

From Glucose Based To Food Based Oral Rehydration Therapy: Triumph and Indictment

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BPH 22nd Batch

Background

Cholera drove the sanitary revolution in the industrialized world in the 19th century and now is driving the development of oral rehydration therapy (ORT) in the developing world.¹ ORT was developed in the late 1960s by researchers in India and International Centre for diarrhoeal Disease research in Bangladesh (then East Pakistan), for the treatment of cholera. The Indo-Pakistani war of 1971 provoked a public health emergency in the refugee camps set up to house those fleeing the violence.^{2,5}

This new understanding sparked clinical studies that revealed the ability of ORT to reduce the mortality associated with acute diarrheal disease. In 2002, Drs. Norbert Hirschhorn, Dilip Mahalanabis, David R. Nalin and Nathaniel F. Pierce were awarded the first Pollin Prize for Pediatric Research, in recognition of their work in developing ORT.^{1,2}

Between 1980 and 2000, ORT decreased the number of children under five dying of diarrhea from 4.6 million worldwide to 1.8 million a 60% reduction. According to The Lancet (1978), ORT is "potentially the most important medical discovery of the 20th century".²

Today, the total production is around 500 million ORS sachets per year, with the children's right agency UNICEF distributing them to children in around 60 developing countries. Oral rehydration therapy, if properly practiced, can cut infant and child mortality rates by at least half and obviate the need for countless millions of costly visits to hospitals, health centers, and clinics in all countries.^{1,2}

The ability to use oral rehydration therapy (ORT) to control mortality associated with cholera and diarrheal diseases counts among the great triumphs of 20th century medicine. The intertwined stories of the fight against cholera and the development of ORT illustrate the critical cycle of clinical observations, physiologic research, and improved clinical outcomes. However, although cholera in the 20th century catalyzed the creation of ORT, the developing world still awaits the sanitary revolution that, along with the fear of cholera, swept across the developed world in the 19th century.¹

Global production of ORS is now more than 350 million packets a year, and access to OR therapy has increased considerably in the last decade. It became the cornerstone of Oral Rehydration Therapy (ORT), which emphasizes

giving a child plenty of fluids, ORS and/or other appropriate household fluids along with continued feeding during the illness and increased feeding for at least a week after.²

In recent years an important new dimension has been added to the debate over the use of packets versus home based ORT. A completely different kind of oral rehydration solution is being explored: cereal based (or food based) oral rehydration therapy. In many ways this is the most promising ORT approach yet. Studies in various countries over the last several years have confirmed that food-based liquids (with a little salt) are at least as effective as and often more effective than sugar-based solutions in preventing and treating dehydration.³ Cereal-based ORT can overcome both of these disadvantages by providing yet another option for oral rehydration therapy.

There are several practices of home management of diarrhoeal disease like giving Sugar-Salt solutions: a 1 liter solution made using Salt, Sugar and Water, familiar Drinks: drinks which are familiar and commonly available but which contain no added salt and relatively little starch or protein. These include weak cereal solutions such as rice water: water in which other cereals have been cooked, and plain water, other drinks such as plain water, Food-salt solutions: food based fluids such as cereal gruels or soups² all over the world. In many societies a drink or gruel made with a cereal or starchy food has long been a favorite folk remedy for diarrhoea in South-East-Asia. For example soaked rice in one or another, often with salt or sugar, has been used to treat diarrhoea in Bangladesh and many other Third world countries for hundreds of years.³

Gruels or porridges for treating diarrhoea are traditionally made from other grains or starchy foods, including millet or maize (Mozambique), wheat (Egypt), quinoa (Bolivia), and cassava (Colombia). Porridges, as well as rice water are traditional folk remedies for diarrhoea in many Asian countries like China, Indonesia and Nepal.³

It was not until the early 1980s, however, that Molla, Mahalanabis, Greenough, Patra, and others carried out studies showing conclusively that in a hospital setting cereal-based oral rehydration is as effective as sugar based oral rehydration. Subsequent studies have found that solutions made from rice flour or any of a number of other cereals reduce the volume, frequency, and duration of diarrhea. When rice drinks are used in the management of

cholera, stool volume is reduced by an average of 35%. In several other meta analysis with noncholera diarrhoea showed that with cereal based oral rehydration solution, stool output was 18% lower than with standard ORS.³ By contrast, sugar-based drinks—including ORS—do not reduce stool volume. Cereal-based ORT (CB-ORT) has also been shown to speed up the resumption of solid food intake and to increase the amount eaten. In its 1994 Interim Programme Report, WHO's Programme for Control of Diarrhoeal Diseases (PCDD) acknowledges that "in cholera, rice-based ORS solution significantly reduces stool output compared with WHO ORS solution. The use of rice-based ORS solution for cholera patients can be recommended for any situation where its preparation and use are practical." With the debate over cereal-based ORT intensifying, WHO together with the International Center of Diarrhoeal Disease Research, Bangladesh (ICDDR,B) held a Meeting on ORS Formulation in Dhaka, Bangladesh, in December, 1994.³

