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Oral Fluid Therapy in Diarrhea and Dehydration: Current Concepts and Practical Considerations

ORAL FLUID THERAPY IN DIARRHEA AND DEHYDRATION: CURRENT CONCEPTS AND PRACTICAL CONSIDERATIONS

ROBERT L. PARKER, M.D., M.P.H.

AID/DSPE-C-0055

Department of International Health
The Johns Hopkins University
School of Hygiene and Public Health
Baltimore, Maryland
U.S.A.

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Widespread interest has been developing over a number of years in the use of oral fluid therapy for the treatment of water and electrolyte losses associated with diarrhea. Giving special oral fluids to diarrhea patients is not new, [1,2,3] but rapid increases in knowledge about its rationale, appropriate composition and indications for use have occurred in the last 10-15 years. Recent experience with the use of oral fluid therapy in many developing country settings resulting in significant reductions in diarrhea mortality [4,5,6,7,8] has catapulted this health intervention into global recognition as one of the few widely applicable and technically simple approaches that could substantially reduce infant and child deaths around the world. The comparative simplicity and effectiveness of oral fluid therapy is particularly attractive because of the technically more complex requirements and higher costs of intravenous rehydration and the much more difficult and protracted actions required to implement primary prevention through environmental sanitation programs and health education. National governments, WHO, UNICEF, and other international agencies such as AID, are increasingly emphasizing oral fluid therapy as an important component of primary health care, often as the major health intervention in simplified health, nutrition, family planning or development projects. [9,10] With this growing interest, a great variety of approaches using oral fluid therapy have sprung up around the world. Simultaneously, concern has been expressed by some

clinicians and investigators about the potential harm of inappropriate use of oral fluid therapy. They are encouraging more deliberate and careful testing and implementation of new approaches.[11,12] The general consensus, however, is that the magnitude of the diarrhea problem and our current level of knowledge warrant rapid implementation of the most widely accepted oral fluid therapy approaches. Dissemination of information about the benefits, risks and unresolved questions associated with oral fluid therapy should be built into any implementation plan. Thus, important program decisions can be made and implementation can move ahead while refinements of our understanding about the most effective and practical approaches can be encouraged by means of careful program evaluation and focussed research studies.

This review is, therefore, an attempt to briefly describe the major approaches to oral fluid therapy of diarrhea in children, important considerations in implementation of these approaches and unresolved issues that should be kept in mind when designing programs. This is not a "how-to-do-it" manual. Detailed guidelines for program development are currently available[13,14,15] and more up-to-date ones are being developed by the Diarrhoeal Disease Control Programme, WHO and the Center for Disease Control, Atlanta.

Magnitude of the Diarrhea Problem

Diarrhea, including its interaction with malnutrition, is considered by many to be the single most important health problem and cause of death in children under five throughout the less developed areas of the world.

Various estimates indicate that in these areas children under five may average five or more episodes of diarrhea a year and have diarrhea on at least 20 to 30 days out of every year.[5,16,17,18] In these same areas approximately 10 to 20 percent of all children will have died from the effects of diarrhea before they reach their fifth year.[19] Diarrhea causes death acutely due to large scale losses of water and electrolytes from the body beyond tolerable limits, i.e., "dehydration." Most acute diarrheas are directly the result of a wide variety of bacterial, viral or parasitic agents. However, in special studies designed to identify the causative agents, specific identification of the agent has been possible in only 50 to 80 percent of episodes.[6,17,20] The severity of the diarrhea, especially in relation to the amount of fluid lost varies considerably by age, nutritional status, causative agent, immunity, and other factors. It has been estimated that less than one percent of diarrhea episodes progress to life threatening levels of dehydration.[5,21] However, it is difficult to know in the early stages of diarrhea which cases will involve significant dehydration.

