# Water, sanitation, and hygiene in emergencies: summary review and recommendations for further research

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*Water, sanitation, and hygiene interventions can interrupt diarrhoeal disease transmission and reduce the burden of morbidity and mortality associated with faecal-oral infections. We know that rapid response of effective WASH infrastructure and services can prevent or lessen the impact of diarrhoeal outbreaks that can exacerbate the human suffering accompanying humanitarian crises. In this review summary, we present an overview of current knowledge about what works to prevent disease in emergency WASH response. We know that providing safe water, safe excreta disposal, and basic hygiene measures such as hand washing with soap are effective interventions both within emergency settings as well as in longer-term development, but innovation and further research are needed to make WASH response more effective. We propose key areas for critical research to support the evidence base for WASH interventions in emergencies and promote innovation.*

**Keywords**: emergencies, humanitarian, water, sanitation, hygiene.

Water, sanitation, and hygiene (WASH) measures are intended to protect health by reducing exposure to pathogens

WATER, SANITATION, AND HYGIENE (WASH) measures are intended to protect health by reducing exposure to pathogens. Their implementation in non-emergency settings is supported by a wealth of evidence suggesting significant health gains as well as other benefits (Bartram and Cairncross, 2010). In emergency settings, rapid WASH provision can prevent outbreaks and an escalation of the total burden of disease and death associated with natural or man-made disasters. Outbreaks of diarrhoeal diseases, including dysentery and cholera, are common in emergencies. Faecal-oral diseases may account for more than 40 per cent of deaths in the acute phase of an emergency, with greater

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than 80 per cent of deaths in children under 2 years of age (Connolly et al., 2004). In some emergencies and post-emergency situations, diarrhoea can be responsible for the majority of deaths. During the Kurdish refugee crisis of 1991, for example, one estimate was that 70 per cent of total deaths were attributable to diarrhoea (including cholera) (Toole and Waldman, 1997). Post-response case studies and outbreak investigations have identified unsafe water (at source and point of use), lack of water (quantity), poor sanitation access or use, scarcity of soap and hand washing, and contaminated foods as risk factors for transmission. Kouadio et al. (2009) summarize infectious disease outbreaks following natural disasters and conflicts, many of which are directly related to WASH.

More suitable approaches and technologies for rapid deployment to emergencies are needed

Emergency situations are challenging environments for WASH implementation, and recent experience from Haiti and elsewhere has highlighted the limitations of current emergency sanitation options (and to a lesser extent safe water supply and hygiene promotion) within humanitarian response (Shultz et al., 2009; Patel et al., 2011). The need for more suitable approaches and technologies for rapid deployment to emergencies has been widely acknowledged in the humanitarian sector and discussed at the recent Stoutenburg workshops (Johannessen, 2011).

The need for improved WASH strategies for emergencies has generated a number of new approaches that have been explored by relief organizations, leading to rapid innovation. However, there remains insufficient confidence and evidence of what works, what doesn't, and why in emerging processes, technologies, and approaches for humanitarian WASH services. Unknowns persist about which strategies are suitable for the immediate emergency phase and which technologies, practices, and approaches may permit a transition towards more sustainable solutions and future resilience.

We reviewed the existing guidance on best practice for WASH delivery in emergencies and published evidence on what works to control disease transmission. Based on our summary, we propose a number of areas for critical research to improve WASH response in humanitarian relief. This paper is an overview of this review.

## Existing guidance: Best practice for wash interventions

There is an extensive grey literature outlining 'what works' and best practice in the delivery of WASH interventions in emergency settings, spanning intra-agency briefing notes, project reports, training packs, and lessons learnt or case study papers. Table 1 summarizes recommendations for best practice in the WASH response according to the widely cited Sphere Project (Sphere, 2011), and Table 2 illustrates the diversity of documents providing guidance for good practice in

emergency response. Much of the knowledge about 'what works' is the mostly tacit knowledge held by the humanitarian workers who are mobilized in response and who learn on the job or by trial and error. Institutional memory is therefore diffuse and grows organically with additional experience from each crisis.

