V Food hygiene and sanitation in infants and young children: a paediatric food-based dietary guideline

Bourne LT,[1] (RD)SA, PhD, Senior Research Specialist, Environment and Health Research Unit, Medical Research Council
Pilime N, MSc, Nutrition Advisor, United States Agency for International Development
Sambo M, BSc, Research Intern, Environment and Health Research Unit, Medical Research Council
Behr A, BSc, RD(SA), Deputy Director: Nutrition, National Department of Health
Correspondence to: Lesley Bourne, e-mail: lbourne@mrc.ac.za
Keywords: food-based dietary guidelines, FBDGs, hygiene, sanitation, infants, young children

Abstract

This paper has three related aims. Firstly, it aims to profile the current food hygiene and safety needs of children under the age of five in South Africa. Secondly, to reflect the importance of domestic hygiene, access to water and sanitation in reducing the transmission of gastrointestinal pathogens while feeding infants and young children. And, thirdly, to highlight the need for collaboration between healthcare professionals and the local authorities who provide basic services. Food safety and hygiene needs for people living with HIV/AIDS (PLWHA) have been mainstreamed in the various sections addressed in this paper that underpin the importance of food safety and hygiene in immune-compromised individuals. The following topics have been covered: water and sanitation, food safety and hygiene, hand washing and personal hygiene, hygiene and sanitation for PLWHA, relevant primary healthcare strategies (e.g. oral rehydration solutions), rotavirus immunisation, and vitamin A and zinc supplementation. Additionally, the paper discusses relevant interventions to prevent diarrhoeal disease. This review utilises sourced references in both global and local evidence-based studies by conducting repeated literature searches via PubMed, the Cochrane Collaboration, Google Scholar, EBSCO Information Services and United Nations' agency documents, as well as the "grey" literature (theses, research reports and other non-indexed material). The main keywords "hygiene", "sanitation", "infants" and "young children" were used, in addition to other keywords and key phrases referred to in the text. On the basis of the literature review, it is proposed that the following message is tested for inclusion in the food-based dietary guidelines for infants and young children: "Hands should be washed with clean water and soap before preparing, feeding or eating, and after going to the toilet".

Ⓟ **Peer reviewed. (Submitted: 2013-04-13. Accepted: 2013-10-12) © SAJCN** **S Afr J Clin Nutr 2013;26(3)(Supplement):S156-S164**

Introduction

The under-five mortality rate in South Africa remains unacceptably high. According to the November 2011 National Department of Health Report of the Health Data Advisory and Coordination Committee (HDACC), the figures for under-five infant mortality rates, neonatal mortality rates and live births were 56 per 1 000, 40 per 1 000 and 14 per 1 000, respectively.[1] Child mortality according to cause of death, derived from adjusted vital statistics data in combination with the Actuarial Society of South Africa model,[2] appears in the 2000 Medical Research Council report that dealt with estimates of provincial mortality as part of a South African burden of disease study.[3] The major causes of childhood deaths include diarrhoeal disease, lower respiratory tract infections and neonatal conditions. Human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) and malnutrition contribute to primary and underlying causes of child mortality.

Deaths due to diarrhoeal diseases are classified as preventable deaths. The HDACC reports that the implementation of the interventions entailed in the national strategic plan for HIV, AIDS and tuberculosis (2012-2016) can be expected to produce a decline in the under-five mortality rate of 10%. Additional efforts to strengthen routine immunisation and the provision of vitamin A supplementation, the introduction of the rotavirus and pneumococcal vaccines, and the promotion of exclusive breastfeeding also suggest that the under-five mortality rate could decline by 10% between 2009 and 2014.[1] Community-based strategies to reduce diarrhoea, such as hand washing and knowledge of oral rehydration therapy (ORT), must be implemented if substantial reductions are to be achieved.[4]

The leading cause of death in all provinces is HIV and AIDS, followed by diarrhoeal diseases (recognising that the two may also overlap). For instance, in the Eastern Cape and KwaZulu-Natal, arguably the most impoverished provinces, diarrhoeal diseases account for 16.15% and 9.6% of deaths in children aged 0-4 years, respectively, while in Gauteng and the Western Cape, arguably the two most affluent provinces, mortality from diarrhoeal diseases account for 5.3% and 10.2% of deaths, respectively, in this age group.

Inadequate sanitation, water supply and poor hygiene practices increase exposure to infectious diseases,

especially diarrhoea.[3] Water is essential for health, hygiene and sanitation. Young children are particularly vulnerable to illnesses that are associated with poor water quality, such as diarrhoea and cholera. In 2008, approximately 7 million children lived in households without access to clean drinking water on site. There was little improvement in access to water from 2002-2008.[5] Poor sanitation compromises children's health, safety and nutritional status, and is associated with diarrhoea and other diseases. Despite the state's goal to provide adequate sanitation to everybody, and to eradicate the bucket system, approximately 7 million children still use unventilated pit latrines, buckets or open land.[6] Improving access to water and sanitation will improve infant and child health only if it is supported by safe hygiene practices.

Access to basic services for piped water, drinking water on site and basic sanitation varies among the provinces. To exemplify this, in the Eastern Cape, 35.3% of children live in households with drinking water on site. In Limpopo, 28.8% of children live in households with basic sanitation. The percentage of households with access to piped water varies from 70.8% in the Eastern Cape, to 97.9% in Gauteng.[7]

Method

This review paper has utilised sourced references in both global and local evidence-based studies, by conducting repeated literature searches via PubMed, the Cochrane Collaboration, Google Scholar, EBSCO Information Services and United Nations' agency documents, as well as the "grey" literature (theses, research reports and other non-indexed material). The main keywords "hygiene", "sanitation", "infants" and "young children" were used, in addition to other keywords and key phrases referred to in the text.