On the other hand, the impact of diarrhea on nutritional status involves the cummulative effect of multiple episodes acting through a number of mechanisms. These include the temporary reduction in food intake due to loss of appetite or the deliberate withholding of food, the metabolic breakdown of body tissues during the illness itself, and reduced intestinal absorption during and following the episode.[6,19] The susceptibility of malnourished children to the effects of diarrhea, along with an increased incidence completes the cycle which all too often continues in a downward "spiral" of diarrhea-malnutrition-diarrhea-malnutrition leading to death.

The Use of Oral Fluid Therapy

From the preceding discussion it should be clear that the use of oral fluids does not prevent diarrhea but acts mainly as a means of replacing water and electrolytes being lost because of the diarrhea. This can also be done by giving water and electrolyte mixtures intravenously, the method that has been preferred in the past. However, with earlier empirical evidence of the usefulness of giving oral fluids,[1,2,3] and more recently the demonstration that glucose and other sugars added to electrolyte solutions facilitated absorption, even in severe diarrhea with large losses of fluid in the stools,[10,19,22] it has become increasingly evident that oral fluid therapy can take the place of most intravenous fluids in cases of diarrhea and dehydration. Good results have been achieved among all ages, including the first month of life, in diarrheas of differing etiologies and in varying states of nutrition.[7,8,10,23,24] This evidence has led to two distinct uses of oral fluids in diarrhea.

1. In children who have lost large amounts of fluid and show signs of dehydration, the use of oral fluid therapy has been demonstrated to be as effective as intravenous therapy in <u>rehydrating</u> and <u>maintaining</u> 80 to 95 percent of such cases.[8,10,18,23,24,25,26]

2. Less clearly documented, but felt by many to be equally important, is the use of oral fluids to <u>prevent</u> the progression of fluid loss leading to dehydration by continually replacing lost fluid right from the start of the episode.[5,7,27,28]

In summary, advantages of oral fluid therapy include:

a. the limited training and technology required for its use;

b. the ready availability of most of the supplies needed for its preparation;

c. its low cost in contrast to intravenous therapy;

d. the elimination of the trauma and chance of infection associated with intravenous therapy;

e. the use of thirst of the child as a safeguard to prevent overhydration in contrast to the very real chance of overhydration in children receiving intravenous therapy without adequate monitoring;

f. its potential to prevent the progression of diarrhea to severe dehydration requiring intravenous therapy;

g. the potential for having even the most remote health worker trained in use of oral fluid therapy in contrast to the limited number of facilities that would be capable of providing intravenous therapy; and finally,

h. the ultimate potential of coverage offered through training mothers to treat their own children under specified conditions.

In terms of the current emphasis on equitable coverage by health services and participation of the community in its own care, the use of oral fluid therapy in the home offers one of the most concrete and potentially effective means to attain these goals.

Oral fluid therapy cannot be used initially in the small proportion of cases who are in shock and require rapid intravenous rehydration. In addition, a small number of children, often severely malnourished, do not tolerate the glucose or sucrose in the oral fluid because of specific

enzyme deficiencies.[18] Vomiting generally is not a contraindication for oral fluids if given slowly, but a few children may be vomiting so severely that nothing can be given by mouth.[19] In children too weak to drink adequate amounts, fluids can be given by a naso-gastric tube as an alternative to intravenous therapy.[18] Use of the naso-gastric tube, however, must be monitored carefully to prevent aspiration. Much more important limitations to use of oral fluids have been cultural practices that dictate withholding fluids during diarrhea, or similar advice from traditional healers or modern physicians whose training until recently has not included the concepts of oral fluid therapy. Major changes in the teaching of the treatment of diarrhea and dehydration to physicians and other health workers plus specific education of the public is needed in most areas before the potential benefits of oral fluid therapy can be realized.[10]

