World Health Organization
REGIONAL OFFICE FOR Europe

# Floods and health

## Fact sheets for health professionals

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# ABSTRACT

Over recent decades an increasing trend in frequency and intensity of heavy precipitation events has been observed across the WHO European Region. High precipitation extremes can result in flash floods, river floods, drinking-water supply and sewage system failure, landslides and mudslides. They can initiate devastating floods, which affect large areas and are of long duration. Floods affect human health through many pathways, and health professionals can take numerous measures to protect the health of affected populations.

A series of fact sheets has been developed, targeted at ministries of health; national, regional and local health authorities; and medical and public health professionals. These fact sheets describe in short what to do in case of a flood, in the absence of a fully functional flood health preparedness and response plan.

This is planned as a "living document" to be updated regularly.



**Keywords**

CATASTROPHIC FLOODING
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# 1. Health effects of floods

Health effects occur directly through contact with flood waters or indirectly from damage to infrastructure, ecosystems, food and water supplies or social support systems. They can be immediate or can appear days, weeks or months after the floods have receded. Two thirds of flood-related deaths worldwide are from drowning and one third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning or fire.

Effects on people exposed to flood water include:

- heart attacks and other acute outcomes of cardiovascular disease;
- drowning from walking or driving through flood water;
- injuries from:
    - contact with debris and submerged objects in flood water;
    - falling into hidden manholes;
    - trying to move possessions during floods;
    - building collapse and damage;
    - electrocution;
- diarrhoeal, vector- and rodent-borne diseases;
- respiratory, skin and eye infections;
- chemical poisoning contamination, including carbon monoxide poisoning from generators used for pumping and dehumidifying;
- stress, and short and longer-term mental health disorders, including the impacts of displacement;
- negative health effects linked with overcrowding.

Effects can occur through:

- damage to health care infrastructure, leading to:
    - loss of access to essential care;
    - loss of access to and failure to obtain continuing health care;
- water shortages and contamination due to loss of water treatment works and sewage treatment plants;
- damage to water and sanitation infrastructure;
- damage to or destruction of property and vital community facilities;
- damage to crops;
- disruption of food supplies;
- disruption of livelihoods and income;
- population displacement;
- length of flood recovery and fear of recurrence;
- stress from dealing with insurance claims and refurbishing properties.

The health impacts of floods vary between affected populations (related to their vulnerability). They also differ according to the type of flood event (slow onset or fast onset floods, for example) and the background health situation of the population.

*Source*: adapted from Menne B, Murray V, editors (2013). Floods in the WHO European Region: health effects and their prevention. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/floods-in-the-who-european-region, accessed 5 June 2014).

## 2. Particular vulnerable groups

Several factors render certain population groups or individuals at particular risk of suffering from health impacts of flooding:

- limited physical capacity
- limited mobility
- reliance on important medication and/or home care
- reliance on regular care at a health facility
- weak social networks
- poor flood awareness
- lack of resources
- lack of access to information and warnings
- staying in buildings at high risk from floods.

Vulnerable population groups include:

- children
- pregnant women
- people with chronic illnesses
- people who rely on home care
- elderly people
- people with physical, sensory and cognitive impairments
- tourists
- homeless people
- people from minority populations
- socially isolated people.

Groups usually identified as particularly vulnerable before, during or after flooding may not necessarily be vulnerable in all phases.

When preparing plans for dealing with vulnerable population groups in cases of flooding it is important to consider:

- accommodation of people with medical needs in temporary shelter;
- ensuring that chronically sick people have a list of medications required at hand;
- availability of short and clear instructions on what to do – for example, in text suitable for children;
- training of first aid workers to work with vulnerable groups;
- business continuity plans for primary health care;
- integration of factors related to race, culture and language in communication strategies;
- integration of specific needs of ethnic and racial groups in programmes for health sector surge capacity, emergency shelter and quarantine.

Family emergency plans have been shown to be useful in planning for emergencies; these should include information on details such as how and when to turn off the gas, electricity and water; how and when to call the police and fire departments; and how to find emergency information on the radio.

*Source*:

adapted from Menne B, Murray V, editors (2013). Floods in the WHO European Region: health effects and their prevention. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/floods-in-the-who-european-region, accessed 5 June 2014).

## 3. Hospital preparedness

During floods, hospitals and other health care services can face damage to infrastructure (for example, power and water supply interruptions, damage to vital equipment, disruption of internal and external communication systems, blocked transport systems and flooded ambulance stations) that disrupts normal activities. They may also experience an increased influx of patients; this may include patients that require particular specialized care. Flooding may require health care services to expand beyond normal capacity to meet community demand.

Hospitals should therefore check that they have the following:

- a well-functioning command-and-control system;
- strategies for clear, accurate and timely communication;
- well-developed safety and security procedures;
- a mass-casualty triage protocol;
- surge capacity – defined as the ability of a health service to expand beyond normal capacity to meet increased demand for clinical care;
- availability of essential services that can continue in parallel with the activation of a hospital emergency response plan;
- systems for effective human resource management;
- a plan to ensure continuity of the hospital supply and delivery chain;
- post-disaster recovery planning procedures.

A checklist and further details of the nine key components of emergency preparedness and response is available:

WHO (2011). Hospital emergency response checklist: an all-hazards tool for hospital administrators and emergency managers. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/health-topics/emergencies/disaster-preparedness-and-response/publications/2011/hospital-emergency-response-checklist, accessed 5 June 2014).

# 4. Dead bodies

Dead or decayed human bodies originating from natural disasters and accidents do not generally represent a health hazard. Only when communicable disease has been the cause of the fatalities does the situation present a health risk. The following tasks should be undertaken when handling dead bodies.