Literature review

Movement of pathogens and combating pathogens: the F diagram

Infants (children < 1 year old) are more prone to food-borne diseases, because of their immature immune systems and developing gastrointestinal tracts. In addition, infants and young children consume more food in proportion to their body weight than adults, hence the physiological consequences of food-borne toxins and contaminants are greater. Diarrhoea is caused by infectious organisms, including viruses, bacteria, protozoa and helminth infestations that are transmitted from the stool to the mouth[8] through contaminated water (fluids), hands (fingers), flies and soil (fields and floors) and food. A schematic diagram (Figure 1) shows the environment-related different disease transmission routes. This diagram is also known as the F diagram, because the main pathways begin with the letter "F". This diagram is frequently used in health education.

Understanding how pathogens are transmitted allows public health workers and carers of children to intervene in appropriate ways to break the transmission cycle, save lives and reduce unnecessary suffering.

Fingers are probably the most important transmission route, because children tend to put them in their mouths after contact with contaminated food and surfaces. The

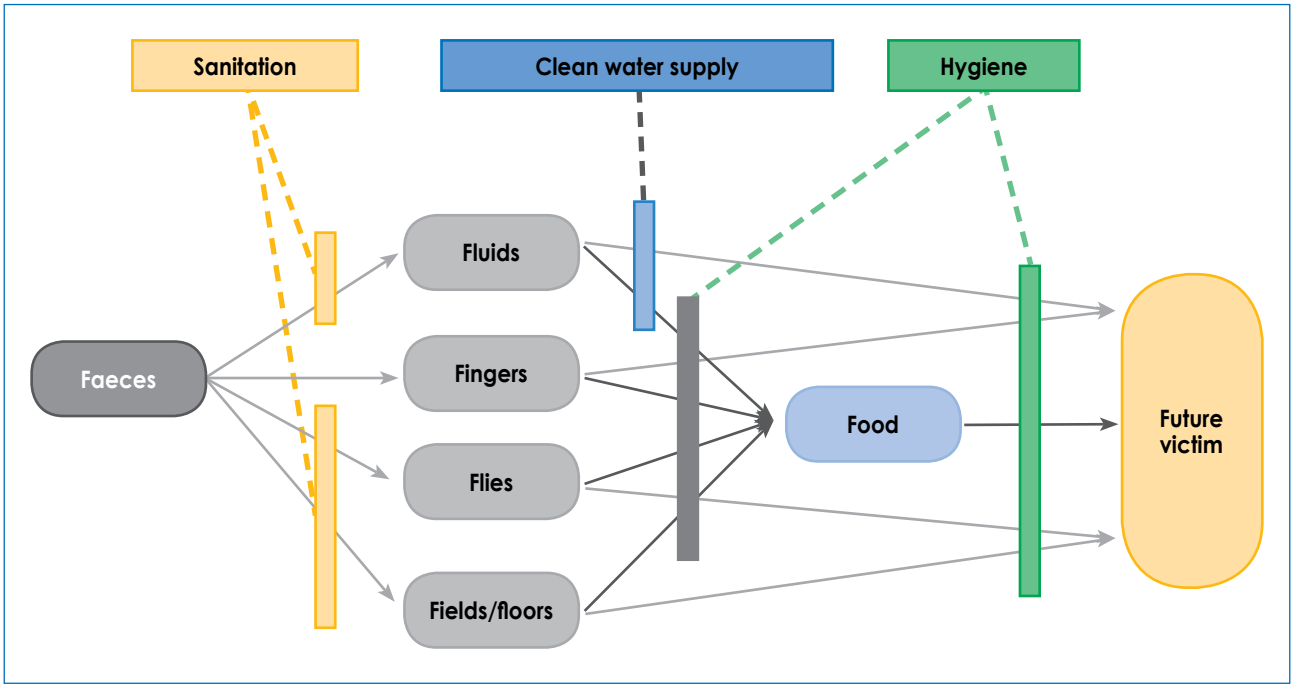

Figure 1: Faecal-oral transmission route diagram, or the F diagram[9]

environment in which children live and play inside and outside the home has a large influence on children's exposure to gastrointestinal pathogens. Children may lack hygienic practices, and there may be random defecation prior to toilet training.[10]

Disease may also spread through close interpersonal contact with other children and adults. Flies carry disease, and are particularly attracted by pit latrine or bucket system toilets. Flies can transfer organisms from faeces to food by carrying them on their bodies, by vomiting on solid food in order to liquefy the food, and by defecating on food. The faeces and vomitus of the fly may contain viable infective organisms from human faeces. Barriers can effectively stop the transmission of disease. These can be primary, e.g. preventing initial contact with the faeces, or secondary, e.g. preventing it being ingested by a new person. Transmission can be controlled by water, sanitation and hygiene interventions.

