



The top killers of children in the developing world are diarrheal disease and acute respiratory infections like pneumonia. The simple act of hand-washing with soap can cut diarrhea risk by almost half and respiratory tract infection by a third.³⁰

example, sanitation with increased hygiene can reduce incidences of diarrhea by 65 percent.

Impact. Optimal hand-washing with soap can reduce diarrhea by 45 percent.²⁸

Since hand-washing requires a behavior change, it works best as part of a broader package of comprehensive intervention methods.⁸ For



KEEPING INFANTS HEALTHY

In Lesotho, a common cultural practice is to wait until a newborn's umbilical cord falls off to begin breastfeeding. When Mamorena Namane gave birth, she fed her child only water for the first seven days of his life. She noticed that her son was frequently ill and later learned that not beginning breastfeeding immediately could have put her baby at risk.

Breast milk is the healthiest and safest food for infants in the first six months because it gives them critical nutrients, antibodies, and fluids to help decrease their risk of illness and infection, including diarrheal disease. USAID's Infant and Young Child Nutrition (IYCN) Project, implemented by PATH, is working to raise awareness among families and communities about healthy and safe feeding practices for young children so that mothers learn how to protect

their babies and young children from illness. This important information is currently spreading throughout the community, strengthening support for early breastfeeding to keep all Lesotho's children safe and healthy.³¹

∴ Infant and Young Child Feeding

Problem. Infants are at greatest risk of diarrheal disease when foods other than breast milk are given because they lose the protection of breast milk's anti-infective properties and are more likely to be exposed to food- and water-borne pathogens. Alternatives to breast milk carry risks, particularly in areas where infectious disease levels and the potential for improper food preparation and storage practices are high.

Infants under 2 months of age who are not breastfed are 25 times more likely to die from

dehydration caused by diarrhea than infants who are exclusively breastfed.

Infants who are fed cow milk are 18 times more likely to die from diarrhea when compared with infants who are exclusively breastfed.³²

Solution. Exclusive breastfeeding has many health benefits for infants less than six months of age, including the prevention and treatment of infections such as diarrheal disease.⁸ Breastfeeding for children 6 to 24 months, with appropriate complementary foods, is a key component of

Relative Risk for Infant Mortality Due to Infectious Diseases at Different Ages According to Type of Milk Consumed

Age (in months)	Type of Milk Consumed		
	Breast Only	Breast + Other*	Other Only*
Diarrhea			
< 2	1.0	3.1	24.7
2-11	1.0	2.5	3.5
Respiratory			
< 2	1.0	2.7	3.3
2-11	1.0	2.5	2.0
Other Infections			
< 2	1.0	0.9	3.9
2-11	1.0	0.7	2.9

*Based on matched analysis but not adjusted for confounding variables.

Source: *The Lancet*, 1987.

an optimal feeding plan, which can significantly reduce diarrhea and provide the nutrients that prevent stunting and the cognitive effects of repeated diarrhea episodes.

Breast milk provides ideal and complete nutrition for infants in their first six months of life. It provides immediate immune protection from the mother and stimulates the development of an infant's immune system. It also improves responses to vaccines and provides many health and growth enhancing molecules, enzymes, proteins, and hormones, which are unique to breast milk.

Initiation of breastfeeding within the first hour of life, exclusive breastfeeding for the first six months, timely and adequate complementary feeding, continued breastfeeding for two years, and good nutrition and restorative feeding for ages over two are some of the key feeding practices that can improve children's health, especially in developing countries.³³

Impact. By increasing the duration and exclusivity of breastfeeding until infants are at least 6 months of age, an estimated 1.5 million infants' lives worldwide could be saved each year.³⁴

Exclusive breastfeeding prevents diarrheal disease in two ways. First, it eliminates the intake of potentially contaminated food and water at the time when infants have poorly developed digestive systems. Second, breast milk contains secretory antibodies and other immune factors specific for protection against gastro-intestinal pathogens, and has demonstrated anti-inflammatory and immunomodulatory effects.³⁵

For an infant, continued breastfeeding during and following an episode of diarrhea significantly reduces the risk of dehydration and prevents weight loss and malnutrition. Breastfeeding may also help infants recover from diarrheal disease faster and reduce the severity and duration of the