Much of the knowledge about 'what works' is tacitly held by humanitarian workers

One of the challenges for practitioners seeking guidance has been the often diverse, and sometimes disparate, sources of information emerging from practitioners when this accumulated experience is communicated. Knowledge sharing has occurred not just through published papers but also through various sector forums – both online and traditional – as well as training and capacity-building activities held within and between operational agencies. Technical enquiry services, for example those offered by RedR, Practical Action, DEW Point, and KnowledgePoint, have played an important role in responding to ad hoc requests for guidance.

Some agencies, particularly international NGOs and UN agencies, have published conference proceedings, technical guidance manuals, and other documents in order to share knowledge. Much of the best practice literature has historically reflected in-agency policy rather than broader sector-level consensus but has laid important foundations for inter-agency dialogue.

There have been various communities of practice and inter-agency meetings convened over the last 20 years to share learning and ideas. Perhaps the most significant recent initiative was the establishment of the WASH Cluster. The 'cluster approach' was one pillar of the reforms agreed in 2006 by UN agencies and other organizations active in the field of humanitarian response. The WASH Cluster has three key responsibilities: 1) setting standard and policy; 2) building response capacity; and 3) providing operational support. Under the first objective of standard setting, the WASH Cluster seeks to both consolidate and disseminate standards and to identify best practice. The cluster has played an important role in both providing a platform for the sharing of learning, and providing a source of information for those seeking guidance through its website.

Another more formalized attempt to improve guidance within the sector is the Sphere project and its *Sphere Handbook*, now in its third edition (Sphere, 2011). Rooted in a rights-based and people-centred approach, the *Sphere Handbook* provides minimum standards for humanitarian responses across six sectors, including WASH. The guidelines are the result of 'sector-wide consultations…involving a wide range of agencies, organizations and individuals, including governments and United Nations' and are generally accepted by the humanitarian sector as representing 'best practice'. Table 1 summarizes the key standards and examples of the recommended indicators from the Sphere Project.

**Table 1.** Selected water, sanitation, and hygiene recommendations for emergency response

| *Water* | | *Sanitation* | | *Hygiene* | |
|---|---|---|---|---|---|
| *Standard* | *Indicators* | *Standard* | *Indicators* | *Standard* | *Indicators* |
| **Water quantity** | Total basic water needs: 7.5–15 litres per day | **Environment free from human faeces** | All sanitation situated >30 m from any ground-water source | **Hygiene promotion implementation** | All facilities are appropriately used and maintained |
| | Max. distance to nearest water point <500 m; queuing time <30 min | | Toilets are used (and children's faeces disposed of) hygienically | | All wash hands after defecation/cleaning children, before eating/preparing food |
| **Water quality** | No faecal coliforms per 100 ml at point of delivery and use | **Appropriate and adequate toilet facilities** | Max. of 20 people use each toilet | **Identification and use of hygiene items** | All have access to hygiene items and these are used effectively |
| | No outbreak of water-borne or water-related diseases | | Security threats are minimized, especially to women and girls | | All women and girls of menstruating age are provided with appropriate menstrual hygiene materials |
| **Water facilities** | Household has min. 2 clean water collecting containers | | | | |
| | At least 1 washing basin per 100 people | | | | |