- Protect the handlers of dead bodies. Basic hygiene is essential:
  - use of gloves, personal protective clothes and equipment;
  - washing of hands with a disinfectant soap and water after handling dead bodies, and avoiding wiping face or mouth with hands;
  - regularly cleaning and disinfecting of all equipment, clothes and vehicles used in transportation and storage of dead bodies;
  - ensuring availability of first aid and provision of medical services in case of injury, and taking necessary preventive measures to address exposure to environmental hazards (for example, vaccinating workers against tetanus).
- Collect dead bodies as soon as possible, but it is not necessary or advisable to hurry their disposal because the bodies are required for identification purposes.
- Support body identification to reduce the psychological effects on survivors. Bodies should be placed in body bags or, if these are not available, in other locally available materials. Waterproof labels with unique reference numbers should be used. The WHO publication *Management of dead bodies after disasters* (Morgan, Tidball-Binz & van Alphen, 2009) provides detailed information on procedures for body recovery.
- Identify the bodies quickly. Personal belongings should be kept with bodies for identification purposes, as well as in consideration of legal and psychological implications for survivors. Forensic procedures (autopsies, fingerprints, DNA and dental records) can be used in case visual identification of bodies or photographs becomes impossible. A dead body should only be released when formal identification has been made. Identified bodies should be released to relatives or their communities to take part in local custom and practice.
- Ensure temporary storage of dead bodies. In warm climates a body will begin to decompose within 12–48 hours. Keep the body refrigerated between 2 °C and 4 °C; where possible, a refrigerated container should be used for transportation of bodies. Temporary burial is an alternative option in case of a lack of electricity and/or lack of refrigerated storage facilities, or where no other method is available. The site for temporary burial should be selected taking the hydrogeological and cultural conditions of the area into consideration, and in consultation with local authorities.
- Organize long-term storage for unidentified bodies. Burial in individual graves is a means for long-term storage of dead bodies. In situations where a local cemetery is not accessible, liaise with the local authority to ensure adequate siting (for example, away from drinking-water sources) of the burial place.
- Provide mental health support. The psychological trauma of losing loved ones and witnessing death on a large scale is the greatest concern. Anyone involved in handling dead bodies should be aware of the stress and trauma of family members, and should provide support to the greatest extent possible.

*Sources*:

Morgan O, Tidball-Binz M, van Alphen D, editors (2009). Management of dead bodies after disasters: a field manual for first responders. Washington DC: Pan American Health Organization (https://www.paho.org/disasters/index.php?option=com_content&task=view&id=673&Itemid=904, accessed 5 June 2014);

WHO (2011). Technical notes on drinking-water, sanitation and hygiene in emergencies: disposal of dead bodies in emergency conditions. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/envsan/technotes/en/, accessed 5 June 2014);

Wisner B, Adams J, editors (2002). Environmental health in emergencies and disasters: a practical guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/emergencies/emergencies2002/en/, accessed 5 June 2014).

# 5. Venomous snake bites

Snake bites during floods are common. Bites by venomous snakes can cause severe consequences. Victims of snake bites may suffer any or all of the following:

- local envenoming, confined to the part of the body that has been bitten – these effects may be debilitating, sometimes permanently;
- systemic envenoming, involving organs and tissues away from the part of the body that has been bitten – these effects may be life-threatening and debilitating, sometimes permanently;
- effects of anxiety prompted by the frightening experience of being bitten and by exaggerated beliefs about the potency and speed of action of snake venoms – these symptoms can be misleading for medical personnel;
- effects of first aid and other pre-hospital treatments that may cause misleading clinical features – these may be debilitating and, rarely, even life-threatening.

These are the stages in the management of snake bites.

- Apply first aid:
    - reassure the victim, who may be very anxious;
    - immobilize the whole of the patient's body by lying him/her down in a comfortable and safe position and, especially, immobilize the bitten limb with a splint or sling – any movement or muscular contraction increases absorption of venom into the bloodstream and lymphatics;
    - consider pressure immobilization or a pressure pad if the necessary equipment and skills are available, unless an elapid bite can be excluded;
    - avoid any interference with the bite wound (incisions, rubbing, vigorous cleaning, massage or application of herbs or chemicals) as this may introduce infection, increase absorption of the venom and increase local bleeding;
    - release tight bands, bandages and ligatures – ideally, these should not be released until the patient is under medical care in hospital, resuscitation facilities are available and antivenom treatment has been started.
- Transport the patient to hospital.
- Undertake rapid clinical assessment and resuscitation.
- Perform detailed clinical assessment and species diagnosis.
- Perform investigations and laboratory tests.
- Administer antivenom treatment.
- Observe the response to antivenom.
- Decide whether further dose(s) of antivenom are needed.
- Administer supportive/ancillary treatment.
- Treat the bitten part of the body.
- Begin rehabilitation.
- Treat chronic complications.

A knowledge of which species of venomous snakes present the greatest risks to human populations in any particular region or country is essential to addressing snake bite problems. Snake antivenoms are the only effective treatment to prevent or reverse most of the venomous effects of snake bites. WHO has created a database and image library to enable users to easily identify the most important venomous snakes in their country, territory or area; see the distributions of each species; and find information about antivenom products for treating envenoming caused by their bites:

> WHO (2010). Venomous snakes distribution and species risk categories [website]. Geneva: World Health Organization (http://apps.who.int/bloodproducts/snakeantivenoms/database/default.htm, accessed 5 June 2014).

*Source*:

Warrell DA (2010). Guidelines for management of snake bites. New Delhi: WHO Regional Office for South-East Asia (http://apps.who.int/medicinedocs/en/d/Js17111e/, accessed 5 June 2014).