A COORDINATED APPROACH TO FIGHTING DIARRHEA IN NICARAGUA

When an outbreak of rotavirus nearly crippled Nicaragua's health system six years ago, several Ministry of Health (MOH) departments formed a dedicated alliance to reduce the burden of diarrheal disease, including a unique team of experts on hygiene, epidemiology, nutrition, and child health. In less than two years, a team of representatives from the ministry — along with NicaSalud (a local coalition of NGOs), PATH, UNICEF, and others — brought public-sector clinics on board and trained health care workers to provide zinc and ORT throughout the country. A parallel demonstration project by the MOH and Merck, which donated more than one million doses of rotavirus vaccine, offered the opportunity to integrate rotavirus vaccination. The introduction of the rotavirus vaccine in 2006 marked the first time in history that a developing country took up a vaccine in the same year as its adoption in the United States. More than 85 percent of vaccine-eligible children were reached in the project's first year. Citing cross-disciplinary cooperation as fundamental to the program's achievements, the MOH credited the alliance with building awareness of zinc treatment, ORT, and rotavirus vaccines. Nicaragua's strategy for diarrheal disease control illustrates how a coordinated approach can strengthen efforts and achieve benefits throughout the health system. The approach is well under way and informing similar strategies throughout the region and the world.

episode because, in addition to replacing lost fluids, it ensures that critical nutrients are provided.

After six months, when breast milk needs to be complemented with other foods, health care workers need to counsel families to ensure food is hygienically prepared and fed so it is safe and adequate for infants and children 6 to 24 months of age. Children are particularly vulnerable to malnutrition during this period due to inadequate infant and young child feeding practices during and after illness.

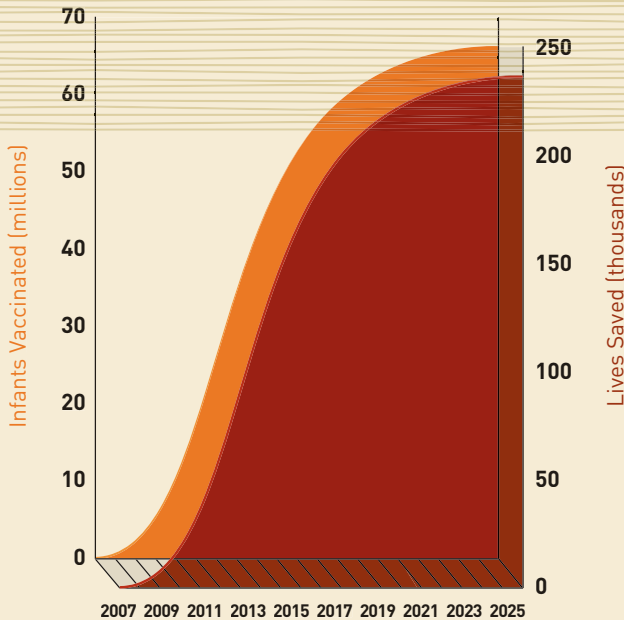
Despite the benefits of breastfeeding, fewer than 35 percent of infants worldwide are exclusively breastfed during their first four months of life, according to the WHO. In addition,

complementary feeding often begins too early or too late, with foods that are often unsafe or nutritionally insufficient, leading these infants, who are more likely to be sick frequently, to become malnourished and suffer the life-long consequences of impaired development.³⁶

Rotavirus and the Promise of New Vaccines

Problem. Each year rotavirus — the leading cause of severe diarrhea — kills more than 500,000 children and hospitalizes millions. While nearly every child in the world will have at least one rotavirus infection by age three, it causes a disproportionate number of deaths in developing nations, where access to emergency care can be limited.³⁷

POTENTIAL LIVES SAVED BY ROTAVIRUS VACCINATION



SOURCE: PATH/D, Atherly.

Solution. Vaccines are another important, proven diarrheal disease prevention method. They are particularly critical in areas where appropriate medical treatment for severe diarrhea and dehydration is limited and access to safe water is inadequate.

Recently developed vaccines have the potential to prevent rotavirus. In 2006, two orally administered rotavirus vaccines — Rotarix™ manufactured by GlaxoSmithKline (GSK) and RotaTeq® manufactured by Merck and Co., Inc. — were demonstrated to be safe and effective in large-scale clinical trials in Europe, Latin America, and North America. With a 90 to 100 percent efficacy rate against severe rotavirus, the vaccines were licensed for use in those regions.³⁷ They are currently part

of the routine immunization programs in several countries throughout the world. Manufacturers in India, China, and Brazil are also working to develop promising new rotavirus vaccine candidates.

