Centre for Affordable Water and Sanitation Technology

Technical Brief: The Importance of Safe Water, Sanitation and Hygiene for the Health of Mothers and Children

Contents

Introduction

Improving access to safe drinking water, adequate sanitation and proper hygiene could prevent around 10% of all the disease in the world (Prüss-Üsten, 2008). These improvements are particularly critical for the health and survival of vulnerable populations, including people living with HIV/AIDS, the sick, elderly, mothers and children (especially children under the age of five).

Preventable diseases related to unsafe water, inadequate sanitation and a lack of hygiene are a major threat to maternal (mother) and child health in developing countries. Mothers and children are a high priority for the health of communities and for achieving the Millennium Development Goals to reduce child mortality and improve maternal health.

In 2010, about 21,000 children under five died every day, 70% of whom were under 1 year old (UNICEF, 2011). Worldwide, 1.5 million children die each year from preventable diarrheal diseases (UNICEF, 2009). An estimated 88% of diarrheal cases are related to unsafe water, inadequate sanitation, and/or a lack of hygiene (Black, 2003). In 2010, about 287,000 women died during pregnancy, during childbirth or in the first 6 weeks after childbirth (WHO, 2012). These statistics only account for the *deaths* of mothers and children. There are millions more mothers and children who are ill. The illness and death of millions of women and children each year causes profound developmental, societal and economic effects. Dr. Paul Farmer of *Partners in Health* describes, “The death of mothers [leads to a mass] of catastrophes in families, to hunger and prostitution, to disease and other deaths.” (Kidder, 2003)

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The health of mothers is important because these women are providing nutrition for both themselves and their babies. For the purpose of this technical brief, mothers can be divided into 2 groups: pregnant and lactating (breastfeeding) women.

Pregnant women are a vulnerable group because while the baby is growing, the mother's body must provide nutrition for both herself and the baby. Pregnant women are also more vulnerable to some diseases, and the effects of some diseases can be worse for pregnant women. Breastfeeding women are another vulnerable group because after birth, they need to provide critical nutrition for the newborn baby. They are also more vulnerable to some diseases.

If pregnant or breastfeeding women become ill, it can lead to their own death, the child's death or underdevelopment of the child. The death or underdevelopment of the child can occur before, during or after birth, which is why the health of the mother throughout these stages is of critical importance.

Children are particularly vulnerable, both before and after birth, because they rely completely on their mothers' health. In addition, newborns' (0-28 days old) and infants' (1-12 months old) immune systems are not yet fully developed. They cannot fight diseases they are exposed to. This is one of the reasons younger children are more likely to get diseases and diarrhea.

The Cycle of Illness and the Impacts

Like any biological system on the planet, the human body is complex and linked to the environment that it lives in. If the balance is disturbed, the body is more vulnerable to further imbalances. For example: a child living in an unsanitary situation gets sick with Rotavirus. The child's fragile immune system works as hard as it can to fight the illness. Then the child comes in contact with a second illness. The child's defences are already working hard on the Rotavirus, making the child more vulnerable to the second illness. The child has a hard time fighting both illnesses. The child also has diarrhea - a symptom of Rotavirus. Diarrhea causes the loss of nutrients and fluids. If the diarrhea is long lasting, and the child does not get a nutritious and balanced diet, the child will become malnourished. The child may die.

Repeated and persistent intestinal infections (possibly causing diarrhea) cause intestinal damage. This results in poor nutrient absorption and malnutrition. Once infected and undernourished, the body is more vulnerable to further infections, continuing the cycle. Overall, the long-term impact on children is growth stunting (they do not grow as well as they should) and damage to the development of their brain and ability to learn and understand. This cycle is illustrated in Figure 1.

