nevertheless are advised to focus their attention on "highest risk" children, because of limitations in available resources. Such efforts should enhance the cost-effectiveness of programme activities.

High risk groups cited are:

- premature neonates, weaning age children
- infants on bottle feeding or mixed feeding, especially those aged 0-4 months
- children with poor nutritional status, or with growth faltering
- malaria patients
- fever patients
- HIV patients
- families living with poor water and sanitation facilities
- children of poor, overworked women with high fertility

The mechanisms suggested to identify these groups are:

- The community identifies those at risk. This approach is not well understood and needs preliminary anthropological research to learn how the community understands the concept of risk.
- Identify them as they enter the "system". This is more effective in a system with easy accessibility and wide coverage. The poorest may still be left out, because they do not use the system, due to transport costs, fees etc.
- Integration of CDD programmes with other primary health care interventions which also identify those at risk, as well as programmes with wide coverage (eg immunisation).

- difficulties in communication with illiterate mothers unaccustomed to measuring; for example as in some parts of Vietnam

Input from mothers must reach up to all levels of decision-making. They can be trusted to tell us what approach is most appropriate, safe and economically feasible. Little is known at present regarding the role of fathers in diarrhoea treatment specifically and childcare decisions generally. In Pakistan, for example, fathers often must agree before a mother is permitted to take a child out of the house for treatment. Fathers in some cases bring the child to health facilities, and they could share the workload of giving oral fluids at home. Thus, efforts to reach fathers through various channels deserve much more attention and trial.

Effective Communication with the Community

Whether programmes choose cereal based ORT or another fluid treatment option, effective implementation demands effective communication of options to the community, through health education or mass media; and to health care providers, through training and supervision.

Participants described several examples of successful approaches using a range of channels, including:

- Traditional Birth Attendants (TBAs), eg in Pakistan, Brazil, Sri Lanka, Egypt, Kenya, with Afghan refugees, and in Zimbabwe.
- Community members, eg in Egypt.
- Schools and school age children, eg in Sri Lanka a physician is assigned to the Ministry of Education to strengthen health education
- Religious leaders, eg in Pakistan
- Women's groups, eg in Bolivia, Uganda, Kenya, Sri Lanka and Bangladesh.
- Slum dwellers associations, eg in Brazil

Training Issues in Cereal Based ORT

Experience with SSS has demonstrated that the ability of mothers to prepare solutions with a safe sodium concentration appears to vary widely from place to



Traditional birth attendants are influential: they should be involved in communicating the ORT message effectively to the community. (Photo by M Nichter)

place. This is clearly related to the quality of training. The experience of BRAC in Bangladesh (Chowdhury et al 1988) and a mass media programme in The Gambia illustrate the high capacity of illiterate mothers to learn and retain for long periods the ability to prepare solutions accurately when good training is given.

Aspects such as lecturing rather than demonstration; failing to allow the mother to practise the skill during the training, and lack of any subsequent refresher retraining after the initial training are common deficiencies in many health education as well as health worker training efforts.

Experience in Ethiopia illustrates the importance of these principles in relation to cereal based ORT. Mothers there were trained in the village in groups of 6-8 to prepare a wheat-salt solution for home diarrhoea treatment. They used their own utensils, fires, wheat, and salt in a participatory training approach. They were retrained 4 months later, in sessions in which dialogue revealed specific misunderstandings which could then be directly corrected. With this preparation a large proportion of the mothers could remember specific educational points two years after the training (67-92% depending on the point), and 89% could correctly make the solutions (Mazumder et al 1987; Carlson et al 1989).

The cost of training will vary according to its intensity and the number of repetitions. The time needed for effective teaching of mothers to make and correctly use home solutions such as cereal based ORT may be costly, but this should be compared with the savings from ORS packets not needed when diarrhoea is effectively managed at home. It was noted that teaching mothers during health visits can convey needed knowledge and skills less expensively than special outreach efforts. Volunteer women can carry out such teaching, thereby saving health worker time.

Conclusions

The discussion concentrated on aspects of the implementation of fluid therapy for diarrhoea at the local level, emphasising the concerns of the mother and community.

- In considering the pros and cons of various options for fluid therapy, a number of characteristics of the proposed fluid approach must be taken into consideration. These include the ability of a candidate fluid such as CBORT to rehydrate, to reduce or stop diarrhoea, and to help support nutrition in an individual patient with diarrhoea. Behavioural and social considerations, rather than these technical biomedical aspects, should be given greater em-



With careful teaching and practice, mothers in Karachi have learnt to make a safe and effective rice based oral rehydration solution. (Aga Khan University – Pakistan)

Step 1: Take one fistful of dry rice grain (20-25g). Wash and soak the rice in some water until soft.



Step 2: Grind the soaked rice in pestle and mortar (or any grinder) until it becomes a paste.



Step 3: Put two and a quarter glasses of water (about 600 ml) in a cooking utensil and mix with the paste.

Step 4: Stir well and bring the mixture to the boil until the first bubble appears. Take the pan off the fire and allow to cool.



Step 5: Add one "three-finger" (up to the first crease of finger) pinch of salt to the mixture and stir well.

The rice based oral rehydration solution is now ready for feeding to the diarrhoeal patient.



Storage: This solution should be kept in a cool and clean place. The solution once prepared should be used within 6-8 hours, after which it should be discarded.

phases than is usually the case in choosing which fluid approach should be recommended.

- Whether a fluid option supports self-reliance of the mother and community rather than producing dependence on health care providers, and the potential for the chosen fluid to be available to even the poorest families, should be given top priority. From this perspective, any which can be made at home, including CBORT as well as SSS, is preferable to packets of CBORS or glucose ORS. Some group members urged that packets should not be promoted for use at home level. However, others recommended that the fluid option which would lead to highest rates of usage should be given higher priority in decision-making.
- Convenience and cost, including the time and effort (eg for grinding rice) needed for preparation or obtaining a fluid (eg supplies, transportation costs), are considerations which influence choice among different ORT options in different local circumstances.
- CBORT has a safety advantage because of the decreased danger of hyperosmolarity should errors in preparation occur.
- Possible interference by CBORT with efforts to promote improved feeding during diarrhoea and improved weaning diets should be considered. The need for additional behavioural research on this aspect was stressed.
- Introduction of a new cereal based ORT approach should be carefully managed to avoid discrediting existing ORS options and, hence, ORT in general.
- The process of deciding among options should receive maximum priority. This process should emphasise obtaining substantial information about current practices and preferences from mothers, as well as establishing and maintaining a dialogue with the community through a range of community groups including traditional healers and community leaders. "Top-down" decision making, the usual approach, was deemed to be both wrong philosophically, and also likely to lead to treatment options which would not be readily adopted by mothers or care providers.
- Effective communication about the chosen option with the community, and to health care providers, requires increased emphasis on working through non-health channels. There is a need to improve training methods used with both mothers and providers, through enhancing participation of the learner during initial training, and retraining and reinforcement over time, to maximise retention, accuracy, and acceptance.
- Programme efforts to target high risk groups and individuals should be supported because of the potential for both greater effectiveness and reduced cost. While techniques to select high risk children from among patients, such as weighing to detect malnutrition, have the advantage of demanding less additional effort by the system, such approaches might fail to reach those who are not currently utilising the health system. Extra efforts, such as engaging the community in detecting high risk children, and integrating selection approaches with activities having high coverage such as immunisation programmes, should be used to reach these groups.

STRATEGIC PLANNING AT GLOBAL AND NATIONAL LEVELS:
STRENGTHENING ORT PROGRAMMES
THROUGH A MULTIPLICITY OF APPROACHES

*"Cottage" industries could potentially
produce cereal based ORS*



as could commercial manufacturers

Widespread acceptance and use of ORT is likely to be based on a multiplicity of approaches.

(left: UNICEF photo by Bernard P. Wolff - Colombia

right: World Health Organization photo by P. Boncas - Egypt)

STRATEGIC PLANNING AT GLOBAL AND NATIONAL LEVELS: STRENGTHENING ORT PROGRAMMES THROUGH A MULTIPLICITY OF APPROACHES

John Bryant, Shanti Ghosh, Jon Rohde, Richard Cash

The group on Strategic Planning at Global and National levels consisted of 26 individuals from 14 countries who were aware of the broad health development context within which the issues of diarrhoeal disease and its management need to be considered.

The larger concern of health development is equity; that there should be universal coverage with services that are effective in addressing important local problems, and affordable, and that communities should be actively involved in the development of those services. A key issue is the nature of community involvement. Wherever possible, individuals, families and communities should have the possibilities of caring for themselves and their children, and self-reliance in health, rather than dependency, should be the goal. At the same time, the health problems of underdevelopment are not to be overcome easily or quickly, and applications of advances in technology that are appropriate to need, are essential to progress in health.

The management of diarrhoea in children can be seen as a paradigm of health development. Diarrhoeal disease is a flagrant manifestation of underdevelopment. Families can do a great deal to protect themselves from the ravages of the disease, but they need the help of advances in technology to do so, exemplified by oral rehydration, and they need guidance in how to use that technology in ways that are safe but do not promote dependency. The crux of the paradigm is to maximise protection of the health of their children while supporting their quest for self-reliance, which is fundamental to individual and community development.

A review of the state of knowledge about the current and potential role of cereal based oral rehydration therapy gave evidence of the effectiveness of cereal based ORT in the treatment of diarrhoea aimed at reducing mortality rates and improving nutrition in infants and young children (Greenough and Molla 1988), including the relevance of cereal based ORT to the building of self-reliance in caring for children at the family level. However, some questions remain to be answered about its use, particularly in relation to estab-

lished programmes built on standard glucose based oral rehydration. This presents a dilemma of how to proceed with a very promising approach to the management of childhood diarrhoea, but which also contains areas of uncertainty about some aspects of its application. The state of knowledge about cereal based CRT points the way to a research and development agenda that, linked to policy-making, can lead to substantial advances in the body of scientific knowledge and operational applications of this technology.

Global Strategy

In considering global strategies, one must be cautious about creating global standards, as the attempt to establish standards on a worldwide basis could be disadvantageous (although a global strategy for sharing scientific findings and experience, however, is needed), in that they could limit the development of ideas and programmatic approaches in a field that is still early in its evolution. In particular:

- emphasis on initiatives, at local levels, in applied research and evaluation should not be dependent on or limited by global standards
- decision-making as to what approaches or products to use should be made on a local rather than an international basis
- the group did not want to be burdened with inappropriate global standards that might have to be countered (the global recommendation that one litre was the appropriate volume for a packet of ORS was offered as an example of a troublesome global standard)

The global strategy that would be most useful at this juncture would be an openness to a multiplicity of approaches, including the continued study and gaining of experience with cereal based ORT.

National Strategies

Policy

In discussing national policies relating to oral rehydration therapy for diarrhoeal disease, it is useful to consider issues that might be taken into account by countries that are formulating national policies in this field, but not to specify which policies they should take, as that is a matter for local decision.

The current state of knowledge and experience with cereal based ORT gives substantial evidence of its effectiveness, but the remaining areas of uncertainty urge continued study and development of the uses of cereal based ORT in at least three areas:

- 1) the special needs of the poorest of the poor
- 2) the problems and possibilities of commercial production of cereal based ORT
- 3) areas of uncertainty about the impact of CBORT on current approaches to management of diarrhoeal disease

The special needs of the poorest poor

Strong support for the use of cereal based ORT is associated with its appropriateness for use in the home (Rahman et al 1985; Ismail et al 1986), particularly with respect to poor and deprived populations. Cereal based ORT carries the special advantages of being prepared from materials available in every home, and thereby escapes from the constraints and dependencies associated with packets of glucose based ORS. It is seen that every mother and caretaker could potentially be made aware of the needs for and how to prepare cereal based ORT from materials available in the home and market.

This ready access to materials that are potentially life-saving and nutrition-supporting is to be seen as much more than simply advantageous. It is part of the larger context of individual and community development, wherein people progress towards self-reliance in coping with the problems of underdevelopment, in which the knowledge and materials for coping are in their own hands, and there is a minimum of dependency on the expertise of others, on availability through uncertain channels, and a minimising of economic burden on the family. Thus, home based preparations represent the possibility of independent and self-reliant action by families to cope with an ever present threat to their own well-being.

Clearly, the poorer and more remote the family, the more pertinent are these arguments. That is not to say,

of course, that the uses of cereal based ORT are to be limited to the poor, or even to underdeveloped societies. These materials are useful and life-saving in every society, including the most developed, where there is reliance on inappropriate and sometimes even dangerous medicines and intravenous therapy for diarrhoea.

The problems and possibilities of commercial production of cereal based ORS

There are two sides to the issue of commercial production and marketing of cereal based ORT:

- 1) Commercial production of cereal based ORS packets is acceptable to some if it would not contradict current promotion, availability of and access to standard glucose based ORS, as through incorporation into similar packaging and given a new title. This approach underscores the willingness of some members of the group to consider packaging CBORT.
- 2) Commercial marketing of cereal based ORS raised concerns that there would be exploitation of poor and uneducated populations with attractive but false claims (problems with commercialisation are discussed further below under Implementation).

Uncertainty about the impact of cereal based ORT on current approaches to the management of diarrhoea

A series of concerns about possible negative impacts of uses of cereal based ORT were identified:

- 1) The physiological advantages of cereal based ORT in clinical studies in hospitalised cases of severe diarrhoea are decreases in stool volume and duration of diarrhoea (Molla et al 1982, 1985, 1989b,c), but more needs to be known about the effects of cereal based ORT in milder cases of diarrhoea at the 'community level'.
- 2) Commercial promotion of cereal based ORT raises concerns, most particularly that promotion of packets may have detrimental effects on acceptance and uses of standard glucose based ORS packets. The matter of 'competition' between cereal based ORT and standard glucose based ORS is of particular concern to those who are currently involved in national programmes promoting widespread utilisation of standard glucose based ORS.
- 3) Possible 'competition' between two ORT approaches and new messages about a different approach to the management of diarrhoea might be confusing to caretakers, communities and health workers, particularly where communication about glucose based ORS still falls short of the desired coverage.

- The major issue of concern is that cereal based ORT might be considered as food by mothers, and divert them from feeding children during treatment of diarrhoea, unless the programme emphasised that continued feeding during diarrhoea, from the beginning of symptoms, is absolutely essential, to combat the diarrhoea and particularly to protect the nutritional status of the child during diarrhoea. The message must be consistent: children should be given food during diarrhoea, whatever the form of ORT.

The group was trying to walk a tightrope between encouraging fluids at the household level and takeover by commercial cereal based ORT packets. Experience so far in most countries has shown that CDD programmes have had only a limited success from the point of view of coverage, training, availability of ORS packets and community understanding and compliance. A change in policy at this point may prove detrimental, considering the problems of training, education, and logistics. Not enough is known at this stage about the community's response to and understanding of cereal based ORS or cereal based ORT and whether there might be a problem regarding *food versus food based fluids*.

Most studies using cereal based ORS have been carried out in acute cases at the hospital level. Whether the results obtained will apply to milder cases at the community level is not quite clear, and remains an issue for research. Whether some reduction in the number of stools will be appreciated by the mother is also not known. We need to know more about mothers' appreciation of cost, time, fuel, availability of food and so forth.