“The best way to protect children from the deadly disease is to prevent them from getting it in the first place.” — Dr. Ruth F. Bishop led the team of researchers that discovered rotavirus.³⁸

Impact. In the United States alone, rotavirus vaccination has led to dramatic drops in severe rotavirus-related hospitalizations and emergency room visits by as much as 80 percent. The vaccines may also have prevented illness in unvaccinated children by limiting the number of circulating infections.³⁹

Once the WHO makes a global recommendation, anticipated in 2009, Africa and Asia will be eligible for GAVI financing for rotavirus vaccines.

Rotavirus vaccines have the potential to prevent the deaths of approximately 225,000 children in the world’s poorest countries each year and more than 2.5 million in approximately the next 20 years.⁴

“Deaths from diarrheal dehydration and other sicknesses triggered by inadequate water and sanitation remain the world’s most serious public health problem — but one that could be solved today.”

— David Douglas, President of Water Advocates⁴⁰

Proven, lifesaving treatment options also exist for diarrheal disease.

When diarrhea occurs, it can be treated effectively with ORS, ORT, and zinc supplementation. Exclusive breastfeeding of infants under 6 months of age and continuing to breastfeed them up to 24 months of age may also help infants recover faster and reduce the risk of malnutrition, which makes infants more susceptible to dying during future diarrhea episodes.

:: Rehydration Therapy

Problem. Diarrheal disease becomes fatal when it leads to severe dehydration. Children in poor countries suffer from dehydrating diarrhea an average of four times per year. In low-resource settings, it can be fatal.⁴¹

Solution. Oral rehydration therapy (ORT) and oral rehydration solution (ORS) involve rehydrating children by replacing fluids and electrolytes lost through diarrhea. The broader intervention method, ORT, involves rehydrating children through increased appropriate and available fluids such as breast milk or rice water mixed with salt, soups, and cereals and continued feeding to prevent and treat diarrhea-related dehydration.

ORS is a specific way of implementing ORT. It is a simple mixture of sugar and salt added to clean water that can be administered at home. This

lifesaving solution was discovered by scientists in the 1970s. In 1978, *The Lancet* referred to ORS as “potentially the most important medical advance of this century.” Today, ORS is the cornerstone of diarrheal disease treatment in both industrialized and developing nations. It reduces dehydration in nearly 90 percent of patients.⁴²

Since the 1970s, ORS has saved an estimated 50 million lives, and it costs less than US\$0.30.⁴¹

In 2001, a new ORS with a reduced sodium and glucose content was created. The new formula, low-osmolarity ORS, is packaged as a powder to be mixed with clean water. It is easy to use and can be administered by a health care provider or at home by parents and caregivers. Compared with the original formula, the new formula improves efficacy and reduces the need for unscheduled IV interventions by almost 33 percent, lowers stool volume by nearly 25 percent, and causes almost 30 percent less vomiting.⁴³

The WHO and UNICEF both recommend use of the low-osmolarity formula.

Impact. ORT and ORS were critical in preventing more than one million diarrheal disease deaths annually by the 1990s. However, despite these successes, ORT and ORS use has stagnated in some countries and declined in others.^{44,45} From 1992 to

CHANGE IN ORT USE

ORT use has declined in 23 countries, 14 of which are located in Africa



Source: Ram et al, Bulletin of the WHO, March 2008.

Change in ORT use in children <3



ORS SUCCESS IN BURUNDI

Diarrhea is a leading cause of death in Burundi, accounting for 18 percent of deaths among children under five. Population Services International/Burundi has been distributing oral rehydration salts (ORS) through commercial outlets in Burundi under the brand Orasel since 2004 as part of a USAID-funded project to reduce childhood morbidity and mortality. Despite these efforts, a nationally representative baseline survey of female caregivers of children under five conducted in 2006 showed that just 20 percent of caregivers had administered Orasel to their child during the child's latest diarrhea episode. Although knowledge of the role of dehydration in causing death was nearly universal, fewer than one-third of caregivers felt capable of preparing and administering Orasel to a child. Based on these findings, PSI/Burundi implemented a variety of strategies to increase Orasel use, including conducting public demonstrations on how to prepare and use it, disseminating print and radio

messages about the benefits of Orasel, and changing the taste from a bitter flavor to an orange flavor. In the follow-up survey in 2007, use of Orasel among all caregivers had increased to 30 percent; among those who were highly exposed to the PSI campaign, 75 percent had treated their child with Orasel during the child's last diarrhea episode. Caregivers highly exposed to the campaign also showed significant increases in knowledge of signs of diarrhea, dehydration, and self-efficacy for Orasel use (from 28 percent at baseline to 88 percent at follow-up). Further, 86 percent of highly exposed caregivers reported having discussed Orasel use with others. These findings suggest that social marketing of ORS and skills-building interventions can improve ORS use among caregivers.⁴⁶