Important Issues

1. Early Use of Oral Fluids in the Home

There is general agreement that oral fluid therapy using well-tested formulae and given by trained health personnel in health facilities to mildly or moderately dehydrated children is rapidly effective in correcting their water and electrolyte deficit and subsequently maintaining adequate hydration. The use of oral fluids in the home, initiated by the mother in all cases of diarrhea, is more controversial. The different positions taken on this topic have usually been based on an individual's field or clinical experience or theoretical possibilities, but there have been few well documented studies to date that can resolve the controversy. The major positions held include:

a. Early use of oral fluids that depends on the mother for preparation and administration is potentially one of the more important applications of oral fluid therapy because of the coverage of all children it can provide, the prevention of progression to dehydration it offers and the involvement of mothers directly in the health care process. Proponents feel that moderate variations in the content of the fluid produced by the inaccuracy of methods used to measure the components of the solution are better tolerated and will not materially change the effectiveness of this intervention early in the course of diarrhea.

b. Early use, although relatively free of potential negative effects has not been adequately demonstrated to change the course of diarrhea. Most cases of diarrhea are self-limited and anything given in the way of fluids is reasonable but will not necessarily prevent the one percent or less of cases that will progress to dehydration. These cases will need rigorous oral fluid therapy once their severity is recognized. Some feel that this therapy needs to be initiated by a well trained and responsive health system in identifiable facilities, but with the mother being involved in continuation of the oral fluid therapy later at home.(11)

c. Early use of home prepared oral fluids may be potentially dangerous. First, by having families attempt to treat all children initially with oral fluids there may be a delay in seeking of medical care by mothers of children with rapidly progressive diarrhea and dehydration. Second, there is the concern that inappropriately prepared solutions with high levels of salt may in fact produce severe electrolyte disturbances (hypernatremia) or in the case of excess sugar, worsen the fluid losses of the diarrhea.(26)

No matter which of these positions is taken, teaching the recognition of severe diarrhea and early signs of dehydration to mothers is considered an essential component of diarrhea control programs, along with increasing the accessibility and acceptability of services to handle these more severe cases by trained health workers in the home or in facilities.

Without extensive data on the efficacy or safety of early home treatment of diarrhea, decision makers must still come to some conclusion whether to include it in their control programs, balancing the possibility of its benefits, especially in situations where adequately trained health workers are not always accessible, against the possibilities of its negative effects and the resources required to implement it. The latter includes having knowledgeable individuals who can teach families at the village level how to make and use oral fluids appropriately. At present, results of the few available village level studies tend to support the conclusion that there are definite benefits of this approach.(5,27,28) Therefore, unless comparable coverage by health services can be provided, or the risks under actual field conditions can be shown to be significant, implementation of early home oral therapy by family members should be recommended as one of the components of diarrhea control programs.

2. Composition of Oral Fluids

A number of issues surface when considering the appropriate composition of oral fluids for use in diarrhea and dehydration. These include:

a. the amounts of the basic components to be used (glucose, sodium, potassium, chloride and bicarbonate) including

whether more than one concentration is needed for differing situations;

b. whether there are more readily available or more stable substitutes for some of the components (glucose and bicarbonate); and

c. whether using only sugar and table salt is adequate (at least in early home use).

Concentration of Components

Extensive research has led to the general agreement that the ideal oral fluids for diarrhea should contain sodium and potassium chloride, sodium bicarbonate and glucose. Most proponents of this so-called "complete" formulation recommend that the oral fluid contain 3.5 grams of sodium chloride (table salt), 2.5 grams of sodium bicarbonate (baking soda), 1.5 grams of potassium chloride, and 20 grams of glucose, dissolved in one liter of water.[22] Some investigators feel that this amount of sodium (90 millimoles per liter) may be too high for common diarrhea in infants.[11,12] They recommend two variations. The first is to have a solution similar in all respects except for a lower sodium content (50-60 millimoles per liter) for infants and young children, to be used initially or at least after the child is rehydrated with the higher sodium content solution. The second approach would have only one strength of the solution (90 millimoles), but in young children and infants the giving of two measures (e.g., cups) of the solution would be followed by giving one measure of plain water, continuing this alternating pattern throughout the use of the oral fluid therapy. In practice, to simplify the development