In every community and culture, there are various kinds of foods and fluids which mothers feed their children during diarrhoea. Empowerment and support to the community, with emphasis on food, is the key to the promotion of good nutrition and hydration practices.

Two major points concerning national policies relating to management of diarrhoeal disease are:

- The national policy must emphasise that breastmilk is the universally desirable and appropriate food and fluid for a breastfed child with diarrhoea; therefore all efforts to protect, preserve and promote breastfeeding should be encouraged.
- Countries at different stages of development of diarrhoeal disease management programmes are likely to take different approaches to policy formulation. Countries that have well established policies and programmes built on standard glucose based ORS, who have been trying to make them more extensive and more effective, may be reluctant to change those policies to incorporate cereal based ORT as

an alternative approach. Countries that are less advanced in policy formulation, whose major steps in programme development are still ahead of them or who are more flexible in their approach, may opt for cereal based ORT or some combination of approaches. In any case, these decisions are national and local prerogatives.

Overall, the group was strongly supportive of proceeding on a number of fronts with cereal based ORT, but, for reasons given above, did not feel that it would be appropriate to recommend a global policy that cereal based ORT should be incorporated into national programmes at this time.



Health workers must make sure mothers do not confuse giving cereal based fluids for rehydration in diarrhoea with proper feeding. (Aga Khan Foundation photo by Jean-Luc Ray)

Implementation

Current approaches to the promotion of ORT are generally having positive effects.

- There have been widespread decreases in rates of hospitalisation, decreases in infant and young child mortality rates and diarrhoea case fatality rates.
- Death rates due to acute diarrhoea appear to be decreasing, which, paradoxically, may lead to a



National programmes need to give prominent attention to the concerns, perceptions and capacities of communities. (World Health Organization photo – India)

relative or proportional "increase" in death rates due to persistent diarrhoea.

At the same time, despite these indications of positive impact, it is apparent that in most countries there are still serious shortfalls in terms of coverage, training and availability of ORS packets, and community understanding and compliance.

Obviously more needs to be done...more time, more effort...and all efforts, including those relating to standard glucose based ORS packets, could benefit from further studies, as noted below.

Many governments are pursuing policies focussed on standard glucose based ORS, and are committed to ever stronger efforts to make that approach effective. Within such a policy some governments may have less flexibility for broader exploration of alternative approaches, as through cereal based ORT.

The strength of non government organisations (NGOs) is their multiplicity and flexibility, and some of them have genuine expertise in dealing with problems such as therapy of diarrhoeal disease. They can be an ideal resource for the continued study of and gaining further experience with the use of cereal based ORT. A further advantage of NGOs is their closeness to communities, often deprived communities; thus they can bring the study of cereal based ORT to the level where it is most appropriate.

Although NGOs are not always research oriented, it is important that they document their experiences and findings, both positive and negative, and consider how successful experiences can be shared with other organisations and spread through other communities. In this connection, it would be desirable for NGOs who do have an orientation toward problem solving studies to

develop effective linkages with governmental policy makers, so that policy-making can be informed by practical field based experience.

The pursuit of alternative approaches to diarrhoea therapy need not be limited to NGOs. Governmental agencies or institutes with an interest in, or responsibility for, exploring or evaluating alternative and more cost-effective approaches to management of diarrhoeal disease could be highly contributory in studying and/or evaluating uses of cereal based ORT in various settings. These activities could be all the more useful because of the natural interactions with existing glucose based ORS programmes that could be assessed, and because of the built-in linkages with governmental policy formulation.

National programmes need to give prominent attention to community concerns, perceptions and capacities for promoting cereal based ORT, in contrast to national strategies that might advocate a standardised approach, as through the use of packets of cereal based ORS.

Special attention needs to be given to training and communication methodologies leading to desired behaviour change.

There was considerable disagreement within the group regarding commercialisation of cereal based ORS. It was seen as advantageous by some. Given the difficulty of getting ORS packets within the reach of remote populations, commercial marketing of cereal based ORS could put a more effective product within easy reach of communities. Further, doctors would probably welcome a safe and useful product which they could prescribe: here is a promising counter strategy to the widespread use of expensive and harmful anti-diarrhoeal medications.

Others were concerned about the negative impacts of commercial approaches. First, and foremost, is the issue of possible commercial misuses, as in the making of wrong claims that could mislead and misinform mothers and health workers, like the flagrant abuses in the commercial marketing of infant formula. Would cereal based ORS be spared these same problems? There was also paired concern about commercial cereal based ORS cost and dependency: poor people would learn that CBORS was the answer to the problem of diarrhoea, but might be unable to afford the commercial product, yet not understand that the equivalent remedy was already in their own home.

Governments and industry should be encouraged to carefully consider responsible and valid guidelines for the marketing and promotion of cereal based ORS. If the product is to be commercially prepared and marketed, this should be done through approaches that are

ethically sound as well as sensitive to a development perspective. Regulatory authorities covering both cereal based ORS and glucose based ORS should ensure appropriate and uniform quality control and marketing practices. It is important that governments and industry pursue these issues constructively and jointly from the beginning, rather than in a confrontational manner after problems appear.

A concern was that cereal based ORS packets are likely to be two or three times more expensive than glucose ORS packets. An alternative approach to manufacturing of cereal based ORS could be production by local cottage industry.

Costs are a critical factor in implementation and the following parameters of costs were identified as being especially relevant, whatever the form of the ORT:

- *Costs of the products* – production, packaging, marketing, retailing, including comparative costs of local versus imported products.
- *Costs to the consumers* – particularly to mothers, as of money, time, convenience; it would be important to stratify consumers according to socio-economic and geographical gradient, so as to

document the cost burdens of alternative preparations on the poorest and most remote populations.

- *Costs of training* – of various levels of workers, and of effective communications to mothers, health workers, and other users, again with alternative preparations in different social and geographic settings.

A further cost issue involves possible decreases in costs associated with use of cereal based ORS, through lessened need for hospitalisation, decreases in the use of medicines etc.

Evaluation

Whatever the approach to oral rehydration, evaluation is critical to knowing its effectiveness and other impacts. The following approaches to evaluation are worth considering, appreciating that this is only a partial list:

- *Utilisation* – of oral rehydration therapy – which methods are used, by whom, how often, at what cost, how effectively, with what changes over time?



The costs to the mother of ORT vary according to her circumstances. Obtaining a packet will cost money and time, for example in travelling to a clinic or shop; making cereal ORT at home will cost energy and time, for example in gathering extra firewood. (Photo by M Nichter)

- *Infant and age-specific crude mortality rates* – clearly these are the ultimate outcome measures of effectiveness; and where multiple factors are at work (Chen et al 1990; Becker 1981; WHO 1981; De-Sweener et al 1982), carefully controlled studies will be required to determine changes in mortality and to be able to attribute these to the interventions under consideration (Kielman et al 1985).
 - *Changes in incidence and severity* – of diarrhoea, a key indicator that reaches beyond therapy to the basic causes of the disease, and which need to be studied in association with the factors that bear on those changes.
 - *Effects on nutritional status* – increasingly seen as a crucial factor, either helping to protect the health of the child and lessen the risks of further diarrhoea, or, failing to do so, adding to the vulnerability of the child and the likelihood of deterioration of health and of death.
 - *Impact on community self-reliance* – an indicator of social development and one of the focal points of oral rehydration as a paradigm of development (see above). Can the community be helped to the technology required to protect the lives of their children without sacrificing the development of their own self-reliance?
 - *Knowledge, attitudes and practices* – of health workers and mothers regarding the uses of oral rehydration therapy; to be used and compared in different locations, with different populations, using different approaches, to gain insights into problems, opportunities and steps to be taken to strengthen oral rehydration programmes.
 - *Hospitalisation rates* – including seriousness of conditions – one of the indicators to be used, recognising the biases built into facilities based data on frequency of occurrence of disease.
 - *Sales and distribution of packets* – tracking commercially oriented programmes.
 - *Costs* – a critical factor (as noted above under Implementation).
- food, which should accompany both. Under these conditions, will treatment with cereal based ORS solutions yield the better results, as shown by reduced volume and duration of diarrhoea? Impact on food intake and growth should be measured as well as stool volume.
- Since the most widely quoted benefits of cereal based ORS are those of reduced volume and duration of diarrhoea in cholera patients treated in hospitals, a question of clear interest is, will those benefits still obtain with non-cholera diarrhoea of different aetiologies and severities?
 - In view of the concern that caretakers will consider cereal based ORT a substitute for food, it is important to study the effects of cereal based ORS and ORT on feeding during diarrhoea and the resultant impact on nutritional status.
 - There was strong interest in studies with a social orientation, such as studies of perceptions, expectations and understanding of health workers with respect to clinical benefits of cereal based ORT.
- Also, again the concern for competition for attention between glucose based ORS and cereal based ORT: will another message (eg about cereal based ORT) be so confusing as to be detrimental to glucose based ORS programmes, or, for that matter, to cereal based ORT programmes? How can the essential information, understanding, and capacities to use cereal based ORT more effectively be conveyed to and absorbed by health workers and communities?
- Research is also needed on the obstacles to and the opportunities for using cereal based ORS: how widely is the product available, to whom, with what ease, and at what cost? What are the costs of home based materials, and the fuel required for the cooking? What costs should be assigned to the mother's time? What are the opportunity costs with respect to her time? Is the availability of utensils a determining factor, such as grinding stones for rice if appropriate, or those needed for alternative methods of preparation?

Research

Given the unanswered questions related to oral rehydration, including cereal based ORT, a number of areas for study are worth considering:

- Further clinical studies on comparisons between glucose based ORS plus food, and cereal based ORS plus food. The focal point of interest here is

Going beyond the questions to be researched, it is necessary that research be done locally. Many of the factors that determine needs, effectiveness and outcomes are specific to local situations, and therefore need to be addressed where the research design takes such factors into account. While some findings, particularly physiological findings, can be expected to have universal applications, caution is needed about cross-cultural and cross-situational applications of research findings where social, behavioural and organisational factors are prominent.

Research findings should be published both locally and internationally. There is a need to give attention to publications in local journals, since international "indexed" journals may not be read in the local setting. It is best to try to reach both kinds of journals, as well as to disseminate information through informal channels available in developing countries.

WHO has a distinct role to play, namely that of helping to frame the relevant research questions and the kinds of studies needing to be done. Of course, WHO could also help to support such studies, as it is currently doing. However, in keeping with the principle of local self-determination enunciated earlier, the group did not feel that global policy specifications would be helpful at this time.

Important considerations

The group emphasised certain cautions as well:

- There is need for a precise standardisation of the terminology used to describe the various types of fluids and foods used in the management of diarrhoea.
- Promotional efforts should not be tied too closely to reduction of volume and duration of diarrhoea, as these effects may be marginal for a mother to notice, and, in any case, the last used therapy may get credit for the cure.
- It is important to consider local conditions...cultural practices, organisational characteristics, costs, availability of materials, perceptions, extent of compliance, etc.
- Finally, the importance of empowerment of people as a major objective in policy, implementation, evaluation and research should be underscored.

Conclusions

Full encouragement should be given to proceed with studies, applications and widespread usage, particularly in poor and difficult to reach communities, even though the group stopped short of endorsing national policies that would incorporate cereal based ORT into national programmes at this time. Countries where there is no firm policy at the present, however, may want to go directly into cereal based ORT or some combination of approaches.

It is important to point out that the factors outlined above set the stage for a carefully reasoned approach

to the international advancement of this complex and important field.

The advantages of cereal based ORT have been delineated, as have the uncertainties. A research and development agenda has been identified, which has the promise of leading to a firm basis for policy formulation. It is appropriate to encourage the development of action plans based on that research and development agenda, including advocating close linkages between researchers and policymakers, to ensure rapid incorporation of positive findings into policy formulation.

A SENSE OF THE SYMPOSIUM



*It is for every mother to know what she can do when she needs to, and with the materials closest to hand. In this instance it is a tasty wheat-salt water solution which is most appropriate for a young Afghani child with diarrhoea.
(Photo by Karen Slerter, IRC/Pakistan)*

A SENSE OF THE SYMPOSIUM

Norbert Hirschhorn

The author of this summary has been charged to present an integrated sense of the major conclusions of the Symposium. The writer's own biases must inevitably show through but will be identified as such.

The Symposium was deliberately designed to bring out diverse points of view, not to reach consensus. We recognised early on that oral rehydration therapy (and cereal based ORT in particular) provides many sorts of benefits, and effects, but differentially valued by different people. We defined these attributes from the start of the conference as: life-saving rehydration, reduced duration of illness (with less need to use antibiotics), a gateway to improve nutrition, a way to strengthen primary health care, and – finally – a way to promote self-sufficiency in families caring for a child with diarrhoea.

But, in fact, much consensus occurred, hard-won, during intense workshops and other discussions; and where not, many participants understood, often for the first time, what the other person meant and why. We defined our confusion.

The final and indivisible element of our discussions is the child with diarrhoea. Scientific inquiry has defined some certainties:

- ☐ Most diarrhoea has some impact on nutrition and hydration. A well-nourished child withstands the impact better than an undernourished child.
- ☐ A child with diarrhoea needs rehydration, and to maintain nutrition.
- ☐ After diarrhoea, rehydration can stop but good nutrition must continue.
- ☐ In rehydration a fluid that contains some salt is better than one that has none. A child with mild diarrhoea and no dehydration can withstand salt and potassium loss being unreplaced, for one or two days. (Salt loss leads directly to potassium loss via an exchange in the kidneys). Because its kidneys are functioning, a child with mild diarrhoea and no dehydration can tolerate modest excesses of salt and

potassium for many days. In the writer's opinion, the concern over too much salt in some solutions prepared by mothers may cause a greater number of children to be harmed, because they may then receive no salt at all.

- ☐ In rehydration, a fluid that is thickened with a carbohydrate-protein food, but which is still drinkable, is better than a thin fluid (glucose oral rehydration solution, say): diarrhoea stops sooner and nutrition is better protected; the risk of sugar-hyperosmolarity is eliminated.
- ☐ No-one should confuse cereal based ORT solutions with real food. Both should be given during diarrhoea; only the real food afterwards. Some researchers hope to find a way to make a food based ORT more calorie dense (by adding oil?), or a weaning food equally suitable for diarrhoea (by alternating with sugar based oral rehydration solution, or liquefying with amylase-containing sprouts?). In the opinion of some of the participants, a special diet for diarrhoea is more consistent with family practices around the world.
- ☐ The participants were unable to decide on a name for the carbohydrate-protein ORT solution. The author proposes the generic name "cereal based ORT", with local names applied to identify the particular food (maize based, sorghum based etc). "Potato" may, for this purpose, be considered an honorary cereal.

When someone says "*the mother should...do this, do that...*" we ought to ask which mother, and who will teach her. We can wish for a paradise, but the realities show us health care in too many countries and cities and districts and communities being controlled by practitioners, not all of them selfless and competent. We find a commercial sector too eager to hustle useless drugs; ministries of health unable to accomplish the rudimentary tasks of paying, training and supervising health workers, much less reaching every mother. This is why cereal based ORT is so appealing – the family can treat its own child at home for over 90% of the time. But who will teach the mother?