*Source*: Sphere, 2011

**Table 2.** Selection of grey literature on WASH interventions in emergencies [all websites accessed 30 January 2012]

| *Type of document* | *Selected references* | *Link* |
|---|---|---|
| Books and manuals | John Hopkins and IFRC (2008) *Public Health Guide for Emergencies*, 2nd edn | http://www.jhsph.edu |
| | Davies, Jan and Robert Lambert (2002) *Engineering in Emergencies: A Practical Guide for Relief Workers*, Practical Action Publishing, Rugby | http://developmentbookshop.com |
| | MSF (1994) *Public Health Engineering in Emergency Situations* | http://www.msf.org.uk |
| | ODI and A. Chalinder (1994) *Good Practice Reviews: Water and Sanitation in Emergencies* | http://www.odihpn.org/ |
| | ACF International network (2005) *Water, Sanitation and Hygiene for Populations at Risk* | http://www.actioncontrelafaim.org |
| Technical guidelines | Oxfam (2006) *Water Treatment Guidelines for Use in Emergencies* | http://www.oxfam.org.uk/ |
| | House, S.J. and R.A. Reed (1997) *Emergency Water Sources: Guidelines for Selection and Treatment*, WEDC, Loughborough | |
| | ADPC (2000) *Tools and Resources for Post-disaster Relief* | http://www.adpc.net |
| | IFRC (2008) *Household Water Treatment and Safe Storage in Emergencies* | http://www.ifrc.org/ |
| Technical briefing notes | Oxfam (2010) *The Use of Poo Bags for Safe Excreta Disposal in Emergency Settings* | http://www.oxfam.org.uk/ |
| | WHO and WEDC (2011) Technical notes for emergencies | http://wedc.lboro.ac.uk |
| | SuSanA (2009) *Sustainable Sanitation for Emergencies and Reconstruction Situations* | http://www.susana.org/ |
| Conference proceedings | World Water Week (2009) *Abstracts volume, Workshop 5: Safe Water Service in Post-conflict and Post-disaster Context* | http://www.worldwaterweek.org/ |
| | Oxfam working paper (1995) *Proceedings of an International Workshop: Sanitation in Emergency Situations* | http://www.oxfam.org.uk/ |
| | P. Paul (2005) *31st WEDC International Conference, Proposals for a Rapidly Deployable Emergency Sanitation Treatment System* | http://www.wedc-knowledge.org |
| Lessons learned | ALNAP (2008) *Flood Disasters: Learning from Previous Relief and Recovery Operations* | http://www.alnap.org/resources/lessons.aspx |
| | Oxfam (2011) *Urban WASH Lessons Learned from Post-earthquake Response in Haiti* | http://www.oxfam.org.uk/ |
| | UNICEF (2010) *Community Led Total Sanitation: Part of the Emergency Response in Flood-Affected Villages in Central Mozambique* | http://www.unicef.org |

| *Type of document* | *Selected references* | *Link* |
|---|---|---|
| Strategic documents | UNICEF (2010) *Core Commitments for Children in Humanitarian Action* | http://www.unicef.org |
| | *Global WASH Cluster, Strategic Plan 2011–2015* | http://oneresponse.info/Pages/default.aspx |
| | WELL (2006) *A Strategic Approach to Water and Sanitation in Disasters* | http://www.wedc-knowledge.org |
| Websites | WEDC publications | http://wedc.lboro.ac.uk |
| | WASH cluster website | http://oneresponse.info/Pages/default.aspx |
| | Tearfund International Learning Zone | http://tilz.tearfund.org |

*Note:* Acronyms: IFRC, International Federation of the Red Cross and Red Crescent Societies; MSF, Médecins Sans Frontières; ODI, Overseas Development Institute; ACF, Action Contre la Faim; ADPC, Asian Disasters Preparedness Centre; ALNAP, Active Learning Network for Accountability and Performance in Humanitarian Action; WHO, World Health Organization; WEDC, Water, Engineering and Development Centre; SuSanA, Sustainable Sanitation Alliance; UNICEF, United Nations Children's Fund.

There is no systematic approach to issues of inclusiveness in the emergency context

### *Inclusion*

Whilst there are examples of good practice, it should be noted that there is no systematic approach or guidelines to issues of inclusiveness in the emergency context. The WASH response should be inclusive with respect to:

*Women and girls*. Safety concerns of women and girls have been documented challenges to implementing sanitation in a humanitarian context (Atuyambe et al., 2011), and females are also usually responsible for managing water, protecting water quality, and maintaining domestic hygiene. Water provision, water quality interventions, and hygiene promotion in an emergency setting must focus on women and girls, include their active participation and empowerment, and account for their needs and preferences in response strategies (Nawaz et al., 2010). Although guidelines for meeting menstrual hygiene needs exist (e.g. Sphere standards), more work is needed to characterize appropriate strategies to meet needs (Sommer, this issue).

