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Special Articles

Oral Rehydration Therapy for Diarrhoea

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INTRODUCTION :

The most widely researched and used treatment for diarrhoea is fluid therapy to combat or diminish dehydration. There are two types of fluid therapy: intravenous and oral. The present paper is a study of oral rehydration therapy but other methods will be briefly reviewed.

An important therapy for diarrhoea is to continue breast and/or other feeding during and following an episode and this may be combined with fluid and drug therapies. Continued feeding during diarrhoea helps avoid an adverse nutritional effect and hastens quick recovery.

There are a number of anti-diarrhoeal drugs which are promoted, but most have very limited usefulness in combating diarrhoea. Antibiotics may be needed in some types of diarrhoea, such as cholera or dysentery but in most cases they are not useful and in many cases they can lead to adverse effects[1].

ORAL REHYDRATION THERAPY (ORT) :

It is likely that from time immemorial people were practicing oral fluid therapy for hydration at least in order to quench thirst[2]. In traditional societies of Bangladesh and China, mothers have been using rice soup for diarrhoea for centuries[3] and rice water is a traditional treatment for gastroenteritis in Indonesia[4].

The best therapy for almost all types of diarrhoea is to replace what is lost in the stool. Tracing the history of medical research on fluid therapy takes us back to 1831 when two letters were published in the Lancet. O'Shaughnessy reported the kind of biochemical changes that occurred in the blood of cholera patients and of the first use of parenteral fluid therapy on patients with similar symptoms in the cholera epidemics in Russia and Scotland[5,6]. Dr. John Snow, a pioneer of modern germ theory who suggested the connection between impure water and the transmission of cholera disease[7], applied a 'weak saline solution' through the veins of severely dehydrated cholera patients with partial success[8]. The important concept of fluid therapy was thus formulated during the last century.

Intravenous therapy was, however, hardly used after the time of Snow until the 1890s when Rogers used it in Calcutta and brought hospital case mortality down from 61 to about 33 percent[9,10]. Early this century, Sellards made improvements on the intravenous saline by adding bicarbonate in order to offset the threat of acidosis[11].

The formula was improved when the use of potassium was advocated[12]. The formula thus contained all the elements that are lost through the diarrhoeal stool water, sodium, chloride, bicarbonate[13]. During the 1950s and 1960s the

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modern scientific formula was determined by examining the electrolyte composition of cholera stool and developing an intravenous fluid appropriate to the fluid lost[14,15] and this was successfully used in cholera epidemics in Asia and the Middle East[16]. Use of the formula has now brought the hospital mortality down to less than one percent[16,16].

For the vast majority of world's population, however, intravenous therapy is impractical as it is expensive and difficult to administer. The best alternative is the oral administration of the solution. Oral salt solution was first attempted in Britain about the same time as Latta in early 1830[17,18], but it was not until the 1940s or so that the oral therapy was considered to correct and maintain hydration. Oral therapy was used for the first time in the USA to maintain a balance after initial intravenous therapy[12,19]. Chatterjee (1953) in the early 1950s tried oral solution for the first time in an epidemic situation in Calcutta and treated 186 moderate to severe cholera patients[20].

Until the role of glucose as a transport medium for sodium was established, glucose was used as a source of calories and better taste. Diarrhoeal disease interferes with the sodium transport across the small intestinal wall and the discovery that glucose can 'carry' sodium and water with it to the small intestine[21], established the scientific basis for the use of glucose in oral solutions. Other workers demonstrated that glucose enhanced the absorption of sodium and water in diarrhoea patients[14,22]. Soon afterwards it was shown that oral therapy reduced net fluid and electrolyte losses and increased sodium and fluid absorption[24,24]. Oral therapy was firmly established as the treatment of choice when in Dhaka and Calcutta it was shown how oral therapy could maintain hydration in adult cholera patients after initial rehydration by intravenous therapy[25,26] and that oral therapy reduced the intravenous fluid requirement by 80%[25]. A large trial in Bangladesh successfully administered oral therapy to maintain hydration on adult cholera patients[27]. In a later study, oral therapy was found effective in cholera patients with acidosis[28]. Soon oral therapy was tried on dehydrated children with encouraging results[29-31] and successfully with diarrhoea patients with an unknown aetiology[32].

