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Through the experience of countries that have drastically reduced their maternal mortality rates, we have learned much about the necessary policies and interventions. Access to clean water, sanitation and hygiene at home and in the clinic play a key role in reducing maternal mortality. Each year 290,000 women die from complications during pregnancy, birth and the neonatal period; and an estimated 10 to 20 million women suffer from related health complications. Almost 90% of the maternal deaths occur in Sub-Saharan Africa and South Asia. Much of this is preventable through practices of hygiene that have long been established. There has been a reduction by one-third over the past 20 years. In part related to increase in safe deliveries by skilled personnel, reduced fertility and antenatal care. Unfortunately the burden of mortality and morbidity still falls disproportionately on the poor and remains a great challenge in low resourced countries. This book is intended for policy makers and primary healthcare practitioners working in low resource environments as a guide for promoting hygiene in maternal child health services.

I am a public health specialist currently working as a lecturer at the school of public health – Moi University Eldoret, Kenya. I have previously worked in challenging environments requiring creativity, originality, dedication and systematic implementation of policies and strategies.

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Maternal Child Health through water, sanitation and hygiene

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Abstract

Each year 290,000 women die from complications during pregnancy, birth and the neonatal period; and, an estimated 10 to 20 million women suffer from related health complications (1)**.** Almost 90% of the maternal deaths occur in Sub-Saharan Africa and South Asia. Much of this is preventable through practices that have long been established. Hygiene and cleanliness are basic concepts in health care. They are included in most health promotion and health worker training programs.Evidence available shows their invaluable contribution to quality health service provision. Maternal mortality has decreased by one-third over the past 20 years**(1),** in part related to increase in safe deliveries by skilled personnel, reduced fertility and antenatal care. However, these substantial improvements have not benefited the rich and the poor alike. The burden of mortality and morbidity falls disproportionately on the poor and remains a great challenge in our world. Provision of clean water, sanitation and hygiene has played a major role in achieving this reduction.

Key words: Maternal Child Health, Sub-Saharan Africa, Water Sanitation and Hygiene, Maternal Mortality, Pregnancy

Introduction

Through the experience of countries that have drastically reduced their maternal mortality rates, we have learned much about the necessary policies and interventions. As with most complex health and development issues, there is no one magic bullet. Besides increasing knowledge on family planning methods, changing theposition of women in their communities and improving access to quality (maternal) health care, it is quite obvious that access to clean water, sanitation and hygiene at home and in the clinic play a key role as well.

Nevertheless, the effect of water, sanitation and hygiene on maternal mortality is greatly under-researched. This paper seeks to address the links through a review of current literature from the water, sanitation and hygiene (WASH) as well as the maternal health angle. A review of a large number of documents reveals both the multitude of relationships between maternal health and WASH, and various areas that deserve further research. The findings show that access to water, sanitation and hygiene, from pregnancy to birth and the weeks of recovery afterwards, have in different ways an impact on the health outcomes and survival of the mother.

Finally, the paper provides several policy, programmatic and research recommendations to address the importance of WASH for maternal health. These recommendations particularly center on the need for integration of WASH and maternal health interventions within Ministries, institutions and organizations.

Maternal mortality has to be reduced by 75% by 2015 to reach Millennium Development Goal5. We are off track, particularly in the poorest countries and regions. Most of these countries also face the grimmest water, sanitation and hygiene situation.

Objectives

The main objective of this review is to outline from literature the underlying challenges in Maternal Child Health in relation to WASH and suggest some remedies.

Methodology

A review published literature describing the impact of water, sanitation and hygiene on maternal health and mortality was undertaken. Published literature was reviewed on evidence-based interventions and "packages" of interventions across: maternal health, mortality or morbidity; reproductive health, antenatal and neonatal care; water or sanitation or hygiene and health services; hand washing practices; quality/cleanliness of health services and clinics; and decision making, power relations and health seeking behavior. The search for relevant materials included the publications of Elsevier, Medline, Lancet, Google scholar as well as international organizations including WHO, UNICEF, UNFPA, WB. Preference was given to interventions and research related to Sub-Saharan Africa and Asia. Of the 2,000 articles identified, approximately 500 were reviewed in full. The emphasis was on peer-reviewed publications and literature mainly dating past the year 2000 with some exceptions where the paper was particularly relevant or dealt with aspects that are not time-bound (eg. history of maternal health interventions).

Expected output

To prepare a firm ground for a concept note aimed at advising the governments'Ministry of Health (MOH). Armed with such information, the Ministries of Health (MOH) will be better placed to devise the best policies to enact in order to facilitate the tackling of the challenges.

Funding

There was no external funding for this review

Limitations of the study

The literature survey and the groups consulted noted that there is relatively little research on the links between water, sanitation and hygiene on the one hand and maternal health on the other. There are no meta-studies specifically on this topic. Much of the research to which reference is made are relatively small studies, are location-specific or not of high quality, thus pre-empting the ability to provide evidence-based generalizations over large populations. In the future, greater emphasis on research and interventions related to the links between water, sanitation, hygiene and maternal health in developing countries is needed.

Issues such as the impact of malaria and environmental hygiene on maternal health are not covered by this literature review.

Results

Maternal mortality—the death of women during pregnancy, childbirth, or in the neonatal period up to four weeks after delivery— remains a major challenge to health systems worldwide. Of the estimated 287,000 maternal deaths in 2010, 99% of these occurred in developing countries with sub-Saharan African and Southern Asia accounting for 85% of the global burden [1].

As shown in figure 1 below, there are large differences between various regions of the world. This extraordinary inequity between the burden of women dying in developing and industrialized countries has been called the largest discrepancy of all public-health statistics **[2]**. Tragically, many of these deaths could be prevented by practices and interventions that have been proven to be effective.

The health of many women who survive beyond childbirth is also compromised. Of the 140 million women who give birth each year, an estimated 10 to 20 million suffer from

complications related to pregnancy and poor birth management. This includes continuing illnesses and conditions such as anemia, urinary tract infections, damage to pelvic structure, fistula, incontinence, infertility **[3] [4] [5]**.

Reduction in maternal deaths

After a long period of very slow improvement, between 1990 and 2010 the estimated worldwide annual maternal mortality has dropped by almost 50%, from about 546,000 deaths down to about 287,000 **[6]** with varying progress found in different regions. South Asia has experienced a far more rapid improvement than Sub-Saharan Africa—about 42% **[7]**. Without the HIV/AIDS epidemic, maternal deaths would have been reduced by perhaps another 18%, with the greatest reduction in Sub-Saharan Africa **[6]**.

Reductions in maternal mortality

As each situation differs, it is difficult to identify all the causes of these improvements in the maternal deaths or to pinpoint the relative importance of each. However, factors often sighted are the increase in safe deliveries by skilled personnel, reduced fertility, antenatal care as well as international advocacy and availability of additional resources to improve maternal health **[8] [1] [6]**.

The early downward trend in maternal mortality in northern Europe (Netherlands, Denmark, Norway and Sweden) starting around 1850 and more recent evidence from Sri Lanka and Malaysia (1945-1955) corroborate the importance of skilled personnel attending childbirth, clean deliveries and good management **[9] [10] [11] [12]**.

Inequity in health provision

The substantial improvements in maternal health have not benefited rich and poor alike. The reduction in maternal mortality has been uneven between and within countries, favoring those

families with more resources. For example, on average in Africa, the richest 20% of African women are three times more likely to have skilled attendants at birth compared to the poorest quintile. These wealthier families are able to afford the direct and indirect costs associated with birth (data 1994-2005) **[13]**.

Figure 1: Maternal mortality ratio—deaths of women per 100,000 live births by region.