Nevertheless, WHO has resisted endorsing cereal-based ORT, either as a manufactured product (CB-ORS) or as a specially formulated home solution (CB-ORT). Although some of its published guidelines include rice water and/or porridges in their list of recommended home fluids (RHF), these do not provide sufficient information about the concentrations of starch or salt needed to make an optimal rehydration drink. For years, WHO's PCDD has been reluctant to officially fully endorse rice-based ORS, insisting that "further studies are required before any recommendation can be made concerning its use in acute non-cholera diarrhoea in children." (For experimental reasons, however, in 1989 it quietly became involved with the baby-food corporation, Galactina, in starting what was to become commercial production of rice-based ORS.³ Notwithstanding the above, WHO has until now decided to stick with its standard glucose-based ORS, which is tested, proven, and familiar to health workers and families world-wide. It argues that, since standard ORS is nearly as effective as cereal-based ORS, there is no justification for promoting the latter. This decision may be partly based on justifiable concerns about flooding the market with yet another confusing array of costly and redundant CB-ORS products. (Alas, this is already happening within the private sector.)

The reason that starch works better than sugar for rehydration has to do with its molecular composition and the principle of osmosis.

Sugar has been used in rehydration drinks because it helps the active transport of water and salt through the lining of the gut into the body. In addition, it provides needed calories, especially in the early stages of diarrhea when the child has no appetite. But there is a problem with sugar that decreases its effectiveness. In a concentrated sugar solution such as ORS (or SSS), the millions of tiny sugar molecules create an osmotic pull that can draw water back out of the bloodstream into the gut. So at the same time that sugar

helps transport water and salt into the bloodstream, its high osmotic pull tends to draw part of that water back out. For this reason, a sugar-based solution—whether in packet form or home mix—does nothing to slow the flow of diarrhea. If the sugar solution is sufficiently dilute, more water is carried into the blood than is pulled back, and rehydration takes place. But if the sugar solution is too concentrated, it can increase both the diarrhea and dehydration. Therefore, too much sugar can be dangerous.²¹⁸ Cereals on the other hand, are composed of large starch molecules with a low osmotic pull. With a cereal based drink the osmotic flow is in the opposite direction, pushing water from the gut into the bloodstream, rather than pulling it back. Where the starch molecules come into contact with the gut lining, enzymes break them down into simple sugars which are immediately absorbed, carrying with them water and salt. But since the starch solution does not have the opposing osmotic pull of a sugar solution, much more water passes into the body from the gut than comes out. This helps to explain why a cereal drink slows down dehydration and diarrhea more efficiently. The rate of stool loss is significantly reduced in patients with acute diarrhoea given rice ORS solution as compared with patients given glucose ORS solution; this effect appears to be twice as great in rapidly purging patients with cholera as in children with less severe, non-cholera diarrhoea. It also reduces the duration of diarrhoea. The percent reductions in the rate of stool loss and in the duration of diarrhoea combine to cause an even greater percent reduction in total stool output during the entire illness.²

Food based ORT practices^{2,3}

Sweet potato water: Papua- New Guinea

People used make a fluid by boiling two pieces of sweet potato in 1.5 liters of water for 35 minutes. The potato was then mashed and water added to make one liter of drinkable solution. Three grams of salt were also added. This pilot project involved very small numbers of patients; the results were encouraging and suggest that sweet potato solution could be both safe and effective for ORT, and culturally acceptable.

Wheat ORS in refugee camps-Pakistan

People used to make a solution by mixing two fistfuls of wheat flour and a two to three finger pinch of salt per liter of water. They liked the wheat solution, as the taste is familiar and wheat flour is used every day to make bread

People felt that it is a little easier than both glucose based ORS, sugar salt solution (SSS) and rice water, because rice needed to be cleaned and washed and cooked longer, and SSS needed correct measurement.

Kishk neshif-a traditional CB-ORT

An Egyptian equivalent of the soured gruels of southern Africa is "kishk neshif." A popular home remedy for diarrhea, kishk is a traditional food made with wheat and the whey of

water buffalo milk. Kishk neshif is made from fermented whey of water buffalo milk in stomach removed from young goat and wheat flour. The wheat flour is washed, pounded just a little, boiled and then mixed with the fermented whey. The resulting Kishk is rolled into little spheres the size of golf balls and dried in the sun. This could be kept for up to a year without spoiling.

Rice Water -Unexplored CB-ORT of Nepal

Rice water or *Vat ko mad*, has long been used in rehydration of patient with diarrhoea especially children in Nepal. Though the promotion of rice water has been a component BCC/IEC activity for prevention and control of Diarrhoea it has not been given adequate priority. Additional nutritional enrichment by putting cereal flour on it has never been promoted. People used to give thin rice water to the child with or without further oral rehydration.

Importance of Food Based ORT ¹⁻⁴

In addition to biological advantages, there are also strong psychological, socioeconomic, and other practical arguments in favor of cereal based ORT as compared to sugar based ORT. Some of these are listed below.

Reduction of Volume, Frequency, and Duration of Diarrhoea, especially in cholera diarrhoea -- Studies have found that solutions made from rice flour or any of a number of other cereals reduces the volume, frequency, and duration of diarrhoea. When rice drinks are used in the management of cholera, stool volume is reduced by an average of 35%. By contrast, sugar-based drinks--including ORS do not reduce stool volume. Cereal-based ORT has been shown to speed up the resumption of solid food intake and to increase the amount eaten.

