CHAPTER 2

ORAL REHYDRATION SALTS

a miracle cure
About 50 million people owe their lives to oral rehydration salts solution, once described as ‘potentially the most important medical advance’ of the 20th century. Yet for years champions of the treatment at the World Health Organization and in the field were resisted by a sceptical medical establishment.

known as East Pakistan and now is called Bangladesh. They were refugees from the war of independence from Pakistan: men, women, children; a mass of half-starved humanity shambling like sleepwalkers in the heat. By the end of May, as temperatures soared to 40 °C and humidity rose to a stifling 90%, more than nine million refugees had crossed into India. It seemed to Mahalanabis that most of them had come to Bangaon (Photo 2.1).

The sheer number of hungry mouths would already have put a strain on the limited infrastructure of this rural area. But the refugees not only brought hunger, but

Bangaon, India, May 1971. There seemed to be no end to them. Every day, Dr Dilip Mahalanabis watched thousands of people cross the border from what was then
also sickness, and one in particular, a disease that thrived in the muddy, slow-draining delta of Bangladesh – cholera. In colonial times, British doctors said that cholera killed a man quicker than he could dig his own grave, and this was only a slight exaggeration. Without proper treatment, the disease can kill a person in a matter of hours, flushing the fluids out of the body in a watery stool.

The human body is mostly water and needs constant replenishment to stay alive. One of the most important ways the body absorbs and secretes water and salts is through tiny channels in the walls of the small intestine – a mechanism that allows the absorption into the bloodstream of nutrients from digested food. Mahalanabis studied cholera for several years at the Johns Hopkins International Center for Medical Research and Training in the Indian city of Kolkata, and made a close study of this process. He knew exactly how the cholera bacterium, *Vibrio cholerae*, turned off the body’s water supply like a hand closing a tap (Photo 2.2).

Cholera lives in the plankton of salt and fresh water. The bacteria enter the body in contaminated food or water. Most of the bacteria are torn into pieces by the stomach’s burning acids, but the few that get past enter the small intestine, grow, and swim through the pasty mucus that lines the small intestine. They then attach themselves to the wall and secrete a poison known as cholera toxin, which causes channels in the intestinal wall to open. This is where the damage is done. Salt leeching out through the channels carries with it water that causes the liquid stool known as diarrhoea. Adults have been known to produce as much as six litres of liquid a day. The loss of salts, which must be
maintained at a certain concentration for the body to function, is just as damaging for the body. The diarrhoea flushes bacteria back into the environment where the cycle begins again.

Cholera thrives where there are no proper toilets or sewers to carry away human waste and where clean drinking-water is in short supply. To a certain extent, the disease is also seasonal, taking advantage of warm, wet conditions, like during the monsoon season in Bangladesh (see Box 2.1 From Bengal to Bangladesh).

### Raining sickness and fear

Watching the refugees pour into Bangaon from war-torn Bangladesh, Mahalanabis knew the monsoon was only a month away and he feared what the rains could bring. The problem was that he and his colleagues in Kolkata and Dhaka, Bangladesh, did not have an effective weapon to fight diarrhoeal disease – at least, not yet.

It was thought that a ‘silver bullet’ like the smallpox vaccine might be found for cholera, but vaccines against the disease had turned out to be a big disappointment. They provided only partial protection for a short period of time and caused mild reactions.

Instead, Mahalanabis and other researchers focused on the problem of rehydration – how to get fluids back into a cholera patient, and get them to stay there. The obvious solution was to force the patient to drink litres of water, but that didn’t work because the fluid went through the digestive system too quickly to be absorbed by the body’s tissues.

Since the beginning of the 20th century doctors had been using another method. If the cholera bug was stopping the small intestine from passing fluids into the bloodstream, why not go round the intestine by injecting salty fluids known as saline directly into the patient’s veins? This approach, known as intravenous or IV therapy, had proved to be effective in hospital conditions, allowing patients to be rehydrated quickly. But outside the hospital environment it had several shortcomings.

Keeping everything sterile and getting a needle into a vein required some medical know-how. Given that most cases of diarrhoea occurred in developing countries where there was limited access to doctors and nurses, this...
presented a big problem. Moreover, diarrhoea – whether or not it was caused by cholera – mainly affected children under the age of five. Trained paramedic or not, it was difficult to get an IV needle into an infant’s tiny veins. Finally, there was the issue of cost. The fluid used had to be properly prepared in sterile conditions. All this posed logistical problems and cost money.