Yet where mothers are contacted by the health system, even if only a few times a year, every contact can be used to demonstrate ORT; this means with EPI vaccinations, on malaria rounds, by family planning visitors, during basic curative care. The sad truth is that every health discipline guards its territory jealously (jobs, perquisites, control of programme policy); at Geneva, at ministries, within donor agencies... but perhaps not at the community level. We teach American citizens, individually, or in community or work-place groups, how to carry out cardio-pulmonary resuscitation. The evidence shows that community notables, traditional and informal practitioners, teachers, children, other citizens, can all learn to carry out ORT.

Under the best of circumstances, how often will mothers use ORT? The study by Bari (Bari et al 1989a) provides a "gold standard". He and his colleagues meticulously and respectfully taught mothers about ORT, using glucose ORS packets in one area, rice-powder ORS in packets in another, with a "treatment as usual" comparison area as control. ORS use rates were 73%, 78% and 8% respectively. Duration of diarrhoea was shortest in the rice-powder ORS group, and nutritional status (for children with over four episodes) the best after two years, by five points towards the median. The ORS groups used antidiarrhoeal drugs in 85% fewer episodes.

Thus we know that, as we scale up our programmes, use rates and thus benefits are likely to be less than this best effort. But our true goal is not simply health outcomes; it is for every mother to know what she can do when she needs to, and with the materials closest to hand, that she can afford, and for the long term.

Packets or home prepared oral rehydration solutions? This battle, in the writer's view, has always been a metaphor, standing for particular views of development, crudely – and pejoratively – called "top-down" and "bottom-up". When it becomes an all-or-none issue for the whole world, the debate is intellectually useless. If a national Control of Diarrhoeal Diseases programme provides or allows packets (whether free or sold on the market), however, families and health workers must know how to use them safely and correctly, and what to do when they are unavailable; anything less is negligence. If a national CDD programme decides that home prepared ORT is to be the dominant mode, health workers must faithfully reach and teach mothers how to adapt their own recipes or take up a new one; anything less is negligence. Even if packets are available, hospitals could still cook up cereal based ORT for out- and in-patients; it would prove that the method is not second class. Both modes must have a back-up to save lives when management fails.



In Kakamega, Kenya, ORT is prepared at home using maize, a commonly available cereal. (Aga Khan Foundation photo by Jean-Luc Ray)

Pity the national CDD programme. It is like a large ocean liner: it takes a long time to get up to speed, a long time to change direction and an iceberg can stop it instantly. It barely rides out storms of change. If a country began with packets of glucose ORS, it will take with difficulty to a change to cereal based ORT, and not even easily to a future rice-powder ORS in packets. People in traditional societies properly ask "what was wrong with the old one?" or as Americans might say: "if it ain't broke, don't fix it". But, over time, changes will come because change always comes. We hope it is for the better and comes sooner.

Professional and bureaucratic horizons are too close for us to be patient for changes. Developmental changes are measured in generations – blocks of twenty years. CDD and EPI programmes have been up and running in most countries for less than a decade. The writer wishes countries would say to donors: "Give us time. Don't pressure us with targets and guidelines you set. Assure us you will be our partners for a generation, and not impose brand new initiatives every three to five years. Recognise that austerity programmes make it harder for us just to stay in place. Above all, recognise the achievements we have made".

A thought about "guidelines": for people who respect books because they may only see a handful in a lifetime, or for "People of the Book", there is no such thing as a "guideline". If it is written, it is law.

By the way, if national CDD programmes want donors to propose overall goals and offer specific technical assistance rather than detailed, global implementation plans and "guidelines", are they willing to extend the same respect to district officers and to communities?

To be fair: standards and guidelines, which are based on the best current scientific knowledge, permit uniformity in logistics and materials – more important in EPI – and allow uniform criteria for evaluation, thus making it safe for CDD programme managers who do not want to risk failure when trying out unorthodox approaches. Thus, one coat fits all. The writer believes, however, that one casualty of such enforced uniformity is truth. If free inquiry, diversity of approach, and careful experiments are not allowed, then differences of opinion go underground, and become subversive.

Dr John Bryant summarised the deliberations of his working group with an eloquent plea for diversity. Evolution of life itself began with an explosion of life forms, many times more species than exist today. Many could not survive changes of climate, many were simply mistakes; but many succumbed that were superbly designed, that deserved to exist but no longer do. Survival is not only of the fittest but also of the lucky (or, some others might claim, of the destined). The same principles apply to strategies in development. It is a

mistake to limit choices from the start because a failure of the choice threatens extinction – a packet only programme where, suddenly, packet production stops, for instance. There must be flexibility permitted, even encouraged, at all levels to test out various approaches. The robust ones will survive.

It is true, however, that change and lack of uniformity always makes us anxious. We should use our anxiety – not run from it – to find better ways to reach families, cure children, make them stronger. Finding better ways should come from scientific research, not opinion or ideology, although these can supply fresh ideas. We need fresh ideas: a cottage industry to make cereal based ORS packets locally; adding oils to give adequate calorie density; teaching ORT to community groups – are examples of fresh ideas deserving rigorous research. The crucial research needing to be done quickly, is to prove whether cereal based ORS protects nutrition better, and hastens recovery sooner, than glucose ORS plus food; and to determine the composition that maximally reduces stool loss.

If this summary were to offer a final consensus statement, the following may be considered, at the risk of being facile:

"Children with diarrhoea need rehydration and nutrition. There are several ways these may be accomplished. This symposium discussed what methods are suitable, depending on national and local circumstances, and what additional research is needed. For all that, reaching the poorest families, whether hidden in valleys or hidden in cities must be foremost in our efforts".

That being said, it is worth closing with the warning that emerged in several plenary session discussions: diarrhoea must be considered in its context of poverty and inequity and biomedical or social solutions that ignore that context (or even contribute to it) are to be avoided.



His name is today.

PERSONAL VIEWPOINT

Katherine Elliott

The author of the following has been part of the team involved in the planning and the editing of this report from the Karachi symposium on cereal based ORT. Unfortunately she was unable to be present at the meeting. Therefore when it was suggested that she should add a short piece at the end of the report, she welcomed the opportunity to offer readers some personal reflections about where we came from with diarrhoea and ORT, where we seem to be at now, and where she believes we should be going.

It must be made crystal clear that the thoughts and suggestions are her own, and those of no other person nor of any organisation. They come from a lifetime spent, not in a laboratory or formal medical setting, but in being interested in the welfare of children in many different ways and places, and in promoting, wherever possible and in her own way, innovative approaches to family health care in developing countries. "We" in what follows is used very loosely to include the many people who, internationally, nationally and locally, have the interests of young children so much at heart, who feel a sense of responsibility for their wellbeing and their future; and who bitterly regret the circumstances which lead to their wastage.

Remember the Year of the Child and the words of Gabriela Mistral written at the time:

*"Many things can wait. The child cannot.
Right now his bones are being formed,
his blood is being made, his senses are
being developed.
To him we cannot say tomorrow.
His name is today."*

The Year of the Child was more than ten years ago. Since then, oral rehydration therapy has assuredly helped millions of children to life instead of death; and many millions more to good instead of poor health. But diarrhoea continues to threaten the children of the world and will do so as long as so many still lack safe water to drink, adequate nutrition and effective sanitation. Resources pour into development projects, but taps and toilets are unlikely magically to appear in every household by the year 2000, the official dawn of the

Health for All new era. And famine continues to ravage much of Africa.

Diarrhoeal disease has always beset the human race. Fixing a date will not wipe out its threat. Changing human behaviour just may succeed if we can accept the dictum that health is what people do, not something that people get.

The challenge of the new cereal based oral rehydration is its potential to enable any family to manage diarrhoea independently of outside help, if need be. The ingredients can be found in every home. The risks of too much glucose or sugar, too much salt – these are minimised. The concept of a diluted gruel as appropriate to be given in illness is hallowed by tradition in all cultures. Cereal based ORT seems to have a lot already going for it even without its special extra advantage of reducing the actual amount of diarrhoea. This asset is particularly appealing to health professionals as well as to mothers, at a time when we are all so anxious about the useless and even dangerous anti-diarrhoeal drugs consumed in such alarming quantities by those who can least afford to buy them.

There is a saying about there being strength in diversity. We might try to remember this when it seems that different types of ORT may not be encouraged to co-exist. The WHO/UNICEF glucose based formula works very effectively and has both advantages and disadvantages when compared with other approaches. Sugar-salt solutions also may have their place. Now we have this new concept of cereals as a base for oral rehydration fluids. And one day we shall be offered a super ORS, based on a perfectly balanced mixture of carbohydrate, protein and electrolytes to maximise rehydration and recovery.

Meanwhile so much, as always, depends on circumstances. The contrast between the well equipped diarrhoeal disease treatment centre and the situation of the isolated mother with miles to walk to buy the ORS packet she cannot afford is stark indeed. Her self-reliance may be the key to the survival of her child. Now that we possess this new knowledge about the use of cereals as an effective basis for ORT, we must in all

conscience spread this good news throughout the world.

Yes, there is of course a real need for more research on all its aspects and this must be carried out. But, in the meantime, we know that cereal based ORT works and is safe and acceptable, especially for home use. Let us therefore stop fussing too much about the relative merits of different forms of ORT and concentrate instead on ORT education and coverage. Ask any woman what she does when she is making a meal and some ingredient is lacking: one way or another she still manages to feed her family. She is flexible of necessity. She needs to know how to be equally flexible when ORS packets, or even sugar, are not within reach. If we honestly wish to empower families to make child survival a reality, we might be wise to humbly remember the words of the great 18th century politician Edmund Burke:

"The public interest requires doing today those things that men of intelligence and goodwill would wish, five or ten years hence, had been done."

The child with diarrhoea cannot wait.

APPENDICES



*The timely use of oral rehydration therapy prevents dehydration
and diminishes child morbidity and mortality.*
(UNICEF photo — Pakistan)

GLOSSARY

Absorption – The movement of molecules generally from a space connected with the exterior, across a membrane made up of specialised cells into the bloodstream. In the case of intestinal absorption, molecules (organic, such as glucose or amino acids; inorganic, such as minerals) are moved by mechanisms specific to each type of molecule from the lumen of the gut across specialised absorbing cells of the intestinal lining epithelium (villus cells) into the bloodstream

Access Rate – The percentage of population having reasonable access to a provider of ORS who is trained in its use and receives adequate supplies

Aldosterone-Mediated Excretion (of K^+) – The adrenal hormone aldosterone regulates the exchange movements of sodium ion (Na^+) and potassium ion (K^+) across cell surfaces (intestinal, kidney, blood, sweat gland among others). In the kidney and large intestine, aldosterone helps restore sodium to the blood in exchange for loss of potassium in urine and stool

Amino acid – Basic molecular components of protein, containing carbon, hydrogen and nitrogen atoms in specific configurations

Anorexia – Profound loss of appetite

Case Fatality Rate – Number of deaths occurring in a standardised number of episodes of a specific illness

CDD – Control of Diarrhoeal Diseases – a specific programme at national or international levels designed to eliminate the mortality and morbidity from infectious diarrhoea

CBORS/Cereal based ORS – The standard WHO/ UNICEF recommended formula but with the glucose substituted by a quantity of starchy food such as maize or rice, sufficient to release at least as much glucose as is present in the standard ORS

CBORT/Cereal based ORT – The administration of a rehydrating fluid composed of a thick but drinkable mixture of a starchy food (approximately 50-100 g/l) mixed with salt added to make a solution of 40-120mEq/litre

CHW – Community Health Worker

Cyclic AMP – A molecule shaped in a ring-like structure (Adenosine-Mono-Phosphate) which is universally present in animal cells and organises the flow of molecules within cells; sometimes called a 'second messenger' because it responds to hormonal signals or toxins from outside the cell

Di-peptide – Two amino acids linked together

DTU – Diarrhoea Training Unit – any area, usually within a recognised health facility where rehydration therapy is practised, demonstrated and taught

Electrolyte – The individually ionised (electrically charged) component of any salt molecule which, in solution, tends to disassociate; for example, sodium chloride (table salt) in solution dissociates into positively charged sodium and negatively charged chloride ions

Enterotoxin – One of a number of complex molecules secreted by certain bacteria, which affect intestinal cells stimulating secretion or blunting absorption of fluid, or both

Epithelium – In the intestine, the one-cell thick lining separating the lumen from the bloodstream

G ORS/GBORS/Glucose based ORS – The standard WHO/ UNICEF formula for oral rehydration therapy

Glycine – An amino acid (used in early studies of an augmented ORS)

Hyperkalemia – A greater than normal concentration of potassium ion in the blood

Hypokalemia – A less than normal concentration of potassium ion in the blood

Hypernatremia – A greater than normal concentration of sodium ion in the blood

Hypонатremia – A less than normal concentration of sodium ion in the blood

Hypertonic – A solution whose osmolarity exceeds that of a normal body fluid

Hypotonic – A solution whose osmolarity is less than that of a normal body fluid

(Either term not to be confused with the same words used as clinical description of muscle activity)

Maize based ORT – As CBORT above but specifically containing maize

Morbidity Rate – Number of episodes of illness per standardised number of population

Mortality Rate – Number of deaths per standardised number of population

Oligopeptide – Two to several amino acids linked together; in the intestinal lumen protein is digested by enzymes into oligopeptides, most of the di- and tri-peptide length

ORS – Oral Rehydration Salts – Specifically the standard WHO/UNICEF recommended formula; when the salts are dissolved in water the product is oral rehydration solution

ORT – Oral Rehydration Therapy – The administration of fluid by mouth to prevent or correct the dehydration that is a consequence of diarrhoea

Osmosis – Movement of molecules across a semi-permeable membrane in response to concentration differences of that molecule on either side

Osmolarity – The concentration of molecules per litre of solution

Osmolality – The concentration of molecules per litre of water

Rice based ORT – As CBORT above but specifically containing rice

Secretion – Generically, the active movement of fluid, or hormones, or chemical messengers from within or across a specialised cell; in the case of fluid (salts and water) the movement is always from the bloodstream to some space or tract, eventually leading to the outside; in the case of intestinal secretion, fluids are moved across specialised cells (crypt cells) into the lumen

Sugar salt solution (SSS) – An oral rehydration solution prepared from home available table salt and table sugar (sucrose)

TBA – Traditional Birth Attendant

Tri-peptide – Three amino acids linked together

Usage Rate – ORT – The percentage of diarrhoea episodes in children under five years of age treated with ORS or a physiologically appropriate household solution

Usage Rate – ORS – The percentage of diarrhoea episodes in children under five years of age treated with ORS

**ABSTRACTS OF CONFERENCE
PLENARY ADDRESSES, TECHNICAL PAPERS AND POSTERS,
REFERENCES AND BACKGROUND READING**

Abed FH, 1983. *Household teaching of oral rehydration therapy in rural Bangladesh. ICORT Proceedings, USAID, Washington DC, 65-70.*

BRAC developed a successful technique for teaching ORT in the home. A three year programme is in place where teams of women (ORWs) teach 2.5 million households in five of 20 districts in Bangladesh.