Source: WHO, UNICEF, WB, UNFPA, 2010

Region		Range	Estimated number of Maternal Deaths 2010	Life time risk maternal deaths (2010)
	Deaths per 100,000 live births			One in -----
Sub-Saharan Africa	500	400-750	162.000	39
South Asia	220	160-320	83,000	150
Europe	20	18-24	2200	2900
worldwide	210	170-300	287.000	180

Direct causes of death

Between 11% and 17% of maternal deaths happen during childbirth itself; and between 50% and 71% occur in the immediate post-partum period. Mortality is extremely high on the first and

second days after birth **[2]**. Four main killers that are the immediate or direct causes of about 70% of maternal deaths worldwide are hemorrhage, Hypertension, Abortion and Embolism**[5]**:

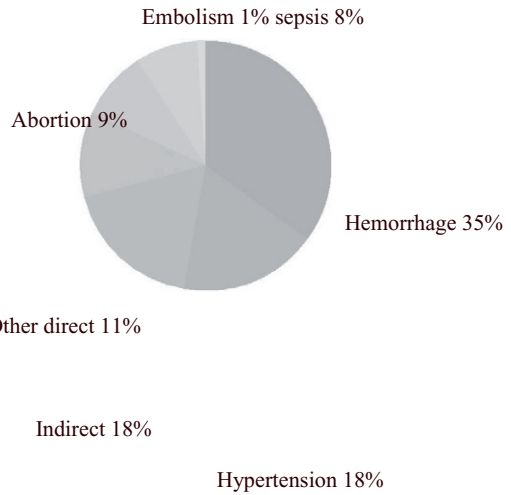

Figure 2: Causes of maternal deaths. (Source: Countdown to 2015)

Severe bleeding/hemorrhage

Each year almost 14 million women are noted to suffer severe blood loss during childbirth or the post-partum period of whom around 140,000 die while another 1 to 2 million suffer long-lasting consequences of complications **[2] [14] [15] [16]**. Anemia reduces resistance to blood loss and is related to hemorrhaging during and after birth. In anemic women, the risk of dying during pregnancy or childbirth is about 3.5 times higher than in non-anemic women **[17] [18, 19] [20]**. With 35% of the maternal deaths caused by hemorrhage, it is the leading direct cause of maternal mortality.

Hypertensive disorders and (Pre-) Eclampsia

Pre-eclampsia, leading to eclampsia consists of central nervous system seizures, which often

leave the patient unconscious and, if untreated, lead to one out of about 5 maternal deaths each year **[14] [15]**.

Puerperal sepsis

A general term used to describe infections of the genital tract and is particularly common with unhygienic births and induced abortions. One path for infections is through the birth canal of the woman, where microorganisms can cause puerperal sepsis. An early symptom of puerperal sepsis is fever **[21] [14] [15]**. It is significantly related to morbidity as women who survive the initial infection may go on to develop pelvic inflammatory disease, chronic pelvic pain, damage to reproductive organs, and infertility**[18]**.

Unsafe abortion

As may be expected, the precise proportion of deaths attributable to complications from unsafe abortion is not known. Estimates range from 8% to 30% of the total maternal mortality, much of which could be averted with family planning services **[14] [15][22]**. Safe abortion reduces maternal mortality **[5]**. An example isthe decrease in maternal mortality in Romania from 159 deaths per 100,000 live births in 1989 to 83 deaths over a two-year period, after the country's restrictive abortion law was revoked **[2]**. In addition, abortion-related morbidity can pose a seriousthreat to women throughout their reproductive years **[21]**.

Significance of water, sanitation and hygiene for health

There is considerable evidence about the importance of water, sanitation and hygiene for health in general. It has been estimated that globally about 2 million deaths could be prevented annually if everyone practiced appropriate hygiene and had access to safe, reliable drinking water and sanitation. In this estimate are many children under five years in developing countries who suffer from diarrhea and subsequent malnutrition and diarrhea-related diseases. Small children are at

greater risk from diarrhea and life-threatening dehydration**(1**).

Based on systematic reviews, Cairncross et al (2010) found risk reductions in diarrhea of 48% from hand washing with soap, 17% associated with improved water quality and 36% from safe excreta disposal **[30]**. Some common health problems related to poor water and sanitation include: bacterial and viral infections (diarrhea, cholera, dysentery, typhoid, poliomyelitis and hepatitis), parasitic infections (amoeba and Guardia, roundworms, whipworms, hookworms and schistosomiasis), and other infections such as upper respiratory infections, trachoma and scabies **[25]**. Much of the impact of safe water supply and improved sanitation on health is mediated through hygiene practices. For example, hand washing with soap reduces the risk of diarrhea, and of upper respiratory and skin infections. Face washing prevents trachoma and other eye infections **[31]**.

Quantity of water

The distance to water source also has implications for maintaining personal and household hygiene. Research indicates that very low amounts of water (often less than 5 litres per capita per day) are collected when the round trip to collect water takes 30 minutes or more **[32]**. The potential health advantage of having a water point in the family compound or in the household is substantial because more water is available for hygiene. A further advantage of having a functioning water supply near or in the home is that less water needs to be stored. Household water storage increases risk of contamination from vector-borne diseases and from oral-faecal routes **[32]**. Curtis (1995) found that provision of a yard tap nearly doubled the odds of a mother washing her hands after cleaning her child's anus and more than doubled the odds that she would wash any faecal soiled linen immediately **[33]**.

Two studies in 1999 and 2004 of household water use in rural areas of sub-Saharan Africa

concluded that a rough average for use of water in rural areas was around 10 litres per person per day with huge variations between countries and households. This average is, however, far below the basic level of 20 litres considered as the minimum needed to maintain personal and domestic hygiene needed for good health **[34] [35]**.

WASH in relation to maternal health.

We examined literature with linkages between WASH and maternal health. However, beyond a few subjects such as hygiene during the birthing process,we found remarkably little research showing a link between water, sanitation and hygiene as independent variables associated with maternal mortality and morbidity.

During pregnancy

During the months before delivery, the health status of the woman can be affected by variables such as: distance to the water source and quantity of water used, quality of water, having and using a clean toilet.

One study, using global databases from World Bank, WHO and UNICEF, found that increased access to improved water sources and improved sanitation is significantly associated with decreased maternal mortality ratios (odds ratio 0.58, P=0.008 and 0.52, P=0.009 respectively). The authors (Cheng et al) suggest that better water quality and sanitation reduce the risk of morbidity related to illnesses such as anemia, nutritional deficiency, hepatitis as well as reducing the workload of women. They note that both clean water and skilled birth attendants are necessary for lower maternal mortality **[36]**.

A recent study by Muldoon and colleagues examined the link between the strength of the health system and important public health outcomes across nations. Access to sustainable water and sanitation was associated with a lower maternal mortality ratio (aRR 0.88; 95% CI 0.82-

0.94). Water and sanitation was also associated with a lower infant mortality and child mortality (aRR 0.85; 95% CI 0.78-0.93 and aRR 0.82; 95% CI 0.75-0.91 respectively) **[98]**.

Distance to water source

Women should gain about one kilogram per month in the second and third trimesters of pregnancy. However, carrying water is one of the heaviest tasks and is known to affect weight gain during pregnancy and infant birth weight. For example, Rosen and Vincent found three studies from Sub-Saharan Africa estimating that carrying water accounted for an average of 10% of the carrier's daily calorie intake, with considerable variation **[34] [35]**. Thus easy access to safe water may improve maternal health, simply because pregnant and nursing women no longer have to carry heavy loads of water several times a day **[18]**. The reader may think about being pregnant and carrying a full suitcase (20 kilograms) one kilometre each day. This is roughly equivalent to the very modest provision of 15 litres of water per person for a family of four people when the water point is located 160 meters away.

A study, in which water was tested as an independent variable, was undertaken by Alvarez et al (2009), comparing variables between many countries in Sub-Saharan Africa using data from studies undertaken between 1997 and 2006. It showed a significant correlation ($r = -0.399$; $P=0.008$) between decreasing maternal mortality and the increasing access to improved water sources such as piped water, public tap, borehole or pump, protected well **[4]**.

Water quality affects maternal health

In addition to the quantity used, the quality of water can have an impact on the pregnant woman. Water quality refers to both its microbiological and chemical (salinity, arsenic, fluoride…) quality.

A study of the impact on pregnant women of biological contamination of water through

faecal-oral routes was undertaken by the IDCCR-B (International Centre for Diarrhoeal Disease Research, Bangladesh) after an urban outbreak of Hepatitis E (HEV). The report noted that the transmission of HEV is an example of an illness which has a differential impact on pregnant women and is transmitted usually through faecal contamination of drinking water, with periodic outbreaks in Asia and Africa. For pregnant women, this HEV infection is a more severe illness than for the general population with poor outcomes for themselves and their babies **[37]**.

Chemical contamination of water can also have negative impacts on pregnant women. The following examples relate to salinization of water and arsenic contamination. One recent study (2011) examined the impact of increasing saline intrusion during the dry season in shallow groundwater aquifers and ponds in coastal areas of Bangladesh with a population of more than 35 million. It appeared that people, particularly the poor, in these coastal areas were consuming 2½ to 8 times the WHO/FAO daily recommended intake of sodium/salt (2 grams a day) in the dry season when water from the sea and from brackish ponds washes into the drinking sources. In the study of 1,000 pregnant women with hypertension, a sharp rise of 2.4 times more cases of hypertension/pre-eclampsia were diagnosed in the pregnant women during the dry season **[38]**.