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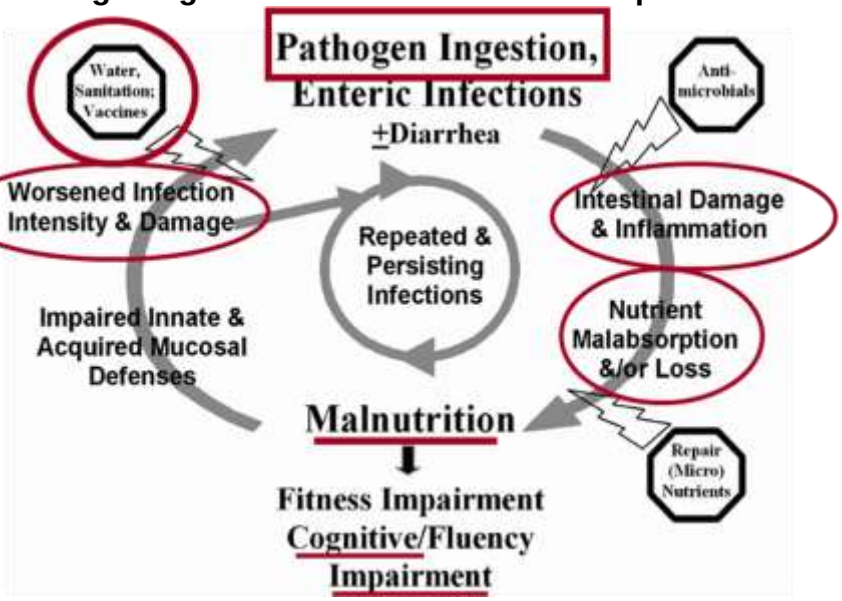
The cycle can be broken if interventions are implemented, such as safe water, adequate sanitation and proper hygiene, antibiotics and micronutrient replacement therapy.

Figure 1: Relationship of Intestinal Infections and Malnutrition and the Resulting Long-Term Effect on Child Development



From "Malnutrition as an enteric infectious disease with long-term effects on child development" (Guerrant et al., 2008)

Impact of Water, Sanitation and Hygiene (WASH) Related Diseases

Mothers and children have a high rate of illness and death from a variety of waterborne pathogens (*Cryptosporidium, Giardia, Schistosomiasis* and *Hepatitis E*) and hygiene related diseases (*Rotavirus, Toxoplasmosis, Non-thyphoidal Salmonella* and *Trachoma*). Children have been found to be even more vulnerable to these diseases once they already have diarrhea (Iqbal, 1999).

A number of research studies have shown that unsafe water, inadequate sanitation and poor hygiene cause mothers and children to suffer from:

- Increased likelihood of becoming infected with waterborne pathogens
- Longer lasting health impacts such as persistent diarrhea, intestinal scarring, malnutrition and growth stunting
- Increased likelihood of death when infected with some waterborne pathogens

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The most important WASH-related pathogens for maternal and child health are listed in the following table.

Table 1: WASH Related Pathogens and Diseases of Particular Concern for the Health of Mothers and Children

Pathogen	Type	Water, Hygiene or Sanitation Related	Symptoms	Impacts
Cryptosporidium	Protozoa	Water and Sanitation	**Diarrhea** (often severe and chronic)	Developmental implications for **children** and life threatening to **vulnerable populations**. Difficult to treat once infected.
Giardia	Protozoa	Water, Sanitation and Hygiene	**Diarrhea** (often severe and chronic)	Resulting dehydration and nutritional loss needs immediate attention. Linked to zinc deficiencies.
Schistosomiasis	Helminth	Water and Sanitation	**Diarrhea**, damage to internal organs	In **children**, impairs growth and cognitive development. Contributes to maternal anemia (low iron levels) and maternal death.
Hepatitis E	Virus	Water, Sanitation and Hygiene	**Diarrhea**, excessive fatigue, lack of appetite	In **pregnant women** the disease is more severe; during the third trimester there is an elevated death rate of 20%.[1]
Rotavirus	Virus	Sanitation and Hygiene	**Diarrhea**, vomiting, severe dehydration.	Leading cause of acute diarrhea. Causes 40% of hospital admissions for diarrhea in **infants** and **young children**.[2]
Toxoplasmosis	Protozoa	Water, Sanitation and Hygiene	Neurological problems (Fever, confusion, headache, seizures, nausea, poor coordination)	More severe effects on vulnerable populations (e.g. **pregnant mothers** and **children**).[3]
Non-Typhoidal Salmonella	Bacteria	Hygiene	**Diarrhea**, fever, vomiting	More severe effects on vulnerable populations (particularly **children**)[4] . Can spread through the body to cause blood infections (Bacteremia).[5]
Trachoma	Bacteria	Hygiene	Blindness in adulthood	**Children** are the most vulnerable to the infection, but the most severe symptoms may not appear until adulthood (e.g. blindness).[6]