Water supply

Clean water is essential for human survival. An adequate and safe water supply is needed for drinking, washing vegetables and fruit, preparing food and drinks, cleaning utensils and personal hygiene, especially hand washing. Water is a route of transmission of faecal material, both at the source and at the point of use. Safe water collected outside the house can become recontaminated in the home from contact with faecally contaminated hands or fingers, or storage in dirty or uncovered containers.[11]

Space constraints in low-income areas necessitate that water storage is mostly in the form of small containers. These are often kept open inside a dwelling, and are thus susceptible to faecal and other contamination.[12] In some cases, water is collected from a contaminated source to begin with. In other cases, water is obtained from a source of high microbiological quality, including treated supplies that contain residual chlorine, but it becomes contaminated in the home because of inadequate and unsanitary storage conditions which facilitate the introduction or proliferation of disease-causing microbes. In either situation, the microbially contaminated water poses health risks that can be reduced by improved storage conditions and household treatment. By contrast, large containers are generally kept closed and outside the home, which is far safer with respect to contamination. In order to reduce the risk of microbial contamination, health professionals frequently advise sick individuals to boil water. However, various barriers, such as lack of social support, expense and maternal depression, are known to compromise the effectiveness of such barriers.[13]

In Tanzania, Pickering et al found that stored water contained between 1.4 and 1.8 times more faecal indicator bacteria material, which is used to indicate the presence of faeces in water and on hands, than the sources from which it was obtained.[14] In the south-eastern Free State, Jagals et al found that members of the case group living between 10 m and 100 m from their respective communal taps were exposed to higher total coliform counts in container-stored water, which could be attributed to the type of container used, as well as to the way water was fetched and stored in these containers.[15] However, when water is freely available at close range, hand washing becomes more frequent.[16] Households in rural and informal settlements have no access to basic water, and often share water points at a distance of approximately 200 m from the dwelling.[17]

Sanitation

Adequate sanitation aims to prevent the spread of disease and promote health through safe and hygienic waste disposal. Good sanitation is essential for a safe and healthy childhood. It is very difficult to maintain good hygiene without water and toilets. Poor sanitation is associated with diarrhoea, cholera, malaria, bilharzia, worm infestations, eye infections and skin diseases. These illnesses compromise children's nutritional status. Using public toilets and open fields away from home can also put children in physical danger. The use of open areas and bucket toilets is also likely to have consequences on water quality in the area, and to contribute to the spread of disease.[18]

A wide gap exists between urban and informal settlements with regard to access to proper sanitation in Cape Town, as well as other urban settings in South Africa. Approximately 47 650 informal households have no access to toilets.[19] Most of the people dispose of their faeces in near proximity to their houses because public toilets are far from their homes, a practice that is associated with a high incidence of diarrhoea in children. A study from Uganda found that the incidence of childhood diarrhoea was highest in households without any established toilet structure. It also showed that access to a private, covered pit latrine was associated with the greatest reduction in the incidence of diarrhoea in children.[20] Two studies in Lesotho reported that water source and sanitation correlated with linear growth in children. In addition, latrine ownership was associated with a reduction in the risk of stunting. A field study of 230 Peruvian children younger than three years of age showed that improved water supply and sanitation may improve the linear growth of children.[21] Children with the worst circumstances with regard to water source, storage and sanitation were one centimetre shorter and experienced 54% more diarrhoeal episodes than those

children in optimal conditions.[21] Inadequate water and sanitation correlated with increased diarrhoeal incidence, but was not associated with the duration of diarrhoea.[22]

Hand washing and personal hygiene

Hand washing with clean water and soap is one of the most effective and cheapest measures against gastrointestinal infection. Hand washing with ordinary non-antibacterial soap is much more effective in removing bacteria from hands than hand washing with water alone.[23] In many low-income homes, household soap is costly and is often stored in places that are not easily accessible,[24] while liquid soap and alcohol-based sanitisers are expensive for these communities.[25] In fact, spaza shops stock soap and cut it into small blocks, since some households cannot afford to buy an entire bar. Soap plays an important role in the hand washing process, because it can effectively remove dirt and soil on surfaces and skin.[26] Hand washing should be carried out after using the toilet in particular, after changing nappies, before expressing breast milk and before food preparation. However, it is important to continue practising hand washing before and after handling raw meat, poultry and fish products during food preparation to prevent cross-contamination, before serving, before eating, after coughing, blowing the nose and sneezing, as well as after handling unsanitary objects, such as garbage containers, and contact with toxic chemicals.[27]

In a systematic review of 17 studies, Curtis and Cairncross concluded that hand washing with soap plays an important role in preventing diarrhoeal disease, and that hand washing was also correlated with a reduced risk of severe outcome.[28] In a study conducted in rural Bangladash, Luby et al[29] concluded that household interventions which improve the presence of water and soap at a designated place for hand washing could improve hand washing behaviour. Generally, anecdotal evidence points to the fact that in South Africa, the further an individual has to walk to wash his or her hands after defecation or before preparing food, the more likely it is that he or she will be distracted by another activity.

The role of primary healthcare interventions in diarrhoea, and in morbidity and mortality

Rotavirus and oral rehydration therapy

Rotavirus is the most common cause of severe dehydrating diarrhoea in infants worldwide.[30] A review by Munos et al[31] on the effectiveness of the rotavirus vaccine estimated that rotavirus vaccines were associated with a 74% reduction in very severe rotavirus infections, a 61% reduction in severe infections, and reduced rotavirus-related hospital admission in young children of 47%.