*People with disabilities*. The World Bank estimates that 20 per cent of the world's poorest people are disabled, yet little attention has been paid to the needs for unrestricted access to WASH. This is especially true in the humanitarian context. Innovation for sanitation access must include careful consideration of meeting the needs of people with disabilities. Some refugee and displaced persons populations may have a high percentage of people with disabilities, and this may be especially true after natural disasters that have resulted in bodily harm (Wolbring, 2011).

Few sanitation options have been documented specifically for use by children

*Children*. Children need different excreta disposal facilities depending on age. If nappies are distributed, waste management is an issue; however with non-disposable nappies there is the problem of washing. Providing potties for children is an option where children are afraid of falling into a pit latrine or might not want to use a toilet for other reasons such as darkness, snakes and other animals, the smell, and dirtiness. Few sanitation options have been documented specifically for use by children, although they are among the most susceptible group to faecal-oral disease.

*People living with HIV/AIDS*. Populations affected by HIV/AIDS are especially susceptible to WASH-related illnesses and appropriate WASH responses may need to consider this and other vulnerable populations in response; high levels of HIV itself can lead to interruption in WASH services and increased vulnerability to disease (Moss, 2004).

## Review of published evidence: Water supply and quality

*There is strong evidence that both sufficient water (quantity) and safety (quality) are critical to interrupting disease transmission in humanitarian settings. Better models are needed for rapid delivery of water to dispersed populations and more research is needed to support adherence to water quality interventions.*

There are established and accepted methods for water provision in emergencies

There are established and accepted methods for water provision in emergencies (e.g. Sherlock, 1988) although context-specific factors such as political, economic, social, and environmental constraints may impact how these are put into place (Shelley, 1994), how effective they are, and whether they may result in increased risk of vector-borne diseases such as malaria or dengue (Bayoh et al., 2011). Installation may be complex, requiring special expertise, and time-consuming, slowing response time and the delivery of safe drinking water in the critical early stages of response. The pursuit of more sustainable water supplies in the first instance may delay response time but may have longer-term advantages (Randall et al., 2008). The process of selecting from available technologies itself may not be straightforward in rapid response, where there is a need for immediate access to potable drinking water but acknowledgement that the supply needs to be sustainable. The need for immediate water provision often takes precedence, justifiably. The delayed water supply response following the 1999 earthquake in Turkey, for example, was linked to higher faecal-oral disease seroconversion in children (Sencan et al., 2004).

There is evidence that sufficient water (quantity) for health and well-being, including hygiene needs, is protective against disease in emergency settings, and international standards exist for water

provision in emergencies (Table 1). Cronin et al. (2008) observed that households reporting diarrhoea within the previous 24 hours had a mean 26 per cent less water available. In a seven-country review of 51 camps from 1998 to 2000, Spiegel et al. (2002) concluded that camps with lower than the recommended 15 litres of water per person per day had significantly higher under-five mortality in a systematic risk factor analysis. Following the arrival of 800,000 Rwandan refugees into the Democratic Republic of the Congo in 1994, 85 per cent of the first month's 50,000 deaths were due to diarrhoeal diseases (cholera and shigellosis). The primary risk factor was lack of access to water: the per capita water allowance was 0.2 L per day in the first week of the crisis (Connolly et al., 2004). Further, water that is supplied must be accessible and acceptable to users. Atuyambe et al. (2011) found that the inconsistent nature of tanked water provision as well as taste acceptability issues resulted in camp residents using untreated surface water. This also underscores the importance of prior knowledge about water safety among the population being served. Water supplies must be both safe and acceptable to users, although quantity may take precedence over quality (Luff, 2004) in terms of delivering a wide range of health benefits, including those that are primarily linked to hygiene.