Oral therapy is now firmly established as the treatment of choice for most cases of diarrhoea. It has been used successfully in rehydration of adults and children, including neonates, patients ranging from no visible dehydration to tho e with acute loss of 10 to 11 percent body weight (not in shock); persons with vomiting or fever; cases of hypernatremia (upto 168 mEq per liter) and hyponatremia; persons with or without malnutrition; case of cholera, rotavirus diarrhoea, shigellosis and diarrhoea due to other causes; and regardless of stool sodium content[33].

OTHER EXPERIENCES WITH ORT :

One of the most dramatic demonstration of the effectiveness of ORT came under the most adverse conditions during a cholera epidemic in the camps of the Bangladesh refugees in India in 1971. Intravenous treatment facilities were too few to cope with the situation. A treatment centre was set up which cared for 3,700 people, 40% of whom were children and almost all were dehydrated and many in shock when they first arrived. The most severe cases were initially given intravenous and then oral fluid only and the death rate was as low as 3.6%[34].

Studies done in several countries suggested that dirrrhoea related mortality could be reduced by up to 50% if people were given access to and used oral therapy. In the Teknaf project in Bangladesh, the case fatality and diarrhoea mortality rates were studied in a village having village-based depot holders in comparison to a 'control' village[35]. Case fatality rate in infants in the study village was 0.5% while, in the control village, it was 6.3%. Similarly, annual diarahoea mortality rates for infants were 0.16% in study village and 1.74% in control village. In the Narangwal study in India in which oral rehydration salts (ORS) were provided in integration with other health

interventions, the case fatality rate for children under 3 years of age was brought down from 0.32% in 1971 to 0.14% in 1973. Similarly, the diarrhoea deaths per 1,000 child years of exposure was halved from 14.1 to 7.3 during the same period[36]. In a study in Egypt, up to 50% reduction in diarrhoea-associated mortality have been reported in children aged between 1 month and 5 years following the introduction of an ORT programme[37,38]. In another project in Egypt, however, no change in mortality was found[39].

The positive effect of ORT on malnutrition is documented. Field studies among Apache Indian children in USA, and on populations in the Philippines, Egypt, Turkey and Liberia indicate that children with diarrhoea gain weight faster with combined ORT and continued feeding than children in control areas who have diarrhoea but received no ORT and are fed according to 'customary' practice[30,31,40,41]. Rowland and Cole, however, did not observe any such change in the Gambian children[42].

Use of ORT at the field level has reduced hospitalization by upto 29% in Bangladesh[43]. The impact of ORT on morbidity is still unknown[44].

COMPOSITION AND DANGERS OF ORT SOLUTION :

Although most opinions agree on the effectiveness of oral rehydration therapy for most types of diarrhoea, controversy has surfaced on the composition of the solution and on the mode of delivery at the community level.

The Dhaka trial by Nalin et al[30], which successfully established the efficacy of ORT in a clinical setting, used the following composition (in mmol/L): sodium 120, bicarbonate 48, potassium 6.5, and glucose 110. There has been a lot of research and debate on this subject since then and it still continues[45,46]. The World Health Organization (WHO) suggested a formula which, according to Hirschhorn, was 'suitable for most cases of diarrhoea regardless of etiology or age of the patient,[32]. Problems with the shelf life of this formula were encountered. In damp situations, sodium bicarbonate reacts with glucose in the formula and the powder becomes discoloured and less effective. The WHO has recently modified this formula and the following one is now suggested[46] :

Composition	mmol/L	Ingredients	gram
Sodium	90	Sodium chloride	3.5
Chloride	80	Trisodium citrate	2.9
Potassium	20	Potassium Chloride	1.5
Bicarbonate	30	Glucose	20.0
Glucose	111		
Water	1 litre	Water	1 litre