of prepackaged supplies, the one standard formula is preferable. In addition, instruction of peripheral health workers and use by mothers in the home would be complicated by having several formulations. However, large institutions or capable rehydration centers may be able to develop several types of formulae for their own use with appropriate standing orders. Alternating plain water with the solution is a much better approach for use in less sophisticated facilities or in the home, but still makes instructions a little more complicated. Current studies indicate that either the complete formula alone or alternating it with water appears to work without significant problems.[18,22,23,29] Under these circumstances a decision in large scale programs about which approach to use should hinge on ease of implementing and assuring understanding of the rationale of the approach by mothers and health workers.

Substitutes for Components

Studies have documented that common sugar (sucrose) for all practical purposes can be used in place of glucose in oral fluid therapy (40 grams in place of 20 grams of glucose).[24,30,31] Glucose is preferred if available at a comparable cost since it has been shown to be slightly more effective. However, cost and availability in most countries make sucrose the best choice for locally packaged complete formulae or home prepared sugar and salt mixtures. In one study crude sugar with a high content of molasses has shown added advantages.[21] Such sugar may often be the only sugar available in rural homes and sometimes has significant quantities of potassium and bicarbonate in it (two components missing from mixtures made only with refined sugar and table salt). Suggestions

have also been made to substitute lactate, citrate or acetate compounds for bicarbonate because of their greater stability.[8,11] However, except for potential use in large scale packet manufacturing, bicarbonate is still the component of choice because of cost and availability.

Sugar and Salt as the Only Components

Probably the single most important controversy at present is that involving the use of oral fluids containing only sugar and table salt in contrast to the complete formula. This issue is complicated by the fact that the sugar and salt solution is generally advocated for use by the mother on her own initiative in the home, thus also involving the arguments presented earlier for and against such home use of oral fluids. Careful studies have documented the less adequate biochemical response of dehydrated children to sugar and salt solutions.[7,10,21] However, few if any adverse clinical signs have been noted with its use in these cases. No studies have been reported to date in which use of sugar and salt before the onset of dehydration have been followed biochemically. At present, because of the definite biochemical advantage shown in children with dehydration, it is probably advisable to use the complete formula whenever possible. However, in many situations widespread implementation of oral fluid therapy using the complete formula would either exhaust supplies of prepackaged ingredients, not be possible because of lack of appropriate ingredients locally, or be blocked by inadequate logistic systems to ensure supplies in the periphery. In such cases complete formula therapy could be reserved for administration or distribution by the health system (as far peripherally as supply permits but especially in

centers set up specifically to treat dehydration), while the remainder of the health system and mothers in their homes could be taught to use the less complete sugar and salt mixture.

Sugar and salt mixtures can be made to contain the various levels of sodium mentioned earlier. Because of potential errors of measurement the amounts of table salt now recommended are in the range to produce approximately 50-70 milliequivalents of sodium per liter or between ½ to 1 teaspoon of salt per liter. (The appropriate quantity of sucrose to achieve optimal absorption of this amount of sugar would be 30 grams or about 4 heaping teaspoons or 7 level teaspoons.)[32,33] This combination preserves a fairly wide margin of safety to protect against the likelihood of excessive sodium in the fluid. When sugar and salt solutions are used it has been recommended that foods high in potassium (e.g., bananas or green coconut water), when available, be started as soon as feasible along with the oral fluid.[21] Many innovative ideas have been developed to improve the measuring of sugar and salt for home mixtures since considerable variation has been documented when using available spoons and containers in the home.[10,34] These involve special plastic spoons and liter containers delivered to all potential users. An alternative is the marking of containers already present in the home by health workers using a standard measuring device, showing the mother the amount of sugar or salt that is in a "teaspoon" and what a liter of water should be.[27,35] Supplying special spoons and containers has the same logistics problems as supplying prepackaged formula; in addition, they can be misplaced. In either case, careful instruction and repeated reinforcement need to be provided users on a regular basis. Because of variability of measuring devices,

perceptions of need for accuracy, and courseness and water content of the ingredients,[10] all approaches advocating home sugar and salt solutions need to be consciously adapted and standardized to local areas. Evaluations of such programs should include sampling of home prepared solutions to measure their sodium and sugar content.