Solutions that are both rapidly deployable and come with a plan for long-term sustainability are needed

There is some evidence that community ownership of water supplies and demand-driven approaches may increase the sustainability of water supplies (Boydell, 1999), but how anything but a top-down, supply-side solution for water provision can be effected in an emergency situation is unclear. In many cases, there would be ethical obstacles to requiring community investment in these types of situation. Transition to a longer-term, sustainable approach to water supply following an emergency often requires a change of approach. Solutions that are both rapidly deployable and come with a plan for the transition to long-term sustainability are needed, especially if new systems and services make communities more resilient against future emergencies. The management of water supplies in post-emergency transition has received some attention (e.g. Pinera and Reed, 2009), but the well-known institutional, financial, environmental, and social constraints that limit water infrastructure services in low-income settings threaten access to safe water once any special attention (funding, human resources) that may have been the result of an emergency has been redirected.

The management of water supplies in post-emergency tran-sition has received some attention

### *Water quality interventions (point-of-use treatment and safe storage)*

There is evidence that drinking water quality at the point of consumption is an important determinant of risk of disease, so a

number of studies have focused on point-of-use (POU) water quality in humanitarian response (Clasen and Boisson, 2006; Gupta et al., 2007; Steele et al., 2008). Water quality interventions such as POU water treatment and safe storage have been studied for their effectiveness in reducing risk of diarrhoeal diseases (including cholera) in emergency response and refugee camp situations. Current evidence is suggestive of protective effects of both active treatment and safe water storage (such as narrow-mouth containers or containers with controlled access) with documented effects against cholera (Hatch et al., 1994; Reller et al., 2001; Hashizume et al., 2008; Shultz et al., 2009) and all diarrhoeal diseases (Roberts, 2001; Kunii et al., 2002; Mourad, 2004; Walden et al., 2005; Doocy and Burnham, 2006; Hashizume et al., 2008). Chlorination, chlorination preceded by flocculation, boiling, and ceramic filters have been studied. Work by Lantagne (2011) has shown that the use of POU water quality interventions in emergencies has the greatest likelihood of success when effective technologies are distributed to households with contaminated water who are familiar and comfortable with the option before the emergency, and have the training and support necessary to use the option after the emergency.

Current evidence is suggestive of protective effects of both active treatment and safe water storage

Critically, consistency of use or adherence may limit the impact of POU water treatment, and some evidence for low adherence exists from studies conducted in humanitarian response. Mong et al. (2001) reported 50 per cent adherence to POU chlorination and Clasen and Boisson reported approximately the same level of adherence to POU ceramic candle filtration at 16 weeks post-implementation. Colindres et al. (2007) reported 45 per cent adherence to a POU combined flocculent-disinfectant at 3 weeks after distribution. Atuyambe et al. (2011) reported 'unsuccessful' uptake of boiling in Uganda due to taste acceptability issues in the target population. Water quality interventions can only protect public health if they are used correctly and consistently, and adherence is especially important when the risk of disease associated with untreated water is high.

### *Research needs: Water supply and water quality*

Research is needed to modify or develop technologies for rapid distribution in emergencies so that beneficiaries in dispersed emergency situations have faster, more predictable, and longer-lasting access to safer drinking water. This includes both rapid deployment of drinking water treatment and distribution methods for safeguarding water to the POU. Because safe water may be distributed and subject to recontamination, appropriate distribution methods to the POU with a focus on protecting water quality are needed. Dedicated safe storage containers or packaged water distribution may be needed to safeguard

Research is needed to modify or develop technologies for rapid distribution in emergencies

quality. The challenge of rapidly providing 15+ litres per person per day of safe water (and the means to protect it from recontamination) is formidable.

Also, more research is needed on appropriate means of creating high adherence to POU water treatment and safe storage through effective technology design and behaviour change. The available evidence from POU interventions in the humanitarian context suggests that water quality interventions may be protective against disease but high adherence is probably required to maintain health impact. A number of studies of POU water treatment from non-emergency settings have shown reduced use of interventions over time, raising questions about the potential for sustained use (Luby et al., 2001; Brown et al., 2007; Mausezahl et al., 2009) and therefore health impact when untreated water is unsafe.