Arsenic contamination of drinking water supplies is a global problem. Estimates are that 136 to 178 million people worldwide drink water contaminated with arsenic above the WHO/FAO guideline of 10 parts per billion for drinking water. Areas where arsenic contamination is of concern include Bangladesh, India, Hungary, Chile, China, Argentina, Taiwan, Ghana, Mexico, the Philippines, New Zealand and the United States **[39]**. Several studies have established a link between moderate arsenic contamination and anemia**[40] [41] [42]**. It is known that anemia adversely affects the pregnant woman and her birth outcomes. One small study in Bangladesh found that high exposure to arsenic (greater than 50 was more likely to lead to spontaneous

abortion (OR=2.5) **[41]**. Two other studies found that high arsenic exposure was associated with anemia and resulted in about 25% more spontaneous abortions and infant deaths **[43]**.

Hygiene affects maternal health

More than 2 out of 5 maternal deaths occur within 24 hours of birth from causes related to hemorrhage and puerperal sepsis, and many surviving mothers probably suffer longer-term effects. Sepsis (bacterial infection in the bloodstream or body tissues) is mainly caused by unhygienic practices and poor infection control in labor and delivery **[50]**. For delivery, the **"sixcleans"** promoted by the World Health Organization are stronglyassociated with a lower incidence of puerperal sepsis saving lives of both mothers and babies **[51] [18]**, that is:

1. Clean hands of the attendant and mother,
2. Clean perineum (region from anus to vulva),
3. Clean delivery surface under the mother,
4. Clean blade for cord cutting
5. Clean cord tying
6. Clean towels to dry then wrap the baby and mother
7. (Some also add: nothing unclean inserted into the vagina)

The relation of these items to maternal health is discussed below, while the health of the newborn is discussed later.

Clean hands

Clean hands are essential to promote safe and healthy deliveries. Hand washing reduces exposure of the mother and newborn to pathogens and thus helps reduce mortality **[18]**. The importance given to hand washing is highlighted in the WHO (World HealthOrganization) short

course called *Essential Newborn CareCourse*, which is given at the local level to clinic staff. The courseguide mentions the need to wash hands 25 times, including stating this 5 times: *Wash hands before and after touching amother or baby* **[52]**. The point is that birth attendants shouldkeep their hands clean throughout the birthing process. Vaginal examination with dirty hands -- which pushes pathogens up into the body-- can kill a mother.

Edmond et al (2010) notes: "Overall, interventions to improve hand washing rates have been remarkably successful in research settings. The reasons for lack of successful scale-up of hand washing interventions into policy, programs, and behavior change are less clear." **[53]**. Indeed, the WASH sector, in general, has over the past 15 years experienced a rapid increase in the number of interventions promoting hand washing with soap, both in developing and industrialized countries. These behavioral change programs take time and commitment. Hand washing promotion, as with hygiene promotion in general deserves consistent and long-term effort.

Clean perineum and bathing

One small study found in Tanzania showed that women who bathed before delivery were almost three times less likely to develop puerperal sepsis than women who did not bathe **[51]**.

Fistula

Access to water and sanitation is essential to living with the consequences of fistula (as well as the healing of perineum ruptures and episiotomy). It is estimated that more than 2 million young women in Asia and sub-Saharan Africa live with untreated obstetric fistula, a hole that develops between the bladder or rectum and the vagina as a result of obstructed and difficult childbirth. Fistula results in incontinence, as women cannot control urine or feces, often meaning they lose status and dignity, becoming shunned by their community and families. Women with fistula tend

to be young, impoverished and have little or no access to medical care. Incontinent of urine and/or stool, these women become ostracized and shunned by their community. Patients with uncomplicated fistulae can undergo a simple surgery to repair the hole in their bladder or rectum **[18][54] [55]**. However, before this, basic personal hygiene, includingfrequent cleansing of the genital area, is very essential to help manage obstetric fistula and to prevent infections **[56]**.

Menstrual hygiene

From a longer-term perspective, safe reproductive health should begin early and include menstrual hygiene to avoid subsequent health problems. Menstrual hygiene refers to having water and clean, private toilets, using menstrual pads only once or reusing cloths that have been adequately cleaned and dried, having a place to wash regularly and change clothes. A survey by WaterAid in Bangladesh reported health problems resulting from poor menstrual hygiene such as vaginal scabies, abnormal discharge, and urinary tract infection. Other studies also suggest links between poor menstrual hygiene and urinary or reproductive tract infections and other illnesses **[57] [58] [59] [18]**.

WASH and neonatal health

Neonatal health and maternal health are closely related. Unhygienic practices that affect the health of the newborn will most likely also affect the health of the mother, although this has not been sufficiently researched. Many gaps remain in our knowledge of how neonatal morbidity and mortality affect maternal outcomes or how common factors affect both.

Globally, in 2009, an estimated 3.3 million babies died before reaching 28 days compared with an estimated 4.6 million deaths in 1990. This is a reduction of 28% in annual deaths from 32 deaths per 1,000 live births in 1990 to 23 in 2009. The average decrease is 1.7% a year, much slower than for maternal mortality (2.3% per year). Direct causes of death include sepsis, which

is reported to account for 6% to 15% of the newborn deaths (that is, 200,000 to 500,000 newborns) **[60] [61]**.

Water quality

In addition to the research on water quality and maternal health mentioned earlier, there are a small number of studies on water quality and neonatal survival. Because fertilizers are applied early in the growing season and residues may subsequently seep into water through soil run-off, the concentrations of agrichemicals in water vary seasonally. A study in India found an association between the presence of fertilizer chemicals in water in the month of conception and infant mortality, particularly neonatal mortality. Similar studies in South Africa and Colombia suggest that 10% increase in water toxins from fertilizers is significantly associated with about a 15 percent increase in infant mortality within the first month **[70]**.

Hand washing and clean deliveries

Edmond (2010) writing in the *Journal of Pediatric Medicine* notes that there is strong evidence that hand washing can reduce neonatal sepsis and infection rates. Hand washing by birth attendants and mothers were reported in one study to increase newborn survival rates by up to 44% **[62]**, and in another study in Bangladesh to decrease neonatal tetanus rates by 36% **[63,62]** and in Pakistan by 56% **[64]**. Hand washing by birth attendants before delivery in another study in Tanzania reduced neonatal mortality rates by 19% **[51]**. Research in southern Nepal, showed that among newborns where both the birth attendant and mothers washed hands with soap, the risk of neonatal death was 41% lower. The benefits of hand washing in the study seemed to be greater among newborns who are at greater risk, for example, babies having low birth weight **[62]**. Another piece of research found that the use of soap to wash hands before delivery reduced

the risk of cord infection by 49%. This study noted: “Many infants (92 percent) are born at home, and almost all are exposed to substantial infectious challenge during the first days of life. In the absence of topical cord antisepsis, hand washing with soap and water before assisting at delivery may reduce the risk of cord infection; in general, continued emphasis should be placed on promoting this important and simple intervention in community health programs” **[65] [18]**.

However, Blencowe et al (2011) commented on the quality of the evidence, in a systematic review of multiple databases, on the relation of clean birth and postnatal care practices to neonatal deaths from sepsis and tetanus. They found: “The overall quality of evidence for impact of clean birth and postnatal newborn care practices reviewed on cause-specific mortality is very low. However as there is strong biological plausibility and this is an accepted standard of care, and randomized controlled trials would be considered unethical”. The authors then had 30 experts examine the evidence. The conclusion of this panel was that about 30% of the neonatal mortality from tetanus was reduced by clean practices at home, by 38% in a health facility and by 40% through clean postnatal care **[66]**.

Clean cord cutting and tying

Infected cords cause neonatal deaths. In rural Nepal, failure to wash hands before cutting the cord or use of dirty clothes on the umbilical cord were associated with 60% and 70% increased risk of cord infection, respectively. Moreover, failure to use a boiled or sterilized blade led to a 2.3-fold increase in risk of cord infections [44]. Tradition and culture play a role in birthing procedures, particularly during deliveries at home. For example, related to care of the umbilical cord, studies in various countries note that many things are applied to cut the umbilical cord: clarified butter, ashes, oil, herbs and/or cow dung (Kenya, Tanzania,parts of India, Pakistan,)

[67] [68,69] [69] [64] [29]. Trying to change these customs to dry cord care, where nothing is applied to the cord (or only an antiseptic), can meet with considerable resistance.

