GLOBAL WATER PATHOGEN PROJECT

PART FOUR. MANAGEMENT OF RISK FROM EXCRETA AND WASTEWATER

EMERGENCY RESPONSE

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Citation:
Lantagne, D., Yates, T., Branz, A. and Bastable, A. (2017). Emergency Response. In: J.B. Rose and B. Jiménez-Cisneros (eds), Water and Sanitation for the 21st Century: Health and Microbiological Aspects of Excreta and Wastewater Management (Global Water Pathogen Project). (C. Haas (eds), Part 4: Management Of Risk from Excreta and Wastewater - Section: Disinfection), Michigan State University, E. Lansing, MI, UNESCO. https://doi.org/10.14321/waterpathogens.72

Acknowledgements: K.R.L. Young, Project Design editor; Website Design: Agroknow (http://www.agroknow.com)

Last published: September 26, 2017

Summary

Safe water, sanitation, and hygiene provision and promotion are critical elements of emergency response to ensure human safety, health, and dignity. Disinfectants, such as chlorine, are widely used in emergency response to treat water for drinking; however, excreta is rarely treated in emergencies. In this chapter, we provide a summary of knowledge on disinfection of excreta in emergencies and recommendations for future research. In particular, we recommend the need to prioritize disinfection of waste in emergencies to prevent ongoing transmission of disease and to work with responders and beneficiaries to develop appropriate, low-cost, transportable, acceptable, and easy-to-use excreta disinfection solutions.

1.0 Introduction

Safe water supply, sanitation, and hygiene (WASH) are immediate priorities for human survival and dignity in emergencies (SPHERE, 2011). There are three types of emergencies worldwide: natural disasters (e.g. earthquakes, volcanic eruptions, landslides, tsunamis, floods, and drought); disease outbreaks; and, complex emergencies (i.e. "situations of disrupted livelihoods and threats to life produced by warfare, civil disturbance and large-scale movements of people, in which any emergency response has to be conducted in a difficult political and security environment") (WHO, 2002).

There are four common WASH interventions in emergencies: provision or repair of water supplies, treatment of water centrally or at the household level, provision of sanitation options such as latrines or latrine alternatives, and promotion of hand washing and environmental hygiene. WASH interventions are particularly important in emergencies that lead to an increased risk of infectious disease, such as: 1) flooding events or natural disasters that lead to displacement; 2) outbreaks caused by untreated drinking water; and, 3) some complex emergency settings (Ahern et al., 2005; Shultz et al., 2005; Watson et al., 2007).

To summarize the current evidence and outline areas needed for future research herein, we examine the available evidence on disinfection of excreta in emergencies, with a focus on emergencies in less developed contexts that lead to an increased risk of infectious disease.

2.0 Sanitation During Emergencies

Safe disposal of human excreta is critical to prevent the spread of fecal-oral diseases in emergencies. The two standards in the Sphere Handbook (the collaboratively published standard reference handbook that establishes minimum standards for humanitarian response) for excreta disposal are: 1) environment free from human feces; and, 2) appropriate and adequate toilet facilities, as below (SPHERE, 2011):

1. Environment free from human feces. The living environment in general and specifically the habitat, food production areas, public centres and surrounds of drinking water sources are free from human faecal contamination.
2. Appropriate and adequate toilet facilities. People have adequate, appropriate and acceptable toilet facilities, sufficiently close to their dwellings, to allow rapid, safe and secure access at all times, day and night.

Specifically, oft-referenced Sphere guidelines include that there should be no more than 20 people sharing one toilet facility and facilities should be no more than 50 meters from the dwelling (SPHERE, 2011). There is no guidance on treatment or disinfection of human excreta in the SPHERE Handbook; however, in the annex, the Standards state "Due consideration should be given to desludging, handling, transportation and final disposal of the sludge" and "When appropriate, and depending on the need, desludging of toilets/septic tanks and excreta containers, including siting of final sewage disposal point, needs to be considered right from the start."

This lack of standards for disinfection of human excreta is reflected in emergency response programming, where the majority of emergency response programs do not include excreta disinfection. The standard emergency response activities for sanitation are output-driven, with the aim to provide some type of latrine (e.g. semi-permanent latrines such as trench latrines or cubicles over a barrel or tank; rehabilitation of existing permanent latrines; or, new permanent latrines) (Yates et al., 2017b; Yates et al., 2017a). Disinfection of waste is not generally considered in these interventions; the main concern is use, with use documented to be highest when latrines are safe, clean, and offer privacy. Recently, there has been promotion of latrine alternatives (e.g. bags for defecation), particularly in urban areas where it is not possible to build latrines due to space constraints; some latrine alternatives incorporate chemical disinfection into the bag. Another recent trend in sanitation in emergencies is to promote community-driven sanitation approaches, such as Community Led Total Sanitation (CLTS) or Participatory Hygiene and Sanitation Transformation (PHAST) activities. Community-driven approaches focus on specific promotion to 'trigger' the community to address their sanitation needs with local materials, have been shown to be more effective when there is trust and cohesion in the community, but to date, have not included a disinfection component.