Ahmad K, 1984. *Old wisdom may yet work on control of diarrhoea cholera. Nutrition News, 2(8):1-2.*

The article recommends implementing old methods of treating diarrhoea into new forms of treatment eg using rice powder.

Armen III PA and Gonzalez CF, 1979. *Breast feeding and fluid intake in a hot climate. Clin Pediatr 18:424.*

Ashworth A and Feachem R, 1985. *Interventions for the control of diarrhoeal diseases among young children: weaning education. World Health Organization, CDD/85 2.*

A review of data from 12 developing countries suggests that it is possible to substantially improve the nutritional status of infants by weaning education. The paper describes several successful weaning education programmes that were community oriented.

Bari A, Rahman A, Molla AM, Greenough III W, 1989a. *Community study of rice based ORT in rural Bangladesh, International Centre for Diarrhoeal Diseases Research, Bangladesh (Submitted for publication).*

Studies were conducted on rice based oral rehydration therapy from 1982 to 1987 in a rural area of Chandpur district, Bangladesh. First we trained 400 mothers to prepare and use rice based ORT and found they could use it to treat children with diarrhoea effectively. We conducted a three-cell study in which we provided packets of rice based oral rehydration salts (rice ORS) in one area. In another, packets of standard glucose

based oral rehydration salts (glucose ORS) were provided, and in a third, no ORS packets were provided but mothers utilised locally available treatment facilities. All the mothers of nought to four year old children in the two intervention cells were trained to prepare and use the respective type of ORS. Some of these mothers were selected as depot holders and distributors of ORS for their communities. We observed the impact of these interventions on diarrhoeal episodes. Biochemical safety of both the ORS solutions was measured by random sampling of solutions prepared by mothers. The long term nutritional impact of ORT on a cohort of nought to four year old children was observed with anthropometric measurements, weight at monthly and height at three monthly intervals. Over 93% of diarrhoeal episodes eventually recovered.

Use of ORT was highest in the rice ORS cell and lowest in the comparison cell where drugs were used most. Duration of diarrhoea differed significantly between the cells, being lowest for the rice ORS users where more than 60% of non-dysenteric episodes recovered within three days and less than 1% suffered beyond 14 days. Those using glucose ORS showed 30% recovery within three days, but about 3% suffered beyond 14 days. In the comparison cell, 6% of drug users recovered within three days and 12% continued beyond 14 days. Rice based ORS was found to be superior to glucose based ORS in all respects. After two years of study, complete data for anthropometric analysis was obtained from 474, 516, and 606 children respectively in the rice ORS cell, glucose ORS cell and the cell with no intervention (comparison cell). There was no significant difference in the baseline weight for age among the children of the three study cells. Children suffering from four diarrhoeal episodes who received rice ORS gained weight significantly more rapidly than those receiving G ORS or mainly drugs.

Bari A, Rahman A, Molla AM, Greenough WB III, 1989b. *Rice-based oral rehydration solution shown to be better than glucose-ORS as treatment of non-dysenteric diarrhoea in children in rural Bangladesh. J Diarr Dis Res 7(1&2):1-7.*

Mothers living in rural Bangladesh were provided with

either rice based oral rehydration solution (rice ORS) (Group A) or glucose ORS (Group B) for treating non-dysenteric diarrhoea in their children aged under 5. Mothers living in a third area (Group C) were advised to use locally available treatment facilities, mainly unregistered medical practitioners. The incidence and duration of diarrhoea was recorded in all children over a two-year period. The outcome of each episode was recorded either as a success if the mother reported her child had recovered or as a failure if the child died or was admitted to hospital. Mothers in Group A used rice ORS as the only treatment for 71% of episodes of non-dysenteric diarrhoea, mothers in Group B used glucose ORS as the sole treatment in 60% of episodes, while mothers in Group C used drugs alone in 55% of episodes. Almost all children recovered successfully but the duration of diarrhoea differed significantly between groups: in the group treated with rice ORS, 60% of children recovered within 3 days and less than 1% had diarrhoea which lasted for more than 14 days. By the criteria of early recovery and low rate of prolongation of diarrhoea, rice ORS was found to be better than glucose ORS.

Bart KJ and Flinberg L, 1976. *Single solution for oral therapy of diarrhoea. Lancet (ii):633-4.*

Bastlen J, 1987. *Cross-cultural communication between doctors and peasants in Bolivia. Soc Sci Med 24:(12).*

Practitioners of modern medicine in Bolivia are often ignorant of traditional health practices among Andean peasants in the department of Oruro. This ignorance makes them less effective agents for improving health. The author describes a method for teaching traditional concepts of health and disease to practitioners of modern medicine (doctors, nurses and assistant nurses). He discusses workshops offered to these practitioners, where the participants were guided through a series of exercises which assisted them in deciding what aspects of the traditional system to change and what aspects to leave alone. He concludes by showing how Andean myths can be used as a method for teaching them how to cure disease. The objective is to educate modern medical practitioners in traditional beliefs and to use those beliefs for teaching peasants about modern medicine.

Becker S, 1981. *Seasonality of deaths in Matlab, Bangladesh. Internat J Epidemiol 10:271-80.*

Beckman R, Flores J, Wittcum PA, Sharp GWG, 1974. *Studies on the mode of action of cholera toxin: effect on solubilised adenyl cyclase. J Clin Invest 53:120-5.*

Bentley ME, Gittelsohn J, Herman E, 1989. *Behavioural issues for the adoption of food based oral rehydration therapy (Plenary Address, International Symposium on Cereal Based ORT).*

In order to realise the full potential of ORT, issues relating to household availability and behavioural factors must be addressed. Food based ORT, using cereal instead of glucose could solve problems of availability of ORS and meet mothers' expectations of "stopping" the diarrhoea by reducing stool volume and diarrhoea duration, thus promoting likely future use in diarrhoea episodes.

Lessons learned from existing ORT programmes which might equally apply to the application of food based ORT include: difficulties of teaching mothers to prepare safe and effective home solutions, and to administer sufficient quantities; the need for practical training of mothers, including reinforcement of teaching; and the need to consider local beliefs about the causes, treatment and consequences of diarrhoea which influence acceptance and use of ORT.

A wide variety of fluids are currently used, or might be used by mothers to manage diarrhoea, ranging from commercially prepared solutions and drinks, to those prepared at home using available ingredients. There is a need to carefully define terms and nomenclature to avoid confusion between fluids suitable only for prevention of dehydration and those suitable for treatment. This relates to the purpose of cereal based ORT and, in particular, when mothers are to be expected to intervene during an episode of diarrhoea; will they be prepared to make something special at the onset of every episode? Studies indicate that mothers do not always act at the beginning of every diarrhoea episode, and consideration must be given to issues of available time and resources; whether the availability of ingredients for a cereal based ORT at home, and the time required to make it would be more or less costly to the mother than using a packet of ready-to-use cereal based ORS.

Information on the composition of foods and fluids traditionally prepared in the home for use during diarrhoea is very limited. Some studies have shown that traditionally used fluids are inadequate for rehydration purposes, in terms of composition and quantity given, and in some cases contain incorrect sodium concentrations where mothers are taught to add salt.

Mothers' primary concern is for the diarrhoea to stop or decrease significantly, rather than to replace fluid losses; cereal based ORT may be advantageous, provided that mothers perceive a reduction in stool volume, and depending on the point at which they start to give it. Promoting food ORT as a cure for diarrhoea may lead to smaller "medicinal" doses being given, offsetting its effectiveness if it is perceived to have failed when the diarrhoea does not stop.

The most serious issue relating to use of cereal based ORS is the potential for confusion between fluid and food, or between cereal based ORS and weaning foods, and the danger that less or no real food will be given because cereal based ORT is mistakenly believed to provide an adequate diet during diarrhoea. Carefully designed messages reinforcing the need for continued feeding during and after diarrhoea will need to complement those concerning fluid therapy. Community based research to investigate possible areas of confusion is recommended. Additional research to ascertain the relative values of administering cereal based ORS and food, versus standard ORS together with food, and extra fluids and continued feeding, is required.

Bentley ME, 1988. *The household management of childhood diarrhoea in rural north India. Soc Sci Med* 27:75-85.

Black RE, Brown K, Becker S et al, 1982. *Contamination of weaning foods and transmission of enterotoxigenic E coli diarrhoea in children in rural Bangladesh. Trans Roy Soc Trop Med Hyg* 76(2):259-64.

The article emphasises the importance of seeking locally available foods that are hygienic as well as nutritious. In a study of two villages, 70 children's dietary intake was assessed. Forty-one per cent of the sample weaning foods tested contained *E coli*.

Black RE, 1985. *Global problems of acute diarrhea in young children. In: Infectious diarrhea in the young. Tzipori S et al (eds). Elsevier Science Publishers, B V, 3-8.*

Brown KB and MacLean NC, 1984. *Nutritional management of acute diarrhea: An appraisal of the alternatives. Pediatrics* 73:119.

Brown KB, Gastanaduy AS et al, 1988. *Effect of continued oral feeding on clinical and nutritional outcomes of acute diarrhea in children. J Pediatr* 112:191-200.

Brown KB, 1989. *Recent clinical trials of the dietary management of childhood diarrhoea, and the relation of dietary management to food based fluid therapy. (Plenary Address, International Symposium on Cereal Based ORT).*

The various approaches which might provide optimal dietary therapy in childhood diarrhoea include con-

tinued feeding during acute illness, or reduced feeding during illness and compensatory feeding during convalescence. Both approaches have potential problems; the paper reviews results of controlled clinical trials which have examined how different dietary strategies and regimens affected severity, duration, and nutritional outcomes of diarrhoea in children. Three studies cited suggest that continued feeding with breastmilk or nutritionally adequate, lactose-free infant formulas does not increase severity or duration of diarrhoea, and may even reduce them. Furthermore, continued feeding during diarrhoea mitigates its otherwise adverse nutritional consequences. Further studies to investigate whether the use of mixed diets in place of infant formulas (since non-human milk formulas can cause complications, and are often unavailable and expensive) would provide the same results, compared nutritional and clinical outcomes in children receiving modified whole milk, lactose-hydrolysed milk, or mixtures of lactose-hydrolysed or non-hydrolysed milk blended with wheat noodles. The noodles were added to the milk in amounts that maintained the total dietary energy content unchanged but reduced the amount of milk by half. Treatment failure rates in the two milk groups combined were significantly higher than in the two noodles-milk groups combined; faecal outputs and duration of diarrhoea were also significantly greater in the milk groups. Nutritional outcomes were similar.

Studies in Nigeria and Peru comparing locally appropriate staple food mixtures with a lactose-free infant formula indicate that mixtures of staple foods are safe to use during diarrhoea, and may yield lower early purging rates than with milk or soy based formula diets, as well as reducing diarrhoeal duration. Children on formula diets in these studies did, however, tend to consume more and gain slightly more weight. This may be of minimal nutritional significance if these diets are given for only a few days.

Could a single food based solution be used for both rehydration and dietary therapy? Only when the energy density of the diet is increased above 80 Kcal per 100g are children able to meet energy intake needs regardless of the severity of diarrhoea, and diets of this energy density cannot be prepared in liquid form, unless substantial amounts of oil or sugar are added, or amylase to reduce the viscosity of the starch. In addition, will children refuse to consume more of the high density diet once their energy needs have been met, even though they may still require ongoing fluid replacement?

The author recommends either a separate fluid source for hydration therapy and food source for nutrition therapy, until further research is completed, or possibly use of a diluted food based fluid source for fluid therapy, recognising that the latter will not satisfy nutrient requirements.

Bucclmazza SS, Hill ID, Yibei MA, Bowle MD, 1986. *The composition of home-made sugar/electrolyte solutions for treating gastroenteritis. S African Med J* 70:728-30.

Burki R, 1989. *Food technology and manufacturing of ORT (Plenary Address, International Symposium on Cereal Based ORT).*

Galactina SA, a Swiss baby food manufacturer, has been collaborating with WHO in trials to test a rice-powder based ORS packaged product for the following: storage stability; curative effect; ease of use; stability of the electrolyte content; and microbiological safety during and after production. The product contains 50g Galactina instant rice, 3.5g sodium chloride, 2.9g trisodium citrate and 1.5g potassium chloride, to be mixed with 1 litre of water. Three different technologies can be used to produce the rice based ORS: mechanical blending; spray drying; and drum drying. With the first process it is difficult to obtain a homogenous mixture due to the different densities of the ingredients; in addition there is a high risk of bacteriological reinfection during blending. With spray drying, liquid is passed through a warm air stream; the water evaporates leaving separated dried food particles. Whilst commonly used in the milk industry it is inappropriate for cereals, being uneconomical, and the heat treatment being insufficient to reduce the total germ count of the rice flour, unless pre-treatment is carried out. The third process, drum drying, is the most popular technology for cereals, providing good homogeneity, gelatinisation (and hence good digestibility) and chemical and bacteriological stability. This process requires precise bacteriological controls of water quality and rice flour quality. A major problem considered during the tests was how to obtain correct proportions of the different mineral salts in the dried end product. With optimal production conditions, the Galactina product produces a pap with a fine consistency and easy digestibility if made with boiling water; and which remains the same if stored in aluminium bags with or without antioxidant (paper bag storage resulted in rancidity after two to three months storage at 35°C).

Carlson D, Tameme M, Gebre Y and Cunningham N, 1989. *Food based oral rehydration therapy in rural Ethiopia: a performance survey of 1,493 women in Yifatna Timuga District. (Paper presented at Addis Ababa May 26, 1989, Ethiopian Medical Doctors Association, Annual Conference).*

The experience in Yifatna Timuga Awraja in Northern Shewa over the past three to four years is described. The area is vulnerable to drought, famine and associated epidemic diseases, including diarrhoea. In 1984-5, during a period of severe food shortage, cereal based ORT became a prominent part of community

health education. Supplies of ORS packets in Ethiopia do not reach beyond health centres to health posts, and almost no rural homes have packets at hand; to supply the annual estimated needs for diarrhoea episodes in Ethiopia would require 80 million packets a year, beyond the capacity of the health system for the foreseeable future.

In 1987, during activities aimed to relieve further famine conditions, a survey was carried out to determine how well rural mothers could prepare cereal based ORT. One thousand six hundred and thirty women in eleven communities were interviewed in house-to-house surveys carried out by 20 nutrition surveillance workers. The 8% of the women who had not previously been trained to make cereal ORT were taught the procedure in their homes. The 1,493 women who had previously been trained were asked 17 questions about diarrhoea and dehydration, and precautions to take in using cereal based ORT. They were also asked to prepare the cereal based solution. Workers observed and assessed each step in the preparation process; only accurate performance of all steps was given a pass mark. Four key questions produced surprisingly good results. In answer to the first: about the understanding of dehydration and the need to replace lost fluids, 92% replied adequately; to the second, concerning the best type of fluid to replace lost fluids, 92% responding by mentioning ORT made from wheat, sorghum, tef, or maize flour, plus salt and water; to the third "tell me two danger signs you may observe", 67% replied mentioning continual vomiting four hours after starting ORT, and decreased skin elasticity; to the fourth question, concerning what to do if the child continues to vomit four hours after giving small sips of fluid every minute, 77% replied that they would take the child immediately to a health centre. In addition to these answers, 89% of the women knew exactly how to prepare cereal based ORT. The survey concluded that a major community education effort on diarrhoeal disease control was not necessary since cereal based ORT had become an integral part of the child care culture in the district. The author concludes that the success of this programme could be repeated elsewhere. The elements of success included, effective learning methods (small groups with active involvement); followup reinforcing education in the community and for health workers; and usage of ingredients common in all homes and similar to a traditional treatment (a thick liquid made usually from ground barley or oats, boiled in water with salt, known as 'Atameet'). The main challenge was to encourage mothers to use a more dilute version of the 'Atameet' preparation.