[1] WHO 2012 Hepatitis E
[2] Fewtrell et al., 2005
[3] CDC 2012
[4] Graham et al. 2009
[5] Bacteremia is the presence of bacteria in the blood causing possible septic shock of the body.
[6] WHO 2012 Trachoma

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Impact of Diarrhea, Malnutrition and Other Related Deficiencies

Children

Diarrhea, a symptom of many water, hygiene and sanitation related diseases, is the second most common cause of death for children under five, after pneumonia. Diarrhea can cause dehydration and mineral imbalances. Prolonged diarrhea (7-13 days) or persistent diarrhea (>14 days) in young children can cause permanent intestinal scarring. This means the intestines cannot absorb nutrients, leading to malnutrition. In the long-term, this leads to growth stunting and the under-development of the ability to learn and understand, and even death (Moore, 2010; Humphrey, 2009; Guerrant, 2008; Niehaus, 2002).

In 2008, it was estimated that 1.87 million children under the age of five died from diarrhea, which accounted for 19% of total child deaths globally (Boschi-Pinto, 2008). By 2009, UNICEF published that 1.5 million children die each year from preventable diarrheal diseases - more than from HIV, measles and malaria combined (UNICEF, 2009).

Malnutrition, a result of unsafe water, inadequate sanitation and lack of hygiene, causes another 860,000 preventable child deaths per year (Prüss-Üsten, 2008). If these figures are combined, 2.35 million children under the age of five die each year from unsafe water, inadequate sanitation and lack of hygiene.

This number does not include the number of children that are sick from diarrheal diseases and malnutrition. It also does not capture the long-term impact for the children, adults or community. “Of the 555 million preschool children in developing countries, 32% are stunted and 20% are underweight… This leads to long-term cognitive deficits, poorer performance in school and fewer years of completed schooling, and lower adult economic productivity” (Humphrey, 2009).

Some water-related pathogens, such as *Giardia*, are linked to low zinc levels (zinc deficiency) in children. Zinc is an essential nutrient for the normal growth and development of infants and children. It is available through a diet that includes meat or other animal products. A deficiency in zinc makes children more susceptible to intestinal infections and reduced intestinal and immune function (WHO/UNICEF, 2012) and has historically resulted in 400,000 child deaths per year (Black et al, 2008). Although not fully understood why, zinc has been found to reduce the duration and severity of diarrhea. Zinc is therefore recommended by the WHO and UNICEF to be supplemented to children that suffer from diarrhea (WHO/UNICEF, 2012).

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Mothers

Maternal anemia, related to low iron levels, is a serious concern for mothers in developing countries. If a mother has anemia, there may not be enough oxygen in her blood. Anemia can be caused by:

- Not enough iron in the woman's diet
- Not taking iron supplements during development and pregnancy
- Malaria infection, and/or
- Diarrhea, HIV or other diseases (USAID, 2006)

Mothers with anemia have a higher risk of death [an estimated 115,000 anemia related maternal deaths per year (Black, 2008)]. Their babies may also have low birth weight, be born too early, or the baby may die before birth (Baktiar, 2007).

Prevention of WASH Related Diseases

There are simple steps mothers can take to protect their own health and the health of their children. Improving water quality, hygiene practices and access to sanitation would significantly reduce the illness and death of vulnerable populations due to WASH related diseases, diarrhea and malnutrition. A greater importance and effort has been dedicated to improving access to water quantity and quality over the years, but without improved sanitation and hygiene as well, exposure to disease remains significant (Gunther et al., 2010).