Numerous studies have been published showing the effectiveness of this or a similar composition in treating most diarrhoeas[28,47]. However the risk of hypernatraemia particularly in children showing symptoms other than cholera, has been raised by some researchers[13,45] who believe that the net sodium excretion caused by the commonest type of childhood diarrhoea is much less than that found in cholera patients[13,48]. They also feel that the sodium concentration in adult cholera stool is more than that in paediatric cholera stool[45,48]. Several studies, however, have found identical results with respect to safety and effectiveness when comparing a high (90 mmol/L) and a low (50 mmol/L) sodium concentration. Such studies were done in diverse settings such as Calcutta[60] and the USA[61].

In general, proponents of the higher sodium concentration advocate the use of extra plain water to offset any threat of hypernatraemia, particularly in children[52] and those preferring low sodium concentration admit that these solutions may be too dilute to be effective particularly in adults with severe diarrhoea[53,54]. However, the range of sodium concentrations that have been shown to give effective results is wide[54,55] and a range of 30-100 mmol/L of sodium is considered 'safe and effective'[56]. Others consider 40-120 'safe and effective'[12].

There is less controversy and dangers associated with other ingredients. Potassium and bicarbonate are probably not essential in mild to moderate diarrhoeas as adjustments may be made more easily by the body[56]. Early replacement of water and salt can reduce acidosis even in the absence of base and eating food rich in potassium can avert hypokalaemia[1].

Glucose is another ingredient. The World Health Organization (WHO) recommends 111 mmol/L of glucose. Fortunately, there is a wide range of glucose concentration at which sodium absorption is facilitated, such as: 14 to 140 mmol/L[57]. Sucrose has been found to be an effective substitute for glucose[58,59]. However, relative cost and availability will dictate the use of a particular substrate.

In Bangladesh, the BRAC ORT programme promotes 'gur', a local unrefined brown sugar[60,61]. The use of 'gur' makes a big difference in the cost of oral solutions: it required $ 1.80 with gur, $ 7.42 with refined sucrose and $ 12.00 with glucose to make 100 litres of ORT solutions[62]. Encouraging results have been found also with rice powder[63]. As rice powder also provides amino acids, there is some evidence which shows that the increased absorption of fluid and electrolytes led to a decrease in stool output and in fluid requirement[61-66]. A 50 percent reduction in net stool output has been shown when an ORT solution also contained glycine[67]. Recently, Mahalanabis examined the efficacy of glycine in infantile diarrhoea and found that the glucose/glycine/electrolyte solution was superior to the standard glucose/electrolyte solution and most notably that the stool volume in the glycine group was significantly lower than in the other group[68]. But glycine is expensive and further research is currently being carried out on this.

In oral solutions, water is a critical factor. Judicious use of the right volume of water is essential in order to ensure a safe and effective solution, with too little water leading to a too higher concentration of electrolytes. In areas where safe water is difficult to obtain, 'drinking water' may be used. According to Feachem[69], 'the benefits of an early oral replacement of water and electrolytes far outweigh the possible risk from contaminated water'.

DELIVERY OF ORAL THERAPY :

Pre-packaged ORS vs. Home-mixed ORS: Considerable controversy existed about the level of implementation at which ORT be used[70]. Should oral therapy be confined to hospital or clinic situations or can it be promoted for use at household level ? Diarrhoea is a considerable problem in the developing world where health care facilities are accessible to only about 10 per cent of the population[33]. It is thus impactical to take care of most diarrhoeal cases in hospitals and clinics. 'ORT must, therefore, be delivered through a community-based program to reach the majority of the developing world's three million villages'[33]. But how to do that ? To ensure that each and every diarrhoea patient in the developing world has access to ORT is very difficult, especially with limited resources. Under the auspices of governments and international organisations such as WHO and UNICEF, national diarrhoea control programmes have been gaining ground in many countries. There is little disagreement that the ideal answer is oral rehydration salts (ORS) contained in an aluminium foil or plastic package and mixed with the recommended amount of water.

