

Diet and Diarrhoea: Which supplements can be used in community acquired infectious diarrhoea in children?

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Infectious diarrhoea is the most common cause of diarrhoea worldwide and is the leading cause of death in childhood. Many infectious agents cause diarrhoea (Table 1) and worldwide rotavirus is the most common cause of severe diarrhoea and diarrhoea-related mortality in children. Despite improvements in public health and economic wealth in the developed world, the incidence of intestinal infections remains high and continues to be an important clinical problem. However, gastrointestinal infections have their major impact in the developing world.

There have been some major improvements in our knowledge base over the past years regarding the treatment of infectious diarrhoea. Oral rehydration therapy (ORT) remains central to case management but advances have been made by the introduction of hypotonic solutions and early evidence on resistant starch indicates that it may be the substrate of the future.

Oral Rehydration Therapy (ORT)

Fluid and electrolyte replacement via the oral route is usually sufficient unless the person is vomiting and/or fluid losses are very severe. The scientific principle and rationale for this therapy is based on active carrier mediated sodium-glucose co-transport. Recommended oral replacement fluids are glucose-electrolyte solutions known collectively as oral rehydration solutions (ORS). A lower sodium concentration of 50–60 mmol/l is as effective as the 90 mmol/l, recommended previously the World

Table 1: Causes of infectious diarrhoea

Enteropathogen	Acute watery diarrhoea usually resolves within 5–10 days	Dysentery (Bloody Diarrhoea)	Persistent diarrhoea with or without evidence of intestinal malabsorption
Viruses			
Rotavirus	yes	no	no
Enteric adenovirus (types 40, 41)	yes	no	no
Calicivirus	yes	no	no
Cytomegalovirus	yes	yes	yes
Astrovirus	yes	no	no
Bacteria			
Vibrio cholera	yes	no	no
Enterotoxigenic E coli	yes	no	no
Enteropathogenic E coli	yes	no	yes
Enteraggregative E coli	yes	no	yes
Enteroinvasive E coli	yes	yes	no
Enterohaemorrhagic E coli	yes	yes	no
Shigella spp	yes	yes	yes
Salmonella spp	yes	yes	yes
Campylobacter spp	yes	yes	yes
Yersinia spp	yes	yes	yes
Clostridium difficile	yes	yes	yes
Mycobacterium tuberculosis	no	yes	yes
Protozoa			
Giardia intestinalis	yes	no	yes
Cryptosporidium parvum	yes	no	yes
Microsporidia	yes	no	yes
Isospora belli	yes	no	yes
Cyclospora cayetanensis	yes	no	yes
Entamoeba histolytica	yes	yes	yes
Balantidium coli	yes	yes	yes
Helminths			
Strongyloides stercoralis	no	no	yes
Schistosoma spp	no	yes	yes

Supportive and Supplement Therapy

Four main approaches to the treatment of infectious diarrhoea

- Supportive therapy—fluid and electrolyte replacement
- **Adults:** Symptomatic antidiarrhoeal treatment to reduce stool frequency and any other symptoms such as abdominal pain
- **Adults:** Antisecretory drug therapy aimed at reducing faecal losses
- Specific therapy such as antimicrobial chemotherapy to reduce duration and severity of the illness

Health Organisation (WHO), and appears to be more efficacious in reducing faecal losses. In 2002, the WHO endorsed the use of a low osmolality ORS (245 mosmol/kg) with a sodium concentration of 75 mmol/l.

Dehydration occurs more quickly in infants and young children and therefore early administration of an ORS is advised to prevent severe dehydration and acidosis. In severe dehydration in infants and young children, intravenous fluids are advisable.

Epidemiological studies have shown a distinct negative association between the frequency and duration of diarrhoea and physical growth and development of a child. It is now generally accepted that early feeding during diarrhoea decreases severity, duration and adverse nutritional sequelae. Food should therefore be started as soon as the child wishes to eat and drink normally and breastfeeding should be continued in infants. In this regard, prospective studies are supportive of this practice

and have documented that the severity and duration of diarrhoeal episodes are decreased significantly among infants who continue breastfeeding. On this basis, recent guidelines have promoted the continuation of breastfeeding in infants who develop diarrhoea. In view of the above information and against the background of rapid growth in childhood, historical guidelines, which encouraged the deliberate withholding of food resulting in poor intake, are no longer justified.