An alternative to IV was needed, and doctors like Mahalanabis thought they had one. It was based on a discovery that had been made several years earlier by doctors in two major research centres in the region: the Johns Hopkins Center for Medical Research and Training in Kolkata and the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) in Dhaka. In its simplest form it involved giving the patient a mix of sugar – known in science as glucose – and salt in water. The doctors in Kolkata and Dhaka called it oral rehydration salts solution and it had only ever been used by specialists to treat adult cholera patients in hospitals. But Mahalanabis, who had worked on oral rehydration as part of his research in Kolkata in 1966, thought it might be effective in children too. Having experimented with oral rehydration and achieved a decrease in patient fatalities from 50% to zero by the late 1960s, the doctors at the International Centre were also convinced it was an effective treatment (see Box 2.2 Kolkata or Calcutta?).

The reason the solution was so effective had to do with the chemical properties of sugar and salt. As stated earlier, simply giving a cholera patient salty water by mouth has no effect because the cholera toxin prevents the intestine from absorbing it. Not only that, the presence of salt in the intestine makes the problem worse, pulling water out through the intestinal wall. But – and here is the simple miracle of it – if sugar is added to the salt solution in the right proportions, all the chemistry changes. What happens is that the sugar and salt molecules become a co-transport coupling mechanism. Even in its poisoned state, the intestine will continue to absorb sugar, and because the salt is attached to it, the intestine absorbs that too. And with the salt goes the water. The result: rehydration.

**Box 2.2. Kolkata or Calcutta?**

Kolkata is the Bengali name for the city Calcutta, the capital of the Indian state of West Bengal. During the late 1990s, the state government, backed by writers, poets and artists, campaigned to change the city’s name to reflect the language and culture of its inhabitants. The proposed change was accepted by the Indian government and came into effect on 1 January 2001. Kolkata followed the example of other Indian cities, such as Mumbai, which changed its name from Bombay in 1995, and Chennai, formerly Madras, in 1996.
As effective as the technique appeared to be, at the beginning of the 1970s many people doubted it could work in the field without trained medical staff. Meanwhile, those who were interested in the approach, such as Dr Dhiman Barua, the World Health Organization cholera specialist, were warned by the medical community not to put oral rehydration in the hands of inexperienced staff. But Barua had seen what had happened during a cholera epidemic in 1932, in what later became Bangladesh. “I was about 11 years old at the time,” he recalls. “People died like flies, whole families were just wiped out. And the problem was we didn’t have the saline needed to treat them.”

Barua didn’t want others to experience what he had witnessed in 1932, but the situation did not look good. The seventh cholera pandemic had started in Indonesia in 1961 and, at the beginning of the 1970s, WHO was bombarded with requests for help as more and more countries became affected (see Box 2.3 Seven cholera pandemics). “I remember receiving a telegram from Africa, in which a consultant said, ‘I see children swimming in the cholera stools of their parents’,” Barua says. “The situation was desperate.” People were asking for thousands of tons of IV saline, but the cost of providing the product to the 40 countries afflicted with cholera was more than WHO’s budget could support.

Barua talked to doctors in Dhaka, Kolkata, and in the Philippines capital, Manila, to see if oral rehydration was a workable alternative. But the unanimous verdict was that this treatment should be left in the hands of experienced health workers. In the 1950s, before the technique was fully understood, early attempts to use oral rehydration in the USA had resulted in the deaths of several children from excess salt. Doctors feared that allowing unqualified people to dispense rehydration therapy could result in similar incidents.

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**Box 2.3. Seven cholera pandemics**

Cholera-like diseases have been described in ancient Chinese, Greek and Sanskrit literature. Since the 19th century, cholera has been particularly associated with the fertile Ganges river delta, with its labyrinth of waterways and swamps. Seven cholera outbreaks have sent waves of the disease across the world. In 1817, an outbreak was reported in the Jessore district of India (now in Bangladesh). From there, it travelled along trade routes throughout Asia and to the shores of the Caspian and Mediterranean seas. By 1823, the disease had receded to the Ganges delta, where it remained endemic.