Antenatal care

In many countries, women have heavy workloads and are involved with these up to the delivery time **[25] [71]**. One of the roles of antenatal education is to help women prepare better for delivery, to help them learn about risk factors and danger signs, to plan for having trained attendants at the delivery and rapid emergency help if needed. Antenatal education also provides the opportunity to learn more, including more about safe hygiene, water and sanitation during and after pregnancy. Thus, the antenatal visit can, at least theoretically, activate the link between improved WASH and maternal health **[5]**.

To make this link, however, the quality of education and service in the antenatal clinic must be adequate. For example, research in Zambia showed that only 15% of women who visited the antenatal clinic had adequate knowledge about the risk factors and/or danger signs of pregnancy **[74]**; and two studies in Tanzania and Kenya showed that only about half those attending the antenatal clinic received health education **[75][76]**. Conversely, the Zambian study showed that 2½ times morewomen who know the risk factors well made use of the clinic delivery services compared to the group of women who did not**[74]**.

Factors influencing maternal health related to WASH

Antenatal care and maternal health interventions usually focus on the woman as the prime controller of reproductive health. However, the woman's control over her own health can vary considerably. She may share decision-making power with others or, indeed, have little say over

basic expenditures and important health decisions such as having birth, provision of water and sanitation facilities or seeking emergency help. For example, research by Stekelenburg et al (2004) in Zambia found that in 47% of cases women themselves decide where to deliver, in 14% the parents, in 11% the husband, in 9% relatives in general and in 3% the traditional birth attendant **[74] [77]**.

In many societies older women or grandmothers traditionally have considerable influence on maternal and child health decisions at the household level such as when to attend the antenatal clinic and where birth takes place **[78]**. Jensen describes research in Ghana showing that older female relatives have a special role in relation to childbirth and after delivery take care for the child for 7 days or so, also showing the new mother how to wash, feed and care for the baby. Additionally, this gives the mother time for recovering from the delivery **[79]**. The influence of men on reproductive health is complex. Men are often important gatekeepers of reproductive health care even though they may lack knowledge about it. Men are excluded from the actual process of childbirth due to cultural norms, yet being decision makers in many families they have the power to decide if a woman is brought to the hospital for care or not**[71]**.

Thus, power over maternal care may not be held not by the individual woman but rather by male family members, older women, elders, or by the wider community. However, traditional arrangements are also shifting, although at different speeds and in different ways, tending to empower women over their own health and that of their children **[80]**.

These decision-making and resource-allocation powers related to maternal health have their parallel in household water, sanitation and hygiene. As Krukkert shows with reference to Nepal, men are not usually the target of hygiene promotion efforts even though they have a major voice in purchases and decisions about investments in and designs of latrines, when to invest in and

where to locate water points. This gap between the focus of promotion efforts and control of decisions appears in one form or another in many countries, with the result that interventions promoting hygiene and sanitation for men are attracting more attention **[81]**. With respect to sanitation and hygiene investments, WASH projects in Nepal (SNV) and Bangladesh (BRAC) are now developing hygiene promotion targeted specifically on men as they often are primary decision-makers about construction of toilets, new water points and even soap purchases **[81, 80]**.

Water, sanitation and hygiene in medical facilities

Health centers and hospitals should have consistent or at least predictable running water, clean toilets, safe refuse disposal, clean beds and areas for birthing **[27]**. Running water is preferred, of course, over storage in barrels and tanks; water-seal toilets (which separate human fecal matter from contact with flies and humans) are preferred to pit latrines. Unfortunately this is not always the reality. For example, in one of the only comprehensive studies that could be found, the Ministry of Health in Uganda stated that poor and inadequate sanitation and lack of water in health units was a major cause of dissatisfaction, especially in rural government health facilities. Toilets were very dirty and unhygienic, something that is complicated by the fact that the public have not developed a culture for using toilets: people defecate in the open even when pit latrines are available. In most of the Kampala City Council health centers there was little running water in toilets, inadequate garbage disposal and few cleaners **[85]**. This situation is not unique to Uganda, although it seems that such sanitary monitoring may be rare or may not be made public.

A challenge in government health care systems is the disjunction between construction of water and sanitation facilities, which is often organized centrally or by other departments, and their repair/maintenance, which is often a local responsibility to which few resources or attention

may be given **[85]**. Interestingly, in Malaysia and Sri Lanka, a World Bank study found that the provision and maintenance of functional basic services for hygiene and WASH in health centers - and the convenient location of clinics - were among the elements that helped these nations achieve early and rapid improvement in maternal health **[12]**. Karlsen has argued that reliable water supply and toilets isan indicator of basic services for health facilities **[72]**.

About Water Sanitation and Hygiene

- Use water from safe sources
- Use and Keep the toilet clean and use footwear
- Wash hands with soap after using the toilet, before eating and before cooking

About Preparation for the birthing process

- Wash your body, particularly area between legs i.e between birth canal and anus.
- Have clean cloths to wear for yourself and the baby.
- Have at least four antenatal check up visits where you receive basic information about Water Sanitation and Hygiene.
- Deliver at the clinic or hospital under the care of a skilled personnel: Nurse. Doctor or official mid-wife

If you have to give birth at home or in the clinic ensure to have the following:

- Clean water available for cleaning mother and much later the baby.
- Clean hands for both attendants and mother washed with soap or disinfectant and water.
- New or properly sterilized razor and threads for tying.

- Clean area for delivery.

After Delivery

- Establish body contact with the baby after birth. Birthing the baby immediately is not required and can be dangerous.
- Breastfeed exclusively until the baby attains 6 months of age. No additional supplementation such as water, juices, or solids should be given during this period. Breast milk has enough water (88%), and a baby's water requirements even in hot climates.
- Feed the baby the first breast milk as this is the ''colostrum'' it helps to protect the baby

The knowledge and practices of Hospital and home care personnel

The reduction of the maternal mortality rate in developing countries by a third since 1990 is, in part, attributable to the growth of the health systems, specifically, the increase in skilled birth attendants and emergency care. Roughly 2 out of 5 women were able to have professional help at childbirth in 1992 while 16 years later, about 2 in three **[1] [24]**.

Another development which has worked to improve both maternal and child health has been the community health approach, that is, outreach programs from the health system into the community. These usually work in one or two ways: firstly, selected local residents are trained as community health workers and are provided with a limited supply of materials and a mandate for improved child, maternal and community health; and, secondly, health extension workers in the clinics and health centers are deployed into communities. These cadres, in addition to health care, often also have a mandate for promoting hygiene and sanitation, for example, promoting the building of safe, closed wells, hygienic latrines, improving refuse disposal, vector control, improved hand washing and personal hygiene. At this point, the WASH and health sectors come together. Brocklehurst of UNICEF (2010) observes: "When such community-based health staff

are told to give priority to hygiene and sanitation and are adequately supported, the results can be remarkable."

Another feature of some community health programs is that the trained community level workers visit pregnant women and women with newborn infants to treat neonatal problems and link the women to the formal health system. Although community case management has been successful in improving health status, it is not easy to maintain and is often neglected due to resource constraints, which results in many health workers being confined to clinics and health centers without sufficient outreach**[82] [25] [67] [83]**.

Resource and personnel constraints

In 2010, the World Health Organization stated that the main obstacle to progress toward better health for mothers remains the lack of skilled personnel, in particular, a global shortage of qualified health workers within facilities that are easily accessible in terms of geography and cost. In 2010, it was estimated that by 2015 another 330,000 midwives would be needed to achieve universal coverage of mothers with skilled birth attendance **[5]**. A low health personnel-to-population ratio is a chronic issue particularly in Sub-Saharan Africa and rural areas **[84] [23] [24]**.

Substandard provision of care can also inhibit its use. Several studies deal with problems of equipment and supplies in hospitals and clinics, meaning that the three main causes of maternal morbidity and mortality (hemorrhage, sepsis and obstructed labor) cannot be adequately treated at all rural health centers**[25]**. Some studies also deal with the quality of care, on the assumption that people will want to come to clinics that give timely and respectful service with adequate medicines and clean facilities. However, the quality of facility-based maternal services is not consistently high. Complaints about neglect and poor treatment in hospitals, poorly understood

reasons for certain procedures, plus the health care workers' views that women are ignorant, may also help explain the unwillingness of women to give birth in health facilities or to seek care for complications **[26][25]**.

Koblinsky (2006) reports on studies in Benin, Jamaica, Ecuador, Nigeria, and Ivory Coast suggesting that professional health workers were incompetent or treatment was not appropriate or timely. In a study in Ghana, as few as 17% of births in health facilities at the primary level met criteria of good clinical practice. Thus, even though more women are accessing care with health professionals in facilities at childbirth, a proportion of these still do not receive adequate health care **[27] [28] [24] [29]**. Supervision and management need special attention as interventions in their own right **[83]**.