Effectiveness in non-cholera diarrhoea -- In studies of children with non-cholera diarrhoea, stool output was 18% lower than with standard ORS. Subsequent studies have shown that when food was given soon after rehydration, the reduction of stool output with CB-ORT was only 3.4%, a difference not considered significant, but regardless, cereal-based ORT was effective in rehydration.

Building on Local Traditions -- The biggest non-clinical advantages of cereal-based rehydration are associated with home-prepared CB-ORT. In many countries, excellent food-based rehydration drinks can be made by building on local traditions. Health workers can help people understand why it is important to add cooked rice to the traditional rice water home remedy to make it somewhat thicker, and how much salt is desirable. Almost any local grain or starch-rich food can give good results. In short, people can usually make an effective ORT drink out of

their locally-available, low-cost food staple.

Nutritional Value -- Cereal-based drinks--because of their low osmotic pull--can be prepared with up to three times the number of calories as sugar or glucose drinks, without any risk to the child. This will be advantageous to children of poor families, and also with a cereal solution, the faster passage of water out of the gut into the bloodstream could mean that space for additional food becomes available more quickly.

Safety -- As with the amount of salt, the amount of sugar (glucose) in the homemade "Sugar, Salt Solution" is close to the upper limit of safety. If mothers prepare an ORS packet with too little water, which often happens, the ORS drink itself can contribute to the dehydration. By contrast, no such danger exists for the cereal drinks unless too much salt is used. Even if it is made more concentrated than usual, it is still safe (and nutritionally richer). The drink will be useful as long as it remains liquid and the child accepts it.

Acceptability to children -- Children are often already used to cereal gruels as weaning food and accept them more readily than the standard ORS solution. Also, most mothers (who usually taste anything before giving it to their child) prefer the taste of a cereal porridge to a solution of sugar and salt. Many say that ORS tastes bad.

Considerations & objections to Cereal based ORT ^{3,4}

Opponents of cereal-based ORT stress the disadvantages that their use entails: the "added cost of fuel," the "extra work," and the "delay caused by the need to cook the mix." However, in the homes of poor families in many societies, cereal gruels are the standard weaning food of babies. They are already cooked and ready for use on a daily basis. All the mother has to do is to scoop some out of the common pot, add a bit of water if it is too thick or salty, and every few minutes give as much to her child as she will take.

Critics also cite the inability of very young infants to digest starch completely, and possible allergic/immunological reactions in such infants to proteins contained in some cereals.

Perhaps the biggest real disadvantage of cereal based rehydration drinks is that they do tend to spoil faster than sugar based drinks--sometimes within 6 or 8 hours (under some conditions within as little as two to three hours). However, when cereal gruels are the traditional weaning food, families often know how to prevent spoiling, either by periodically reheating the gruel or through "souring" or fermentation. This latter process opens up some exciting possibilities for an improved

cereal-based rehydration drink.

- n Commercial promotion of cereal-based ORT raises concerns; particularly the 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 utilization of standard glucose based ORS.
- n The physiological advantages of cereal-based ORT in clinical studies in hospitalized cases of severe diarrhoea are decreases of stool volume and duration of diarrhoea, but more needs to be known about the effects of cereal-based ORT in milder cases of diarrhoea at the 'community level.'
- n 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
- n 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 emphasized the continued feeding during diarrhoea, from the beginning of symptoms, is absolutely essential, to combat diarrhoea and particularly to protect the nutritional status of the child during diarrhoea.

Conclusion

Researchers have devised a rice-based ORT solution that matches one the Chinese had for thousands of years. The glucose in ORS comes from rice, a starch. Rice happens to be food staple in Nepal, Bangladesh and other countries. Instead of sending grains to factories and buying commercially branded and marketed ORS, the time demands to use home based cereal based oral rehydration solutions instead.

Poor user compliance, inadequate social marketing, difficulties of maintaining production and supply of ORS packets, etc has clearly shown the lack of efficiency of present Sugar based ORS packets advocated by WHO. One problem is the idea that a technological fix can solve an illness so deeply rooted in social and economic inequities. Another problem has been prioritization of product over process: to market ORS packets rather than to facilitate informed intelligent use of local solutions. The product has been packaged and promoted as a "wonder drug," thus creating false expectations and undermining efforts to encourage cheaper, home-made, and potentially more effective alternatives. Families are enticed to misspend their

limited food money on a fancy, medicalized, and (for most diarrheas) unnecessary product. Thus Oral Rehydration Therapy—when introduced in a disempowering way—can result in additional nutritional deficit to already undernourished children. Last but not least, the ORS technology—like the other Child Survival interventions—was developed in a selective, top-down way. Little effort has been made to link it to any comprehensive approach to resolve to underlying causes of death from diarrhea: malnutrition and extreme poverty.

An approach to promote the use of Cereal based ORT in settings where appropriate than Glucose based ORT would be key in excelling present effort to prevent and control diarrhoeal diseases.

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