Many diarrhoea control programmes have been using these packets, which are produced on

a mass scale or even as a cottage industry[10,33,64] and they can be produced for as little as 8 US cents or 6 UK pence[33]. But there are several problems in a developing country situation. Although the per-unit cost is low, the provision of at least one packet (this is not enough in most cases) per episode will require huge resources in a country like Bangladesh where each person suffers approximately two episodes per year[71] and the population is over 90 millions. Alternately, ORT packets could be distributed through commercial channels such as chemists, pharmacist, etc. But the purchasing power of the people is limited and the sellers exploit the situation, particularly when certain goods are in great demand. Lately, UNICEF has been helping national governments to produce ORT packets for free distribution. But in a situation where most people live in rural areas with difficult access, ensuring a proper distribution to the needy is almost impossible. In addition, the correct volume of water is critical and this is difficult to ensure. Instructions on packets may be of little value as many people in developing countries do not know how to read and radio and television have little impact where people have limited access to them[56]. Moreover, the packets have a limited shelf-life.

To circumvent the problems posed in the widespread use of the packets, several alternatives have been suggested. These include the use of locally available ingredients such as common salt to supply sodium and chloride and sugar for sucrose (or glucose) and domestic measures. These are incomplete formulae and do not in most cases contain any potassium or bicarbonate. Several experts feel that this is sufficient to correct mild to moderate dehydration and to save lives[33]. Some programmes, however, have used local unrefined sugar which contains good amounts of potassium[56,60] and some others recommened eating of additional potassium-rich food such as green coconut[74]. Rice powder electrolyte solution is another promising innovation [62,66].

Preparing a home solution from salt and sugar is more risky as it requires both the ingredients and water to be correctly measured. Broadly there are three such systems of measurements which are in use in different parts of the world. The first one is the plastic spoon to measure salt and sugar[73,74] which have been successfully used in Indonesia[64]. A two-year field trial in Bangladesh found no difference in the acceptability, use and effectiveness of ORS prepared at home using packets and spoon measurements[76]. But a special spoon is a foreign element to a home and could, therefore, increase the household dependency. If it is lost, it has to be replaced. Melamed and Segall[76] experimented with these spoons and observed that variability of the solution could be greatly influenced by the grade of local ingredients. The second system uses household spoons instead of the previous standard one. But because of the wide variability of spoon types and sizes, this has not become more popular with programme organisers.

The third home preparation method uses the finger pinch-and-scoop system. Of the three, this is most widely used and probably the most controversial. Here salt is measured by the three finger pinch and sugar is measured by finger scoop (or fist). Mixed results have been reported on the use of this technique but good results were found in Bangladesh. One month after teaching, more than 90 percent of rural mothers were found capable of preparing a 'safe and effective' solution with sodium concentration in the range 33-99 mmol/L[56,77,78]. Snyder conducted a one year controlled trial in Bangladesh and concluded that ORT could safely be prepared at home using this method[78]. Good results were also found in Uganda[80]. Other workers have reported poor results. A comparative trial of three home methods found 'too great' variability in the pinch-and-scoop and household spoon methods[81]. In a test of the reliability of the pinch technique using four groups of people in 3 countries, an 'unacceptably wide variability' in measured weights was found[82].

Measurement of water may also be a big problem. Different ORT programmes have used different types of containers depending on local habits and availability. For example, a beer bottle has been used in the Phillippines, a coke bottle in Egypt and Indonesia and a formula feeding bottle in Costa Rica. Where standard containers are rare such as in Bangladesh, local popular measures have been used, such as 1/2 seer, equivalent to 467 cc.

In summary it can be said that both pre-packaged ORS and homemixed ORS have relative advantages and disadvantages and these have been presented in Table 1.