Some groups have concluded that improving sanitation infrastructure, particularly private access, should receive more attention than it has in the past. This does not question the importance of water quality, but rather questions the relevance of improving water infrastructure without improved sanitation and hygiene conditions (Gunther, 2010). The Joint Monitoring Program report on water and sanitation has stated that the water targets have been met, but the current rate of improvement to sanitation infrastructure is behind and the target will not be met at the current rate. More efforts must therefore be dedicated to improving access to basic sanitation (WHO/UNICEF, 2012).

CAWST recommends a comprehensive WASH approach to improve maternal and child health: safe drinking water, improved sanitation and proper hygiene practices.

Safe Water for Maternal and Child Health

The following types of water sources represent particular risks to mothers and children:

- Surface water sources (e.g. rivers, streams, lakes, ponds, canals)
- Dug wells, tube wells and other wells that are subject to flooding

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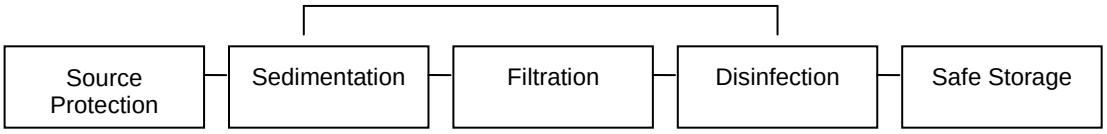
Very high waterborne pathogen levels are common in surface water around the world due to fecal contamination from humans and animals. Surface water is also subject to significant microbiological contamination after rain events, since the runoff helps to wash even more fecal contamination into water bodies.

Wells (particularly shallow dug wells) constructed in a manner that doesn't prevent or minimize surface water runoff are also at risk. This is particularly true during heavy rains or monsoon type conditions when flooding of such wells can occur. Wells located in valleys, near rivers or streams or at other low lying areas are also at increased risk of significant microbiological contamination. In addition, wells constructed in coarse sand or gravel aquifers are at a greater risk, especially if they are shallow and/or close to contamination sources such as latrines and surface water bodies.

Household Water Treatment

Household water treatment (HWT) is an effective approach to providing safe water. Using the **multi-barrier approach** is the best way to reduce the risk of drinking unsafe water. Each step in the process, from source protection, to water treatment and safe storage, provides an incremental health risk reduction.

Household Water Treatment



Sedimentation is a physical treatment process used to reduce the turbidity of the water. It may not always be necessary if the source water has low turbidity (e.g. deep ground water wells).

Filtration is commonly used after sedimentation to further reduce turbidity and remove pathogens. Filtration is a physical process which involves passing water through filter media. Some filters are also designed to grow a biological layer that consumes pathogens and improves the removal efficiency.There are various types of filters that are used by households around the world, including:

- Biosand filter
- Ceramic pot filter
- Ceramic candle filter

The last step in household water treatment is to remove or kill any remaining pathogens through **disinfection**. The most common methods used by households around the world to disinfect their drinking water are:

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- Chlorine disinfection
- Solar disinfection (SODIS)
- Boiling

The following table lists different HWT options and their effectiveness in removing or inactivating different pathogens:

Table 2: Effectiveness of HWT Options for Waterborne Pathogens

HWT Option	Very Effective For	Somewhat Effective For	Not Effective For
Biosand Filter	Bacteria, Protozoa (e.g. *Cryptosporidium, Giardia*)	Viruses	
Ceramic Filters (Pot or Candle)	Bacteria, Protozoa (e.g. *Cryptosporidium*)	Viruses	
Chlorine	Bacteria (except *M. avium),* Viruses[1]	*Giardia*[2] and some protozoa	*Cryptosporidium Toxoplasmosis*
Flocculation & Disinfection (e.g. Purifier of Water)	Bacteria, Viruses, *Cryptosporidium*[3]		
Solar Disinfection (SODIS)	Bacteria, Viruses[4]	*Cryptosporidium*[3]	
Boiling	Bacteria, Viruses, Protozoa (e.g. *Cryptosporidium*)		