## Review of published evidence: Sanitation

*Effective sanitation can prevent disease and rapid response is important. Whilst basic options exist, innovation is needed to meet known challenges.*

Safe excreta disposal is the first line of defence against faecal-oral pathogen transmission

Safe excreta disposal is the first line of defence against faecal-oral pathogen transmission. Sanitation options for the humanitarian context have been widely studied and it is widely recognized that no one solution is appropriate for all cases (Howard, 1996; Wisner and Adams, 2002; Harvey and Reed, 2005). Excreta need to be contained in the quickest time possible to prevent the spread of infection (Sencan et al., 2004), but currently available options may not be adequate to meet the challenge of rapid response. Some emerging sanitation solutions are not developed or refined enough to be available for immediate dispatch in the first phase of an emergency.

Sanitation is often a defecation field, trench latrine, or communal latrine solution until the immediate emergency phase is over, during which capacity is quickly overwhelmed by the numbers of users, pits fill up and become a hazard, and maintaining hygienic conditions becomes a challenge. Open defecation, and the use of plastic bags (flying latrines) are commonly practised alternatives (Patel et al., 2011). Lora-Suarez et al. (2002) noted a significant increase in giardiasis among children associated with shared sanitation (compared with individual household sanitation) following an earthquake in Colombia. Standards recommend no more than 20 people per latrine (Table 1), but for maintaining hygienic conditions one household per latrine is ideal.

Problems with safe excreta disposal were particularly evident in Haiti (Johannessen, 2011; Bastable and Lamb, this issue). The inability to dig pit latrines – due to a high water table, concrete sites,

The use of Portaloos as a temporary measure in these contexts proved inadequate

or lack of permission – slowed the aid effort considerably. Agencies took many days, if not weeks, to construct wooden raised latrines with small holding tanks. In 2009 similar problems were experienced in the floods in Greater Manila, the Philippines. The use of Portaloos as a temporary measure in these contexts proved inadequate owing to high cost and small storage capacity. Such examples illustrate that agencies may be poorly equipped to deal with the rapid provision of safe excreta disposal in urban emergency contexts.

### *Research needs: Sanitation*

*Wastewater and faecal sludge treatment and disposal.* There is a clear need for innovation in managing wastewater and faecal sludges that are generated in the humanitarian context. Innovative, decentralized wastewater treatment options (membrane bioreactors, constructed wetlands, anaerobic filters) have been studied (e.g. Paul, 2005; Randall et al., 2008) but have not been widely adopted. Current solutions for sludges, such as desludging and sludge disposal and treatment kits, may be too costly and require skilled management, and may result in health risks where the sludge is finally dumped. There has been some innovation with desludging (Oxfam GB's work with diaphragm mud pumps, supernatant water pump), but more work remains to be done to drive down costs and expand the range of appropriate, practical options. Where and how waste is disposed of is critically important to containing faecal-oral disease (Howard, 1996).

Containment and chemical disinfection of waste and wastewater from cholera- and other infectious disease-impacted environments has been practised using chlorine, lime, and other means, although the effectiveness of these strategies *in situ* in reducing target microbial contaminants has not been formally assessed and deserves greater attention.

There is a need for more research on the effect of existing and emerging strategies for sanitation on available water sources

*Sanitation under challenging conditions.* Implementing effective excreta containment under challenging physical conditions such as unstable soils, high water tables, and in flood-prone areas remains a challenge in both the development and the post-emergency context (Djonoputro et al., 2010). Alternative systems may be required, including lining of pits to prevent pits from collapsing or building raised latrines (when digging down is not an option). There is potential to develop new technologies (such as septic tanks that can be rapidly constructed in areas with a high water table) as well as a need for more research on the effect of existing and emerging strategies for sanitation on available water sources.