There has been an increased interest in consideration of human excreta disinfection, particularly in: 1) urban emergencies where there is limited space for latrines or the accumulation of waste, and 2) highly infectious outbreaks (i.e. cholera and Ebola). Examples of pilot excreta disinfection emergency response programs in these two contexts are presented below.

2.1 Case Study: Sanitation Disinfection in Haiti after the Earthquake

In 2010, two major emergencies occurred in Haiti. An

earthquake on January 12, 2010 killed over 200,000 people while leaving another 2 million people homeless, and a cholera outbreak began in October 2010 and has since killed over 9,000 people and infected over 750,000 (Gelting et al., 2013; MSPP, 2016). Following these emergencies, there was international interest in providing safe water and sanitation to the Haitian population.

The sanitation response to the Haitian earthquake was severely limited by the living situation, as, due to space constraints, it was not possible to build latrines in the densely populated spontaneous settlements. Refugees are persons that flee an emergency and cross an international border, while internally displaced persons are persons fleeing an emergency that are displaced within their own country. In Haiti specifically, disaster-affected persons in Port-au-Prince moved into tent shelter spontaneous settlements in parks, fields, and open areas of the city. Additionally, in densely populated areas it was difficult to set up community management committees, to desludge latrines, and to dispose of waste in sewage ponds without increasing risk (Bastable and Lamb, 2012). Many residents living in spontaneous settlements reported going back to their destroyed homes to defecate privately and safely. A number of innovative solutions were implemented in Port-au-Prince spontaneous settlements, including the use of imported Port-o-Potties and the distribution of single use bags for defecation.

2.1.1 Imported Port-o-Potties

Port-o-Potties were imported and set up in rows surrounding spontaneous settlements, local residents were hired for cleaning, and trucks were imported or hired to empty the Port-o-Potties. Disinfection was limited by the fact that, at the time of the earthquake, there were no wastewater treatment facilities in Haiti, and thus human excreta was dumped in local streams and rivers, remote areas, or garbage dumps (such as one site that accepted solid waste, medical waste, and fecal waste) (Bastable and Lamb, 2012). Two wastewater treatment facilities were planned to open in 2012, but by 2012 many of the spontaneous settlements, and the Port-o-Potties, had been abandoned. Additionally, the high cost of operation (from $9-20 per day) and user dislike of seeing other's waste made Port-o-Potties appropriate as a short-term intervention only (Bastable and Lamb, 2012), although some organizations negotiated long term rental prices equivalent to the cost of semi-permanent latrines (Eyrard, 2011). Some organizations moved from using Port-a-Potties to using raised latrines with large common collection containers in the spontaneous settlements, which were less expensive to operate.

2.1.2 Single Use Bags

Response organizations also distributed single use bags, such as PeePoo brand bags with disinfection solution inside, biodegradable bags, or simple plastic bags. PeePoo bags are reported to be personal, self-sanitizing, fully biodegradable toilet bags that prevent feces from contaminating the local environment, and can be used as fertilizer. Each bag contains six grams of urea, which is reported to act to destroy pathogens in human excreta; these claims have not been independently verified. These bags had the benefit that they built upon an existing sanitation practice, "flying toilets", where users defecate in plastic bags and throw them away 'somewhere'. The bags also offered privacy and a safe defecation experience for women, children, and the elderly at night in shelters (Bastable and Lamb, 2012). Currently, there are data from three projects that distributed bags in emergencies; these data are summarized below.

1. In a small pilot project conducted in spontaneous settlements in Haiti that distributed multiple types of collection bags, 91% of recipients reported using the bags as their primary toilet and 96% reported they were very satisfied. The respondents reported that the reasons for bag use were: security concerns at night, keeping the camp cleaner, freedom of access, having no other toilet, and difficulty accessing their pre-earthquake toilet. Recipients reported preferring the PeePoo bags to normal plastic bags, due to the reduction in smell. However, 100% of recipients reported disposing the bags in "indiscriminate locations". Thus, PeePoo bags were recommended by program implementers and evaluators as a cost-effective option in the short-term for emergencies where space and desludging are difficult, provided a disposal system is established and phase-out to a new option occurs as response progresses (Patel et al., 2011). Potential contamination from indiscriminately disposed bags was not investigated.
2. In a report of actual operational field experience from a larger community-based program in spontaneous settlements in Haiti, only 13% of recipients reported using the mobile toilets and bags. In this program, mobile toilets with sitting areas were built and a stock of individual-use PeePoo bags were distributed. The sanitation facilities the remaining 87% used were not reported. This rate differed from the high usage rates detailed above, perhaps due to shifts in settlement populations, the use of community cubicles for defecation instead of household-level cubicles, or because this program was orders of magnitude larger, and less education was able to be completed. Although the mobile toilets were considered fast and easy to build, it was recommended by the program implementers and evaluators that bags be used in "urban settings only as a stop-gap approach until other interventions are possible" (Coloni et al., 2012). Additionally, it was recommended to use biodegradable bags, establish a final disposal site, to not institutionalize temporary approaches, and to not use bags during outbreaks due to risk of spreading disease.
3. To determine people's sanitation habits and willingness to use PeePoo, a program in the Philippines that distributed bags with community health worker promotion and collection and burial of the bags was assessed. In this case, 74% of recipients reported using the bags (Parsa et al.,

2014). Please note no further data was presented. It was recommended by the evaluators and implementers to have bags stocked locally before the emergency, have pre-trained staff, pay cash-for-work for bag collection, and to develop an exit sanitation strategy.