3. Feeding During Diarrhea

One of the most widespread practices associated with diarrhea is the withholding of food during the episode. This practice is supported by folk beliefs, traditional healers, and modern health practitioners. There is an obvious rationale involved--both empirical as well as quantitative observations document the increase in volume and frequency of stools when individuals with diarrhea are fed. However, one balance study has shown a net positive retention of nutrients when children with diarrhea received food.[36] Weight gain was also better in children who were fed during a diarrhea episode.[37] Other studies have demonstrated that adverse changes in the absorptive capacity of the intestines associated with fasting and diarrhea may be prevented by continued feeding.[22] On the other hand, there is evidence that continued feeding of foods containing lactose, especially cow's milk, may aggravate the diarrhea and induce prolonged lactose intolerance leading to malnutrition.[44]

Since withholding of fluids often goes along with the stopping of feeding, probably the most important benefit of changing feeding practices during diarrhea includes the more ready acceptance of oral fluid therapy. However, there is concern that continued feeding, although nutritionally advisable, may increase net water and electrolyte loss. Although the latter has not been documented, the standard provision of oral fluid therapy as outlined earlier, while continuing feeding in children with diarrhea could protect against such a possible effect. In fact, one study in the Philippines indicated that oral fluid therapy combined with continued

feeding produced short-term and long-term better weight gain than continued feeding practiced without the home use of oral fluids.[38] The results may be due to the protection the oral fluids provide against the possible negative effects of continued feeding (in terms of increased water and electrolyte loss). On the other hand, their use may encourage mothers to give the child food once it is seen that the child improves when taking fluids by mouth. There is general agreement that rehydrating a child, and possibly replacing lost potassium, increases the well being and appetite of the child, thus stimulating increased food intake.

In children with severe dehydration, the overwhelming importance of rapidly restoring water and electrolytes initially outweighs nutritional concerns. In these cases, rehydration usually can be completed within six to eight hours, concentrating on getting the oral fluid into the child.[14,18,22,23] Thereafter, feeding the child should start and continue along with maintenance levels of oral fluids. As mentioned earlier, an additional reason for feeding children (at least selected foods) when using only sugar and table salt solutions is the concern to provide them a source of potassium. In young infants, breast milk, giving of plain water or other low solute liquids are seen by a number of investigators as useful adjuncts along with the provision of the complete oral fluid formula, effectively reducing the overall concentration of sodium in the ingested fluids.[12] With the nutritional consequences of diarrhea becoming more clearly delineated, the consensus currently is to recommend continuing breast feeding in all children with diarrhea who are still on the breast, except in the few cases of severe vomiting or for a few hours

during rapid rehydration of a dehydrated child.[14] In these cases when the child is not put to the breast for a period of time, mothers must be instructed to express their milk to maintain its production. Similar advice is less clear for non-breast fed children. Half strength milk* (not skim milk), if tolerated, and an otherwise normal diet (some would exclude high residue and spicy foods and legumes) have been advised in combination with oral fluid therapy in non-dehydrated children.[14] In dehydrated children these foods need to be withheld only during the time of rapid replacement of lost fluids and then re-introduced carefully.