Some settings may require unconventional approaches. Technical solutions need to be innovative and responsive to the specific physical, social, and cultural circumstances of the disaster-affected

population. There has been some experience with people using a Peepoo bag (a double bag system containing powdered urea which prevents bad smells and speeds up the biodigestion process) or simple biodegradable bags (Patel et al., 2011), although more research is needed to characterize the role of Peepoo or conventional bags in meeting emergency sanitation needs and their implications for sludge treatment and disposal.

*Design.* Some sanitation options may benefit from design improvements for specific contexts. Plastic sheeting as a superstructure material, used in rapid response, often gets ripped, which has implications for dignity and security and often means the latrine isn't used (Johannessen, 2011). Oxfam has done some innovative work with prefabricated superstructure(s) that can be shipped or easily assembled with local materials and easily erected over latrines on site. Sanitation options that are user-friendly for women, men, children, and disabled persons exist, but innovation may increase available options' acceptability, effectiveness in excreta containment, safety, and maintenance over time. This is an area of rapid development by sectoral stakeholders, but focused research is needed to evaluate and implement emerging options.

## Review of published evidence: Hygiene

The role of hand washing in preventing faecal-oral disease transmission is known, including in outbreaks

*The role of hand washing in preventing faecal-oral disease transmission is known, including in outbreaks. Promotion of hand washing with soap involves behaviour change, which can be slow. Are there rapid approaches that work? Is there a role for hardware?*

Hygiene interventions can interrupt faecal-oral disease transmission and hand washing with soap in particular may be critical in outbreaks. Peterson et al. (1998) demonstrated that regular soap distribution (240 g bar soap per person per month) resulted in a 27 per cent reduction in diarrhoeal disease among households with consistent soap availability in a refugee camp in Malawi, and two studies have suggested a protective effect of hand washing with soap against cholera in outbreaks (Reller et al., 2001; Hutin et al., 2003). Soap availability and use behaviour is also critical, however, and user preferences and knowledge must be addressed, as suggested by data from a Ugandan emergency response in 2010 (Atuyambe et al., 2011) where hand washing was limited by soap type preferences and inconsistent availability. These factors suggest that hygiene promotion in emergencies is recommended and should accompany soap provision. There are examples of innovative hygiene promotion approaches such as Community Health Clubs that have been promoted in IDP

camps in Uganda. No peer-reviewed studies exist on the associated hygiene 'hardware' such as hand washing stations or hygiene kits that may promote healthy hygiene behaviours in an emergency context. Rapidly deployable hardware that may aid in hygiene promotion is an area of potentially important innovation for WASH emergency response.

***Research needs: Hygiene***

Hygiene hardware innovation and research may facilitate more effective behaviour change. Hand washing stations or personal hygiene kits may increase uptake and consistency of hand washing. Their use in humanitarian response should be formally assessed.

Hygiene promotion software that rapidly increases hygiene behaviours should be the focus of innovation and evaluation

Hygiene promotion software that rapidly increases hand washing and healthy hygiene behaviours should be the focus of innovation and evaluation. Soap distribution may need to be supplemented by specific supporting activities to be most effective. Given the critical role of hand hygiene in protecting health – especially during an outbreak – hand washing behaviours may merit further research to make the available interventions more effective.

## The need for more research

Within the humanitarian emergency sector, the importance of the research and evidence base is well recognized

Within the humanitarian emergency sector, the importance of the research and evidence base is well recognized. There is a culture that is supportive of research as well as key champions together with the motivation to undertake further research. NGOs and operational agencies (such as Oxfam, ACF, MSF, Tearfund, IRC, and IFRC) are proactively innovating in humanitarian response technologies and appropriate WASH product design, either individually or with inter-agency cooperation. They are working closely with product designers and suppliers to generate new technologies for rapid deployment in humanitarian settings. Experience has shown that the outputs of research – technologies, techniques, and processes – tend to be rapidly adopted.

There is a need to investigate innovative relief support services, tools, and technologies for water, sanitation, and hygiene (WASH) regionally and globally to meet the needs of disaster-affected communities in a modern context and deliver solutions at scale. The WASH response must be rapid to be effective: outbreaks happen quickly. Whilst there are kit-based and other rapidly deployable solutions (particularly for water), this is an area that deserves further research and innovation to improve response time post-emergency. Few WASH agencies currently stockpile standardized kits, even though kits are probably necessary to achieve rapid response.