Resistant Starch

Although glucose has traditionally been the main substrate for ORS, the possibility that the efficacy of ORS may be increased by using complex substrates, such as cereals or defined glucose polymers, has been extensively investigated. Replacing glucose with a glucose polymer such as rice starch has the advantage of producing low osmolality solutions while delivering an increased amount

of substrate in the form of rice starch polymer along with some protein, which is also thought to promote active sodium absorption. Additionally, short-chain fatty acids are produced in the colon by the bacterial fermentation of unabsorbed carbohydrates. Starch that is resistant to digestion by amylases in the small intestine (amylase-resistant starch) is found in small quantities in many cereals and is a good substrate for colonic fermentation. High-amylose maize starch, obtained from a specific variety of corn, is rich in resistant starch that is type 2, a classification based on the structure and conformation of native starch molecules. When it is eaten uncooked, 50 to 70 percent of the starch is not digested in the small intestine. Resistant starch is only partially hydrolysed in the small intestine and approximately 30% enters the colon where it is degraded by colonic bacteria to short chain fatty acids. Short-chain fatty acids are a potent stimulus for the colonic

Zinc, vitamin A and diarrhoea in infants and children:

The available evidence is strongly supportive of zinc deficiency, as measured by plasma zinc concentrations, being associated with an increased risk of diarrhoea. (the human body contains 2–4 g of zinc, but in the plasma, zinc only occurs in a concentration of 12–16 µmol/L) The substantial benefits of zinc supplementation in the prevention of diarrhoea, one of the leading causes of death in children in developing countries, suggest that zinc supplements may be an important contributory means to improving child survival

absorption of sodium and water from both the normal and the secreting colon.

A randomised trial in cholera diarrhoea revealed that a resistant starch ORS was superior to the standard therapy (WHO-ORS) and a rice-flour ORS in its effectiveness in reducing faecal losses. The time to the first formed stool in the resistant-starch group (56.7 18.6 hours) was significantly shorter than in either the standard-therapy group ($P=0.001$) or the rice-flour group ($P=0.05$). The loss of fluid in stools was considerably reduced, when resistant starch was administered in addition to the standard oral rehydration solution and when children were encouraged to eat as soon as possible after the administration of the solution. The use of cereal-based oral rehydration therapy in patients with cholera and rice-derived glucose polymer in infants with diarrhoea (predominantly those with rotavirus infection) has been reported to significantly reduce stool output. These clinical benefits are thought to stem from the increased absorption of sodium and water. Although the hypo-osmolality of cereal-based solutions has been considered critical to the absorption of sodium and water, other possible contributory factors include the enhancement of mucosal repair by luminal nutrients and a specific antisecretory factor in rice. It is possible that some of these effects may contribute to the benefit of amylase-resistant starch, because some of the starch is digested in the small intestine.

Diarrhoea is thought to increase zinc losses and the same is true of vitamin A. In the presence of an inadequate dietary intake, such losses may further impair zinc nutriture and

contribute to zinc deficiency and its consequences in terms of growth and development.

Zinc supplements added to conventional anti-diarrhoeal therapy have been reported to be effective in reducing the duration of acute and persistent diarrhoea in developing countries. In this regard, pooled analysis of 10 clinical trials from 9 developing countries indicate that zinc-supplemented children had a 15% lower probability of continuing diarrhoea in the acute diarrhoea trials, a 24% lower probability of continuing diarrhoea and a 42% lower rate of treatment failure or death in the persistent diarrhoea trials. The pooled analyses included randomised trials, which provided supplements containing at least one half of the US Recommended Daily Allowances (RDA) for children (3–10 mg elemental zinc). The study populations included in the pooled analysis varied widely in background characteristics and nutritional status. The beneficial effects of zinc supplements in diarrhoeal morbidity were accompanied by an increase in plasma zinc concentrations in the zinc-supplemented children, with a decrease or no change in the plasma zinc concentrations in the control non-supplemented group. More recently, other investigators had confirmed these beneficial effects. These findings indicate that interventions to improve zinc intake deserve more attention as means to improve child health. Zinc deficiency during childhood, contributes to stunting and is associated with an increased incidence and prevalence of infectious diarrhoea. Supplementation at RDA levels has been shown to improve these clinical conditions, with children who are zinc-deficient

deriving the greatest benefit. Therefore, supplementing with zinc may be considered doubly beneficial in improving child health. Irrespective, due care should be exercised with any such supplements in view of the findings of a significantly ($p = 0.03$) higher mortality (primarily due to sepsis) among severely malnourished children receiving higher doses of zinc supplements [2 fatalities in the low dose supplementation group (1.5 mg/kg zinc, as zinc sulphate) daily for 15 days followed by placebo for 15 days vs. 17 fatalities combined in the groups receiving higher zinc doses (6 mg/kg) for 15 days followed by placebo for 15 days or 6 mg/kg for 30 days].