# 6. Vaccination during flood events

Any additions to routine vaccination should only be considered for vulnerable population groups under certain specific circumstances.

## Rescuers and relief workers

- Hepatitis A and/or B vaccination is recommended for selected high-risk individuals such as public utility workers – those involved in cleaning operations, sewage, waste or drinking-water management.
- Tetanus toxoid with or without tetanus immunoglobulin, as appropriate, is recommended for those whose vaccinations are not up to date, and should accompany wound treatment.

## Flood victims

- Hepatitis A vaccine is generally not recommended to prevent outbreaks in the disaster area, although in certain circumstances it can be used to control outbreaks (for example, in small self-contained communities, when vaccination is started early in the course of the outbreak, and when high coverage of multiple-age cohorts is achieved). Vaccination efforts should always be supplemented by health education and improved sanitation. Hepatitis A is not routinely recommended after disasters.
- As with rescuers and relief workers, tetanus toxoid with or without tetanus immunoglobulin, as appropriate, is recommended for those whose vaccinations are not up to date, and should accompany wound treatment. Tetanus boosters may be indicated for previously vaccinated people who sustain open wounds or for other injured people, depending on their tetanus immunization history (if available). Mass tetanus vaccination programmes to prevent disease are not indicated.
- Current typhoid vaccines are not recommended for mass campaigns to prevent typhoid disease. Typhoid vaccination in conjunction with other preventive measures may be useful to control typhoid outbreaks, depending on local circumstances.

## Crowded circumstances

- Unimmunized or underimmunized individuals are at risk of acquiring vaccine-preventable diseases, particularly in crowded circumstances.
- Attention should be given to ensure high coverage against measles and poliomyelitis. If countries report measles outbreaks, outbreak management needs to be accelerated and broadened in the context of the environmental emergency. Inclusion of age groups depends on vaccination coverage, available resources (vaccine availability, funding and human resources) and local measles epidemiology.

General guidance on vaccination is available at the following websites:

- WHO (2014). WHO recommendations for routine immunization – summary tables [website]. Geneva: World Health Organization (http://www.who.int/immunization/policy/immunization_tables/en/, accessed 5 June 2014);
- WHO (2014). Vaccine position papers [website]. Geneva: World Health Organization (http://www.who.int/immunization/documents/positionpapers/en/, accessed 5 June 2014).

*Sources*:

Connolly MA, editor (2005). Communicable disease control in emergencies: a field manual. Geneva: World Health Organization (http://www.who.int/diseasecontrol_emergencies/publications/9241546166/en/, accessed 5 June 2014);

WHO (2012). Vaccination in humanitarian emergencies: literature review and case studies. Geneva: World Health Organization (http://www.who.int/immunization/sage/meetings/2012/april/presentations_background_docs/en/, accessed 5 June 2014).

# 7. Food safety during or after flood events

Food can become contaminated at any point before its consumption, including during preparation if not properly handled, prepared and stored. Food safety is particularly important for infants, pregnant women and elderly people, who are most susceptible to foodborne disease.

Food safety concerns include:

- increased risk of outbreaks of foodborne disease, including diarrhoea, dysentery, hepatitis A and typhoid fever;
- increased likelihood of using contaminated water for food handling and preparation;
- population displacement forcing people to have fewer food choices and use more risky food handling practices;
- contaminated fruit and vegetables;
- poor sanitation, including lack of safe water and toilet facilities;
- impairment of the cold chain and proper heat-treatment of foods because of problems with the electricity supply.

Avoid communicable disease outbreaks by advising people to follow the five keys to safer food:

- keep hands and utensils clean
- separate raw and cooked food
- cook food thoroughly
- keep food at a safe temperature
- choose to use safe water and raw materials.

Key behaviours surrounding safe food handling, preparation, hygiene and sanitation are the most important measures to protect individuals and families.

*Source*: WHO (2014). Five keys to safer food. Geneva: World Health Organization (http://www.who.int/foodsafety/publications/consumer/5keys/en/, accessed 5 June 2014).

# 8. Water and hygiene in health care facilities during and after flood events

## Needs assessment

- Consult with local authorities on whether tap water is safe to use. Agree a procedure to receive warnings and an emergency water supply if the tap water becomes unfit for human consumption.
- With the help of the relevant authority, establish mechanisms to monitor water quality at the health care facility.
- Should the tap water be unsafe, assess needs using the following recommended minimum quantities of water per person in each setting type:
    - outpatients: 5 litres/consultation
    - inpatients: 40–60 litres/patient/day
    - operating theatre or maternity unit: 100 litres/intervention
    - viral haemorrhagic fever isolation centre 300–400 litres/patient/day.

## Emergency water supply

- Consult with local authorities to organize the emergency water supply and technical options for sources, treatment, disinfection, storage and distribution. Emergency water supplies can consist of packaged water, tanker water, direct use of alternative water sources or on-site production of drinking-water.
- If circumstances allow, separate emergency supplies (including both materials and human resources) are encouraged for health care facilities and the general public.
- Prevent access of unauthorized people to the emergency water supply and storage system.

## Water storage

During an emergency, health care facilities may experience intermittent breaks in water supply or the need to store water after emergency treatment.

- Store water safely in order to prevent it becoming (re-)contaminated or a breeding place for mosquitoes.
- Containers for transportation and storage of drinking-water should be cleaned and preferably disinfected before they are put into operation.

## Water quality

During an emergency, water quality may be compromised and emergency treatment may not achieve the usual levels of quality.