Cash RA, 1987. *A history of the development of oral rehydration therapy. In: Symposium Proceedings – Cereal Based Oral Rehydration Therapy: Theory and Practice. Dale CB and Northrup RS (eds). J Diarr Dis Res 5(4):256-61.*

Cash RA, Forrest JN, Nalin DR, Abrutyn E, 1970a. Rapid correction of acidosis and dehydration of cholera with an oral electrolytes and glucose solution. *Lancet* (ii):549-50.

Cash RA, Nalin DR, Rochat R, Reller B, Haque Z, Rahman M, 1970b. A clinical trial of oral therapy in a rural cholera treatment center. *Am J Trop Med* 19(4):653-6.

Cereal based ORS in China (taken from Collaborative Research on Children's Diarrhoeal Diseases in the 7 MCH Model Counties of China 1986-1988 Report, Capital Institute of Paediatrics)

In a pilot study by the West China Medical University: 50g of rice powder was used in place of the 20g glucose powder in the WHO ORS prescription and a control study was carried out in the paediatric ward on diarrhoeal cases under five by random sampling. The success rate of cereal based ORS was 94.5% (67 cases), of WHO ORS 89.7% (29 cases); there was no significant difference in time of dehydration correction and time of diarrhoea stopping in the two groups; increment of body weight in the same time interval was significantly greater in the cereal based ORS group than in the WHO ORS group; acceptability of ORT by diarrhoeal children and their parents was better in the cereal based group.

Cereal based ORS was used in prevention of dehydration as well as treatment of mild to moderate cases in the three model counties. The success rate of prevention of dehydration was 91.3% (254 cases); the success rate of correction of dehydration was 97.3% (146 cases). A control group study was carried out by comparing 232 cases with cereal ORS and 111 cases without ORT. Cereal based ORS was also compared in the two counties (Renshow and Macheng) with two other counties where WHO ORS was used. Production and utilisation of cereal based ORS are more acceptable and practical in Chinese villages.

Chauhan S and Molla AM, 1984. Rice powder instead of sugar. *International Institute for Environment and Development, London Feb*:18-21.

Chen LC, Rahman M, Sarder AM, 1970. Epidemiology and causes of death among children in a rural area of Bangladesh. *Internat J Epidemiol* 9:25-33.

Chen LC, 1983. Interaction of diarrhea and malnutrition. In: *Diarrhea and Malnutrition*. Chen LC and Scrimshaw N (eds). Plenum Press, NY, 3-19.

Chowdhury AMR, Vaughan JP, Abed FH, 1988. Mothers learn to save the lives of children. *World Health Forum* 9:239-44.

Creed HM and Graham GG, 1980. Determinants of growth among poor children 1: Food and nutrient intake. *Am J Clin Nutr* 33:715-22.

Cutling W and Elliott K, 1983. Oral rehydration. *Brit Med J* 287:1141.

The article points to the need for early ORT interventions in response to diarrhoea. Home mix remedies are encouraged as well as traditional fluids.

Dale C and Northrup R, 1988. *Symposium proceedings, cereal based ORT: theory and practice. International Child Health Foundation.*

This report contains the proceedings of a symposium on cereal based ORT that took place at the National Academy of Sciences in February 1987. Discussion topics included the history of ORT development, implementation of ORT, status of cereal based ORT research, and nutritional aspects.

DeGarline I, 1984. *De la perception de la malnutrition dans les sociétés traditionnelles. Information sur les Sciences Sociales* 23(4/5):731-754.

This article is a review of social and cultural factors which may contribute just as significantly to malnutrition and other nutrition disorders in the Third World as actual physiological deficiencies.

DeSweemer C, Trosbridge FL, Parker RL, Merlweather D, Brown KH, Black RE, Reinke WA, Taylor CE, 1982. Critical factors in obtaining data relevant to health programs. In: *Methodologies for human population studies in nutrition related to health. NIH publication* 82-2462:59-81.

DeZoysa I, Carlson D, Feachem R, 1984. Perceptions of childhood diarrhoea and its treatment in rural Zimbabwe. *Soc Sci Med* 19(7).

Attitudes and beliefs about diarrhoea and treatment were revealed in a study of home based ORT in rural Zimbabwe. Diarrhoea was perceived as a community and family threat caused by physical, social and spiritual factors. This article confirms the necessity to incorporate local beliefs into health care activities.

Dibley M, Phillips F, Mahoney TJ, Berry RJ, 1984. Oral rehydration fluids used in the treatment of diarrhoea. *Med J Australia* 140:341-7.

Editorial, 1978. Water with sugar and salt. *Lancet* (ii): 300.

Ellerbrock T, 1981. Oral rehydration therapy in rural Bangladesh with home ingredients. *Tropical Doctor*, Oct:179-183.

The programme demonstrated that village women in rural Bangladesh who are predominantly illiterate can learn oral therapy, including how to make oral solution correctly from locally available substances using finger measurements.

Escobar GJ, Salazar E, Chuy M, 1983. Beliefs regarding the etiology and treatment of infantile diarrhoea in Lima, Peru. *Soc Sci Med* 17:1257-1269.

Three groups of women were interviewed regarding their beliefs about the aetiology and treatment of infantile diarrhoea. Results confirm that diarrhoea is not seen as an infectious disease; rather it is believed to be caused by an invasion of the body by cold or ingestion of foods designated as being cold.

Fagundes-Neto J, Vlaro T, Lifshitz F, 1985. Tolerance to glucose polymers in malnourished infants with diarrhoea and disaccharide intolerance. *Am J Clin Nutr* 41(2):228-234.

The article assesses the response of 20 infants with diarrhoea and lactose intolerance to feeding containing soy protein and sucrose (sobe) and/or to a carbohydrate free formula to which glucose polymers were added. It shows that some infants with diarrhoea, malnutrition and lactose-sucrose intolerance may also develop intolerance to glucose polymers and require further dietary management.

Feachem R and Koblinsky M, 1984. Interventions for the control of diarrhoeal diseases among children: promotion of breastfeeding. *Bull WHO* 62(2):271-291.

Thirty-five studies from 14 countries are reviewed regarding relative risks of diarrhoeal morbidity to infants on different feeding modes. Promotion of breastfeeding can reduce diarrhoea morbidity rates

Feld M, 1971. Ion transport in rabbit ileal mucosa II. Effects of cyclic 3'5'AMP. *Am J Physiol* 225:781-6.

Feld M, Fromm D, Al-Awqati Q, Greenough WB III, 1972. Effects of cholera on ion transport across isolated ileal mucosa. *J Clin Invest* 51:796-801.

Feld M, 1975. Regulations of action of ion transport in the small intestine. In: *Acute Diarrhoea in Childhood*. Ciba Foundation Symposium 42. Elliott K and Knight J (eds), Elsevier Science Publishers, B V, 109-127.

Feld M, 1977. New strategies for treating watery diarrhea. *N Eng J Med* 297:1121-1122.

Feld M, 1989. Nutrient absorption: biophysical factors important to the design of oral rehydration solutions (Plenary Address, International Symposium on Cereal Based ORT).

Intestinal secretion is stimulated temporarily after eating, for several days by a variety of bacterial enterotoxins (or intestinal inflammation caused by invasive microorganisms). In either instance, secretion is the result of active secretion mainly by crypt cells, and inhibition of absorption in the brush border cells. The former is driven by chloride transport from cell to lumen; the latter by inhibition of brush border membrane carriers for coupled sodium-chloride transport from lumen to cell. The inhibition does not affect sodium-nutrient coupled absorption or the sodium pump, except in the case of shiga shigella toxin or rotavirus invasion, both of which kill absorptive cells (although the damage is usually patchy). When a molecule of sodium and a nutrient molecule (glucose for example) are absorbed into the cell, both are separately transported into the space between cells, which creates a hyperosmotic and electrically positive area, drawing water and other electrolytes in from the lumen in the pathway between cells. This is how oral rehydration therapy works in diarrhoea, and how fluid is restored to the bloodstream after digestion.

Glucose is made available to the cell brush border from intra-luminal digestion of complex carbohydrate, after brush border disaccharides split di- and tri-saccharides. Amino acids also are co-transported with sodium in a process analogous to glucose but through a different carrier. Amino acids are made available to the cell brush border from intra-luminal digestion of protein, after brush border peptidases split di-, tri- and higher order oligopeptides. Unlike disaccharides, di- and tri-peptides are absorbed into the cell by specific carriers, linked to protons (hydrogen ion). Since there is a sodium-proton exchange mechanism, effectively absorption of oligopeptides is linked to sodium absorption. Little more is known about oligopeptide transport except that cyclic-AMP inhibits the sodium-proton exchange; the role of oligopeptides in complex oral rehydration solutions is also unexplored.

Amino acids are transported by six classes of carriers, with separate systems for acidic, basic, neutral amino acids; imino-acid and two carriers specific to certain individual amino acids. It is presumed none of these are affected in secretory diarrhoea. Some amino acids have a greater affinity for their carriers than others; higher affinity means that near maximal transport is achieved at a lower concentration of the amino acid. Evidence from *in vitro* and *in vivo* studies suggests that some combination of nutrients – a variety of amino acids, oligopeptides, complex carbohydrate, at low osmotic cost – should stimulate sodium and water absorption more than any one component alone, presumably because of the separate entry points for sodium. In an oral rehydration solution it is probable that such a mixture, whether as a cereal food or defined chemicals, will decrease diarrhoea substantially while speeding up rehydration.

Finberg L, 1980. *The role of oral electrolyte-glucose in hydration for children: international and domestic aspects.* *J Pediatr* 96:51.

Fondacaro JD, 1986. *Intestinal ion transport and diarrhoeal disease.* *Am J Physiol* 250:G1-G8.

The article concentrates on three major areas: the physiology of intestinal electrolyte transport and its regulation; the pathophysiology of secretory diarrhoea; and current thoughts and practices in the therapeutic approach to the disease.

Gordon JE, Guzman MA, Ascoli N, Scrimshaw NS, 1964. *Acute diarrhoeal diseases in less developed countries.* *Bull WHO* 31:9-20.

Gray GM, 1981. *Carbohydrate absorption and malabsorption.* In: *Physiology of the gastrointestinal tract.* Johnson LR (ed). New York, Raven Press, 1063-72.

Greenough WB III, 1980. *Oral replacement therapy in diarrhea: consensus and controversy.* In: *Secretory Diarrhea.* Field M, Fordtran JS and Schultz SG (eds). Maryland American Physiological Society, Baltimore, 179-85.

Greenough WB III, 1983. "Super ORT" (editorial). *J Diarr Dis Res* 1:74-5.

Greenough WB III, 1987. *Status of cereal-based oral rehydration therapy.* *J Diarr Dis Res* 5(4):275-8.

Greenough WB III and Molla AM, 1988. *Oral rehydration therapy (ORT): Present and future.* In: *Vibrio cholerae and Cholera.* Takeda Y and Kuwahara S (eds). KTK Scientific Publishers, Tokyo, 117-27.

Guandalini S, Miglilavacca M, DeCampora E, Rubino A, 1982a. *Cyclic GMP effects on nutrient and electrolyte transport in rabbit ileum.* *Gastroenterol* 83:15-21.

Guandalini S, Rao MC, Smith PL, Field M, 1982b. *cGMP modulation of ileal ion transport: in vitro effects of Escherichia coli heat-stable enterotoxin.* *Am J Physiol* 243:G36-G41.

Guandalini S, 1988. *Intestinal ion and nutrient transport in health and infectious diarrheal diseases.* *Drugs* 36(Suppl 4):26-38.

Guerrant RL, Moore RA, Kuschenfeld PM, Sande MA, 1975. *Role of toxigenic and invasive bacteria in acute diarrhea of childhood.* *N Engl J Med* 293:567-73.

Guerrant RL and McAuliffe JR, 1986. *Special problems in developing countries.* In: *Infectious Diarrhea.* Gorbach SL (ed). Blackwell Scientific Publications, Boston, 287-301.

Haffee I E and Moosa A, 1985. *Honey in the treatment of infantile gastroenteritis.* *Brit Med J* 290:1866-1867.

A clinical study was undertaken at the R K Khan Hospital in Durban, South Africa which used honey in oral rehydration solution in infants and children suffering from gastroenteritis. The aim of the study was to evaluate the influence of honey on the duration of acute diarrhoea and to determine its value as a glucose substitute in oral rehydration. The results indicated that honey shortens the duration of bacterial diarrhoea, does not prolong the duration of non-bacterial diarrhoea and may safely be used as a substitute for glucose in an ORS containing electrolytes.

Harland PSEG, Cox DL, Lyew M, Lindo F, 1981. *Compositions of oral solutions prepared by Jamaican mothers for treatment of diarrhea.* *Lancet* (i):600-1.

Hirschhorn N, 1975. *Single solution for oral therapy of diarrhoea.* *Lancet* (ii):1049.

Hirschhorn N, Kinzle JR, Sacher DB et al, 1968. Decrease in net stool output in cholera during intestinal perfusion with glucose-containing solutions. *N Engl J Med* 279:176-81.

Ho M-S, Glass RI, Plinski PF, Anderson LJ, 1988a. Rotavirus as a cause of diarrheal morbidity and mortality in the United States. *J Inf Dis* 158:1112-6.

Ho M-S, Glass RI, Plinski PF, Young-Okoh NC, Sappenfeld WM, Buehler JW, Gunter N, Anderson LJ, 1988b. Diarrheal deaths in American children: are they preventable. *JAMA* 260(22):3281-5.

Ho T, Yip W, Tay J et al, 1982a. Rice water and milk: effect on ileal fluid osmolality and volume. *Lancet* (i):169.

This letter to the editor states that rice water produced significantly lower ileal fluid osmolality and lower ileal fluid volume when compared with milk.

Ho T, Yip W, Tay J et al, 1982b. Rice water and dextrose-saline solution: a comparative study of osmolality. *J Sing Ped Soc* 24:87-91.

Osmolality of dextrose-saline solution and rice water was tested. Results show that rice water has much lower osmolality which could prevent hyperosmolality associated with dextrose saline solution.

Hopfer U, Groseclose R, 1980. The mechanism of Na-dependent D-glucose transport. *J Biol Chem* 255:4453-62.