Table—1

Relative Advantages and Disadvantages of Packet and Home-mixed ORS for Developing Countries

Advantages of Packet	Disadvantages of Packet
1. No danger through faulty mixing of ingredients	1. Difficulties in making it available in villages
2. Standardization of ingredients possible	2. May be costly to individual and to government
3. Increased acceptance as it may be considered as a 'm[illegible]e'	3. Danger of using an inappropriate volume of water
	4. Increases dependence of families on supplies of packets
	5. Limited shelf-life
Advantages of Home-mixed ORS	**Disadvantages of Home ORS**
1. More easily available when needed	1. Danger of mixing inappropriate quantities of ingredients and/or water volume
2. Families not dependent on outside supplies	2. Thought to be ineffective by villagers
3. No problems of limited shelf-life	3. Opposition to its use from village health practitioners.
4. Use of ORS-rice powder may reduce volume of stool output.	

HOW POPULAR IS ORT ?

This is a difficult question to answer. However, Cutting et al.,[67] have provided some information. In a world-wide mail survey of practitioners, they found oral fluid quite popular, with approximately three quarter of acute diarrhoeas reportedly treated with oral fluid, with homemade solutions being most widely used. However in 28 community based ORT programmes cited in a recent publication, only 6 used homemade solutions[10]. Information on household level use of ORT is even scantier. Households which were taught the pinch-and-scoop method one month previously were surveyed in Bangladesh and it was found that about 17% of all dirrrhoea cases, or 35% of those treated by any method, used this method[83]. However, only 5% of interviewed respondents in rural Zimbabwe reported that they gave the solution to a child during the reference period[84]. In Honduras and the Gambia where an ORT campaign is being implemented together with the mass media, nearly 50% mothers were reported to have tried ORS at least once[84].

CONCLUSION :

We have come a long way since the days of Latta, Snow and Phillips. The chequered history of fluid therapy will bear testimony to the co

ibution of these souls. Oral therapy has been lled the 'most important medical advance this ntury'[66].

The technical barrier to preventing diarrhoeal eaths appears to have been largely solved. The reatest challenge now is probably how to apply [34]. Controversy still exists in the mode of elivery-should ORT be allowed to become a ome remedy and if so, how to deliver it at home? oth prepackaged ORS and home salt-sugar olutions have respective advantages and disad-antages (Table 1). As the Lancet put it, 'the nore accurate the ORT mix, the more dependent will be the patient on the health delivery system; he less complete and standardized the mix, the more accessible will be ORT. There are trade-offs in both directions[67]. While distributing ORS packets presents a challenge, the single home solution may prove satisfactory for a vast majority of mild to moderate cases[47]. There are reports which suggest that given adequate training and back-up, oral rehydration can be made a form of home remedy[40,41] but continued monitoring of these home solutions will be needed[68,69].

One of the ultimate aims of oral rehydration or any such form of treatment is to reduce mortality but delivering ORT itself will hardly solve the problem. If we assume that mothers are capable of preparing a safe and effective solution, a major question remains: will the mothers give ORT to their children ? There is a need for motivation. In other words mothers must feel the need for rehydration and stop believing that 'diarrhoea is part of growing up'. One of the reasons given for the lack of popularity of ORT amongst people is that 'it does not stop diarrhoea'[68], but recent research has raised hopes of developing an ORS which reduces stool output as well[44].

It should be clear that oral rehydration in itself is not enough to drastically reduce child mortality. The story of Costa Rica may be cited. Diarrhoeal mortality in Costa Rica decreased from 400 per 100,000 in 1930 to about 10 in 1980. As Mata[80] has described, this has been possible by a combination of reforms in the social, economic, health and sanitation sectors. Thus in order to attain a level similar to Costa Rica, efforts will have to be made to improve all aspects of people's lives. Oral rehydration therapy along with low-cost and easy to-implement preventive measures[44] may however go a long way in controlling a vast majority of deaths and illnesses from diarrhoea.

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