- In an emergency situation, microbial drinking-water quality is the first concern. Water of insufficient or uncertain microbial quality must be boiled if it is intended for drinking or food preparation. Water can be made safe by bringing it to a rolling boil (for example, in a kettle or pot on a cooker). After boiling, the water should be allowed to cool down on its own without the addition of ice. If water cannot be boiled for all patients, give priority to boiling drinking-water for formula-fed infants, immunocompromized and other vulnerable patients.
- If it is not possible to boil water, chemical disinfection of clear, non-turbid water is effective for killing bacteria and most viruses, but not for protozoa like *Cryptosporidium*. Options for chemical disinfection include chlorine compounds or iodine; further information is available in Table 1.
- Encourage women to breastfeed their babies, especially when the water quality at the health care setting is uncertain or insufficient.
- Ensure that water that is below drinking-water quality is used only for cleaning, laundry and sanitation, and that it is labelled as such. Water below drinking-water quality should be used for cleaning and laundry only in combination with detergent.

Table 1. Drinking-water disinfection methods in emergencies

| Method | Recommendations |
|---|---|
| Boiling | • Bring water to a rolling boil, remove the water from the heat and allow it to cool naturally. Protect it from post-treatment contamination during storage. |
| Chlorine compounds:<br>1. unscented household bleach (sodium hypochlorite)<br>2. sodium dichloroisocyanurate (NaDCC) tablet<br>3. calcium hypochlorite | • For typical room temperature and water temperature of 25 °C, minimum contact time should be 30 minutes; increase contact time for colder water (e.g. double time for each 10 °C less than 25 °C).<br>• Prepare according to package instructions.<br>• Add to clear water or after settling or clarification to be most effective.<br>• Type and typical dosage:<br>1. household bleach (5%): 4 drops per litre<br>2. NaDCC: 1 tablet (per package directions)<br>3. calcium hypochlorite (1% stock solution): 4 drops per litre. |
| Iodine compounds:<br>1. tincture of iodine<br>2. iodine<br>3. iodine tablet<br>4. iodinated (triiodide or pentaiodide) resin<br>*Caution: not recommended for pregnant women or people with thyroid problems or for more than a few months' time. Excess iodine may be removed after iodine treatment through use of a carbon filter or other effective process.* | • For typical room temperature and water temperature of 25 °C, minimum contact time should be 30 minutes; increase contact time for colder water (e.g. double time for each 10 °C less than 25 °C).<br>• Prepare according to package instructions.<br>• Type and typical dosage:<br>1. tincture of iodine (2% solution): 5 drops per litre<br>2. iodine (10% solution): 8 drops per litre<br>3. iodine tablet: 1 or 2 tablets per litre<br>4. iodinated (triiodide or pentaiodide) resin: room temperature according to directions and stay within rated capacity. |

*Source*: WHO (2011).

## Ensure hygiene when you have limited or no water in your health care facility

- Use waterless alcohol-based hand rubs for rapid, repeated decontamination of clean hands.
- Hand rub dispensers can be installed at convenient points, and can also be carried by staff as they move between patients (note: hand rubs do not replace soap and water for cleaning soiled hands).
- Where the piped water supply system is dysfunctional or unsafe for use, a basin, soap and a jug of water can be placed on trolleys to encourage hand washing by patients and staff. Similarly, such a trolley can be used on ward rounds to encourage hand washing by staff as often as needed and between patient contacts.
- Wet mopping is recommended for routine floor cleaning. Water for cleaning does not need to be of drinking-water quality, but it should be hot and must be used with detergent. If hot water is not available a 0.2% chlorine solution or other suitable disinfectant in cold water can be used. Routine cleaning procedures should also be applied in emergencies.

*Sources*:

Adams J, Bartram J, Chartier Y, editors (2008). Essential environmental health standards in health care. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/settings/ehs_hc/en/, accessed 5 June 2014);

Chartier Y, et al., editors (2013). Safe management of wastes from health-care activities, second edition. Geneva: World Health Organization (http://apps.who.int/iris/handle/10665/85349, accessed 5 June 2014);

WHO (2005). Management of solid health-care waste at primary health-care centres: a decision-making guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/medicalwaste/hcwdmguide/en/, accessed 5 June 2014);

WHO (2011). Guidelines for drinking-water quality, fourth edition. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/, accessed 5 June 2014);

Wisner B, Adams J, editors (2002). Environmental health in emergencies and disasters: a practical guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/emergencies/emergencies2002/en/, accessed 5 June 2014).

# 9. Sanitation and hygiene in health care facilities during and after flood events

## Needs assessment (toilets)

- For non-emergency circumstances, WHO recommends one toilet per 20 users for inpatient settings (including patients who use bedpans instead of toilets) and at least four toilets for small outpatient settings (one for staff; one for females and one that is appropriate for use by children for patients). The number should be increased for larger outpatient settings.

## Needs assessment (waste handling and disposal)

- In the absence of functioning sewers and routine waste collection/treatment services, collection mechanisms for both human and medical waste will experience additional strain. Staff involved with handling human waste from emergency sanitation must be provided with personal protective equipment. For staff handling medical waste, personal protective equipment includes aprons, masks, boots and gloves.
- Waste collection zones need to be protected to prevent access by the general public, disease vectors and the dispersion of hazardous materials by floods and storms. Local authorities can advise siting of additional disposal areas for human waste (such as deep trench latrines for emptying bucket latrines). Provide a possibility of hand washing or hand disinfection in the waste collection zones.