With regard to vitamin A, fever is known to increase the urinary excretion of the vitamin and vitamin A status is adversely affected by the frequency and duration of diarrhoea. Nevertheless, the data relating to the effect of high dose vitamin A supplements on the frequency and/or severity of infections is variable and needs to be better defined. In Ghana for instance, vitamin A supplementation did not significantly affect the prevalence of diarrhoea and respiratory infections, despite the fact that children who received the supplements attended health clinics less frequently and had fewer hospital admissions. Similar findings have been reported from Brazil regarding the frequency of hospitalisation and the prevalence of pneumonia, despite the concomitant reduction in the number of diarrhoeal stools and episodes of severe diarrhoea. Of further interest is the more recent trial in Tanzania, which reported a significant (44%) reduction in severe watery diarrhoea during the year after discharge among children admitted to hospital with pneumonia who received vitamin A supplements as compared with those who received placebo.

Lactobacillus rhamnosus GG and *Lactobacillus reuteri* has been repeatedly shown to reduce the duration of acute infantile diarrhoea, often the result of infection with rotavirus, by about 50%. This strain

Probiotic Supplements:

Probiotics have been shown to be effective in the treatment of acute infectious diarrhoea and in the prevention of nosocomial and community acquired diarrhoea in children. The full clinical implications of the role of probiotics in the prevention of diarrhoea must however be more comprehensively documented. Nevertheless, greater clinical experience is necessary before the use of probiotics becomes an accepted practice.

has also been useful as a prophylaxis of diarrhoea in undernourished children, especially in infants who are not breastfed. The underlying mechanism is thought to be the stimulation of the immune response and/or enhancement of mucosal integrity.

Bifidobacterium bifidum, given in conjunction with *Streptococcus thermophilus* in standard milk formula, has also been shown to reduce the incidence of rotaviral diarrhoea. Other studies in children with gastroenteritis who received a probiotic supplement (either *Lactobacillus rhamnosus*, *Lactobacillus reuteri* or *Lactobacillus casei*) have documented a significant decrease in the duration of diarrhoea in the children studied. It should however, be borne in mind that although probiotics are consumed as food(s) by many children, and the tolerance and safety of long-term consumption of specific types and strains of bacteria is being increasingly documented, on a cautionary note such foods/supplements should not be consumed by sick children without medical supervision.

Conclusions and recommendations:

- Fluid and electrolyte replacement via the oral route is usually sufficient unless the person is vomiting and/or fluid losses are large and sustained. ORT has been a life saving therapy for many children with severe diarrhoea.
- Studies in which children with cholera-induced diarrhoea consumed resistant starch plus the usual hydration therapy showed a major reduction in fluid loss and time of recovery
- Food should be started as soon as the child wishes to eat and drink

normally. Feeding with cooked rice, a source of resistant starch has been found to reduce the severity of diarrhoeal disease with a reduction on mortality.

- Breastfeeding should be continued in infants.
- During childhood, zinc deficiency contributes to stunting and is associated with an increased incidence and prevalence of infectious diarrhoea. Supplementation at RDA levels has been shown to improve these clinical conditions, with children who are zinc deficient deriving the greatest benefit. The role of vitamin A in the prevention and treatment of diarrhoea needs to be better defined.
- A supplement providing the RDA for zinc may be necessary when dietary intake is not adequate and or the intake of phytic acid is very high in the diet. Higher dose supplements should best be avoided.
- Probiotics have been shown to be effective in the treatment of acute infectious diarrhoea in children, prevention of antibiotic associated diarrhoea, prevention of nosocomial and community acquired diarrhoea in children. As a general rule, probiotics (foods or supplements) in sick children should be consumed under medical supervision.

For further, personalised and more detailed information, please contact NICUS or a dietitian registered with the Health Professions Council of South Africa

References from the scientific literature used to compile this document are available on request. 📄