Howard P, Jenkins C, Cerhan J, MacGregor D, 1989. Proposed use of sweet potato water as a fluid for home therapy for diarrhoea. Papua New Guinea Institute of Medical Research, Goroka, Papua New Guinea and Goroka Base Hospital. (Poster presentation, International Symposium on Cereal Based ORT)

Although the most important aspect of management of a child with diarrhoea is to give more fluids, some are preferable to others because of their efficiency in promoting the absorption of water and salts. Whilst oral rehydration solution is the fluid recommended for the treatment of dehydration it may be more convenient and less costly to use alternatives for the prevention of dehydration, especially in the home. In Papua New Guinea, there are limited choices for the selection of suitable home fluids because no grains are grown traditionally. In the coastal and most lowland areas coconut water is widely available and its use to prevent dehydration is recommended by health staff. However,

in the highlands no suitable traditional fluid is available.

This lack of suitable fluid in the highland areas led to a pilot study of the efficacy and safety of an ORT solution made from Kaukau (sweet potato, *Ipomoea batatas*) which is the staple root crop in many parts of the country and universally grown throughout the highlands. After experimenting with various "recipes", a fluid was produced by boiling two average sized pieces of Kaukau in 1500ml of water for 35 minutes. The potato was then mashed and water added to one litre to make a drinkable solution. Three grams (one finger pinch) of salt was added. When analysed the sodium concentration was 60mEq/l, the potassium concentration 17.5mEq/l and the glucose concentration 14mEq/l.

This ORT solution was then compared with the standard WHO formula ORS in a small series of patients. Thirteen infants with mild to moderate dehydration caused by acute diarrhoea were treated with the WHO ORS and 10 infants were treated with "Kaukau" ORT. The ages ranged from four to 23 months in both groups and there were approximately the same proportion of mild and moderate cases in each group. The mean time to clinical rehydration was 34.8 hours in the ORS group and 36.1 hours in the Kaukau group (difference not statistically significant). There were no side effects in the Kaukau group and all infants seemed to like the taste of the solution. Both mothers and nursing staff were enthusiastic about its use. All solutions used were tested for bacteriological quality and none were found to be contaminated even after two hours storage.

Although this pilot project involved very small numbers of patients, the results were encouraging and suggest to us that sweet potato water can be safe and effective as ORT and is culturally acceptable. It is our intention to carry out further studies in 1990 to confirm its safety when prepared by mothers in the village situation. We also plan to initiate the teaching of sweet potato based ORT to the mothers of the Goroka area. Initial feasibility studies of the attitudes of mothers and nurses in the paediatric ward at Goroka Hospital showed that demonstrations of preparations carried out at the "cook house", a traditional structure located on the hospital grounds, will be appropriate and acceptable. It is our intention to begin with mothers of children presently suffering from diarrhoea in order to develop teaching and communication skills with more motivated mothers.

Following this phase, we will take the lesson to the villages. We anticipate that this will be a much more difficult task, largely because diarrhoea is simply not viewed as a serious or life-threatening illness in this area. Wherever possible, we will try to place the lesson in the context of an institutional framework, for example, at the local meeting of church women. In our area, there are very few situations in which women of different clan groups gather together, other than through the churches. Consequently, in the majority of

cases, we will be addressing the women of a single hamlet or sub-clan at one time. This will allow us to utilise the existing social structures in a way which, hopefully, will lead to reinforcement of the message by one woman to another. It is also extremely important in highland New Guinea for the fathers of children to be educated to the value of ORT. Men dominate all decision making, including those regarding children, and, if not specifically addressed, may well criticise, or even forbid their wives from using ORT. Although fluids are not customarily withdrawn during bouts of diarrhoea, few Papua New Guineans make an attempt to offer additional fluids and highlanders in general seldom drink liquids or store any in their homes.

Hoyle B, Yunus MD, Chen LC, 1980. *Breast feeding and food intake among children with acute diarrheal disease.* *Am J Clin Nutr* 33:2365-71.

Hutchins P, Wilson C, Manley JAE, Walker-Smith JA, 1980. *Oral solutions for infantile gastroenteritis: variations in composition.* *Arch Dis Child* 55:616-8.

Islam A, Molla A M, Molla A, Thara R, Yameen Z, Issani Z, Snyder J, Hendricks K, 1989. *Comparison of efficacy of rice based ORS and glucose ORS in acute diarrhoea of infants -- a preliminary report. Karachi, Pakistan. (Poster presentation, International Symposium on Cereal Based ORT)*

A randomised clinical trial is being conducted to study the efficacy and digestibility of rice based oral rehydration salts solution in acute diarrhoea in infants less than six months of age. The study group (n = 10) received ORS containing 50g of rice (R ORS) instead of 20g of glucose. The control group (n = 11) received glucose ORS (G ORS). Outcome variables included stool, urine and vomitus output and intake of ORS, milk and water. Digestibility of carbohydrate during treatment with R ORS or G ORS was assessed by stool pH, reducing substances and breath hydrogen test (BHT). Either R ORS/G ORS solution was offered according to the degree of dehydration. Breastfeeding and/or formula milk feeds were also resumed after initial rehydration was achieved. Preliminary results of the study showed that the mean stool volume of infants receiving R ORS were less than those of G ORS during the first 24 hours: 101.7 ± 50.2 vs 176.7 ± 72.1gm/kg., and 24-48 hours period 90.8 ± 40.2 vs 184.7 ± 108.3gm/kg. After 48 hours there was no longer a trend towards decrease in stool volume in the R ORS group as compared to G ORS group. Preliminary results indicate that infants can tolerate R ORS.

Ismail R, Pardede N et al, 1986. *Home made rice-water-salt solution for oral rehydration therapy -- a field trial.* *J Diarr Dis Res* 4(1):20-5.

Keljo DJ, McLeod RJ, Perdue MH, Butler DG, Hamilton JR, 1985. *D-glucose transport in piglet jejunal brush border membranes: insights from a disease model.* *Am J Physiol* 249:G751-G760.

Kenya P, Muttunga J, Molla AM, Bari A, Juma R and Were B, 1990. *Rural Kenyan mothers can prepare safe, effective oral rehydration solutions: analysis of variability and margins of safety of maize and glucose ORT solutions prepared at home (Submitted for publication).*

The paper reports the safety margins and variability in composition of glucose and maize based ORT prepared by mothers in a rural district of Western Kenya. In a two year longitudinal field study packets containing WHO glucose ORS or maize together with common table salt were provided to the mothers of 6,180 children in Kakamega District in two separate sub-locations. Experienced and trained field workers, supported by a community registered nurse, provided training for the preparation and use of ORT during weekly visits to every household. On four occasions separated by four to six months a 5% random sampling of the home prepared solutions was done. The water used for preparing ORT was also sampled. We analysed 174 samples of glucose based ORS, 148 samples of maize based ORT and 201 samples of water. Maize solutions had less variability with less than 2% falling outside the 50-120 meq/litre safe range of sodium concentration than was true for the glucose solutions (p 0001). Some water samples contained substantial amounts of salt which could unpredictably affect the final composition of ORT solutions. We concluded that maize based ORT had a better margin of safety than glucose based ORS.

Kenya P, Odongo H, Oundo G, Waswa K, Muttunga J, Molla AM, Nath S, Molla A, Greenough WB III, Juma R and Were B, 1989. *Cereal based oral rehydration solutions (Submitted for publication).*

A total of 257 boys (age range four to 55 months) who had acute diarrhoea with moderate to severe dehydration, were randomly assigned to treatment with either the WHO-UNICEF recommended oral rehydration solution or cereal based oral rehydration solution made with either maize, millet, sorghum, or rice. After the initial rehydration was achieved, patients were offered traditional weaning foods. Treatment with oral rehydration solution continued until diarrhoea stopped. Accurate intake and output was maintained throughout the study period. Efficacy of the treatment was compared between the different treatment groups in terms

of intake of the solution, stool output, duration of diarrhoea after admission, and weight gain after 24, 48 and 72 hours, and after resolution of diarrhoea. Results suggest that all the cereal based solutions were as effective as glucose based standard oral rehydration solution in the treatment of diarrhoea.

Kerzner B, Kelly MH, Gal DG, Butler DG, Hamllton JR, 1977. *Transmissible gastroenteritis: sodium transport and the intestinal epithelium during the course of viral enteritis. Gastroenterol* 72:457-61.

KhIn-Maung-U, 1986. *In vitro determination of intestinal amino acid (14-C-L-Glycine) absorption during cholera. Am J Gastroenterol* 81:536-9.

KhIn-Maung-U, Nyunt-Nyunt-Wal, Myo-KhIn, Mu-Mu-KhIn, Tin-U, Thane-Toe, 1985. *Effect on clinical outcome of breast feeding during acute diarrhoea. Brit Med J* 290:587-9.

KhIn-Maung-U, Nyunt-Nyunt-Wal, Myo-KhIn, Mu-Mu-KhIn, Tin-U, Thane-Toe, 1986. *Effect on clinical outcome of boiled rice feeding in childhood cholera. Human Nutrition: Clinical Nutrition* 40(C):249-54.

Kielman AA and McCord C, 1977. *Home treatment of childhood diarrhoea in Punjab villages. J Trop Paediat* 23:197-201.

Kielman AA, Mobarak AB et al, 1985. *Control of deaths from diarrheal diseases in rural communities I. Design of an intervention study and effects on child mortality. Tropical Med Parasit* 36:191-8.

Kimmich GA and Randles J, 1980. *Evidence for an intestinal Na-sugar transport coupling stoichiometry of 2.0. Biochim Biophys Acta* 596:439-44.

KInoti S, Wasunna A et al, 1986. *A comparison of the efficacy of maize based ORS and standard WHO ORS in the treatment of acute childhood diarrhoea at Kenyatta National Hospital, Nairobi, Kenya. E Afr Med J March:* 168-174.

Lepage P, HItimana D, VandGoethem C, Ntahoruttaba M, Nsengumuremyl F, 1989. *Food based oral rehydration salt solution for acute childhood diarrhoea. Lancet (ii):*868.

The efficacy of sorghum flour, the traditional weaning

food in Rwanda, in the treatment of 100 children with acute diarrhoea, was tested. After informed consent was obtained from at least one of the parents, children with acute diarrhoea were randomly assigned to sorghum ORS, or WHO-UNICEF ORS. The patients were enrolled in the study if they were boys with good nutritional status, were aged six to 24 months, and had a diarrhoea of less than 72 hours duration with moderate dehydration (loss of 5-9% body weight). Exclusion criteria were dysentery, fever (temperature over 39°C) on admission, and/or the presence of another severe infection (eg pneumonia, measles). The cereal based ORS was composed of 50g sorghum flour with 3.5g sodium chloride, 2.9g trisodium citrate, and 1.5g potassium chloride, in 1 litre of water. During the first six hours (rehydration phase) children were given 100ml/kg of either sorghum based ORS or WHO-UNICEF ORS. Breastfeeding was maintained during the rehydration phase. Food (milk and bananas) was reintroduced as soon as rehydration was achieved.

On admission there were no differences in group characteristics. The sorghum based ORS group showed a significant reduction in the duration of diarrhoea (defined as the number of hours between entry to the study and the last liquid stool before two well formed stools), in the total OPS intake and the total output of stools. This hospital based randomised clinical trial shows that cereals other than rice can be acceptable and effective in the treatment of acute childhood diarrhoea. It remains to be seen how such cereal based ORS can be used in the community.

Levine MM, 1987. *Escherichia coli that cause diarrhea: enterotoxigenic, enteropathogenic, enteroinvasive, enterohemorrhagic and enteroadherent. J Inf Dis* 155:377-89.

Levine MM, Hughes TP, Black RE, Clements ML, Matheny S et al, 1980. *Variability of sodium and sucrose levels of simple sugar/salt oral rehydration solutions prepared under optimal and field conditions. J Pediatr* 97:324-7.

Lifshitz F, Wapnir RA, 1985. *Oral hydration solutions: Experimental optimisation of water and sodium absorption. J Pediatr* 106:383-9.

Mahalanabis D, 1989. *Application of basic transport to improved solutions (Plenary Address, International Symposium on Cereal Based ORT).*

Early in the 1960s it was shown that glucose, when added to oral perfusions, could produce a positive fluid balance in purging cholera patients. Studies in Dhaka and Calcutta defined the parameters for a successful

ORT which was standardised and put to global use by WHO and UNICEF to save the lives of millions of children with diarrhoea. This formulation can prevent and treat diarrhoeal dehydration but does not reduce fluid loss or shorten illness.

Recently, by using ORT solution composed of amino acids and glucose or by the use of starchy foods in place of glucose, not only has efficient hydration been achieved but also amelioration of symptoms. By utilising all possible co-transport pathways, diminishing osmotic forces that impede absorption, and using optimal electrolyte composition, an ORT that also markedly reduces diarrhoea seems possible. Clinical and field studies using rice, maize and other cereals have shown encouraging results with 30-50% reductions in fluid losses, and a shorter duration of diarrhoea. Alanine also has shown promise, but as yet no studies on proteins of different composition are available. Commercially prepared maltodextrin or polyglucose solutions have been disappointing. Data on the state of knowledge concerning the efficacy of different cereals to reduce diarrhoeal symptoms is reviewed. Packaging an optimally formulated ORT requires more research.

Mahalanabls D and Patra FC, 1983. *In search of a super oral rehydration solution: can optimum use of organic solute-mediated sodium absorption lead to the development of an absorption promoting drug?* *J Diarr Dis Res* 1:76.

Mazumder A, Tesfaye G, Mazumder J, 1987. *The effectiveness of wheat flour based oral rehydration fluid in the early treatment of infantile diarrhoea.* *Ethiopian Medical Journal, Apr:25 (2):59-63.*

A study from Ethiopia reported that wheat based ORS appeared to be as effective as standard glucose ORS in mildly and moderately dehydrated children. Children aged under five were included in the study. Fifty-two children with diarrhoea in two out-patient clinics in Wello, north west Ethiopia were treated with ORS in which glucose was replaced by wheat flour and boiled before use. A control group of 42 children with diarrhoea received conventional ORS (solution made from UNICEF packets). The two groups were randomly allocated. For the study group children, 50g of wheat flour was boiled in 1150ml of water with 3.5g of salt on a low heat for ten minutes, resulting in one litre of solution to which 20mmol potassium chloride solution (1.5g/l) and 30mmol sodium bicarbonate solution (2.5g/l) were added. All patients were assessed and weighed initially, after four hours and on discharge. They were treated on a day care basis in the two centres. Patients re-attended each day on maintenance therapy until the diarrhoea had stopped and the bowel habit was back to normal. The relevant fluid was given to mothers to take home for use at night. During the study, health

education regarding diarrhoea, rehydration, breastfeeding and hygiene was given to all the mothers.

In Wello, a gruel made from barley, wheat, or indigenous tef (*Eragrostis tef*) is called atmeet, and is often given to children from six months of age. This type of solution is, therefore, familiar to many mothers. Knowledge of ORT was low even among comparatively better off urban mothers. Only 20% of mothers had heard of ORS.

From the analysis of the study, the authors concluded that wheat based ORS was found to be as effective as standard glucose ORS, and was superior in terms of weight gain in the first four hours. Mothers and children preferred this solution to conventional ORS. Further studies to show its effectiveness as an early home therapy are indicated. The use of a complete cereal based ORS in moderate and severe dehydration in hospital trials in Africa is also suggested.