## Toilets and hygiene

- Remind patients and staff of the importance of hand washing with soap after every toilet use. If the hand-washing facilities have become dysfunctional, provide temporary alternatives (such as a basin, soap and a jug of water and/or hand rub). In an emergency situation, it is particularly important to clean toilets regularly, preferably with detergent and/or disinfectant. Provide gloves for cleaners.
- Prevent toilets from becoming a breeding place for disease-transmitting organisms (such as mosquitoes, flies and rats) – no puddles or other habitats for mosquitoes and other animals should be present in toilet rooms.
- Provide emergency lighting to ensure the safe use of toilets during power outages.

## Dysfunctional or insufficient numbers of toilets

Where toilets in health care facilities are dysfunctional or insufficient in number, open defecation in the surroundings of hospitals and health care centres must be avoided. In order to prevent open defecation, the following measures can be taken.

***In urban settings***

- If the sewers or water pipes are broken or unusable but the toilet bowls are still functional, cover them with sealable plastic bags. After each use, add disinfectant or garden mould to decrease infectivity and odour. Store full bags in tight containers until a waste collection system has been re-established.
- Where the toilet bowls have become unusable, provide chemical toilets if financially and logistically viable (including transport and regular emptying/replacement). The least preferred alternative is the use of (camping-)bucket toilets, but this can be encouraged to prevent open defecation.

***In rural settings***

- Construct (additional) latrines in the surroundings of the health care facility, but at least 30 metres away from any water source and 10 metres away from any water storage tank or treatment facility. If latrines cannot be built, defecation fields provide an alternative.
- Guidance on construction and considerations for choosing appropriate sanitation technologies is available from WHO (see, for example, pages 131–139 of *Environmental health in emergencies and disasters* [Wisner & Adams, 2002]).
- Where toilets are functional but insufficient in numbers and additional sanitation facilities are provided outside the health care facility, patients with restricted mobility (including heavily pregnant

women, people with physical disabilities and elderly people) should be given priority access to the functioning indoor toilets.
- Where additional or alternative sanitation facilities are built or used, the same considerations regarding functioning toilets for patients with restricted mobility apply.

## Safe management of health care waste in the absence of routine collection and treatment services

- Provide sufficient numbers of containers, safety boxes and waste bags for collection and storage of waste generated in the health care facility. These should be properly labelled to indicate the type of waste (for example, pathological, infectious, chemical and sharps).
- If the waste is not collected frequently, make local storage available inside or near the facility.
- Use a dedicated vehicle for offsite transportation of the waste to treatment and/or disposal facilities; where this is not available use a bulk container that can be lifted onto a vehicle chassis.
- Waste containers and vehicles used for the transportation of waste should be cleaned and disinfected regularly after use.
- Disinfectant solution is recommended to disinfect sharps and other health care waste products prior to disposal. This type of disinfection is not at all suitable for making medical devices reusable – it should be used solely to decrease the risk of accidental exposure to hazardous materials during transport and storage prior to treatment or final disposal.
- If routine collection and treatment services cannot be re-established in due course and the space in the protected waste storage area reaches its limit, on an exceptional basis the disinfected health care waste should be safely buried or disposed of on site. The site for disposal should be selected in close consultation with relevant local authorities.
- Detailed information on selecting appropriate waste treatment and disposal technologies can be found on pages 105–138 of *Safe management of wastes from health-care activities* (Chartier et al., 2013).

*Sources*:

Adams J, Bartram J, Chartier Y, editors (2008). Essential environmental health standards in health care. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/settings/ehs_hc/en/, accessed 5 June 2014);

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WHO (2005). Management of solid health-care waste at primary health-care centres: a decision-making guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/medicalwaste/hcwdmguide/en/, accessed 5 June 2014);

Wisner B, Adams J, editors (2002). Environmental health in emergencies and disasters: a practical guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/emergencies/emergencies2002/en/, accessed 5 June 2014).

# 10. Vector-borne diseases during or after flood events

Vectors such as mosquitoes can transmit infectious diseases. Risk factors include increasing temperatures during or after floods and remaining standing water. Health effects may be observed many weeks after the flood event. As a result, the following actions are recommended.

- Ensure sustainable vector control to prevent transmission. Use a combination of top-down and bottom-up approaches that integrate chemical, mechanical and biological vector control methods and personal protection methods, with the active participation of communities and involvement of relevant sectors and agencies.
- Prevent outbreaks. Plans for hospitalization, emergency vector control, advocacy, community mobilization, logistics, and monitoring and evaluation in the case of increased risk or presence of vector-borne diseases are advisable.
- Strengthen disease diagnosis and case management. Early recognition of disease – as well as thorough knowledge of the anticipated clinical manifestation in successive phases of disease – is the basis for effective case management. Prompt notification of infections and their locations must be communicated to the emergency response unit to assist in detection and management of outbreaks.

*Sources*:

ECDC (2012). Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: European Centre for Disease Prevention and Control (http://www.ecdc.europa.eu/en/healthtopics/vectors/mosquito-guidelines/Pages/mosquito-guidelines.aspx, accessed 5 June 2014);

van den Berg H, Velayudhan R, Ejov M (2013). Regional framework for surveillance and control of invasive mosquito vectors and re-emerging vector-borne diseases 2014–2020. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/health-topics/communicable-diseases/vector-borne-and-parasitic-diseases/publications/2013/regional-framework-for-surveillance-and-control-of-invasive-mosquito-vectors-and-re-emerging-vector-borne-diseases,-20142020, accessed 5 June 2014).

## 11. Rodent-borne diseases

There is some concern about diseases transmitted by rodents, which could increase during or after heavy rainfall and flooding as a result of altered patterns of contact. Leptospirosis is an example of such diseases.

The following advice should be given to people during floods and when returning home.

- Keep food in sealed cupboards and/or containers out of the reach of rodents.
- Do not leave pet food out in the open.
- Keep waste sealed in rubbish bins.
- Ensure that all entrances and windows are suitably sealed to prevent entry of rodents into the property.