Water, sanitation and hygiene in medical facilities

Health centers and hospitals should have consistent or at least predictable running water, clean toilets, safe refuse disposal, clean beds and areas for birthing **[27]**. Running water is preferred, of course, over storage in barrels and tanks; water-seal toilets (which separate human fecal matter from contact with flies and humans) are preferred to pit latrines. Unfortunately this is not always the reality. For example, in one of the only comprehensive studies that could be found, the Ministry of Health in Uganda stated that poor and inadequate sanitation and lack of water in health units was a major cause of dissatisfaction, especially in rural government health facilities. Toilets were very dirty and unhygienic, something that is complicated by the fact that the public have not developed a culture for using toilets: people defecate in the open even when pit latrines are available. In most of the Kampala City Council health centers there was little running water in toilets, inadequate garbage disposal and few cleaners **[85]**. This situation is not unique to Uganda, although it seems that such sanitary monitoring may be rare or may not be made public.

A challenge in government health care systems is the disjunction between construction of water and sanitation facilities, which is often organized centrally or by other departments, and their repair/maintenance, which is often a local responsibility to which few resources or attention may be given **[85]**. Interestingly, in Malaysia and Sri Lanka, a World Bank study found that the provision and maintenance of functional basic services for hygiene and WASH in health centers - and the convenient location of clinics - were among the elements that helped these nations achieve early and rapid improvement in maternal health **[12]**. Karlsen has argued that reliable water supply and toilets isan indicator of basic services for health facilities **[72]**.

Traditional Birth Attendants

Traditional birth attendants (TBAs) are the lowest, often untrained tier of birth attendants in maternal health care. They work at roughly one third of all births, a proportion that continues to decrease, however **[8]**. In the medical world there has been a lively debate about whether investments should be made in traditional birth attendants (TBAs) **[86] [87] [74]**.

The traditional birth attendants do not form a homogeneous group: some are trained, but most are not; some have well established businesses, but most attend only a few births a year; most work from home, but some work in health facilities when there is a shortage of skilled care providers **[74]**. An exhaustive literature review of maternal health Bangladesh showed that the trained TBA's knowledge of hygiene is much better than practice. In the study, the TBA's self-reports about hand washing were good but many performed repeated vaginal examinations (for example, up to 40 per pregnancy) with unwashed hands, to decide if it was time for delivery **[77]**.

Training with supervision

Bhutta (2005), Rowe (2005) and Koblinsky (2006) report on studies in sub-Saharan Africa

where training of TBAs about clean delivery and early referral to the formal health care system resulted in decreases in neonatal complications and deaths. However, the training of TBAs in countries where the community commonly used their services apparently had strong impacts on maternal health outcomes only when it was supported by functioning referral systems and good working relationships with the formal health care systems. Training in isolation is not sufficient; however, the TBA is difficult to train and supervise, as she is community-based and often somewhat invisible as a part-time practitioner of her trade.

The knowledge Traditional Birth attendants (TBA) should have

Ways in which the TBAs can reduce the risk of death or long-term illness in home delivery include:

- Detection of genital tract infection that is present prior to labor;
- Risk detection and recognition of signs of infection or ruptured membranes;
- Care seeking and referrals of all pregnant women for antenatal care and delivery.

Experience with clean delivery kits

To ensure safe delivery, beginning in the late 1980s, clean delivery kits were developed for use by TBAs, typically containing materials that contribute to clean delivery practices such as a plastic sheet, pads, clean razor blade and cord ties with user instructions. All kits contain soap for hand washing. In some programs the kits have been provided for free, or a small fee, to the pregnant women together with health education at antenatal sessions. In other cases, the kits are provided to or purchased by the TBA with training based on the principles of the "six cleans" recognized by WHO.

Evidence about the effectiveness of the kits is mixed. Hundley et al (2011) undertook a survey

of experience with 21 birth kits used in 50 different countries, many of which were part of a package of interventions. The findings are that, although birth kits are available, evidence regarding implementation in the home is limited and difficult to measure. Impact assessment on maternal health has given varied results when it has been undertaken **[88]**. Behavior change communication and education appear to be exceptionally important to promote clean delivery **[89]**. In contrast to the Hundley study, another recent study (Seward et al, 2012) used logistic regression to explore the association between neonatal mortality and clean delivery kits in more than 19,000 home births in rural India, Nepal and Bangladesh. Seward et al. found an association between the use of clean delivery practices including hand washing with a significant reduction in neonatal mortality **[95]**.

The things the Health Professional should know and practice related to water, Sanitation Hygiene and Maternal child health

- Clean birthing protocols including the WHO ‘’six cleans’’. Also clean hands and medical clothing.
- Clean health facility: Maintain and manage water, sanitation and hygiene facilities and materials in the clinic or hospital. Clean birthing and patient beds and rooms.
- Informative and respectful communication with mothers, families of all ethnic and economic backgrounds. During antenatal sessions and hospital and clinic stays, health staff should communicate in organized and clear manner on a small number of key water, sanitation and hygiene issues.
- Routine supplies and equipment should always be in place for clean appropriate and rapid emergency responses.

Linking maternal and newborn health with WASH

From the point of view of linking WASH interventions to maternal health, responsibility is held across Ministries potentially creating hurdles to linking the two sectors. However, the apparent invisibility of the issue is a barrier in itself. While medical staff at the local level often participate in hygiene promotion and sanitation programs, above this level there seems to be little joint policy or programming strategy. Within the large WASH sector, maternal health services and hygiene promotion for maternal health are seldom if ever to be found [31].

Most countries have various policies and strategies and road maps relating to maternal and newborn health. These issues can also be found in policies related to other issues such as human resources for health and education; however, there is often a lack of alignment between policies. Although most countries have separate policies and guidelines on WASH may be found, there is lack of a multi-sectorial approach (involving health, WASH and possibly education).

The Partnership for Maternal, Newborn & Child Health (2011) undertook a global review of 142 interventions meant to improve maternal, newborn and child health. The review identified only one essential intervention related to WASH, specifically, hygienic cord and skin care for newborns **[97]**. This reflects the lack of alignment or evidence-based linkages between maternal health and WASH, as stated earlier.

On the other hand, Countdown to 2015 considers water and sanitation an important factor in maternal and newborn health. It reports the data for improved drinking water coverage and improved sanitation coverage for the 72 low and middle income 'countdown' countries, that need to make progress on maternal and newborn health. The attention to water and sanitation through this Countdown initiative that concentrates primarily on reporting progress for MDGs 4 and 5 will hopefully stimulate a more multi-sectorial approach to maternal, newborn and child health.

Relevant Policy Frameworks for Linking

Global Strategy for Women's and Children's Health

In 2010, UN Secretary-General Ban Ki-moon initiated a global movement and agenda for action to improve the health of women and children around the world. It calls for integrated interventions whereby partners coordinate efforts to finance country-led health plans and address issues that impact on health, including sanitation and safe drinking water.

World Health Assembly Resolution 64.24 on Drinking Water, Sanitation and Health

In 2011 the 64th World Health Assembly adopted resolution 64.24 that (among others) urges member states to develop and strengthen, with all stakeholders, national public health strategies so that they highlight the importance of safe drinking water, sanitation and hygiene as the basis for primary prevention.

Universal Access to Water and Sanitation by 2020

During the 4th United Nations Conference on the Least Developed Countries in 2011, it was agreed to set the target of universal access to safe drinking water and basic sanitation by 2020. Governments and donor countries should support the target of Universal Access by 2020 by ensuring that sufficient funding for water, sanitation and hygiene is allocated and reaches most vulnerable communities to achieve Universal Access by 2020.

The Actions that can be undertaken

The evidence described in this paper can be reviewed to identify some possible programmatic responses that may help reduce maternal and neonatal mortality and morbidity. Many of the issues raised require continuing effort in programming within one sector such as Water Sanitation and Hygiene, health and education. The others will require the strengthening of the bonds across sectors.

In the Water Sanitation and Hygiene Sector

Specifically, for the WASH (water, sanitation and hygiene) sector, there is some evidence that there are health benefits for maternal well-being from safe water quality, free from chemical and bacterial contamination. In terms of programming, this implies the need for **effective water service delivery**, including testing of water sources for basic chemical and bacterial quality. **Watertesting** is identified here as it helps target the programming, canbe very effective element for advocacy and mobilization and, as well, is often insufficiently emphasized. Targets for water testing should include, for example, areas where drinking water is provided by shallow wells and areas with known chemical contamination. Further, a commitment to long-term promotion of hygiene practices is needed focusing on maintaining the quality of water from source to mouth, including safe home storage and transport.