One of the worst cholera years on record was 1854 when 23,000 people died in Great Britain alone. That was also the year that English physician John Snow first demonstrated the link between contaminated water supplies and the spread of cholera. Another milestone in the fight against cholera came in 1883 when German physician Robert Koch – one of the first doctors to study bacteria – first isolated the *Vibrio cholerae* bacterium that causes cholera, while studying outbreaks in Egypt and India.

The seventh pandemic originated in Indonesia and was caused by a different strain of the bacterium, termed ‘El Tor’. In 1970 it spread to Africa where it remains a problem today. The risk of cholera outbreaks often intensifies as a result of conflicts, disasters and other crises where there is a lack of clean water and sanitation. For example in the aftermath of the Rwanda crisis in 1994, outbreaks of cholera caused at least 48,000 cases and 23,800 deaths within one month in the refugee camps in Goma, the Congo.
The World Health Organization took the warnings seriously and responded by organizing crash courses in administering the solution, and published a document that included a chapter on oral rehydration. In Geneva, where the Organization has its headquarters, WHO also persuaded a pharmaceutical company to solve the problem of packaging the salts, which tended to form cakes inside the packages that were unusable. It was discovered that if the packs were made of aluminium foil of the right thickness, the mixture lasted for a long time and stood up to transportation (Photo 2.3). The new packets were sent out to affected countries with instructions for proper use. These were all moves in the right direction, but it wasn’t until after 1971 that a global shift in attitudes took place. It wasn’t until after what happened in Bangaon.

A desperate decision

The rains came in June, and the cholera came with them. The steady trickle of cases that Mahalanabis and his team treated, suddenly swelled into a full-blown outbreak as the refugees poured into the camp. By mid-June it had swollen to around 350,000 people, and was admitting 6000 new people per day.

Mahalanabis and his team set up wards in two cottages in the camp, which had 16 beds. The doctors singled out the most severe cases as they were brought in, then hooked them up to IV saline. The therapy worked wonders, but there were too many sick people, and, as always, not enough saline. Mahalanabis called for more supplies from Kolkata, which was not far away. Soon trucks arrived bringing IV saline, but in a matter of hours it had been all used up.

One in three people succumbed to the disease. The children were too weak even to cry. Some of them were only a third of their proper weight, little bundles of stick-like limbs attached to a hugely distended belly (Photo 2.4). Frantic calls for more saline brought more trucks. Soon a continuous convoy of trucks was running between Bangaon and Kolkata. But no matter how much saline the convoy brought, it was never enough.

A couple of weeks into June, it became clear to Mahalanabis that they were losing the battle. Something had to be done. The decision was taken to start administering oral rehydration salts solution on a massive scale, even though that meant handing it to people with no medical training. It was a
huge decision to make, one that went against the prevailing wisdom among the medical establishment in Dhaka and Kolkata.

But Mahalanabis saw no other choice, and he decided on a simple rehydration formula made of sugar, salt, and bicarbonate of soda, ingredients that had been found to be effective in severe cholera cases. He later wrote that he would have included potassium, a mineral that is essential to nerve and muscle function, if there had been enough of it available, but that wasn’t the case.

It was essential to get the quantities of each ingredient right, particularly salt, which could kill a child if there was too much. There was no room to put together tons of oral rehydration salts solution at the refugee camp. “We converted the library at Johns Hopkins Center into a factory,” Mahalanabis recalls. “We brought in drums with side-taps, filled them up and sent them to the field. We were essentially using people to experiment on. But we were pushed to the wall. We had no choice.” Staff weighed the correct proportions of sugar, salt and bicarbonate of soda and put the mixture into plastic bags along with instructions on how to dissolve it in water. The bags were then sent to Bangaon.

At the camp, Mahalanabis organized the staff into two groups. One group was given the task of treating the very sick, who were given IV saline to increase their fluid levels as quickly as possible. The job of dispensing the solution was given to everyone else – paramedics, friends and relatives (Photo 2.5). The instructions were very simple: as soon as the patient was able to drink – give him or her the solution.

In a sense, Mahalanabis had set in motion a huge experiment involving thousands of critically sick people. Over the next few days he watched for the tell-tale signs of hypernatraemia, a condition caused by excess salt in the bloodstream. It went well at first, but then the high salt content of the mixture began to make people vomit. This was particularly a problem in infants and small children. Adults presented other problems. As they became more hydrated and regained their strength, they started calling for plain water. Sometimes it was necessary to force the solution into patients, even feeding it through the nose.