In most cases, deaths due to diarrhoeal disease are caused by dehydration. Oral rehydration therapy involves the administration of appropriate fluids by mouth to prevent or correct dehydration that is the result of diarrhoea. This can be achieved at home using a salt-sugar solution, or by giving an adequate glucose-electrolyte solution called an oral rehydration solution by mouth. The salt-sugar solution and oral rehydration solution are the simplest, most effective and cheapest ways of keeping children alive during severe episodes of diarrhoea. The oral rehydration solution is absorbed in the small intestine, thus replacing the water and electrolytes lost.[31]

In a review of the efficacy and effectiveness of oral rehydration solution and recommended home fluids, Munos et al[32] (WHO)[45] concluded that the use of oral rehydration solution reduced diarrhoea-specific mortality by 69% and rates of treatment failure by 0.2%, mostly in developing countries.

Vitamin A and zinc supplementation

The Scaling Up Nutrition framework recommends improved hygienic practices, vitamin A supplementation and therapeutic zinc treatment for the management of diarrhoea as key evidence-based direct nutrition interventions, to prevent and treat undernutrition in young children and their mothers.[33] In their review of zinc supplementation for diarrhoea, Walker et al[34] concluded that zinc administration for diarrhoea management significantly reduced all-cause mortality by 46% [relative risk (RR) 0.54, 95% confidence interval (CI): 0.32-0·88) and hospital admission by 23% (RR 0.77, 95% CI: 0.69-0.85). Zinc treatment resulted in a nonsignificant reduction in diarrhoea mortality of 66% (RR 0.34, 95 CI: 0.04-1.37), and diarrhoea prevalence of 19% (RR 0.81, 95% CI: 0.53-1.04).

Vitamin A deficiency compromises the immune system, which, in turn, increases the risk of disease, and even death, from diseases such as malaria, measles and diarrhoea. A Cochrane review of 43 randomised trials showed that vitamin A supplementation reduced all-cause mortality by 24%, and diarrhoea-related mortality by 28%, in children aged 6-59 months. Vitamin A supplementation also reduced the incidence of diarrhoea and measles in this age group.[35]

While the management of childhood illness focuses on treatment, the United Nations Children's Fund Integrated Management of Childhood Illnesses approach also provides the opportunity to emphasise the prevention of illness through education on the importance of rotavirus immunisation, ORT, micronutrient supplementation (zinc and vitamin A), breastfeeding and infant feeding.[36]

Home sterilisation of water

The practice of home purification of water is important in reducing diarrhoeal incidences. In the study entitled "An investigation into risk factors associated with the cholera epidemic in KwaZulu-Natal during 2000", knowledge and use of home water purification techniques was shown to be significantly associated with decreased diarrhoeal disease. Boiling and the use of sodium hypochlorite, (i.e. household bleach) were the most common techniques used.[37]

Methods for water purification include:[38]

- Bringing the water to a rolling boil, and then cooling it before consumption.
- Adding calcium hypochlorite, such as household bleach, to a bucket of water (one teaspoon or 5 ml in 25 l), mixing it thoroughly and allowing it to stand for at least 30 minutes prior to consumption. Turbid water should be clarified by settling and/or filtration before disinfection.
- Vigorously shaking small volumes of water in a clean transparent container, such as that used for a soft drink, for 20 seconds, and exposing to it to sunlight for a least six hours.

The most common techniques used to purify water that has been contaminated at the source include boiling and the use of sodium hypochloride (i.e. household bleach). However, boiling water requires energy from fire wood, electricity, paraffin or gas. These sources of energy are expensive for the majority of the people in rural areas, and can be economically and environmentally unsustainable. Household bleach is inexpensive. However, it may contain impurities and additives that may be harmful if ingested. Using too much bleach may result in an unpleasant taste that may discourage use.[39] Therefore, standard concentrations of household bleach should be monitored at manufacturing and distribution points to ensure consumer safety.

Infant and young child feeding

Table II provides guidance on how to maintain good hygiene during exclusive breastfeeding and expressing milk for infants.

The WHO recommends five key steps for food safety. South Africa has adopted these:[41]

- Keep clean by washing the hands, surfaces and equipment used in food preparation, washing cutting boards (as pathogens are carried on the hands), and wiping cloths and utensils. Protect kitchen areas and food from insects, pests and other animals, as they can also transfer pathogens.
- Separate raw and cooked food, such as raw meat, fish and chicken, which may contain gastrointestinal pathogens which can be transferred to other food during preparation and storage.
- Cook food thoroughly at a minimum of 70°C to ensure that it is safe for consumption.
- Keep food at a safe temperature. Pathogens can multiply very quickly if food is stored at room temperature. Therefore, timeously refrigerate cooked and perishable food, preferably < 5°C, and keep cooked food hot (> 60°C) before serving.
- Use safe water and raw materials. Use safe water to wash vegetables and fruit, and for drinking and food preparation.

However, two extra keys steps can be included:

- Prepare fresh food for infants and young children, and give it to them immediately after preparation, when it is cool enough to eat. Food that is prepared for infants and young children should not be stored at all.
- Cooking food reduces the number of microorganisms and inhibits the growth of moulds, yeasts, and bacteria which promote decay and infection. However, when food is allowed to stand at high ambient temperatures after being cooked, the multiplication of pathogenic bacteria is promoted.[42] Therefore, before feeding, stored food should be reheated thoroughly. Again, this means that all parts of the foods must reach at least 70°C, i.e. it should not boil. When available, microwave ovens can be used to heat food, as they use less energy than an electrical plate and comparatively little time.