To reduce the risks of parasitic infestation and resulting anemia for pregnant women, **consistent use of hygieniclatrines** is crucial, by all members of the household andcommunity. In this sanitation effort, some countries have been more successful than others. Those with lower coverage in Sub-Saharan Africa and Asia should be targeted. Some need, not new policies, but perhaps **greater political will** at the national level to ensure safe sanitation for poor populations. Among these may be included large countries such as India, Indonesia and Nigeria, which according to the WHO/UNICEF Joint Monitoring Program have, respectively, 34%, 54% and 31% coverage with improved sanitation.

The potential risk for the pregnant women carrying water implies that **water points should be conveniently located** near the household. Convenient locations also mean that greater quantities of water are used for personal hygiene. However, convenient locations for water points are not always feasible. Perhaps an additional entry point may be: who carries the water. This is

traditionally a woman's task in many countries. Some programs in Bangladesh have advocated **having men carrywater**, in the context of the greater distances required to getwater which is arsenic free. Interestingly, in the BRAC WASH programme, the motivation given seems to relate to traditional values, that is, the safety of the woman against what is called 'eve-teasing' when they must walk far to collect safe water. It is not known what, if any, the impact of this community advocacy has been; however, this does indicate that campaigns within the context of on-going WASH programs to reduce the physical burden on (pregnant) women can be undertaken.

Hand hygiene is extremely important during the birth deliveryand the neonatal period. In the WASH sector, increasing attention has been paid to handwashing with soap and water, often through national social marketing campaigns in a range of countries as varied as Uganda, Panama, Ecuador, Vietnam, Indonesia and Scotland. The 18th of October has been designated by UNICEF and its partners as Global Handwashing Day, with activities in more than 80 countries. Within the health sector, handwashing has also been the subject of advocacy and research in both industrialized and developing countries[2]. However, changing handwashing practices world-wide will require both a **long timeframe and continuing commitment** implying, among otherthings, that it should remain a feature in hygiene promotion within WASH programming as well as in health education, in general, and antenatal education in particular.

In the maternal and newborn health sector

Educational/promotionalaspects relating to Water Sanitation and Hygiene and health, especially maternaland newborn health should be improved. This should involve more than one-sided health messaging, Information, Education and Communication. It will require Behavioral Change Communication (BCC) activities that are action oriented and participatory leading to

sustainable change. The focus should include the childbearing woman and those around her who influence decision making such as husbands, mothers-in-law, elders, female leaders and traditional authoritative leaders.

Hygienic and functional WASH facilities in the formal and informal health care setting will be required. It is the responsibility ofgovernments and policy makers to develop minimal standards for health facilities that include adequate water and sanitation facilities with a practical maintenance systems. It may be possible to monitor Water Sanitation and Hygiene standards through one or two simple indicators that could be added to routine health information management systems that are present or being developed in most countries. This would inform health authorities in a timely way when there are problems.

Another important area is the **hygienic practice of clinic andhospital personnel**. It is clear that there is often a gap betweenthe **knowledge** and **practice** of clinic and hospital staff. Steps towards addressing this problem need to take place during pre-service education/training in order to transfer knowledge about the relationship between WASH and good maternal and newborn health outcomes to health workers. This should continue through in-service training in order to keep the issues 'on the radar' when staff are on the job, focusing on staff being more conscientious about hygiene and cleanliness. Another way of addressing this issue is to emphasize hygienic facilities and practices during the existing periodic supervision visits carried out by health management teams or authorities.

Besides clinic and hospital staff, it is also important that **community based health providers** are also trained in hygieneand cleanliness. As reported earlier, most community health worker programs and some TBA training programs include clean practices in the core training. In the past there was little interaction between these groups and formal health providers but there is

currently a shift towards embedding these groups within the formal health sector **[96]**. This often involves (supportive) supervision of community-based providers by staff. This is another development that might encourage the awareness and practice of hygiene by the community based health workers who provide with maternal and newborn health care.

Clean birth kits have been shown to help improve healthoutcomes of newborns, as noted earlier. However, having kits does not guarantee that adequate hand washing practice as shown by data from India **[95]**. **Continuous education, mentoring andsupervision of the community based providers** using thesekits might lead to better understanding and use of the supplies provided and in turn lead to better hand washing (and other clean delivery) practices.

In the education sector

The rapid increase in the enrolment of girls in upper primary and secondary school provides an excellent **opportunity forreproductive health and menstrual hygiene education**. Ingeneral, the **maintenance of water supply, toilets and handwashing facilities** in schools is overlooked, requiring sustainedcommitment and continuing interest of educational authorities. The aim of intervention, with educational authorities and Ministries, would be to ensure use and maintenance together with education. This should also involve implementation of hygiene practices in school such as hand washing before eating.

Legislation and reproductive health

It appears that current data in some countries vastly underestimates the problem of unsafe and unhygienic induced abortion. Estimates from UNFPA as well as experience from countries such as Romania indicate that **legalizing abortion - or making it available under safe and hygienic conditions through regulation -** would quickly reduce the rates of mortalityand morbidity

among women. Therefore adapting relevant legislation or regulation that may reduce maternal mortality should be looked into in other settings as well.

Cross-sectoral collaboration

There are existing community-based and non-governmental groups that could serve as channels to promote hygiene, safe water and sanitation for maternal and neonatal health. At the local level, in rural communities, there is often cooperation among health, sanitation, and hygiene promotion and education personnel. For example, local WASH personnel work to provide water and sanitation facilities for schools. Open Defecation Free (ODF) and other sanitation programs frequently involve local health personnel for mobilization and sanitation promotion. In rural communities, village water and sanitation committees relate to or even include health personnel members in many communities. It should be noted that these ubiquitous village committees are mandated by policy in countries such as India, Bangladesh, Tanzania, and Zambia and so on. Thus, it would logically seem possible to include a **focus on promotion of maternal healthin water and sanitation committees**. It would be interesting totry this out, with suitable monitoring, on a small scale. However, this local level collaboration is not usually matched by regional or national collaboration among ministries. Thus, to infuse maternal health promotion at scale in WASH programs would perhaps first require demonstrating the effectiveness of such an approach followed by attempts to scale up through national institutions.

In addition, many NGOs and external donors are involved in both maternal health and WASH programming. Consideration should be given to linking the two programmatically, **reducingthe compartmentalization of programming** within theseorganizations.

In the Final Analysis

Creating equitable and sustainable access to safe water and improved sanitation and hygiene

(WASH) can dramatically benefit reproductive, maternal, neonatal and child health. Integrating Water Sanitation and Hygiene services and practices into health services delivery in health facilities and improving access to Water Sanitation and Hygiene within communities has been shown to decrease both morbidity and mortality of women and children. Water Sanitation and Hygiene interventions are cost-effective and have the potential to improve gender equality and human rights – crucial to the post-2015 development agenda – by giving women and girls more social freedom and safety, and removing inequitable work burdens. Creating multisector interventions that address Water Sanitation and Hygiene and Reproductive Maternal and Neonatal Child Health, and integrating Water Sanitation and hygiene into existing frameworks and agendas for health, has the potential to bring about lasting and positive change for women, children, families and communities.

The challenge

There is a clear link between unsafe water, sanitation and hygiene, and detrimental health outcomes for women and children, especially in developing countries. Despite great advancements in reproductive, adolescent, maternal, neonatal and child health, increasing investments in WASH interventions may further improve the health and well-being of women and children. Yet WASH interventions are more than a means to improve RMNCH outcomes; they may also improve gender equality and human rights crucial to the post-2015 development agenda.

Girls are disproportionally affected, missing school as a result of walking great distances to carry water for household use, as well as lacking adequate sanitation and hygiene facilities in schools to allow them to manage their menstruation.

Further, inadequate WASH facilities are associated with sexual assault and gender based violence where toilets are unavailable or unsafe.3,4 Interventions and programmes that specifically target maternal and child mortality have made great advancements towards the achievement of Millennium Development Goals (MDGs) 4 and 5 (to reduce child mortality and improve maternal health).

Inequitable progress on MDG 7c, (to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation), especially for sanitation in rural areas and Africa, is holding back general development, equality and progress on other health-related MDGs such as reducing child and maternal mortality.

Globally 8% of maternal deaths, and in developing countries an estimated 10-15%, are due to infections that can be directly linked to unhygienic conditions during labour and birth, at home or in facilities, and to poor hygiene practices in the six weeks after birth.