One of the biggest challenges was getting paramedics and family members to administer a sufficient quantity of fluid, especially in the first stages of the disease. When someone died, it usually turned out that the patient had not received the massive amount of fluid needed.
However, as the days went by fewer people died, but patients still kept pouring in. There was so little room that Mahalanabis was forced to discharge many patients after only 24 hours and supply them with packages to continue rehydration treatment at home. But the treatment had been so effective that few patients came back. Mercifully admissions began drop to below 60 per day in the latter half of July. By the end of August, Mahalanabis knew that the worst of the cholera outbreak was over.

It was a stunning victory. Mahalanabis and his team had treated more than 3700 people during the peak period, and fewer than four in every had 100 died. The staff from the Johns Hopkins Center had treated 1200 people of whom only 12 had died – a remarkable 1% death rate. If proof was needed that the approach worked, Bangaon had given it.

However, despite these exceptional results many doctors continued to be sceptical, recalling how problematic the solution had been earlier. Later, when Mahalanabis produced a paper describing the Bangaon outbreak, several medical journals refused to publish it. Fortunately, the events at Bangaon had been witnessed by someone who was not so easy to ignore.

The Organization’s cholera specialist, Barua, had visited Bangaon during the crisis and what he had seen there amazed him. Here was a supposedly problematic therapy being administered by people with no training whatsoever. “They had these big five-litre packets of the salts which they mixed in drums that had a tap on the side, and then everyone just helped themselves to it with a cup,” Barua remembers. It was beyond simple. It was basic – a treatment that could work anywhere in the developing world.

As a treatment for cholera, oral rehydration solution was more than promising, but for Barua it went way beyond that. After all cholera was not the only bug that caused diarrhoea (see Box 2.4 The bug brigade).

### Box 2.4. The bug brigade

Bacteria, viruses and parasites – tiny agents too small to be seen with the human eye – can all cause diarrhoeal diseases as well as many other diseases. Most of these are spread by contaminated drinking-water and food due to poor hygiene and sanitation.

The bacteria that most commonly cause diarrhoea are *Campylobacter* spp. and *Salmonella* spp., which are both found in food products derived from animals, particularly poultry, and *Shigella* spp., which is transmitted through what is known as the faecal-oral route. This means that organisms excreted in human faeces contaminate people’s hands and, in turn, their food.

*Vibrio cholerae*, the bacterium that causes cholera, is usually found in contaminated water but can be present in food too. *Escherichia coli* (better known as *E. coli*) is another significant bacterial cause of diarrhoea. The *Clostridium difficile* bacterium is the most common cause of infectious diarrhoea in hospital patients.

Several viruses are commonly associated with diarrhoea including rotavirus, norovirus, cytomegalovirus and viral hepatitis. Meanwhile, parasites such as *Giardia lamblia* and *Entamoeba histolytica* can also provoke the condition. These minute organisms enter the body through food, water or person-to-person contact, and lodge themselves in the digestive system.
The condition can be provoked by several bacteria, as well as by a host of viruses and parasites. At the beginning of the 1970s, diarrhoeal diseases were the single major killer of children under five years of age worldwide. Barua believed oral rehydration had the potential to cut those figures.

To further test this hypothesis, Barua organized a clinical trial in rural centres in the Philippines where paramedics, after some training, treated children with acute watery diarrhoea with oral rehydration solution. The trial clearly demonstrated the acceptability, safety and effectiveness of this treatment and this finding provided a strong impetus to develop a global plea to promote oral rehydration solution to save lives (Photo 2.6).

**WHO’s global campaign**

First, Barua led an effort to establish a single oral rehydration salts formula to treat all episodes of acute diarrhoea among adults and children. It was an important breakthrough that greatly simplified discussions about the treatment, and enabled comparisons between countries. From that point, Barua put all his efforts into establishing a global campaign to fight diarrhoeal disease, and in 1978 WHO established the Diarrhoeal Diseases Control programme.

The main focus of the programme was children under five years. From the outset, WHO worked closely with the United Nations Children’s Fund (UNICEF) to achieve its goals, as well as aid agencies of individual governments, notably that of Denmark, Sweden, the United Kingdom and the USA, along with nongovernmental organizations. Meanwhile, resistance and opposition to rehydration salts formula continued from paediatricians, child health specialists, trained in the developed world; it required years of patient persuasion to win their support.