Food labelling and date marking

When selecting food, mothers and caregivers should pay attention to information that is provided on food labels in South Africa. When functional literacy is low, the terms can appear to be abstract, and so the health professional might need to take the time to educate mothers and caregivers to especially date marking.[43]

Table II: Hygiene and feeding[40]

Exclusive breastfeeding	Expressing
• Wash your hands with soap and water before breastfeeding • Wash your breasts with plain water daily	• Wash your hands with soap and water before expressing • Use clean containers to collect and store the expressed breast milk
General	
• Clean the cups and utensils • Wash the feeding cups and expressing utensils with water and soap • Use a soft brush or cloth to remove milk that is left in the containers • Rinse everything in fresh hot water • Cover the equipment with a clean cloth to keep insects and dust off it • Only remove the equipment from under the cloth when you need to sterilise it	

It is mandatory, based on the Regulations Relating to the Labelling and Advertising of Foodstuffs, for almost all food labels, with a few exceptions, to provide a "best before" and/or "use by" and/or "sell by" date on the product, depending on its nature.[43] The date marking is determined by the manufacturer, based on the time during which the food product will remain safe, retain the desired sensory, chemical, physical and microbiological characteristics, and comply with any label declaration of nutritional data, such as that pertaining to nutrient content claims. The term "use by" is generally used for perishable food products, such as fresh milk, meat, fish and eggs, after which the microbiological stability, and thus food safety, is questionable. Therefore, it is not recommended that food which is past its "use by" date is given to children, especially if they are immunocompromised. A "best before" date signifies the date after which the food will not have the quality attributes that are normally expected, such as flavour and texture, although the product may be perfectly satisfactory and safe to eat, especially if it has been kept under the recommended storage conditions. This date pertains to quality, not safety, and is usually applied to food with a long shelf life. The "sell by" date is a tool for the store that sells the product to know for how long it can continue to sell the item. Therefore, often a product will contain a "sell by" and a "use by" or "best before" date. Mothers and caregivers should not purchase products that have extended beyond their "sell by" date. Date marking is now also required for donated foods.[43]

The water and sanitation needs of people living with HIV/AIDS

South Africa has the highest number of people infected with HIV in the world.[44] Clean water is crucial to maintain the quality of life of PLWHA, and for the success of home-based care of PLWHA. AIDS is not a water-related disease. HIV is not spread via contaminated water or poor hygiene. Safe drinking water is necessary to take medicine, and nearby latrines make life more tolerable for weak patients. Finally, water is needed to keep the house environment and latrine clean in order to reduce the risk of opportunistic infections.[38]

Diarrhoeal diseases are the most common opportunistic infections experienced by PLWHA in Africa and elsewhere. Most of these diarrhoeal opportunistic infections are water-borne or water-washed, and cause significant loss of functional days (missed work and school days) and loss of income, considerable human suffering, increased burden on caregivers, the weakening of general health, and eventually death. Diarrhoeal diseases also reduce the absorption of antiretroviral medicines and essential nutrients.[45]

Water, sanitation and hygiene practices, such as hand washing and water treatment and safe storage, have all been proven to reduce the rate of diarrhoea by 30-40%.[36,46,47] Water quality and supply, sanitation and hygiene practices also help to prevent caregivers and other household members from contracting water-related diarrhoeal diseases. A healthier and stronger household is more economically viable and resilient in the face of HIV challenges.

PLWHA have compromised immune systems, making them more susceptible to opportunistic infections, such as diarrhoea and skin diseases. For example, diarrhoeal rates are 2-6 times higher in PLWHA than in those who are not infected, and the rate of acute and persistent diarrhoea is twice as high in populations of PLWHA as it is in uninfected populations.[48] Infections reduce the quality of life of people living with HIV, and can speed the progression from HIV to AIDS.

Therefore, PLWHA and households that are affected by HIV and AIDS have a substantially greater need for access to water and sanitation. Evidence indicates that HIV-affected households require more than the 20 l of water per capita daily,[49] including 1.5 l of safe water required to take medication. Women in southern Africa require 24 buckets of water a day to wash people living with AIDS, as well as the clothing, bedding and the house, especially during bouts of extreme diarrhoea.[50] A study from South Africa by Kgalushi et al[51] surveyed home-based caregivers who estimated a need for 200 l of water daily, a figure that included water that is necessary for income-generating activities and food production. A case study by the Mvula Trust in the Limpopo province in South Africa showed that as a result of public water services breaking down or not being properly managed, residents with already weak immune systems were forced to revert to unprotected water sources. When infants who are born to HIV-positive mothers are not breastfed, a safe water source must be used to mix formula for the babies. Such infants are at greater risk of dying from diarrhoeal diseases. In the first two months, a child who receives replacement feeding is six times more likely to die than a breastfed child.[52,53]

Health education and promotion

Health education

The importance of immunisation with rotavirus vaccine and breastfeeding in preventing diarrhoea and other diseases has been recognised by public health authorities. However, no attention has been paid to safe food handling during the preparation and feeding of complementary foods. If there is to be a substantial improvement in the prevention of diarrhoeal diseases in infants and children, the education of mothers and caregivers on food safety principles is important. Most primary health centres already

advise mothers about breastfeeding, cup feeding, infant feeding and nutrition, as well as other aspects of care of infants and children. Health workers should demonstrate how to express breast milk safely by hand, and how to feed infants with a cup, ideally on a one-to-one basis. The role of primary healthcare facilities in managing diarrhoea through ORT "corners" (i.e. designated spaces in clinics) can reduce diarrhoeal disease deaths in children under five years. For example, the Western Cape Department of Health managed to achieve a 90% reduction in diarrhoeal disease-related, in-hospital deaths of children under five in 2011, compared to 2010, in the metro. The department developed strategies and interventions, in collaboration with the City of Cape Town and community-based health organisations, to deal with the seasonal rise of diarrhoea, especially in areas where water and sanitation facilities are shared.[54]

These interventions at primary healthcare facilities include:

- A rapid triage of children on entry into a primary healthcare facility.
- Well-situated and functional ORT corners.
- Skilled clinicians and staff who are deployed to manage diarrhoea cases.