Most importantly, during periods of flooding, people should be encouraged to seek professional medical help if they fall ill.

In general, the control of commensal rodents prior to any event is very important.

*Source*: Bonnefoy X, Kampen H, Sweeney K (2008). Public health significance of urban pests. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/publications/abstracts/public-health-significance-of-urban-pests, accessed 5 June 2014).

## 12. Disease surveillance during and after flood events

During and after a flood event:

- assess the needs of the affected population;
- match available resources to those needs;
- prevent exacerbation of adverse effects;
- protect the population from further health effects by implementing disease control strategies where appropriate and well defined;
- monitor and evaluate the effectiveness of emergency health plans and activities;
- improve contingency planning from the experience gained.

Surveillance is the systematic collection, analysis, interpretation and dissemination of information for public health. As floods significantly affect public health, robust surveillance is important during and after flooding to identify and control infectious disease outbreaks and other health issues rapidly (see Table 2); to guide local and regional health service delivery; and to add information about possible associations between floods and ill health.

Table 2. Important health outcomes to consider when assessing flood impacts

| Health effect | Examples |
|---|---|
| Mortality | • Drowning, injuries, hypothermia<br>• Death from myocardial infarction or stroke |
| Infectious disease | • Diseases linked to poor water, sanitation and food safety<br>• Rodent-borne diseases<br>• Vector-borne diseases<br>• Diseases associated with overcrowding |
| Injuries | • Drowning, electrocution, sprains or strains, lacerations, poisoning from use of generators, exposure to chemicals, animal bites or stings |
| Mental health | • Depression, post-traumatic stress disorder, acute neurological diseases |
| Other noncommunicable diseases | • Diabetes, acute renal failure – for example, related to lack of continuation of treatment or lack of access to health care, long-term exposure to chemicals |
| Other diseases and conditions | • Nutritional stress, sexual and non-sexual assault, infant and maternal mortality, others |

*Source*: adapted from Menne B, Murray V, editors (2013). Floods in the WHO European Region: health effects and their prevention. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/floods-in-the-who-european-region, accessed 5 June 2014).

## 13. Outbreak surveillance

During humanitarian emergencies, an early warning alert and response network (EWARN) is often set up to support broad public health surveillance systems that may be underperforming, disrupted or nonexistent, particularly in the acute phase of an emergency, while the routine systems recover from the effects of the disaster.

Certain diseases must be considered priorities and monitored systematically. Ideally, a maximum of 8–12 diseases or syndromes should be prioritized (see Table 3) in the emergency outbreak surveillance, ranked by:

- epidemic potential;
- ability to cause severe morbidity or death;
- international surveillance requirements (International Health Regulations/public health emergency of international concern);
- availability of prevention and control measures;
- availability of reliable and meaningful case definitions and simple laboratory tests, where appropriate.

The WHO publication *How to organize outbreak surveillance and response in emergencies* provides detailed advice and recommendations.

Table 3. Infectious diseases that may be encountered during floods in the WHO European Region

| Diseases linked to poor water, sanitation and food safety | Diseases associated with overcrowding | Vector-borne diseases | Rodent-borne diseases | Other |
|---|---|---|---|---|
| Diarrhoeal diseases[a] | Diarrhoeal diseases[a] | Dengue<br>Chikungunya | Leptospirosis | Tetanus |
| Acute respiratory infections | Acute respiratory infections<br>Pneumonia | Malaria | Hantavirus | Rabies |
| Legionnellosis | Influenza | West Nile virus | Tularaemia | |
| Hepatitis A<br>Hepatitis E | Hepatitis A<br>Hepatitis E | Tahyna virus | Louse-borne typhus | |
| | Meningitis | Other mosquito-borne viruses | | |
| | Tuberculosis | | | |
| | Measles | | | |
| | Diphtheria | | | |
| | Pertussis | | | |
| | Scabies and head lice | | | |

[a]Diarrhoeal diseases, potentially sensitive to flooding include:

- bacterial diseases: *Campylobacter* enteritis, cholera, *Escherichia coli* enteritis, paratyphoid, salmonellosis enteritis, shigellosis, typhoid, yersiniosis;
- viral diseases: rotavirus diarrhoea, norovirus diarrhoea;
- parasitic diseases: amoebic dysentery, ancylostomiasis (hookworm), ascariasis (roundworm), balantidiasis, *Cryptosporidium* enteritis, diphyllobothriasis, giardiasis, strongyloidasis, trichuarisis (whipworm).

*Sources*:

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WHO (2012). Outbreak surveillance and response in humanitarian emergencies. Geneva: World Health Organization (http://www.who.int/diseasecontrol_emergencies/publications/who_hse_epr_dce_2012.1/en/, accessed 6 June 2014).

# 14. Chemicals hazards management during and after the flood

Floods and other disasters often cause hazardous chemicals (fuel, corrosive chemicals, industrial and agricultural chemicals) to spill out of vehicles, industrial facilities, chemical storage places, fuel supplies and other sources. They may also bury or move chemicals and chemical containers. These can pose health hazards to the general public, emergency service personnel and clean-up workers.

Chemical spills resulting from environmental disasters can cause acute and long-term risks for and effects in humans.

## During a flood

The main chemical health hazards during a flood include:

- injuries from chemical explosions;
- burning or blistering and severe damage to skin, eyes or respiratory tract from release of corrosive chemicals;
- intoxication and acute poisoning, mostly from inhalation of evaporated highly toxic chemicals such as fuel compounds, solvents, burning products, and so on.

The measures taken to prevent transmission of communicable diseases are also effective for prevention of exposure to chemicals during a flood.