One of the first things WHO did was to issue guidelines for the assessment and treatment of patients with diarrhoea. The diagnostic process was stripped to a few simple questions and a brief examination to identify symptoms with no medical instruments or laboratory studies needed. Three kinds of diarrhoea or ‘syndromes’ were recognized: acute watery diarrhoea, bloody diarrhoea (dysentery) and diarrhoea that lasted longer than 14 days (persistent diarrhoea). The Organization recommended that all three forms of the condition be treated with oral rehydration solution until the diarrhoea stopped. Importantly, WHO also recommended continued feeding of the patient, and
the limited use of antibiotics only for bloody diarrhoea or severe cholera. The guidelines were summarized on a one-page treatment chart, which later found its way onto the walls of almost every health facility across the developing world.

Countries were also helped to develop their own national diarrhoeal disease control programmes, and five years after WHO’s Diarrhoeal Diseases Control programme came into being, 52 countries were launching their own plans. By 1986 that number had risen to 100 and eventually swelled to 130 countries, which were home to more than 99% of all children in the developing world.

Working together WHO and UNICEF made sure that these countries had a reliable supply of the solution, giving technical expert assistance where it was needed, helping them build factories and providing raw materials and packaging. By the end of 1985 more than 40 developing countries were manufacturing their own salts.

The development of national diarrhoea control programmes was a huge task. It required the training of hundreds of managers, tens of thousands of doctors, not to mention the veritable army of physicians’ assistants and nurses needed to provide care for children with diarrhoea. The Organization developed training materials and, with its partners – particularly the International Centre for Diarrhoeal Disease Research, Bangladesh in Dhaka – supported thousands of courses. It also worked with medical and nursing schools to get the treatment guidelines into their curricula, and with publishers to include them in influential medical textbooks.

The Diarrhoeal Diseases Control programme was nothing less than an attempt to change global attitudes to an ancient problem, and to address every parent on the planet struggling to care for a child sick with diarrhoea. In some cases, this meant telling mothers how to care for their babies. For example, numerous studies have shown that one of the best ways to reduce the risk of diarrhoea in infants is breastfeeding (Photo 2.7). Studies in Brazil and Iraq show that the risk of severe diarrhoea and diarrhoea death increases 20 times for babies who are not breastfed. But breastfeeding in developing countries declined in the 1960s and 1970s, reflecting a global trend that was driven by corporations arguing for the supposed advantages of breast-milk substitutes over mother’s breast milk. The decline in breastfeeding that resulted was particularly worrying in urban slums and shanty towns where diarrhoea was a major cause of death.
The campaign to change attitudes to treating diarrhoea was also difficult because mothers already used a range of treatments for diarrhoea. One of the biggest killers was the practice of starving the child to ‘rest’ the stomach, or to starve the microbe, worm or parasite. What parents didn’t know was that, even during the worst case of diarrhoea, more than half the normal absorption of nutrients took place. Cutting off food altogether, just meant that the weakened child was suddenly deprived of its main source of recovery.

Therefore, WHO needed to make mothers understand that the main cause of death from diarrhoea was dehydration, and then convince them that oral rehydration was the best way to counter it. Perhaps not surprisingly, it turned out that one of the most effective ways of doing this was to have the mothers give it to their own child and see how rapidly the child improved.

Working closely with UNICEF, WHO used a variety of approaches to get the message across to the mothers who didn’t come to the treatment centres, including teaching through the church or mosque, or by working with trusted figures in their communities. In some countries, this meant getting traditional midwives or schoolteachers to talk about oral rehydration (Photo 2.8). In other cultures, party officials or the heads of women’s organizations spread the word. Where possible – in Egypt and India for example – television, radio and newspapers were also used.

Because oral rehydration treatment is so easy to administer, and based on an equally simple preparation of ingredients, it is perhaps not surprising that in many cases, public information campaigns brought about a big change in attitudes. In Bangladesh in 1984, for example, a public information campaign resulted in more than 50% of primary schoolchildren learning how to make the solution themselves, while in over 74% of homes, home-made solutions were being used to treat diarrhoea. This use of home-made solutions was a result of UNICEF’s promotion of the use of household ingredients such as rice gruel, starchy soups or sugar and salt to prevent dehydration.
Continuing research

The World Health Organization also supported research into improving the oral rehydration salts formula. When new research revealed that substituting sodium citrate for sodium bicarbonate made the formula more stable – dramatically increasing its shelf life and making it cheaper to pack – WHO revised its guidelines.