[1] High ammonia levels can result in "combined chlorine" being formed instead of "free chlorine" which significantly reduces virus inactivation
[2] Depends on temperature, pH and contact time
[3] Data not available for most other protozoa
[4] Only somewhat effective for Adenoviruses

For surface water sources, sedimentation and filtration are important steps in the multi-barrier approach to ensure that protozoa are removed from the source water. Chlorine, although it maintains a residual disinfectant in drinking water for killing bacteria and viruses, should not be relied on alone to treat surface water. Chlorine alone is ineffective for *Cryptosporidium* and *Toxoplasmosis*, pathogens which are particularly harmful to mothers and children. However, chlorine can and should be used as part of a multi-barrier approach to safe water. In this approach, sedimentation and filtration options can be used to remove the *Cryptosporidium* and *Toxoplasmosis* oocysts, and chlorination can disinfect any remaining pathogens. This would provide the safest drinking water possible.

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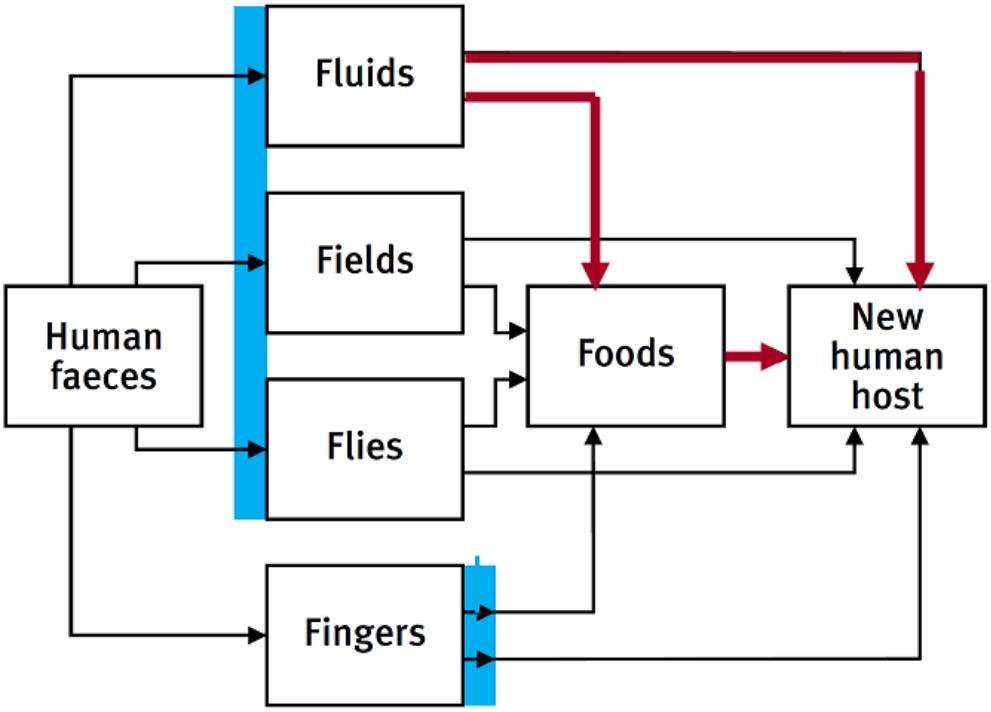
Even after the water is treated, it should be handled and **stored properly** to keep it safe. If it is not stored safely, the treated water quality could become worse than the source water and may cause people to get sick. Recontamination of safe drinking water is a common issue and has been documented in several cases around the world.

More often than not, people focus on a particular technology that is directed towards one step rather than considering the water treatment process as a whole. While individual technologies can incrementally improve drinking water quality, the entire process is essential in providing the best water quality possible, which is especially important for mothers and children.