Poor hygiene during and after umbilical cord cutting, such as unclean hands or use of dirty cloth, can produce significantly more cord site infections in newborns.

Children from birth through childhood risk infections, illness, delayed development and reduced cognitive function as a result of unsafe water, poor sanitation and unhygienic practices.

Approximately half a million children die every year of diarrhoeal disease caused by unsafe water and poor sanitation and hygiene practices.

Fifty percent of global malnutrition is due to waterborne diseases such as diarrhoea and intestinal worms, and one quarter of stunting can be attributed to five or more episodes of diarrhoea before two years of age.

Some recent progress has been made in recognizing the importance of WASH for broader health and development. The importance of WASH is increasingly recognized in global health

frameworks such as the Global Strategy on Women's and Children's Health and the draft Every New-born Action Plan.

The framework provided under Universal Health Coverage also provides important opportunities to embed WASH into the key functions of the health system. Furthermore, the United Nations General Assembly, in resolution A/RES/58/217, proclaimed the period 2005-2015 International Decade for Action 'Water for Life.

Despite this progress WASH is still often viewed as an infrastructure-led issue, the responsibility for which lies outside that of health systems. This perception goes handin-hand with the increasingly curative focus of the health sector and acts as a barrier to integration of WASH aspects in health strategies and programs. In addition, the creation of a supportive enabling environment and the development and implementation of appropriate policies are an essential element of sustainable WASH programmes.

Yet, many programmes do not strengthen policies or provide technical guidance to sector institutions and local stakeholders.

The knowledge available

Investment in women and girls is crucial for sustainable development. Creating equitable and sustainable access to safe drinking water, basic sanitation and promoting improved hygiene benefits the community at large, and women and children in particular. RMNCH programmes can see great improvements through the inclusion of WASH interventions.

Access to improved water sources within the community can decrease maternal mortality by decreasing the risk of intestinal worms and thus anemia and diarrheal diseases, which lead to nutritional deficiencies, and hepatitis.

Decreasing the distance to safe water sources can support healthy pregnancy, by reducing the

workload for women and supporting healthy weight gain, and is associated with decreased diarrheal disease in children.

Improved WASH within hospitals and health facilities is also essential for improved RMNCH outcomes. Basic and simple hygiene practices during antenatal care, labor and birth, such as birth attendant hand washing and clean birthing surfaces, can reduce the risk of infections, sepsis and death for infants and mothers by up to 25%.

This is particularly evident during the management of complications, such as caesarean or preterm delivery.

Clean-birthing kits used for umbilical cord cutting can reduce the odds of cord site infections twofold.

The combined benefit of hand washing, food hygiene and household hygiene reduces infant diarrhea by more than one third, and safe excreta disposal can reduce the risk of infant diarrhea by up to 37%.

Improved drinking water sanitation and hygiene also lead directly to improved child growth and development.

The experience that has been known to work.

Multisector collaborations and investment in evidence-based interventions are essential for improving WASH and RMNCH outcomes.

The private sector has great experience in behavior change and innovation, while governments can develop enabling environments and ensure WASH infrastructures and budgets exist. Combined, these efforts can be highly beneficial in driving greater improvements in WASH access.

Successful programs collaborate across work-streams, engage communities and build on the

strengths of existing programs. Within health facilities, improved WASH requires wider health-systems strengthening with key links to areas such as quality improvement, patient safety, infection prevention and control, and health administration.

At national level, coordination across ministries, partners and advocacy groups can ensure WASH interventions are included in RMNCH programs. In Nepal, the Ministry of Health appointed a focal point to coordinate with the WASH sector to ensure that WASH was embedded within the Nepal Health Sector Support Programme (NHSSP II).

The development of NHSSP II, and events like Global Handwashing Day, have brought together various ministries including those responsible for health, water, planning, works, education and local government, as well as UN agencies and civil society organizations.39 Integrating WASH into existing implementation frameworks can build upon the strength of established programs.

In Kenya hygiene interventions and education were integrated into the Expanded Programme on Immunization services by either nurses or community health workers.

Both delivery strategies led to an improvement in hygiene indicators such as knowledge and use of household disinfection of water.

Both strategies also had great acceptance and uptake in rural and urban communities alike.

Guidelines, frameworks and action plans, such as the integrated Global Action Plan for Pneumonia and Diarrhea, Integrated Management of Childhood Illnesses (IMCI) and the community integrated version C-IMCI, provide comprehensive planning and implementation tools to address childhood illnesses including WASH interventions.

In Democratic Republic of the Congo, Nicaragua, and Peru specific hygiene and WASH integrated C-IMCI programs have been developed and implemented. These programs found improvements in drinking water storage, hand washing, water handling and the decrease in

diarrhea after one year of programme implementation.

Research

It has been noted repeatedly that there is a lack of robust research, assessment and program evaluation related to the intersection of the WASH and maternal health sectors. Some suggestions for further research include:

1. Studies on the impact of water, sanitation andhygiene on maternal mortality and morbidity athousehold and/or community level.
2. Studies on the influence of socio-cultural perspectives, identifying the barriers for behaviorchange and potential change agents within communities, in relation to maternal health andWASH. Assessments and pilots would be useful of the most appropriate, cost-effective, and sustainable cleandelivery strategies in community and rural settings.This could include TBA practices and their links to the formal medical setting. Better evaluation is needed, for example, of the actual use and impact of clean delivery kits that include education components on maternal health outcomes **[89]**.
3. Rapid assessments of current water and sanitary conditions in health facilities. The dissemination ofevidence about current conditions could help catalyze efforts to improve facilities and their maintenance. Additionally, research should be undertaken on the impact of improved water and sanitation in health facilities on maternal health outcomes. This should also include a focus on safe disposal of medical waste at health facilities.

Conclusion

This review has shown the synergy of WASH and maternal health as well as highlighting how little these themes are addressed collectively in research, interventions and programs.

Hygiene and cleanliness are basic concepts in health care. They are included in most health

promotion and health worker training programs. However, there appears to be a gap between education, knowledge and practice. Health information and behavior/practice change are essential to ensuring cleaner environments for better health. Effective WASH programs could work to help communities better understand the advantages of clean water and environment for maternal and child health. Effective behavioral change communication is significant to supporting individuals to improve their practices, especially pregnant women and their families. Health professionals should consistently provide hygienic services and need the support of health systems to achieve this. The global crisis in human resources for health has resulted in lower level cadres and health volunteers taking on more responsibilities relating to maternal and newborn health. These groups receive short training and need to be mentored and supported in the field to ensure that they provide clean practices.

Health systems and WASH sector institutions must work together to advocate for clean water and sanitary facilities at home, school and in the clinic to enable communities and maternal health providers to live and practice according to the principles of WASH. Governments and NGOs play a large role in this and should ensure that WASH elements are incorporated into maternal and newborn health programs.

In summary, there is some information available and evidence about the benefits of water and sanitation to improve health in general and about specific interventions that could improve maternal health. These two areas have not been sufficiently addressed as complimentary themes in global development programming. More collaboration between the two sectors could improve the lives of childbearing women and their children in the future.

The inclusion of WASH interventions and priorities in RMNCH programs can bring about greater health improvements at community, health facility and individual levels. Including

universal access to WASH in the post-2015 agenda can also help ensure that vulnerable and hard-to-reach communities and individuals gain access, and that WASH becomes a global priority. WASH programs can also benefit from the inclusion of RMNCH priority agendas within programme planning and implementation, reaching the most vulnerable people experiencing the most detrimental effects of poor sanitation and hygiene, and improving health, equality and social justice. Investment in WASH, especially for hard-to-reach communities, has the potential to bring about lasting change.

Competing Interest

The authors declare that they have no competing interests.