Research into diarrhoeal disease control was not limited to improving the oral rehydration mix. By 1983, WHO’s Diarrhoeal Diseases Control programme was backing 147 biomedical research projects, nearly half of which were based in developing countries. The development of effective and affordable vaccines against diarrhoeal disease continues to be challenging, although there have been encouraging developments to make new vaccines for rotavirus more accessible in some countries.

Meanwhile, other simpler measures have been developed that look promising. A series of studies in the 1990s and early 2000s showed that watering down the concentrations of some ingredients makes oral rehydration solution more effective. At field research centre of the International Centre for Diarrhoeal Disease Research, Bangladesh, children who had diarrhoea and were given a 10-day course of zinc tablets in addition to oral rehydration therapy had shorter episodes and 30% fewer relapses, and 20% fewer developed pneumonia, reducing non-injury death by 50%. Since 2004, these new findings have been included in the recommendations made by WHO and UNICEF for the management of diarrhoea. An programme run by the International Centre for Diarrhoeal Disease Research, Bangladesh, now aims to provide zinc tablets to every child under five in Bangladesh and many other counties are moving towards national coverage with zinc treatment of diarrhoea such as Ethiopia, India, Indonesia, Madagascar, Pakistan and the United Republic of Tanzania.

One of the biggest challenges faced by WHO’s Diarrhoeal Diseases Control programme was getting a clear picture of the impact of diarrhoeal disease on the global population along with the effectiveness of oral rehydration solution. Monitoring and evaluation mechanisms were set up by WHO to find out the extent to which the solution was being made available to children under five years old, and what effect it was having on sickness and deaths due to diarrhoea.
The first reliable estimate of global mortality – i.e. the number of deaths – from diarrhoea among young children was reported by Dr John Snyder and Dr Michael Merson who showed that in 1980 diarrhoea was killing 4.6 million children annually, and was implicated in nearly a third of all deaths of children under five years of age. By the mid-1980s, surveys undertaken by 40 countries working within the Diarrhoeal Diseases Control programme showed that Barua’s campaign was beginning to bear fruit.

Where only 6% of children under five had access to oral rehydration solution in 1982, around 33% were receiving it in 1985. The numbers were even more encouraging in WHO’s Eastern Mediterranean and Western Pacific regions, where 40% of children were receiving the treatment, and in South-East Asia, where 66% were reported to be receiving it. All over the globe people were seeing a marked decline in deaths due to diarrhoeal disease. At the Massey Street Clinic in Lagos, Nigeria, for example, the number of child deaths due to diarrhoeal disease fell from 17% to 3% within seven months of setting up of the oral rehydration clinic there. By the mid-1980s, diarrhoea deaths were falling by between 40% and 50% in Egypt, Honduras, the Philippines and Thailand.

Snyder and Merson had shown that in 1980 an estimated 4.6 million children under five years died each year from diarrhoea, but by 2000 the number had fallen to around 1.8 million. By 2007, diarrhoea as a cause of death in young children had fallen from an estimated 33% of deaths to 18% since the 1980s. This drop is largely responsible for the decline in overall deaths among young children, from 14 million globally to just under 9 million during this 20-year period. It has been estimated that oral rehydration treatment saved 50 million lives in the past 25 years. One of the reasons the international medical journal *The Lancet* once described it as “potentially the most important medical advance of the 20th century”.

**The real front line**

Despite the enormous progress in saving lives, poor sanitation, unclean water (Photo 2.9) and inadequate education about hygiene in developing countries continues to be the root of the problem. Diarrhoeal diseases still kill around
1.4 million children every year and children are still getting sick at roughly the same levels as they were back in 1970 – suffering on average three episodes of diarrhoea per year.

Oral rehydration treatment cannot stop children from getting sick, but it can prevent them from dying. For this reason, the front line in the war against diarrhoeal disease is not likely to be a vaccine laboratory. It will be a village well in Cambodia, or a standpipe in an Angolan shanty town (see Box 2.5 Necessity of a sanitary world).