4. The Use of Antibiotics and Other Medicines

The treatment of diarrhea with antibiotics is indicated only in the case of cholera, shigella dysentery and possibly enterotoxigenic E. coli related disease.[6,8,13,26] The majority of childhood diarrheas are caused by viral or unknown agents and do not respond to antibiotics.[6,17] The drug of choice for cholera is tetracycline and for shigella is ampicillin or trimethoprim/sulfamethoxazole.[39] The widespread use of antibiotics for a large proportion of cases of diarrhea is not only a waste of scarce supplies but has potential hazards in itself. One such example is the frequent use of chloramphenicol, a particularly hazardous antibiotic. One of the important components of the training of physicians in the use of oral fluid therapy is to teach the limited indications for antibiotics and the contrasting overriding importance of oral fluids as the major treatment intervention.

It has repeatedly been demonstrated that other medications such as kaolin, paragoric mixtures, or "Lomotil" type drugs do not change the

*This recommendation is made primarily to reduce the intake of lactose since there often is decreased lastase (enzyme) activity in the small intestines associated with diarrhea as mentioned earlier.

course of the diarrhea and have basically only symptomatic effects. In infants that are severely ill, dehydrated and in shock, the latter two drugs are quite hazardous since they may depress respiration and worsen the cardio-vascular state of the infant.[7,13] There is, therefore, no place for these agents in the treatment of diarrhea in children under five.

Studies are currently being made using some specific "anti-secretory" drugs, but at present they are experimental.[7,8] The use of vaccines to prevent diarrhea has been limited primarily to cholera where it has only moderate effectiveness.[6] Work on rotavirus vaccines has been considered promising. Recent evidence from Bangladesh indicates that although only about 10 percent of diarrheas in infants may be rotavirus related with even smaller percentages at older ages, nearly 50 percent of children under two years of age coming to a treatment center have rotavirus associated diarrhea, probably indicating its greater severity in this age group.[17,20] The development of an effective rotavirus vaccine, therefore, should make a significant impact on early childhood diarrhea morbidity and mortality.

5. <u>The Use of Boiled Water and Baby Bottles</u>

Concern about the potability of the water for making oral fluids has led to recommendations that water be boiled and cooled before adding the sugar and salt or packaged ingredients. Although non-contaminated water is certainly desirable, if available, the obstacles imposed by having to boil and cool water before its use would severely limit the use of oral fluids in diarrhea if rigidly required. Families have too little

fuel or are seldom willing to take the time to boil water just to prepare the oral fluid. Because of the overriding importance to get water and electrolytes into a sick or dehydrated child, the cleanest water immediately available should be recommended in diarrhea control programs. Boiling is not essential, but can be advised in those situations when it is feasible and mothers are willing to prepare it and cool it in advance of mixing in the sugar and electrolytes. Studies have demonstrated that bacteria multiply rapidly in oral therapy solutions after 24 hours.[39] Since even fluids made with boiled water cannot be kept uncontaminated, the preparation of fresh fluid daily is recommended. Any unused fluid should be discarded after 24 hours.

The use of bottles and nipples for feeding the oral fluid to infants should be strongly discouraged in homes not already using them. For much the same reasons for not boiling water, most homes would not have the time or fuel to keep the bottles clean. In addition, the introduction of bottles into a breast feeding environment has far reaching and serious repercussions. Fortunately, infants can be easily given oral fluids with a "cup and spoon" and older children will drink right from the cup.

6. <u>The Role of Intravenous Therapy</u>

It has been found that between 5 to 20 percent of diarrhea cases that become dehydrated do not respond adequately to oral fluid therapy, at least initially.[23,26] The proportion requiring intravenous fluids at some point in their treatment will depend on the type of diarrhea, the extent of dehydration, the rapidity of water and electrolyte loss through the stools, the presence of glucose intolerance, and whether there is

associated severe vomiting. With only about one percent of all diarrhea episodes progressing to dehydration (21) it can be seen that intravenous therapy is required in about one to two episodes out of a thousand. When planning diarrhea control programs, therefore, as resources permit, the siting of facilities with intravenous capability and supplies and the development of referral patterns can be based on this estimate of need. An important assumption, however, is that maximum effectiveness be achieved with the oral rehydration program in treating dehydration in its earlier stages. Thus, the priority will generally lie with the oral component of the program in situations where resources are limited.