McMichael HB, 1975. *Absorption of carbohydrates.* In: *Intestinal absorption in man.* McColl I, Sladen GE (eds). London, Academic Press: 99-142.

Mehta M and Subramaniam S, 1986. *Comparison of rice water, rice electrolyte solution, and glucose electrolyte solution in the management of infantile diarrhoea.* *Lancet (ii):843-45.*

Based on a study of treatments of 150 infants aged under six months admitted to hospitals with acute gastroenteritis, the authors conclude that rice water and rice based electrolyte solutions were superior to glucose electrolyte solutions in reducing the frequency and volume of stool output and in producing weight gain.

Misfeldt DS and Sanders MJ, 1983. *Transepithelial transport in cell culture: stoichiometry of Na⁺/phlorizin binding and Na⁺/D-glucose co-transport. A two-step, two-sodium model of binding and translocation.* *J Membr Biol* 76:1-17.

Molla A, Molla AM, Sarker SA et al, 1983. *Food intake during and after recovery from diarrhea in children.* In: *Diarrhea and malnutrition: interactions, mechanisms, interventions.* Chen LC and Scrimshaw NS (eds). New York, Plenum Press: 113-24.

Molla AM, Hossain M, Sarker S et al, 1982. *Rice powder electrolyte solution as oral therapy in diarrhoea due to Vibrio cholerae and Escherichia coli.* *Lancet (i): 1318-19.*

A rice powder electrolyte solution is efficient and safe to use as a rehydrating oral fluid in acute diarrhoea. One hundred twenty-four patients with acute diarrhoea due to *V. Cholerae* or *E. Coli* were treated with either the standard sucrose electrolyte solution or cereal based electrolyte solution. Treatments were compared and results were comparably positive.

Molla AM, Greenough WB III, Rohde J et al, 1984. *Rice water is not rice cereal oral rehydration solution. Lancet (ii): 40.*

The distinction between rice powder ORS and rice water ORT is drawn. ICDDR,B regards the former as effective ORS. The latter is suitable for early or mild diarrhoea.

Molla AM, Ahmed S, Greenough WB III, 1985. *Rice based oral rehydration solution decreases the stool volume in acute diarrhoea. Bull WHO 63(4):751-756.*

A randomised trial using oral rehydration solutions with rice or glucose was carried out in 342 patients with acute watery diarrhoea. On admission, 75% of these patients had severe dehydration and 70% were positive for *V. Cholerae*. There were 185 children under ten years and 157 adults; 169 patients were treated with rice ORS and 173 with glucose ORS. Patients in both groups were comparable in age and body weight, as well as the duration and severity of illness. Patients with severe dehydration were first rehydrated intravenously, and then treated with ORS. Those with moderate dehydration received ORS from the beginning. The mean stool output in the first 24 hours in children treated with rice ORS was less than that in those treated with glucose ORS (155 vs 204ml/kg/24 hours; $p < 0.01$). The same was true for the adult patients, the corresponding values for stool output being 115 vs 159ml/kg/24 hours (p). The mean ORS intake in children was 263.5 vs 379.6ml/kg/24 hours respectively for rice ORS and glucose ORS (p); the corresponding intakes in adult patients were, respectively 180.5 and 247ml/kg/24 hours. A gain of about 10% of the body weight on admission was observed in all the groups. Six cases (four children and two adults) who failed to respond to oral therapy all belonged to the glucose ORS group.

Molla AM and Molla A, 1989a. *Cereal based oral rehydration solution – a new horizon for diarrhoea management. Postgraduate Doctor – Africa 9(6).*

The article describes the problem of diarrhoeal dehydration, development and use of glucose ORS, and recent developments in cereal ORS research. The advantages of a cereal (rice) based ORS are described, as is the recipe for home preparation of the rice ORT used in rural Bangladesh in the authors' field studies.

Scientific findings providing evidence to show that rice ORS is superior to glucose ORS are presented, including the results of clinical hospital studies and community based field trials of both types of ORS. Future research areas are also outlined.

Molla AM, Molla A, Nath S, Khatun M, 1989b. *Food based oral rehydration salt solutions for acute childhood diarrhoea. Lancet (ii):429-431.*

The efficacy in acute childhood diarrhoea of oral rehydration therapy (ORT) based on staple foods (maize, millet, wheat, sorghum, rice, or potato) was compared with that of standard ORS based on glucose. Two hundred and sixty-six children aged on average five years, with a history of acute diarrhoea for 48 hours or less, moderate to severe dehydration, and no complications, were assigned to treatment with one of the food based oral rehydration salt solutions (ORS) or standard ORS. The mean stool output over the first 24 hours of treatment in the group receiving standard ORS was significantly higher than that of any other treatment group, and the groups receiving food based ORT showed substantial reductions in stool output compared with the standard ORS group. Abnormalities in electrolyte concentrations were corrected in all treatment groups with similar efficiency. The digestibility of food based ORS was assessed by the stool pH, glucose content before and after acid hydrolysis, and osmolality; there were no significant differences between standard ORS and food based ORS groups. Food based ORT should be more acceptable to users in developing countries since the mixtures are similar to traditional weaning foods and since, unlike standard ORT, it reduces stool output substantially.

Molla AM, Molla A, Rohde J, and Greenough WB III, 1989c. *Turning off the diarrhoea: the role of food and ORS. J Pediatr & Nutr 8:81-84.*

Ninety-three boys aged five years or less who had diarrhoea due to *V. Cholerae* were randomly assigned to treatment with glucose oral rehydration solution or rice based ORS. For the first 24h, ORS only was given to all the patients. During the next 24h, ORS and normal food were given. The efficacy of the two types of ORS was compared in terms of ORS intake, stool output, change in hematocrit reading, serum specific gravity, and increase in body weight. At the end of the first 24h of treatment, a 50% reduction in ORS intake and stool output was observed in the 47 patients randomly assigned to receive rice ORS as compared with the 46 patients who received glucose ORS. During the second 24h of treatment, a significant reduction in the stool output was noticed in the glucose ORS group, making the efficacy of glucose ORS equal to that of rice ORS. The study suggests that normal food can impart some of the superiority of 'super' ORS to standard glucose

ORS with reduction of stool volume.

Molla AM, Bari A, Greenough WB III, 1989d. *Food based oral rehydration solutions, their efficacy and application. (Plenary Address, International Symposium on Cereal Based ORT).*

Cereal based oral rehydration therapy using 50g to 60g of rice, maize, millet, wheat or sorghum along with electrolytes as in WHO formulation of ORS, were given clinical trials in children and adults suffering from acute diarrhoea due to *V. Cholerae*, ETEC and rotavirus. Serial clinical studies involving balance techniques were carried out. Patients treated with cereal based ORT showed between 25% and 40% reduction in stool output, and 50-60% reduction in vomiting. The study was extended into the field in rural Bangladesh. The three cell study design of two years' duration included 6,000 children less than five years of age. One cell was treated by rice ORS, another by glucose ORS, and a third cell receiving no ORS was the comparison group. Cumulative recovery rate in the three cells was very different, being 66%, 30% and 6% in rice ORS, G ORS and the comparison cells respectively (p .0001). Similarly, monthly weight gain in rice ORS was the highest followed by G ORS and the comparison cells. The series of studies suggest that cereal based ORS was superior to G ORS in terms of reduction in stool volume, vomiting, weight gain and duration of diarrhoea. Incorporation of this new ORT in national programmes has the potential to save lives from diarrhoeal dehydration.

Moss J and Vaughan F., 1980. *Mechanism of action of adenylate cyclase by Cholera toxin and E. coli heat-stable enterotoxin. In: Secretory Diarrhea. Field M et al (eds). American Physiological Society, Bethesda, 107-124.*

Nalin D and Cash RA, 1982. *Rice powder and electrolyte solutions. Lancet (ii):155-6.*

Rice powder appears to be most useful in the majority of mild cases of dehydration which most often confront the mother at home, particularly in rice-eating Asian countries.

Nalin DR, Cash RA, Rahman M, Yunus MD, 1970. *Effect of glycine and glucose on sodium and water absorption in patients with cholera. Gut 11:768-72.*

Natlans M, deSousa M, Correia L, daSilva D, 1988. *Brazilian popular healers as effective promoters of oral rehydration therapy and related child survival strategies. PAHO Bull 22(4):335-354.*

The article describes the problem of dehydrating diarrhoea in north eastern Brazil where 50% of infant deaths were found to be due to the disease. Obstacles to widespread implementation of ORT in this region are reported, including lack of access to ORS packets, professional attitudes poor training, poor health infrastructure, and inappropriate messages. The author argues that successful ORT use depends on integration of the approach into the indigenous medical system, through traditional healers, from whom the majority of mothers sought advice prior to attendance at a health facility. A study, involving traditional healers in surveying attitudes and practices, and in teaching mothers, was carried out in a rural population of 7,000. Results showed that the healers had a significant impact on vital child survival beliefs and behaviours of mothers, surpassing that of most official ORT programmes, and costly mass media campaigns. Integration of teaching into popular medicine using traditional healers can ensure greater acceptance and use rates of ORT.

Newell K, 1989. *Food based oral rehydration therapy within a diarrhoeal disease strategy (Plenary Address, International Symposium on Cereal Based ORT).*

Evidence available suggests that, although they take increased time and effort to prepare, food based oral rehydration solutions rehydrate at least as effectively as does the WHO ORS formula, have clear nutritional advantages, may decrease stool loss, and can be made from ingredients available in most households. This important new intervention, however, still needs to be reviewed against the wider symptom complex of diarrhoeal disease, which remains one of the two major recorded causes of death of infants in deprived populations. Since cereal based solutions do not save more lives than glucose based solutions, any improvement in prevention of mortality will depend on a variety of distribution and acceptance factors which increase the number of sick children receiving this therapy. These factors are influenced in many ways, including consumer and provider behaviour and attitudes.

In every society there are 'family illnesses' which are treated at home with readily available actions or products and generally without outside assistance; and unusual or dangerous illnesses requiring some form of outside help. In most societies, diarrhoea in small children is classed as a family disease, an expected variation of normal living. It needs to become widely accepted that all children should be given oral rehydration therapy whenever they have diarrhoeal symptoms, and that the vast majority can be coped with at home using home available products. This reinforces the case for cereal based ORT, and against packaging such a product, if oral rehydration is to be seen as something as 'ordinary' as possible, and not as 'magic' or 'medicine'.

Even if the above were to be the case, in no society will all at risk children be given ORT, nor will diarrhoeal morbidity be reduced, and some children will still die. ORT cannot solve the problem of diarrhoeal disease by itself; interventions of high effectiveness and feasibility including promotion of breastfeeding, improved weaning practices and improved water and sanitation as well as personal and domestic hygiene, could all reduce diarrhoea incidence and prevent transmission. In deciding upon interventions, choices need to be made about resource allocation. Steps are required to deal with failures to prevent transmission of diarrhoeal disease, eg ORT, including cereal based ORT, to be promoted for use at health facilities as well as in homes.

Palmer DL, Koster FT, Alam AKMJ, Islam MR, 1976. *Nutritional status: a determinant of severity of diarrhea in patients with cholera. J Inf Dis 134:8-14.*

Patra F, Mahalanabis D, Jalan K, Sen A, Banerjee P, 1982. *Is oral rice electrolyte solution superior to glucose electrolyte solution in infantile diarrhoea? Arch Dis Child, 52:910-912.*

In a controlled trial of ORT, a rice based electrolyte solution was evaluated in a group of infants and young children with moderate to acute diarrhoeal dehydration and results were compared with a group receiving WHO ORS. The rice based electrolyte solution was more effective: lower rate of stool output, a shorter duration of diarrhoea, and a smaller intake of rehydration fluid were demonstrated.

Patra FC, Sack D, Islam A et al, 1989. *Oral rehydration formula containing alanine and glucose for treatment of diarrhoea: a controlled trial. Brit Med J 298:1353-1356.*

An oral rehydration glucose solution with L-alanine added to the glucose and salts of the standard formula was compared to standard ORS to see if the added amino acid would improve the efficacy of the ORS. A double-blind, controlled study was carried out in 97 male patients ages 6-59 with acute and severe dehydration from diarrhoea caused by *V. Cholerae* or enterotoxigenic *E coli*, at the ICDDR,B in Dhaka. Median stool output per kg of body weight during the initial 24 hours of oral rehydration treatment was reduced in the study group compared to the control group, from 309 ml to 196 ml, a reduction of 37%, while total stool output until the diarrhoea stopped was reduced from 393 ml to 236 ml, a reduction of 40%. The amount of oral fluid and intravenous fluid needed for rehydration and maintenance was also reduced. The authors conclude that the ORS containing L-alanine and glucose was considerably better than the standard ORS formula in this type of patient.

Pierce NF, Banwell JF, Mitra RC, Caranasos GJ, Kelmowitz RJ et al, 1968. *Effect of intragastric glucose-electrolyte infusion upon water and electrolyte balance in Asiatic cholera. Gastroenterology 55:333-43.*

Pierce NF, Sack RB, Mitra RC, Banwell JF, Brigham KL, Fedson DS, Mondal A, 1969. *Replacement of water and electrolyte losses in cholera by an oral glucose electrolyte solution. Ann Intern Med 70:1173-81.*

Pierce NF and Fontaine O, 1989. *What have we learned from clinical trials of rice based ORS? (Plenary Address, International Symposium on Cereal Based ORT).*

We analysed 13 clinical trials comparing rice based ORS (containing 50-80g/litre of cooked rice powder) and standard glucose ORS in 1272 patients with acute diarrhoea. In all studies, the rate of stool loss was less during the first 24 hours of treatment in patients given rice ORS than in those given glucose ORS, the average per cent reduction ranging from 3-53%. The benefit of rice ORS was greater in rapidly purging patients with cholera (six studies; average reduction in first 24 hour stool output = 33%) than in young children with acute non cholera diarrhoea and slower rates of purging (seven studies; average reduction = 17%). In four studies (three involving cholera patients), a rice based diet was given following initial rehydration. Nevertheless, the rate of stool loss during the first 24 hours averaged 31% less in recipients of rice ORS than glucose ORS. Five studies reporting the average duration of diarrhoea after onset of therapy with rice ORS showed that it was reduced by 21-49%, when compared with patients treated with ORS.

These results show that (i) rice ORS significantly reduces the rate of stool output during the first 24 hours of treatment in patients with acute diarrhoea when compared with those given glucose ORS, the effect being twice as great in patients with rapid stool loss due to cholera, as in those with less severe non cholera diarrhoea; (ii) feeding a rice based diet to patients given glucose ORS does not appear to cause the same reduction in rate of stool output as treatment with rice ORS; (iii) treatment with rice ORS also reduces the duration of diarrhoea; this, combined with its effect on the rate of stool loss, causes an even greater per cent reduction in total stool output; and (iv) the effect of rice ORS on total stool output in acute non cholera diarrhoea has not been precisely defined, but may be in the range of 30-35%.

Portnoy BL, Dupont HL, Prullt D, Abdo JA, Rodriguez JT, 1976. *Drugs and diarrhea.* JAMA 16:844.