The ORT corners are simple areas in the emergency centre where children who are dehydrated or are unable to drink enough fluid are given a trial of oral rehydration solution. The parent gives small amounts of fluid frequently to the child, while the health worker monitors whether adequate fluid is being consumed, and that the correct technique is being used by the parent. This is also an ideal place in which to convey key messages on how to make a home oral rehydration solution (the sugar-salt solution) and diarrhoea management. The salt-sugar solution is a mixture of eight teaspoons of sugar and half a teaspoon of salt in one litre of clean water.[55] It is important that primary healthcare centres extend their education to include information on safe food handling practices,[24] domestic hygiene and hand washing during antenatal and postnatal visits.

Health promotion

The education of households and consumers in food safety and hygiene in communities should involve primary healthcare workers, home-based care workers, nongovernmental organisations (NGOs), government departments and the private sector. Educating and informing mothers in the community plays a key role in the promotion of safe complementary food and the prevention of diarrhoea in infants and young children. Other modes of food safety and hygiene education are via pamphlets or televison.[24] Some innovative means of educating with entertainment, known as "edutainment", have been used by Soul City entertainment education. Entertainment education "is the process of purposely designing and implementing a media message to both entertain and educate, in order to increase audience members' knowledge of an educational issue, create favourable attitudes, shift social norms and change overt behaviour".[56] The Soul City Institute for Health and Development Communication is an NGO that was established in 1992 to "harness the mass media when promoting health". The Soul City initiative shares health messages, including how to address diarrhoea, through soap operas.

Clearly, the above measures are valuable, but haven't solved the problem sufficiently, given mortality rates. Thus, innovative strategies need to be sought, such as the development of a training manual to inform health workers, training on its application, and advising on how the information can be adapted according to specific cultural and geographical settings. Ideally, a "diarrhoea corner" should be created in healthcare facilities to provide focused education. The role of consumer education, using pamphlets in point-of-sale settings, could also be tested. However, the education of children in schools should be a priority.

Child care and early learning centres

Staff in all child care facilities should be trained in hygiene and food safety regulations. Environmental health practitioners need to regularly visit these centres, including formal and informal crèches, to educate staff and inspect the facilities. Day care staff must teach children personal hygiene, especially hand washing. Ideally, school health programmes should be provided by authorities to monitor child care centres, where primary healthcare workers are trained to check on the immunisation status and development of the children.[57]

Policy and advocacy

Food safety and hygiene play a role in preventing infectious disease and food-borne illness, especially in children. However, relatively low priority is given to these issues in the public health agenda of many developing countries. Advocacy on issues such as water, sanitation, hygiene and food safety can help to improve child health. This can be achieved by creating a platform for dialogue among stakeholders, collecting and disseminating relevant data and literature in a readily understandable form that targets audiences, monitoring policies and the law-making process on food safety and hygiene, and public awareness and education.[58,59]

Local level responses

In some parts of South Africa, the management of water treatment plants has either collapsed or is poorly controlled. In many instances, this can be attributed to a high turnover of staff or a lack of capacity at local and provincial level. This applies to other significant aspects of service delivery, such as refuse removal. The control of dogs and rodents scavenging in bins has become overwhelming for both the authorities and the public. Constucting and clearing storm water drains and other forms of drainage is highly problematic in areas where there is very rapid development, as well as in informal settlements. This can lead to contaminated bodies of water in which children play, and where water is accessed for domestic use or the irrigation of crops.

In South Africa, studies have found that water from municipal sources is of good microbial quality, but the water quality deteriorates significantly after handling and storage, in both case and control households in a study conducted in Khayelitsha.[60] Safe water from municipal sources can become recontaminated in the home because of contact with faecally tainted hands or fingers, or storage in dirty uncovered containers. Education on hand washing, before handling water and using water storage containers with a small opening of 5-8 cm in diameter, is important to prevent recontamination.

Contamination mainly occurs at source in the rural areas. A study in Venda found that water from the Khandanama River and two water storage tanks was of poor microbial quality when compared to that recommended in the South African drinking water quality guidelines.[61,62] Momba et al[63] also reported that rural water treatment plants are still failing to produce safe drinking water in the Eastern Cape.

Conclusion

Ideally, general awareness of hygiene should be created and constantly reinforced in various ways, from the time that young children can understand simple instructions, throughout childhood and adolescence, and into adulthood. Each generation must become mutually supportive of the next. It is also important that children's mothers or caregivers are educated on the importance of hygiene, as they will be responsible for teaching children its importance. Mothers and caregivers must wash their hands before feeding children and preparing food. Hand washing with soap is the most effective way of reducing diarrhoeal disease. It is worth mentioning that hand washing with water alone also reduces the prevalence of diarrhoeal disease.[29] It is proposed that the following message is tested and included in the food-based dietary guidelines for infants and young children: "Hands should be washed with clean water and soap before preparing, feeding or eating, and after going to the toilet".