7. Production of Packets, Spoons and Bottles

The use of the complete oral rehydration formula depends on widespread availability of the ingredients. The mechanisms for achieving this range from sophisticated processes producing ingredients packaged in foil which are mixed with a fixed quantity of water, to solutions or packages prepared by local health services. The former offer advantages of standardization and long shelf life, but may be more costly (about $0.05-0.10 per packet), (40 and currently can supply only a fraction of overall need. (For example, worldwide production of UNICEF packets in 1980 will be about 24 million, (41) yet the need for such packets in just one country, Egypt, has been estimated to be as high as 50-60 million annually assuming complete coverage of the population. Production of packets in Egypt is projected to reach only 5 million in 1980.) (33,42) Packets prepared using simple equipment and sealed in plastic bags can often be done at the health center or regional level but still depend on

an adequate supply of ingredients. They may or may not be less expensive than mass manufactured packets, but they do not require much technology, are labor intensive and their quantities can be varied depending on the most common local standard measuring device for water.[11] One example of such local production is the filling of plastic bags with the various ingredients using an old glass syringe as the measuring device. The "complete" formula would consist of measuring 3cc of table salt, 3cc of baking soda, 1.5cc of potassium chloride, and 30cc of glucose (or 60cc sucrose) into a packet which would be diluted with one liter of water when used.[43]

Multiple types of spoons also have been developed for home use when making sugar and salt mixtures. These offer distinct advantages over poorly standardized use of home spoons or the finger "pinch and scoop" methods.[34] However, adequate production and supply of such spoons to every home, their cost and problems of loss and resupply are currently serious obstacles to their wider use. The same can be said for the manufacture and distribution of standard (usually one liter) plastic bottles. Their usefulness is unquestioned, but the associated logistics and costs again are limiting factors. Multiple substitute approaches have been developed with the most common being to have the health workers who teach the mothers how to prepare the solutions measure and mark home utensils indelibly using measuring devices (spoon and bottle) they carry with them as the standard. Care needs to be exercised in developing these approaches so that they are as accurate and replicable as possible under the conditions of the area in which they are being used.

8. Evaluation Criteria

As mentioned earlier, although oral therapy is being extensively spread throughout health care systems, it is important to monitor and evaluate its effectiveness in these large scale situations. Even more important, when innovations, modifications, or less well documented approaches are tried, careful assessment of efficacy and safety as well as cost, acceptance, and ease of application are required. The following measurement parameters should be considered when planning evaluation procedures:

a. Production and consumption of supplies (packets, spoons, bottles);

b. Utilization data--coverage of population, use and amount per episode of diarrhea, proportion of use that is spontaneous, stage at which started, source of supply, etc.;

c. Diarrhea morbidity (incidence and prevalence), percent of cases with dehydration (mild, moderate, severe), case fatality rates, and overall diarrhea mortality by age;

d. Attendance rates at fixed facilities, referral rates to rehydration centers, hospitalizations, need for intravenous fluid;

e. Knowledge about correct use and preparation, actual preparation procedures and amount given;

f. Evaluation of worker knowle , skills and performance;

g. Measurement of fluid composition (sample check of chemical content);

h. Weight gain (nutrition measures);

i. Diet provided, if any;

j. Complications of treatment.

All of these measures cannot be used for routine service evaluations, but selected indicators can be built into ongoing information systems. Depending on resources available for evaluation, priority should usually be given first to input data (supply, consumption, cost) and output data (knowledge and utilization), with outcome data (decrease in cases with dehydration, case fatality rates, and total diarrhea mortality) being measured only if inputs and outputs approach levels at which an impact can be anticipated. In actual practice baseline outcome data will need to be gathered prior to knowing whether inputs or use are adequate. However, in order to conserve resources, evaluation procedures should be flexible enough to permit cancellation of follow-up outcome measures when inputs and utilization are clearly inadequate. If such flexibility is explicitly built into evaluations, administrators might be more willing to fund a larger variety of measures, increasing the value of assessment efforts substantially.