Sanitation and Hygiene for Maternal and Child Health

Adequate sanitation and proper hygiene practices can significantly reduce exposure to pathogens. Human feces can have many different pathogens and therefore can contaminate water, food sources and be exposed to flies. Diseases reach other humans through drinking contaminated water, eating unwashed food, flies, and through eating with unwashed hands. Refer to Table 1 for information on which WASH related pathogens and diseases are related to sanitation and hygiene.

Figure 2: Disease Transmission Diagram



Adapted from: "Tackling the silent killer, the case for sanitation" by WaterAid (2008)

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Depending on what level of sanitation already exists in the community or home will determine the level to which the sanitation infrastructure can be improved. For example, if open defecation is the norm, it is not likely that flush toilets would realistically be implemented. A successful sanitation program requires a thorough assessment of the social, cultural, environmental and technological factors. These factors impact the design of the different elements of the program. It is these factors that will guide the identification and selection of appropriate technology options, promotion approaches, and effective methods of implementing the program.

It has been found that the greatest improvements in health are when sanitation infrastructure can be privately accessed due to the privacy needs of many populations as well as being able to maintain the hygiene of the superstructure (Gunther et al., 2010).

Hygiene plays a critical part in the improvement of maternal and child health. Newborn and maternal health can be severely compromised if the hands of those handling the mother and newborn are not washed. “Birth attendant and maternal hand-washing with soap and water were associated with significantly lower neonatal mortality.” (Rhee, 2008). A large proportion of maternal deaths occur during the 6 weeks after childbirth due to unhygienic practices used in the care of the mother after delivery. Hygiene education, particularly hand washing practices, for health practitioners and midwives during labour, deliver and post-delivery would have a significant benefit to the health of those they are caring for.

Hand washing is of particular importance due to the fingers-to-mouth route of disease transmission. “Hygiene interventions…are effective in reducing diarrhea morbidity” (Waddington, 2009). There are two critical times for hand washing with soap and water: before preparing or eating food and after coming into contact with feces (whether that’s going to the toilet or handling baby feces). Mothers are most often the ones handling baby feces and in some regions it is believed that baby feces are safe and clean. Hygiene education of mothers is particularly important for the health of themselves and their children.

Conclusions

The Millennium Development Goals to reduce child mortality rates (Goal 4) and to improve maternal health (Goal 5) are more achievable if access to safe drinking water, basic sanitation and hygiene is improved (Goal 7). To reduce maternal and child deaths, access to improved water, hygiene and sanitation are important strategies (Cheng, 2012).

To meet these goals, household water treatment can be implemented to remove or inactivate all waterborne pathogens whether they originate from the water source, from

contamination of a water distribution system, or from household contamination. To strengthen the impact, improving hygiene and sanitation will prevent the spread of disease by decreasing overall exposure to human feces.

Combining the multi-barrier approach including household water treatment, proper hygiene and at least basic sanitation will make a significant impact on mothers and children worldwide. This will ensure the safest water quality possible, and prevent waterborne and hygiene related pathogens from continuing to be a common cause of illness and death of millions globally.

Further Information

CAWST has conducted a detailed review of documents and information published on WASH related diseases affecting mothers and children. These studies have been summarized in a CAWST document entitled *Water, Hygiene and Sanitation Related Diseases: Impact on Maternal and Child Health* (2012). The review includes approximately 70 studies and summaries, most of them from developing countries in Africa, Asia and Latin America.

CAWST offers workshops in Canada and around the world to train individuals, NGOs, and government agencies on household water treatment, hygiene and low-cost sanitation. CAWST's workshops use participatory activities to effectively deliver the hands-on knowledge people need to implement household water treatment, sanitation and hygiene projects in a developing country. Please visit the website www.cawst.org for a list of upcoming workshops or contact us at cawst@cawst.org for more information.

For technical questions on safe water and maternal and child health please contact Tommy Ngai, Director Research Learning, at tngai@cawst.org.

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