Health care and public health professionals should undertake a number of specific activities:

- ensure decontamination of people who have been in contact with hazardous chemicals;
- provide health care services to all affected people, taking into account the possibility of acute poisoning by hazardous chemicals, and bearing in mind that the most vulnerable population groups for chemical hazards are children, the elderly, hospital patients and rescue workers, who may be exposed to high levels of chemicals (note: greater attention should be paid during the acute phase of a disaster);
- register all cases of contact with hazardous chemicals and acute poisoning to ensure long-term assessment and prevention of effects – sampling and storage of biological samples is recommended for future analysis and assessment;
- conduct a rapid risk assessment of the event and assist in identification of places where hazardous chemicals are stored to facilitate implementation of measures to prevent releases and spills;
- communicate information about chemical hazards to the public.

## After a flood: cleaning up

Despite the sheer volume of water during a flood, which might dilute chemical spills, chemical pollution can be high in certain areas and precautions should be taken when cleaning up after flooding.

Clean-up workers and people returning to their houses after a flood should be made aware of chemical hazards and provided with clear instructions to protect them from chemical exposure, including exposure to chemical waste.

Several core characteristics of chemical contamination after a flood should be kept in mind for effective protection of the population.

- The concentration of chemicals is usually higher in places where chemicals are stored or used, such as industrial facilities, garages, cellars, farms, and so on – these should be ventilated before entering.
- While some signs of possible chemical contamination are usually present – such as water colour, smell/odour, oil films, empty or damaged containers – many hazardous chemicals are colour and odourless. Nevertheless, the presence of damaged, unlabelled chemical containers can be an indicator of potential chemical pollution.
- Chemical waste should be collected separately and disposed of in specially designated places.

- Permission to return home should be given only after all possible sources of chemical spills are eliminated and there are no visible signs of chemical contamination.
- Floods often result in the need for emergency renovations to damaged homes and other structures; when common renovation activities like sanding, cutting and demolition occur in structures that contain lead-based paint and asbestos, these can increase exposure to such hazards.

## Recovery stage

Measures taken during the recovery stage are designed to prevent indirect chemical effects and long-term exposure.

Priority should be given to areas where contamination would have significant effects, such as farmland (prevention of chemical contamination of food), water bodies used for water supplies and leisure activities, kindergartens and school yards, as well as other places for children.

Public health can play an important role in four of the many activities that need to be undertaken in the recovery phase:

- organization of health care and provision of access to information and assistance;
- risk and health outcome assessment, including exposure and environmental and human health assessments;
- implementation of remediation and restoration activities;
- evaluation, including root cause analysis, response and lessons learnt.

Practical considerations of measures undertaken include the following.

- For each site and substance, a vulnerable zone (the area in which the contaminants might pose risks for human health) should be estimated and mapped out, based on environmental monitoring – it is important to identify the spectrum of toxic chemicals present whenever possible.
- Appropriate health surveillance systems should be in place – virtually every organ system can be damaged by chemical exposure, with the degree of harm related to the chemical hazard, the amount and the route of exposure.

*Sources*:

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Wisner B, Adams J, editors (2002). Environmental health in emergencies and disasters: a practical guide. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/emergencies/emergencies2002/en/, accessed 6 June 2014).

# 15. Generic post-flood recovery

The health sector has a role in the provision of health advice regarding the clean-up process and any short- and longer-term risks to health from flood contaminants. Specifically, immediately after the flood health professionals need to provide practical advice to people re-entering their homes, clean-up workers and deployed personnel. Thereafter, they can help to track and minimize delayed long-term health outcomes such as mental health issues.

As flood water recedes, health professionals should undertake the following tasks.

- Communicate with emergency services to ensure that people do not return home before it is safe.
- Highlight and raise awareness of likely carbon monoxide poisoning cases to all health services.
- Release warnings and information to the general public about risks and having proper ventilation when using generators and dryers.
- Raise awareness of remaining threats to food and water safety from contamination of supplies and surfaces by flood waters – encourage people to maintain hygienic and sanitary precautions until the clean-up is complete.
- Re-emphasize health messages after a flood event, especially:
    - good hand hygiene practices
    - boiling or chlorination of drinking-water
    - safe food preparation techniques
    - early treatment-seeking behaviour in case of fever
    - personal protection against vectors and zoonoses
    - vector control interventions, adapted to the local context and disease epidemiology.

The safety requirements for clean-up personnel should also be reiterated.

- Clean-up crews should in general wear full personal protective equipment, including waterproof safety boots, hard hats, goggles and work gloves. This is particularly essential when dealing with chemical spills or sewage contamination. If necessary, they should use ear plugs.
- Every worker should undergo at least basic training on likely hazards in post-flood clean-up work.
- Clean-up workers should be vaccinated against tetanus if their vaccination status is not up to date.
- Wounds, burns, cuts and injuries should be treated immediately, even if minor.

Floods can have a strong effect on people's mental health. Mental distress is the commonest issue – this is usually temporary, with most people overcoming it by themselves in a reasonable time. Post-flood psychological assistance should in general be provided by psychologists and/or trained personnel. Several specific issues should be kept in mind.

- People should be encouraged to seek assistance if psychological symptoms aggravate or persist.
- The mental health of responders and health care personnel should be considered, and may be addressed through the appropriate course determined by field psychologists.
- If considered necessary, field workers could receive training in psychological first aid (not administered by professionals).
- Long-term mental health issues (such as depression or post-traumatic stress disorder) should be monitored in affected communities.
- Prompt restoration of communities and social cohesion is important in the context of prevention of long-term mental health outcomes of disasters.