2005, ORS use declined in 23 countries, including 14 in Africa alone. This decline may be due to lack of knowledge about and access to ORS and ORT.⁴⁷

A recent study found that households in the poorest socioeconomic groups consistently experienced greater diarrhea death rates and used ORT less frequently than those in higher socioeconomic groups. This disparity may be due

to households in the higher socioeconomic group having better access to safe drinking water and sanitation as well as awareness of, access to, and funding for ORT and related health care services. To address this disparity, the researchers involved in the study recommended educating lower-income groups on the importance of ORT and making it more accessible and affordable.⁴⁸

ZINC TREATMENTS AND WATER DISINFECTION FOR INDIA'S POOREST

In India, 25 percent of diarrheal deaths occur every year in Uttar Pradesh (UP), one of the country's most populous and impoverished states. One of the main causes of diarrhea is the lack of clean drinking water. That is why USAID and Academy for Educational Development (AED) stepped in with a household water treatment program known as Point-of-Use Water Disinfection and Zinc Treatment (POUZN) with an aim to reach more than one million poor residents in the region. By combining these two important treatments, POUZN expects to halve the number of instances of diarrhea among children under age five. Self-help groups and grassroots organizations are working together with POUZN to provide households with water products and systems to create clean drinking water. Not only are the tools made available, but the families are also given information on why water disinfection is so critical. Community members are shown the contaminants in their water before water disinfection practices begin. Water samples from wells, lakes, and rivers, as well as water samples from water stored at home, are publicly tested to demonstrate contaminated water and how important it is to disinfect water before drinking it. POUZN is training and engaging grassroots organizations to promote improved diarrhea treatment to the Rural Medical Practitioners, who are the community's first recourse for advice and treatment when a child is sick.⁴⁹



However, the decline in use and awareness of ORS and ORT is not limited to developing countries. According to research conducted in 2008, 74 percent of pediatric health facilities in London were not aware of ORT use as an intervention for diarrhea.⁵⁰

:: Zinc Treatment and Other Micronutrients Problem. Zinc, an important micronutrient that is needed for the overall health and development of infants and young children, can become depleted through diarrhea.

Solution. Zinc is a critical new intervention for treating diarrhea, particularly in the developing world. It is a safe and effective treatment option

that can considerably reduce the duration and severity of diarrhea episodes, decrease stool output, and lessen the need for hospitalization. It may also prevent future diarrhea for up to three months.

Zinc can be administered as syrup or a tablet that is dissolved in clean water or breast milk. When using zinc to treat diarrheal disease, it is important that the full course of zinc is taken in conjunction with ORS/ORT and that follow-up and behavior change messages for caregivers are given to ensure full compliance.

Vitamin A supplementation is another important and low-cost intervention for controlling severe



Zinc Treatment Results In:

- 25% reduction in duration of acute diarrhea
- 29% reduction in duration of persistent diarrhea
- 40% reduction in treatment failure or death from persistent diarrhea ⁵¹

and potentially fatal diarrheal episodes. The relative risk of dying from diarrhea increases two-fold in children with vitamin A deficiency. In countries where under-five mortality rates are high, giving semi-annual vitamin A supplements to children 6 to 59 months old decreases overall mortality from all childhood diseases by 23 percent and mortality from diarrhea by 32 percent. A dose

of vitamin A for newborns has been found to be effective in reducing early mortality, and may soon be widely recommended.⁵²

Impact. In 2004, the WHO and UNICEF issued a joint statement recommending the use of a 10- to 14-day zinc treatment in conjunction with low-osmolarity ORS as a two-pronged approach to treat acute diarrhea in children.

In a study in Bangladesh, the use of zinc therapy not only expanded control of diarrheal diseases, but also increased use of ORS and decreased the administration of unnecessary antibiotics.⁵³ It has been determined that the use of both zinc and ORS for diarrhea can dramatically reduce the need for unscheduled IV therapy and, more importantly, reduce the number of diarrheal disease-related deaths.