Incorporating applied research into emergency response and publishing the results can help accelerate innovation. Most disaster response experience related to water, sanitation, and hygiene is not recorded in the peer-reviewed literature: communication of findings in the form of peer-reviewed research or case studies is understandably a second consideration after more immediate needs are met. Moreover, crisis situations themselves are often not suited to controlled research, and experimental methods may not be applied for ethical, logistical, financial, or human resource reasons. Therefore, few experimental studies of WASH interventions are conducted in humanitarian settings. Nevertheless, there is an urgent need to learn more about how to do research in this context, and the implications of different methods for the rigour of research in emergencies and thus the reliability of the evidence. Of the available observational and retrospective studies, case studies are most common and report context-specific data on acceptability, use, and impact of strategies employed. Whilst such studies are useful as 'snapshots' of the success of available practice, they may be more a commentary on the operational and programmatic responses to specific emergency situations themselves rather than controlled experiments of specific WASH interventions. Communication of findings is critical to collective learning about what works in WASH response.

## Conclusion and recommendations

Recent experience suggests progress has still to be made in meeting the basic WASH needs of people in crisis

Evidence suggests that providing safe water, safe excreta disposal, and basic hygiene measures such as hand washing are effective interventions both within emergency settings and in longer-term development. Recent experience from humanitarian relief suggests progress has still to be made in meeting the basic WASH needs of people in crisis, however. We propose the following immediate priorities for research and innovation:

- *Innovative sanitation options for difficult settings*. To identify and/or develop new emergency kits that are appropriate to a number of difficult settings including: high water tables, urban settings, and unstable soil situations (Bastable and Lamb, this issue). In addition improved promotional messaging is required for rapid take up of the facilities. Work in this area is expected to fill an important gap in understanding the solutions required in both *in situ* and displaced situations including in dense/urban and scattered contexts.
- *Technologies for water provision for dispersed communities*. Whilst there is an abundance of technologies available for bulk water treatment for rapid provision of clean water in emergencies,

the picture is less clear when it comes to providing water for dispersed affected populations (Johannessen, 2011; Bastable and Lamb, this issue; Luff and Dorea, this issue). There is a need to modify or develop technologies for rapid distribution in dispersed emergency situations to ensure faster, more predictable, and longer-lasting access to safe drinking water.

- *Approaches to promote consistent, correct, and sustained use of water quality interventions*. Point-of-use (POU) water treatment and safe storage has been shown to be effective and suitable for rapid access to safe water in relief settings (Lantagne and Clasen, this issue). Documented low adherence may, however, limit the protective effects of these interventions. More research is needed on whether new technologies, new approaches, or new behaviour change interventions – or more likely a combination of all three – may play a role in providing sustained access to safer water at the point of consumption.
- *Effective hygiene hardware and software*. Hand washing stations, safe water in sufficient quantity, and the availability of soap can contribute to more effective hygiene. Rapidly deployable hand washing stations have not been systematically evaluated in a humanitarian setting. As for POU, further research is required to assess whether and how new technologies, new approaches, or new behaviour-change interventions may increase the uptake of hand washing as a sustained practice in the relief context.

Rapidly deployable hand washing stations have not been systematically evaluated

Emergency response happens within the longer-term development process (Davis, 1988) and WASH strategies that promote or are consistent with sustainable development over time are needed. Institutional memory of organizations is an important factor in ensuring appropriate response in emergency settings, since programmatic lessons learned may help improve WASH response (Anema and Fesselet, 2003). Also, many refugee or displaced persons camps are in existence for long periods, up to many years (e.g. Sudan, Palestine: Mourad, 2004; Walden et al., 2005). Although this subject is too big to deal with adequately in this paper, it is one that requires further research.

Institutional memory is an important factor in ensuring appropriate response in emergencies

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