In Ethiopia, only 40% of people have access to safe water, while less than a third has regular access to basic sanitation. For these two simple reasons, the average Ethiopian child suffers on average five to 12 episodes of diarrhoea per year, resulting in around 50 000 to 112 000 deaths every year.

Real change in Ethiopia will come with programmes like the current initiative supported by nongovernmental organizations to build pit latrines.

Almost 90% of diarrhoeal diseases can be attributed to contaminated water and/or food, and inadequate sanitation and hygiene. It has been estimated that by improving the water supply it is possible to reduce death as a result of diarrhoea by up to 25%, while improving sanitation can cut diarrhoea

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Box 2.5. Necessity of a sanitary world

For people living in developed countries where proper sanitation and access to clean drinking-water are widely available, diarrhoea is little more than an occasional inconvenience. But for the 1.1 billion people who lack a regular supply of clean water and the 2.6 billion living without proper sanitation, it can be a killer disease.

Clean water comes from: public standpipes, tube wells or boreholes; protected dug-wells; springs; and rain water. Sources of water that are unsafe to drink are: unprotected dug-wells and springs; carts with a small tank; tanker trucks; and surface water, such as rivers, dams, canals and irrigation channels.

Proper sanitation decreases the chance of people coming into contact with human waste thus reducing the spread of disease. This includes toilets that flush waste into a piped sewer, septic tanks, and pit latrines that have a cover; latrines that circulate air to eliminate flies and smell; and composting toilets, which transform human waste into organic compost.

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deaths by around a third. Hygiene education – which may be as basic as teaching people the importance of hand-washing – can reduce diarrhoea cases by around 45%.

The WHO designated the 1980s the International Drinking-water Supply and Sanitation Decade. During this period the Organization encouraged its Member States to improve water supply and sanitation, which resulted in an additional 1.6 billion people getting access to safe water. But that still left 1.2 billion people in developing countries without access to clean water.

In March 2010, a WHO/UNICEF report warned that the world was in danger of missing the Millennium Development Goal for sanitation by 2015. Given the prevailing outlook on the world’s water supplies and sanitation status, oral rehydration salts solution is likely to continue to be an essential tool for saving lives (see Box 2.6 Fact file: oral rehydration salts (ORS) solution).

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**Box 2.6. Fact file: oral rehydration salts (ORS) solution**

**When was it first used on a large scale?** In 1970, in a refugee camp along the Bangladesh border during the war of independence. In 1978, WHO issued a recommendation to use a single ORS formulation to treat clinical dehydration from acute diarrhoea of any origin and at any age, except when it is severe. In 1984, the mixture was changed (tri-sodium citrate replaced sodium bicarbonate) to make it more stable in hot and humid climates. Finally in 2004, the mixture was further modified (reduction in the concentrations of both sodium and glucose) to make it more efficacious (reduction in stool volume, vomiting and need for unscheduled intravenous drip to treat diarrhoea).

**What is it made of?** The solution is a glucose and salt-based formula, recommended by WHO and UNICEF for the treatment of dehydration due to acute diarrhoea irrespective of the cause or age group affected. The new ORS solution recommended since 2004 consists of a balanced combination of sugar (glucose), sodium, potassium, and tri-sodium citrate.

**How does it work?** Each component plays a special role that makes ORS effective. The sugar (glucose) allows the intestines to absorb the sodium, which in turn, drags the water into the intestinal cell and the body. Potassium replaces this essential ion, which is lost during diarrhoea and vomiting. Citrate is used to treat the high level of acidity that builds up in diarrhoea patients. The proportions of the different ingredients must be accurate, to ensure maximum efficacy.

**How is the mixture packaged?** In packets containing 20.5 g of mixture (to prepare 1 litre of ORS solution) made of aluminium foil to protect it from humidity. These packets are packed in boxes of 100 and shipped in overseas containers.

**How are the ORS packets distributed?** At the point of use, each packet is mixed in one litre of drinking-water. The packets can be delivered by village health-care workers and by mothers in the home, with some guidance. To prevent or to treat dehydration, ORS is used in every child with acute non-cholera diarrhoea, as well as adults and children with cholera. Along with proper feeding practices, and the administration of zinc supplements, as recommended by WHO and UNICEF since 2004, ORS treatment will lead to better weight gain, and thus reduce the adverse effects caused by diarrhoea in children.