References

1. National Department of Health. South Africa's national strategic plan for a campaign on accelerated reduction of maternal and child mortality in Africa. Pretoria: Department of Health; 2011.
2. Bradshaw D, Nannan N, Laubsher R, et al. South African Burden of Disease Study: estimates of provincial mortality Western Cape Province, 2000. Cape Town: Medical Research Council; 2004.
3. Sanders D, Bradshaw D, Ngongo N. The status of child health in South Africa. In: Kibel MLL, Pendlebury S, Smith C, editors. South Africa child gauge. Cape Town: University of Cape Town, Children's Institute, 2010; p. 29-40.
4. ASSA 2000 AIDS and demographic model. Actuarial Society of South Africa AIDS Committee; 2002.
5. Guidelines for human settlement planning and design. Pretoria: Council for Scientific and Industrial Research; 2005.
6. Hall K, Marera D-H. Children's access to basic services. In: Kibel MLL, Pendlebury S, Smith C, editors. South Africa child gauge. Cape Town: University of Cape Town: Children's Institute, 2010; p. 130-134.
7. Statistics South Africa. General household survey. Statistics South Africa; 2005.
8. Keusch GT, Fontaine O, Bhargava A. Disease control priorities in developing countries. Diarrheal diseases. 2nd ed. New York: Oxford University Press, 2006; p. 372-387.
9. Wagner EG, Lanoix JN. Excreta disposal for rural areas and small communities. Geneva: World Health Organization; 1958.
10. Pickering LK. The day care center diarrhea dilemma. Am J Public Health. 1986;76(6):623-624.
11. Sobsey MD. Managing water in the home: accelerated health gains from improved water supply. Geneva: World Health Organization; 2002.
12. Duse AG, da Silva MP, Zietsman I. Coping with hygiene in South Africa, a water scarce country. Int J Environ Health Res. 2003;13 Suppl 1:S95-S105.
13. Joubert G, Jagals P, Theron, L. Water-related household practices in section K, Botshabelo, and associations with diarrhoea. S Afr J Epidemiol Infec. 2003;19:13-19.
14. Pickering AJ, Davis J, Walters SP, et al. Hands, water, and health: fecal contamination in Tanzanian communities with improved, non-networked water supplies. Environ Sci Technol. 2010;44(9):3267-3272.
15. Jagals P, Nala NP, Bokako TC, Genthe B. An assessment of the link between stored water quality and the occurrence of diarrhoea in an urban community: a community case-control study. eWISA [homepage on the Internet]. 2000. c2013. Available from: http://www.ewisa.co.za/literature/files/221nala.pdf
16. Cairncross S. More water: better health. People Planet. 1997;6(3):10-11.
17. Thomas EP, Seager JR, Viljoen E, Potgieter, et al. Household environment and health in Port Elizabeth, South Africa. Cape Town: Medical Research Council; 1999.
18. Hall K. Housing and services: access to basic sanitation [homepage on the Internet]. 2010. c2013. Available from: http://www.childrencount.ci.org.za/indicator.php?id=3&indicator=42
19. Goldberg K, Kula, S, Mhlalisi M, et al. The water dialogues: Cape Town case study. Cape Town: The Water Dialogues; 2009.
20. Kasirye I. Household environmental conditions and disease prevalence in Uganda: the impact of access to safe water and improved sanitation on diarrhea. International Development Research Center [homepage on the Internet]. 2010. c2013. Available from: http://hdl.handle.net/10625/43094