Authors' Contribution

SJ conducted the extensive literature review. MM participated in the sequence alignment. MM participated in the design of the study.RC conceived of the study, and participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript

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ILLUSTRATIONS OF SOME KEY FINDINGS

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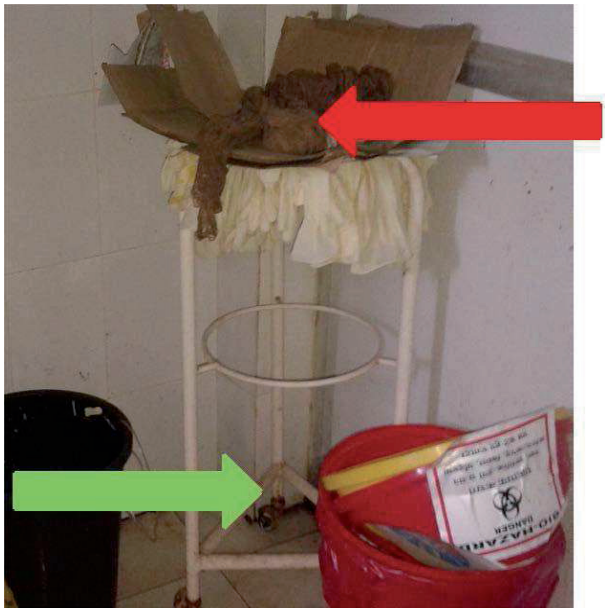
Poor	→→	Moderate	→→	Good/Optimum
Poor knowledge,awareness,practice, attitude, infrastructure, assets, leadership, systems		Good knowledge, some practice, infrastructure, assets- poor attitude, systems and leadership		Good knowledge,awareness,practice, attitude, infrastructure, assets, strong leadership, robust systems
	Training, Infrastructure and resources		Systems, structure,leadership and Attitudes	
	Quick Wins		Change Management	

POOR DISPOSAL OF WASTE IN A HEALTH FACILITY

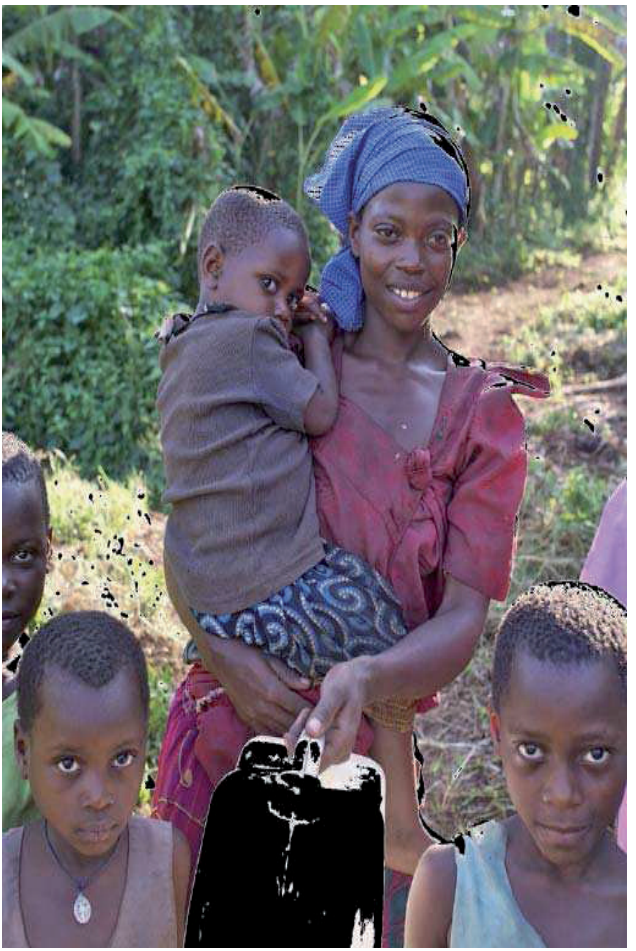
27 out of 27 facilities	0 out of 27 facilities	0 out of 27 facilities

PLACENTA

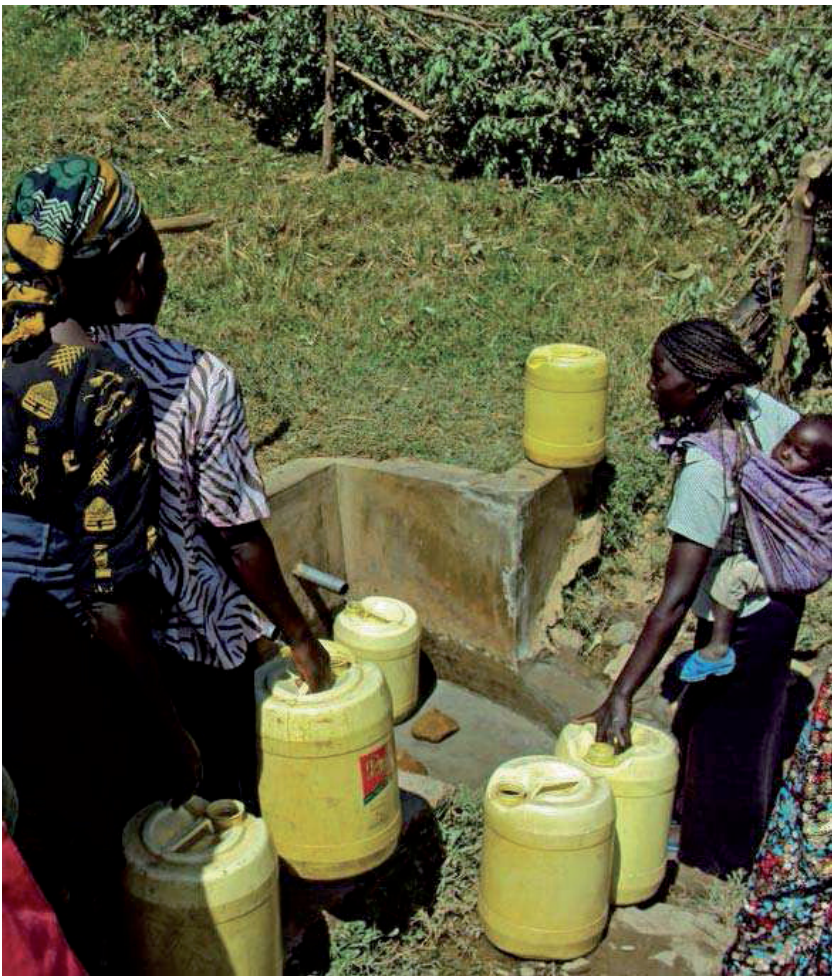


POOR SANITATION MANAGEMENT

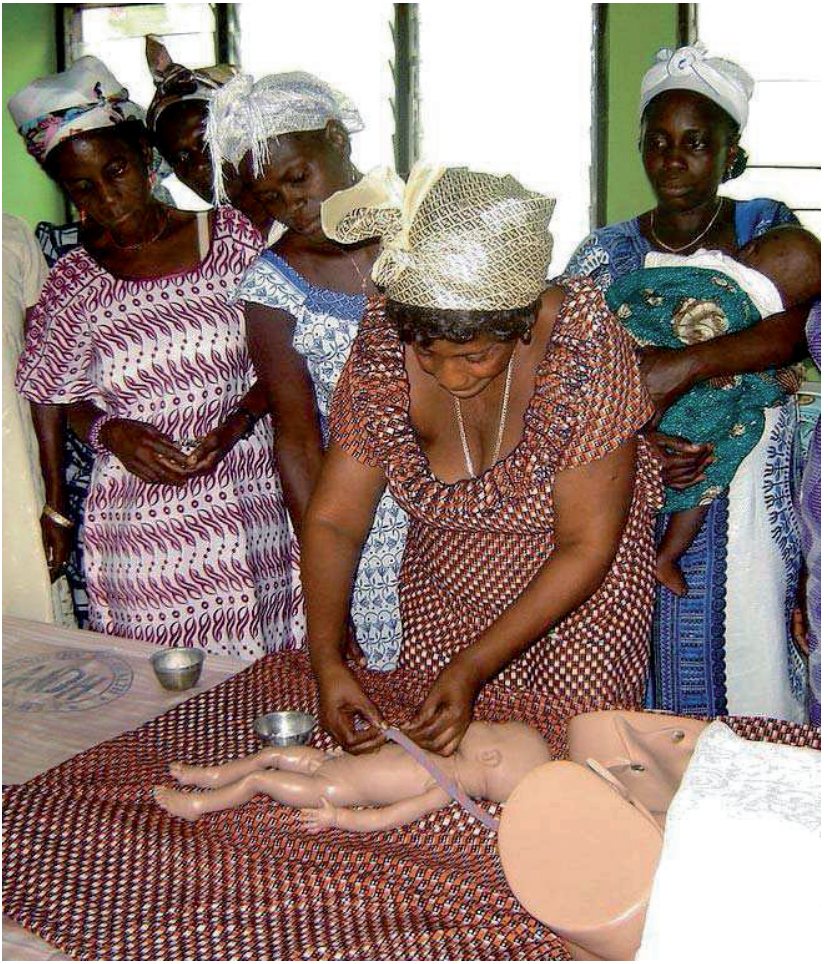
A MOTHER IN SEARCH OF WATER IN KENYA



MOTHERS FETCHING WATER FROM A WELL IN RURAL KENYA



HEALTH EDUCATION



A MOTHER IN HOSPITAL AFTER DELIVERY

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