Summary and Conclusions

One of the significant challenges to health services around the world is the need to reduce the high rates of morbidity and mortality associated with diarrhea and dehydration in children. Few interventions offer more promise to rapidly meet this need than well designed oral fluid therapy programs. Although some controversy still persists in relation to oral fluid therapy, there has been enough experience with its use to yield

a reasonable consensus on which to build recommendations for large scale programs. In the meantime, continuing research should provide information that will guide future modifications. In summary oral fluid therapy programs should include the following:

1. The use of a standard complete mixture, packaged appropriately for the specific requirements of the service area. The final solution should yield 90 millimoles of sodium per liter of fluid. When possible, additional free water can be recommended for infants receiving this mixture.

2. The teaching of families how to prepare and use simple sugar and salt mixtures at home immediately with the onset of diarrhea and continued until a more complete mixture can be obtained, or the diarrhea ceases. The methods for preparation should be clearly standardized for each different area to consistently yield about 60 millimoles of sodium per liter of fluid.

3. Except in cases of dehydration, children, and especially infants on the breast, should continue to be fed throughout the diarrhea episode as they concurrently receive oral fluid therapy. Dehydrated children should be rehydrated rapidly first and then started back on food.

4. There is little place for any other type of treatment for diarrhea in children. Antibiotics should be reserved for cholera and shigella cases. Other medicines such as paragoric may actually be harmful to children with dehydration.

5. Although preferable when available, boiled water for the preparation of oral fluids is not essential.

6. Finally, a multi-tiered system should be organized to treat diarrhea. In this system as much of the prevention and treatment of

dehydration as possible should be done using the complete oral fluid mixture. Intravenous therapy should be saved for severe cases which do not respond to oral therapy.

Simple salt and sugar preparations should be used in the periphery of the system and especially in the home where it may not be possible to cover the population with supplies of the complete mixture. The tiers of the system should include at least four levels.

1. The Home--Sugar and salt mixtures, or when readily available packets of complete mixtures, should be used in each home. Families should know how to prepare these fluids appropriately and how much to give. In this setting oral fluids should be started immediately at the onset of the episode of diarrhea and continued until the child improves. Families should know when to take their children for care to the health system.

2. The Peripheral Health Workers--These workers should be supplied with the more complete mixture which they could give to children brought to them or seen in the home. These workers are essential for teaching families how to use oral fluids and for continually monitoring its appropriate use. They also need to know how to prepare and use sugar and salt mixtures in cases when supplies of the complete mixture are not available or are temporarily interrupted.

3. The Peripheral Fixed Facility or Rehydration Center--These facilities need to be equipped to at least handle most cases of dehydration, relying primarily on the use of complete oral fluids, but having the capability to insert naso-gastric tubes to provide fluids for children too weak to drink, or to give intravenous fluids. These centers should also be able to reinforce the teaching capabilities of peripheral workers.

4. **Referral Centers or Hospitals**--Adequate back-up to the other levels is needed for the more serious cases that do not respond to the various treatments available in the periphery. Oral fluids can still be used at this level, and should be to save on costs. However, intravenous therapy will probably be used in a greater proportion of cases at this level. An important function of the referral or regional center will be the overall supervision and monitoring of the performance of the other levels including the assurance of a smooth flow of supplies. In order to make the whole system work, flexibility will need to be built in permitting the use of different approaches depending upon the availability of supplies and the ability of staff to maintain the necessary knowledge and skills in the system and in the homes.

None of the approaches can be dropped into place and then be expected to continue to be effective without repeated reinforcement. At best, oral fluid therapy should be an integral part of a primary care program with continued support for its appropriate use coming from ongoing home and clinic contacts and repeated inservice training of health workers.

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