Rahaman MM, Aziz KMS, Patwari Y, Munshi MH, 1979. *Diarrhoea mortality in two Bangladeshi villages with and without community-based oral rehydration therapy.* Lancet (ii):809-12.

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Relser S and Lewis CG, 1986. *Effect of the type of dietary carbohydrate on small intestinal function.* Prog Biochem Pharmacol 21:135-57, Karger, Basel.

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Faced with the facts on childhood diarrhoea (1,000 million episodes a year – too much to be handled by the health system), there is only one practical solution: mothers.

Rohde JE, 1984. *Selective primary health care: strategies for control of disease in the developing world. Acute diarrhea.* Rev Int Dis 6:840-54.

Rohde J and Northrup R, 1985. *Diarrhea is a nutritional disease. ICORT II Conference Proceedings, USAID Washington DC, December, 30-41.*

Rohde J, 1989. *Food based ORT – management considerations (Plenary Address, International Symposium on Cereal Based ORT).*

Implications for the acceptance of food based ORT should be examined in terms of the following objectives: reducing diarrhoeal dehydration deaths; improved nutritional state/reduction of nutritional effects of diarrhoea; reduction in diarrhoea incidence and severity; reduction in costs to the CDD programme, and to the family; self-reliance. Home made cereal ORS and packaged cereal ORS are considered in relation to: medical expectations; nutritional effects; audience considerations; and management concerns. Firstly,

will the physiological advantages of cereal based ORS (CBORS) assure earlier and more effective ORS use; will its enhanced effectiveness be perceived by patients; stop use of inappropriate drugs; and how effective will CBORS be in dysentery? Secondly, the nutritional effects of CBORS, for the author the major determining factor. While CBORS has a higher nutrient density, less is required for rehydration and hydration; therefore the total calorie intake is likely to be similar to or only slightly higher than G ORS. The most important consideration is whether mothers will consider that giving a food based fluid is sufficient to meet nutritional needs, leading to an overall reduction in calorie intake and hence to malnutrition. Thirdly, audience considerations including: the ability to convince physicians about the efficacy of CBORS; mothers' expectations of a diarrhoea treatment and the acceptability to them of a food based formula compared to a glucose based one; ease of teaching about preparation of CBORS, including the likelihood of adding too much salt to the fluid; effort required to make a cereal based ORS and whether this will lead to lower usage rates. Finally, with regard to management concerns, clear, unambiguous policies are crucial to the success of national CDD programmes: introduction of cereal based ORS to existing policy and plans requires a precise position for the product at all levels of the health care system, and careful revision of health education and training materials, to ensure that communications do not undermine existing messages about ORT. Issues of logistics, storage and shelf life will also be pertinent to a packaged cereal based ORS product, as will considerations of costs, to governments and families.

The author suggests initially introducing packet cereal based ORS including marketing and distribution, as a private sector undertaking, the possible later introduction of the packaged product into the government programme following additional field and clinical studies, including investigation of socio-cultural attitudes influencing the likely acceptability and popularity of such a product, and finally, later still, introduction of a home made product into the national programme if field research has proven it to be feasible and preferable. The approach adopted will, however, depend on a complex range of considerations, some of which have been outlined in this paper.

Rolston D, Mathew M, Mathan V, 1990. *Food based solutions are a viable alternative to glucose-electrolyte solutions for oral rehydration in acute diarrhoea – studies in a rat model of secretory diarrhoea.* Trans R Soc Trop Med Hyg 84(1):156-159.

A survey of acute diarrhoea and its treatment in rural south India revealed that utilisation of the WHO ORS was virtually non-existent and that several liquid foods were given to children during acute diarrhoea. The three most commonly used liquid foods were rice

water, ragi water and arrowroot water. The effect on intestinal water transport of the supernatants of these liquid foods and of tender coconut water, and the citrate- and bicarbonate-WHO oral rehydration solutions were compared using a rat model of secretory diarrhoea. All solutions either decreased cholera toxin-induced net water secretion or reversed it to net absorption. Ragi water produced maximum water absorption, significantly greater than the WHO oral rehydration solutions. Perfusion studies aimed at further identifying and optimising liquid foods which stimulate intestinal water absorption are presently being undertaken.

Sabchareon T, Chongsuphaisiddhi P, Kittkool P, Chanthavanich P, 1989. Rice salt solution in treatment of acute diarrhoea. Bangkok, Thailand. (Poster presentation, International Symposium on Cereal Based ORT)

In an attempt to find other appropriate oral rehydration solutions to be used in areas where ORS is not available, we used rice-salt solution. This was because rice powder could be prepared locally and hydrolysis converts 80-86% of rice powder into glucose. Thirty g/l of rice powder will liberate glucose 24g (132mmol/l) in the intestinal lumen well within the WHO standard of glucose concentration in ORS. In addition, 100g of rice contains at least 30mg of glycine, lysine, leucine and isoleucine.

The study objective was to evaluate the efficacy of rice-salt oral rehydration solution containing rice powder 30g/l and sodium chloride 3.5g/l in treatment of acute diarrhoea. ORS with glycine 100mmol/l and ORS alone were served as controls.

A total of 67 children with acute diarrhoeal disease aged 4-60 months of age (mean 15.5) with mild to moderate dehydration admitted to the Chonburi Hospital were randomly treated with one type of fluid. Twenty-six, 21 and 20 patients received rice-salt, ORS with glycine and ORS alone respectively. Microscopic examinations for intestinal parasites and bacteriological studies of stool samples from all patients gave negative results.

	Rice-salt solution	ORS with glycine	ORS
Stool output (grams)	775.8	1920.2	2046.3
(SE)	(85)	(258)	(322)
Total no. of stools (SE)	12.4	29.4	30.3
Volume of fluid (ml)	1125	3625	2980
(SE)	(135)	(360)	(378)

Cost of fluid per patient (USD)	0.08	1.5	0.6
Duration of diarrhoea (hr)	51	63	64

The three fluids were equally effective in correcting dehydration and abnormal electrolytes in acute diarrhoea patients who had mild/moderate dehydration. It was found that mean values of stool output, number of stools, and volume of fluid consumed of the rice-salt solution treated patients were significantly less than those of the ORS with glycine treated patients and ORS treated patients (p). There was no significant difference between stool output, number of stools, and volume of fluid consumed of ORS with glycine treated patients and ORS treated patients. Symptoms of diarrhoea in rice-salt solution treated patients also ceased more rapidly (51 hr) than those in ORS with glycine treated patients (63 hr) and ORS treated patients (64 hr).

The results indicated that rice-salt solution is therapeutically as effective as ORS and ORS with glycine. This plus the fact that rice is more available, more economical and nutritious, makes rice-salt solution an as good, if not better substitute to ORS. The ORS with glycine does not appear to be more effective than ORS alone.

Santosham M, Brown K and Sack R, 1987. Oral rehydration therapy and dietary therapy for acute childhood diarrhea. *Pediatr Rev* 8:273-278.

Santosham M, Burns BA, Reid R, Leston GW, Duncan B, Powlesland JA, Foster S, Garrett S, Croll L, Nyunt-Nyunt-Wal, Marshall WN, Almeldo-Hill J, Sack RB, 1986. Glycine-based oral rehydration solution: reassessment of safety and efficacy. *J Pediatrics* 109(5):795-801.

Scrimshaw NS, Taylor CE, Gordon JE, 1968. Interactions of nutrition and infection. Geneva, WHO. WHO Monograph Ser No 57.

Shakh S, Molla AM, Islam A, Billoo A, Hendricks K, Snyder J, 1989. Early feeding therapy helps recovery in acute diarrhoea in childhood. (Poster presentation, International Symposium on Cereal Based ORT)

In Karachi, Pakistan, a randomised clinical trial was conducted to evaluate the effect on stool output and frequency of feeding the traditional diet of khitchri (rice and lentils cooked with oil) along with half strength infant formula in addition to oral rehydration salt (ORS)

solution to children 9-48 months old suffering from acute watery diarrhoea and moderate to severe dehydration. Patients were randomised to either of the two therapy regimes after initial rehydration: Group A received standard ORS but no food for 24 hours and after that khitchri and half strength formula milk were introduced. Group B received khitchri and milk formula in addition to ORS after the initial rehydration. A total of 69 patients were admitted, of which 33 belonged to treatment group A, and 36 to treatment group B. Of these, 21 in group A and 23 in group B were successfully treated and the rest either needed intravenous fluid during the study period (group A ten patients, group B nine patients) or left before completion (six patients). Patients were similar with regard to age, weight, duration of vomiting and diarrhoea prior to admission, and dehydration status. Results showed that there was a trend in reduction of stool volume and frequency and the diet was well accepted in those patients given food as well as ORS.

Shu-Cheng D, 1983. *Oral rehydration therapy in children with acute diarrhoea in some places in China.* ICORT Conference Proceedings, USAID, Washington DC, 124-126.

ORS has been widely distributed in some places in China. In the future modified rice soup may be used, as it is more suitable to Chinese custom, particularly in the countryside.

Shulman R, Wong W, Irving C et al, 1983. *Utilisation of dietary cereal by young infants.* *J Paediatr* 103(1):23-28.

This clinical trial determined the extent to which young infants can utilise cereal. Absorption of carbohydrates was measured by the appearance of breath CO₂, and stools were analysed for the quantity of carbon that originated from the cereal. The authors conclude that young infants can utilise cereal, although absorption of the complex carbohydrates is not always complete.

Slener K, 1989. *Wheat based ORS for Afghans.* *International Rescue Committee, Peshawar, Pakistan.* (Poster presentation, *International Symposium on Cereal Based ORT*)

Mothers in refugee camps in Pakistan have been taught to use packet oral rehydration salts (ORS) and to mix a home salt sugar solution (SSS) for children with diarrhoea. Because most mothers mix SSS incorrectly with the risk of an ineffective or adverse solution, and because research shows positive results with cereal based ORS, it has been questioned whether home made wheat and/or rice solutions would be the more advantageous home solution for Afghans. Wheat is commonly available to Afghan refugees and the least

expensive grain; it is also commonly grown in Afghanistan (rice is considered to be a luxury and is not kept in most Afghan homes).

Research undertaken to determine the acceptability, likely use and acceptance by mothers and children, included teaching women (mostly illiterate) the wheat solution recipe (two fistfuls of wheat flour, a two to three finger pinch of salt added to a litre of water. Teaching was carried out in homes and basic health centres by trained female health workers. Follow up visits between two weeks and two months later investigated whether mothers could still make the recipe correctly, if they had used it when their children had diarrhoea, and their opinion of it. Sixty-four women were interviewed: 60% said they gave ORS or SSS the first day of diarrhoea (other fluids given the first day included water, slombai, a yoghurt drink, green tea, as well as some traditional herbal drinks and rice water. Ninety-eight per cent gave some sort of fluids during diarrhoea, 95% continued to breastfeed, 94% had used ORS packets during diarrhoea, 80% had made SSS, and 78% had given rice water or rice for diarrhoea.

It was noted that 77% gave food during diarrhoea episodes while 16% withheld food. A high percentage of women gave rice based diets (even though a small percentage usually had it in the home) including simple rice and khitchri, or ugra, rice mixed with watery curd. 'Sar sar' (rice water) is a traditional fluid made by most women in Afghanistan used during illness. Bread was given frequently, and occasionally halwa, a sweet dish made with fried wheat or suji flour, sugar and oil. Also mentioned were bananas, vegetables, eggs and soups. There were no cultural beliefs contraindicating the use of a wheat based solution for diarrhoea. Depending on the location and the method of teaching used, between 42% and 94% of the women could correctly demonstrate making wheat based ORT solution. They liked the wheat solution, as the taste is familiar and wheat flour is used every day to make nan, a flat bread, and found the recipe easy to make, even though it does not closely resemble any traditional dish.

When discussing what solution the women preferred and why, most mothers said all the solutions were good. When asked which was easier, a significant number pointed out that wheat water was a little easier than SSS and rice water because rice needed to be cleaned and washed and cooked longer, and SSS needed correct measurements and took time if they boiled the water first and then had to let it cool. And while many thought rice water tasted best, they suggested that it was not practical because of its expense.

The Afghan women taught learned the new recipe quickly, had good recall when followed up, knew why and when to give it, continued to give other foods in addition to the wheat solution; furthermore they did not find it confusing to remember two or three recipes (eg SSS, rice water and wheat based ORT), in some cases

used both SSS and the wheat solution, and liked being able to choose which, depending on what they had available. For Afghan families, for whom sugar is expensive, ORS packets unavailable, who may mix SSS incorrectly, there are reasons to continue to study wheat water, or both wheat and rice water as alternatives or additions to the SSS solution being taught now.

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Snyder JD, Yunus M, Wahed MA, Chakraborty JC, 1982. *Home administered oral therapy for diarrhoea: a laboratory study of safety and efficacy.* Trans Roy Soc Trop Med Hyg 76:329-33.

Tay AHN, Quak SH, Wong HB, Murugasu B, 1987. *Oral rehydration therapy in acute gastroenteritis — a clinical trial with 3 electrolyte solutions.* Journal of the Singapore Pediatric Society 29 (Supply 1):172-5.

Thane-Toe, Khin-Maung-U, Tin-Aye, Mar-Mar-Nyeln, Ye-Htut, 1984. *Oral rehydration therapy in the home by village mothers in Burma.* Trans Roy Soc Trop Med Hyg 78:581-9.

Thaver I, Islam A, Bryant J, Molla AM, 1969. *Cereal based oral rehydration therapy, 'mothers' choice, a study in urban squatter settlements of Karachi. (Poster presentation, International Symposium on Cereal Based ORT)*

Diarrhoeal deaths can be prevented by prompt use of oral rehydration therapy. Effective management is dependent on ready availability of ingredients for preparing oral rehydration solution, which have a low cost and are culturally acceptable. The present study was conducted in five squatter settlements of Karachi to determine mothers' preference for cereals in preparing cereal based oral rehydration solution.

Fifty-one to ninety-one per cent of the respondents living in the different squatter settlements preferred ground rice (home made) or rice flour (ready made) for preparing oral rehydration solution. There were no differences in the choices of rice or wheat when compared among diverse ethnic groups. In only one setting -- among Punjabi speaking people in Azam Basti -- did the majority of mothers (41%) prefer wheat flour. A majority (90%) of the mothers chose rice because of its softness and cooling effect. Preference for rice was dependent on its availability (p) and price (p 0.05). In addition, during diarrhoea, rice is commonly used as a diet in combination with lentils (khitchri). Rice is also

found to be easily cooked by 81% of the mothers. The results of this study indicate that rice is preferred for preparing oral rehydration solution in urban squatter settlements irrespective of ethnicity. However, availability and cost need to be taken into account.

UNICEF, 1985a. *Lifelines: oral rehydration therapy.* In: *The State of the World's Children 1986.* Oxford University Press for UNICEF.

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Vesikari T and Isolauri E, 1986. *Glycine supplemented oral rehydration solutions for diarrhea.* Arch Dis Child 61:372-6.

Victoria CG et al, 1987. *Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil.* Lancet (iii):319-21.

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World Health Organization, 1981. *Manual for the Planning and Evaluation of National Diarrhoeal Diseases Control Programmes.* WHO/CDD/SER/81.5.

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