PROGRESS: IDENTIFYING NEW INTERVENTIONS

■ The Institute for OneWorld Health (iOWH) is working on two new treatments to complement existing interventions. iOWH is working to develop novel medicines through a new approach by reducing or preventing the massive fluid loss that can lead to death by dehydration. Used in conjunction with ORT, such a medicine could speed recovery and help save many lives. Additionally, iOWH is in the early stages of discovery of antibiotic combination therapies that can overcome the emergence of dysentery-causing bacteria such as *Shigella* that are resistant to current antibiotic therapies.

■ PATH is working with public- and private-sector partners on new vaccines to address the main bacterial causes of diarrhea: enterotoxigenic *Escherichia coli* (ETEC) and *Shigella*, which combined are responsible for at least one million diarrheal disease deaths each year. For many infants, ETEC may be the first enteric illness they encounter, and *Shigella*, along with rotavirus, is the most frequent cause of hospitalization for infants and young children. These bacterial causes of diarrhea can easily spread in areas with poor sanitation and limited access to clean water, which are frequent concerns in the developing world. Their growing antibiotic resistance further underscores the need for vaccines to prevent these forms of bacterial diarrhea. A number of vaccine candidates for the prevention of ETEC and *Shigella* are in development, and they are moving through a series of rigorous preclinical and clinical trials to ensure their safety and efficacy.

■ Two oral vaccines (one an inactivated whole cell vaccine and the other an attenuated vaccine) against cholera, which is one of the deadliest forms of diarrhea, are already licensed internationally. However, work continues toward developing a vaccine that is both effective and affordable in low-resource and emergency settings. A vaccine tested in India by scientists working with the Seoul-based International Vaccine Institute recently demonstrated positive results that may pave the way for the world's first affordable cholera vaccine.

■ Pediatricians and research scientists at Yale University, Christian Medical College Vellore, and Flinders University are collaborating on the development and testing of a new starch-based ORS formulation that has shown promise in reducing symptoms faster and being more appealing to caregivers.

■ PATH is working with partners to develop a point-of-care diagnostic tool — a “lab-on-a-card.” This credit card-sized piece of plastic will contain minute amounts of the chemicals and reagents needed to translate a stool sample into an instant diagnosis. An accurate diagnostic tool that can be used in real-world conditions will help to quickly identify infections, determine efficient treatment plans, and avoid the inappropriate use of antibiotics that fosters resistance.

“It is still just unbelievable to us that diarrhea is one of the leading causes of child deaths in the world.” — Melinda Gates, Bill & Melinda Gates Foundation⁵⁴

Fighting Diarrheal Disease with a Coordinated Strategy

We have the lifesaving, cost-effective prevention and treatment interventions at hand to stop the second-leading killer of children worldwide.

Over the last three decades, millions of children's lives have been saved by protecting them against diarrheal disease through proven methods such as ORS, ORT, optimal infant and young child feeding practices such as exclusive breastfeeding, zinc treatment, improved hygiene, better sanitation, and the availability of clean water. But individual solutions alone will not be enough. We need a coordinated approach that involves both prevention and treatment solutions.

■ Because there are many different causes of diarrheal disease, we need to enlist every available intervention to ensure we are preventing and treating all of its forms. For example, rotavirus vaccines only prevent diarrheal disease caused by rotavirus, so additional methods are necessary in order to prevent and treat other forms of diarrheal disease.

■ Diarrhea prevention and treatment methods are complementary. Improved sanitation and hand-washing go hand-in-hand. Safe drinking water is a necessary component of ORS and ORT.

■ One intervention can mobilize the adoption of others. For example, the WHO and UNICEF recently issued a recommendation that zinc and ORS be used together as a two-pronged approach to diarrheal disease.

■ Combining and implementing interventions may be more cost effective.

We have the tools at hand. What we need now is a renewed commitment.

“Looking forward, the large-scale introduction of pneumococcal and rotavirus vaccines in developing countries will provide us with an historic opportunity to address two of the most important causes of mortality in children under five — pneumonia and diarrhea — in a comprehensive way...a focus on ORT, vitamin A, and zinc; community-case management of diarrhea and pneumonia; social and behavior change, including promotion of early and exclusive breastfeeding; hand-washing with soap; and home-treatment of water; as well as community sanitation approaches. By introducing these new vaccines as part of a comprehensive package of services and strengthening community-based systems, we will maximize their impact on MDG 4, and do so in a sustainable way.” — Saad Houry, Deputy

Executive Director of UNICEF.⁵⁵