21. Checkley W, Gilman RH, Black RE, et al. Effects of nutritional status on diarrhoea in Peruvian children. J Pediatr. 2002;140(2):210-218.
22. Checkley W, Gilman RH, Black RE, et al. Effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. Lancet. 2004;363(9403):112-118.
23. Bouton M, Cobb E, Donachie P, et al. The effect of handwashing with water or soap on bacterial contamination of hands. Int J Environ Res Public Health. 2011;8(1):97-104.
24. Scott B, Curtis V, Rabie T, Garbrah-Aidoo N. Health in our hands, but not in our heads: understanding hygiene motivation in Ghana. Health Policy Plan. 2007;22(4):225-233.
25. Langford RM. Hand-washing and its impact on child health in Kathmandu, Nepal. [Thesis]. Durham: Durham University; 2009.
26. Chase C, Do QT. Scaling up handwashing behaviour: findings from the impact evaluation baseline survey in Vietnam. Washington: World Bank; 2010.
27. Adams M, Motarjemi Y. Basic food safety for health workers. Geneva: World Health Organization; 1999.
28. Curtis V, Cairncross S. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. Lancet Infect Dis. 2003;3(5):275-281.
29. Luby SP, Halder AK, Tronchet C, et al. Household characteristics associated with handwashing with soap in rural Bangladesh. Am Soc Trop Med Hygiene. 2009;81(5):882-887.
30. Walker CL, Rudan I, Liu L, et al. Global burden of childhood pneumonia and diarrhoea. Lancet. 2013;381(9875):1405-1416.
31. World Health Organization. Improved formula for oral rehydration salts to save children's lives. WHO [homepage on the Internet]. 2006. Available from: http://www.who.int/mediacentre/news/releases/2006/pr14/en/index.html
32. Munos MK, Walker CL, Black RE. The effect of oral rehydration solution and recommended home fluids on diarrhoea mortality. Int J Epidemiol. 2010; 39 Suppl 1:i75-i87.
33. Lazzerini M, Ronfani L. Oral zinc for treating diarrhoea in children. [Cochrane review]. In: The Cochrane Library, Issue 6, 2012. Oxford: Update Software.
34. Walker CLF, Black RE. Zinc for the treatment of diarrhoea: effect on diarrhoea morbidity, mortality and incidence of future episodes. Int J Epidemiol. 2010;39 Suppl 1:i63-i69.
35. Imdad A, Herzer K, Mayo-Wilson E, et al. Vitamin A supplementation for preventing morbidity and mortality in children from 6 months to 5 years of age. [Cochrane review]. In: The Cochrane Library, Issue 12, 2010. Oxford: Update Software.
36. United Nations Children's Fund. What is IMCI? Fact sheet. UNICEF [homepage on the Internet]. c2013. Available from: http://www.unicef.org/health/23958_imci.html
37. Hoque A. An investigation into risk factors associated with the cholera epidemic in KwaZulu-Natal during 2000. [Master's dissertation]. Pretoria: University of Pretoria; 2003.
38. Bushen OY, Davenport JA, Lima AB, et al. Diarrhea and reduced levels of antiretroviral drugs: improvement with glutamine or alanyl-glutamine in a randomized controlled trial in northeast Brazil. Clinical Infect Dis. 2004;38(12):1764-1770.
39. Mintz E, Reiff F, Tauxe R. Safe water treatment and storage in the home: a practical new strategy to prevent waterborne disease. JAMA. 1995;273(12):948-953.
40. World Health Organization. How to prepare formula in care setting. Geneva: World Health Organization; 2007.
41. World Health Organization. Five keys to safer food manual. Geneva: WHO; 2006.
42. Black RE, Lopez de Romana G, Brown KH, et al. The incidence and etiology of infantile diarrhea and major routes of transmission in Huascar, Peru. Am J Epidemiol. 1989;129(4):785-799.
43. Department of Health. Regulation R146. Regulations relating to the labelling and advertising of foodstuffs and associated amendments R1091 of 19 November 2010 and R45 of 19 January 2012. Pretoria: Government Gazette.
44. Department of Health. National HIV and Syphilis Antenatal Sero-Prevalence Survey in South Africa, 2005. Pretoria: Department of Health; 2006.
45. World Health Organization. How to integrate water, sanitation and hygiene into HIV programs. Geneva: World Health Organization; 2010.
46. Fewtrell L, Kaufmann RB, Kay D, et al. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. Lancet Infect Dis. 2005;5(1):42-52.
47. Clasen T, Schmidt WP, Rabie T, et al. Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. BMJ. 2007;334(7597):782.
48. Lule JR, Mermin J, Ekwaru JP, et al. Effect of home-based water chlorination and safe storage on diarrhea among persons with human immunodeficiency virus in Uganda. Am J Trop Med Hygiene. 2005;73(5):926-933.
49. Water, sanitation, and hygiene for people living with HIV and AIDS. Washington: Water and Sanitation Program; 2007.
50 . Kamminga E, Wegelin-Schuringa M. HIV/AIDS and water, sanitation and hygiene: thematic overview paper. Delft: IRC International Water and Sanitation Centre; 2006.
51. Kgalushi R, Smits S, Eales K. People living with HIV/AIDS in a context of rural poverty: the importance of water and sanitation services and hygiene education. A case study from Bolobedu (Limpopo Province, South Africa). IRC International Water and Sanitation Centre [homepage on the Interent]. 2004. Available from: http://www.irc.nl/content/download/11414/167794/file/Case_study_Limpopo_South_Af.pdf
52. United Nations Children's Fund. HIV and infant feeding: a UNICEF fact sheet. New York: UNICEF; 2002.
53. United Nations Children's Fund. Maternal to child transmission of HIV: a UNICEF fact sheet. New York: UNICEF; 2002.
54. Western Cape Department of Health. Campaign against diarrheal disease. Western Cape: Western Cape Department of Health; 2011.
55. Western Cape Department of Health. Diarrhoeal diseases campaign. Western Cape: Western Cape Department of Health; 2011.
56. Singhal A, Rogers EM. Entertainment-education and social change: history, research and practice. London: Routledge; 2004.
57. Pillay Y, Barron P. The implementation of PHC re-engineering in South Africa. Public Health Association of South Africa [homepage on the Internet]. 2011. Available from: http://www.phasa.org.za/wp-content/uploads/2011/11/Pillay-The-implementation-of-PHC.pdf
58. World Health Organization. WHO global strategy for food safety: safer food for better health. Geneva: WHO; 2002.
59. Proudlock P, Giese S. A new advocacy team in the child health unit. Gainesville: Institute for Child Health Policy; 2013.
60. Genthe B, Strauss N, Seager J, et al. The effect of type of water supply on water quality in a developing community in South Africa. Water Sci Technol. 1997;35(11-13):35-40.
61. Bessong PO, Odiyo JO, Musekene JN, Tessema A. Spatial distribution of diarrhoea and microbial quality of domestic water during an outbreak of diarrhoea in the Tshikuwi community in Venda, South Africa. J Health Popul Nutr. 2009;27(5):652-659.
62. South African water quality guidelines. 2nd ed. Department of Water Affairs and Forestry; 1996.
63. Momba MNB, Tyafa, Z, Makala, N, et al. Safe drinking water still a dream in rural areas of South Africa. Case study: the Eastern Cape Province. 2006.