*Sources*:

WHO (2005). Food safety in natural disasters. Geneva, World Health Organization (http://www.who.int/foodsafety/fs_management/infosan_archives/en/index5.html, accessed 6 June 2014);

WHO (2011). Psychological first aid: guide for field workers. Geneva, World Health Organization (http://www.who.int/mental_health/publications/guide_field_workers/en/, accessed 6 June 2014);

WHO (2014). Flooding and communicable diseases fact sheet. Geneva, World Health Organization (http://www.who.int/hac/techguidance/ems/flood_cds/en/index.html, accessed 20 May 2014).

# 16. Mould clean-up and removal after flooding

## Advice to local public health authorities

- Identify mould remediation service providers and provide information to the public on available service providers in the area.
- Inform the public that large-scale mould remediation should be conducted by professional service providers.
- Inform the public that remedial work should be conducted in well-ventilated rooms. Access to uncontaminated areas should be blocked to avoid the spreading of spores.
- Advise the public on careful use of detergents and cleaning products when cleaning and removing mould, ensuring that protective gear is worn (see below for details on protection).
- Advise members of the public to consult their doctor/GP if they suspect their health is affected by mould in the home.
- Implement inspections and train inspectors to advise private households on the specific needs of their home.
- Establish a special government fund to support the costs of such services.

In the case that flooding has triggered mould damage, remedial work is a necessary measure. The government can help to assure that remediation of mould is adequately undertaken. If existing environmental or sanitary inspectors are available, they should be called upon to support this effort.

## Advice to the general public

Mould and fungal spores are common and people are constantly exposed to spores as part of normal everyday life. The most important measure in controlling mould is to control moisture levels in the environment. After flooding, take note of the following details.

- You may notice mould growing on damp walls. This will stop growing as your home dries out.
- Heating, dehumidifiers and good ventilation can help to dry out your home.
- Small areas of mould can be easily removed with home-bought mould removal solutions. These can be purchased in hardware stores. If the mould persists or is extensive it may be advisable to contract a specialist cleaner. In this case it is important that professional contractors have experience in the field of fungal remediation and follow current guidance.

After floods, excess moisture and standing water contribute to the growth of mould in homes and other buildings. When re-entering your flooded home, be aware that mould may be present and could pose a health risk to your family. If you find mould growing in your home, affected areas or items should be treated to remove mould spores as soon as possible. Follow these steps for home cleaning and removal of moulds: clean, dry and disinfect.

***To start – protect yourself***

- Take care with electrics and gas: do not turn on gas or electrics if they may have been wet. Only turn them on when they have been checked, if possible by a qualified technician.
- Wear rubber boots, waterproof gloves and an apron while cleaning. If scrubbing, hosing or pressure washing causes water to splash, or the release of dust particles, wear a standard face mask (such as those available from hardware stores). Goggles offer added protection and can be reused after thorough washing, if necessary.
- Ventilate the work area before and during cleaning.

***How and what to clean and disinfect***

- If belongings were wet for two or more days, take them outside. Items made of cloth can be washed in hot water.
- Remove contaminated or mouldy materials and debris that has been contaminated with sewage, flood water sludge or mud.

- Remove building materials containing cellulose or processed wooden fibres (gypsum board coated with cellulose, cardboard, wood fibreboard, oriented strand board and medium-density fibreboard), unless it is naturally grown solid wood. Material containing cellulose has a high risk for growth of *Stachybotrys* (toxic mould). In particular, cellulose and wood fibre materials used in hidden spaces, where mould growth is not visible, should be removed first.
- Place waste in hard bins or rubbish bags.
- Clean all hard surfaces (such as walls and floors) with hot water and detergent. If the surface is rough, scrub it with a stiff brush.
- Remember to wash your hands thoroughly after each clean-up. Keep open cuts or sores clean and use waterproof plasters to prevent exposure to flood water.

***Drying out***

- Heating, dehumidifiers and good ventilation can help to dry out your home.
- If using indoor heating appliances to dry out an indoor space, ensure that there is adequate ventilation. Do not use petrol or diesel generators or other fuel-driven equipment indoors as exhaust gases contain carbon monoxide, which can be harmful.
- If you have gas or oil central heating and it has been checked by an engineer, turn it on. Keep the thermostat between 20 °C and 22 °C for steady drying.
- If you have air vents to under floor spaces, ensure that they are unblocked to provide cross-ventilation in these areas. As floorboards and walls dry out, loose material and resulting dust should be vacuumed on a regular basis.
- When possible, remove dirty water and silt from the property. Rooms below ground level may need pumping out, especially if you have wooden flooring. Mould should disappear as your home dries out. If it persists, contact a specialist cleaner and local public health authority for help.

*Sources*:

CDC (2005). Population-specific recommendations for protection from exposure to mold in buildings flooded after hurricanes Katrina and Rita, by specific activity and risk factor. Atlanta, GA: Centers for Disease Control and Prevention (http://www.cdc.gov/mold/related.htm, accessed 6 June 2014);

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**The WHO Regional Office for Europe**

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

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Over recent decades an increasing trend in frequency and intensity of heavy precipitation events has been observed across the WHO European Region. High precipitation extremes can result in flash floods, river floods, drinking-water supply and sewage system failure, landslides and mudslides. They can initiate devastating floods, which affect large areas and are of long duration. Floods affect human health through many pathways, and health professionals can take numerous measures to protect the health of affected populations.

A series of fact sheets has been developed, targeted at ministries of health; national, regional and local health authorities; and medical and public health professionals. These fact sheets describe in short what to do in case of a flood, in the absence of a fully functional flood health preparedness and response plan.

This is planned as a “living document” to be updated regularly.

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