Overall, treatment bags seem to have potential as a short-term emergency response, although results were contextual and implementation dependent.

2.2 Case Study: Sanitation Disinfection in Disease Outbreak Emergencies

2.2.1 Cholera Response in Haiti

In October 2010, a cholera outbreak began in Haiti, which most likely started when untreated excreta from an infected soldier contaminated a local stream (Lantagne et al., 2014). The cholera outbreak grew to such a scale that Doctors without Borders (MSF) was concerned how to safely dispose the large volume of infectious cholera wastes from their Cholera Treatment Centers (CTC). Health care facilities produce pathogen-laden wastewaters that can lead to onward disease transmission. The established MSF protocol for disposing of hospital waste is the addition of 2% concentration chlorine solution to each bucket of patient feces or vomit and to dispose of the wastes in soil infiltration pits, or established treatment facilities (MSF, 2010). However, this approach was assessed as not appropriate considering the local areas had high water tables, were densely populated, and had inadequate wastewater treatment systems. In response, two novel in situ treatment/disinfectant systems were developed. The first system used coagulation/flocculation and disinfection with hydrated (slaked) lime, the second system the addition of hydrochloric acid, followed by pH neutralization and coagulation/ flocculation of suspended solids using aluminum sulfate (Sozzi et al., 2015). Both use pH changes (the first to high pH, the second to low) with the intent to inactivate the cholera bacteria. Removal rates in large scale (30,000 Liter) tanks in actual CTC situations were similar for both systems, with turbidity removals of 91.3-98.2%, thermotolerant coliform removals of 99.52-99.97%, suspended solid removals of 90.5-92.9%, and chemical oxygen demand removals of 99.1-99.2%. It is unknown if this removal rate of thermotolerant coliforms would reduce transmission of cholera from the waste, but the risk of transmission would be reduced.

2.2.2 Ebola Response in West Africa

Survival of the Ebola virus is theoretically possible in wastewater (Bibby et al., 2014), but there has been no documented Ebola transmission solely via a water and sanitation route (Lantagne and Hunter, 2015). However, in Ebola Treatment Units in outbreak contexts, feces in Ebola patients is often mixed with other bodily fluids which are highly infectious, such as blood or vomit. Thus, safety precautions are recommended, and the MSF guidelines for Ebola Treatment Unit settings include collection of patient liquid Ebola wastes in a bucket, superchlorination by placing 0.5% chlorine solution from a cup into the bucket, and disposal of the waste in a latrine/soak pit (MSF, 2008).

The volume of wastes in the 2014 West African outbreak exceeded the absorbative capacity of latrines and soak pits (they overflowed) and in this case wastes were superchlorinated in the bucket, then transferred to water bladders. Water bladders are common water storage containers in emergencies, and are large, flat, plastic bladders that hold 1,000-10,000 Liters of water with an attachment for filling and dispensing. In the water bladder the wastes were superchlorinated again before being sent in a tanker truck and to a wastewater treatment facility. Staff along the entire disposal chain was in full personal protective equipment. This system was highly staff and resource dependent, and not evidence-based.

In hospital settings with sewer systems, the CDC and WHO recommended that Ebola wastes from patients be directly disposed of into sewer systems; this recommendation created concern in the United States (Lowe et al., 2014). The risk of Ebola transmission to sewage workers from hospital wastes disposal directly into sewage lines has been estimated, in worst-case scenarios, at less than 0.001% (Haas et al., 2017). However, due to unknowns of Ebola transmission and fear, there is current research into disinfection options to treat Ebola liquid wastes in hospital settings in the United States. Whether this hospital/sewer system based research will be applicable, and can be transferred to, Ebola Treatment Unit contexts is unknown.

3.0 Recommendations and Data Gaps

Disinfection of human excreta in the emergency context is currently rare and the current evidence base for excreta disinfection is weak. However, there is active research and interest in learning how to treat excreta in emergencies. This increased interest is attributed to the recognition of the risks of untreated excreta in the environment, particularly in areas with high population density and in outbreaks. Donors have responded to this interest, and there is funding available to develop and pilot fecal sludge management programs in emergency response (HIF, 2016).

In the future, it is recommended to:

1. Prioritize disinfection of excreta in emergencies where untreated wastewater has the potential to transmit infectious disease; particularly in outbreaks, displacement events, and high population density emergencies.
2. Develop appropriate excreta disinfection treatment options in collaboration with responders and beneficiaries. These options should be low-cost, transportable in cargo on an airplane or able to be produced locally, acceptable to the responders and beneficiaries, and easy-to-use. The options also will need to disinfect that types of waste in developing country emergency contexts where sewage systems are not available, from excreta in a bedside bucket mixed with other bodily fluids to pit latrines.

Demanding a better understanding of disinfection of excreta in emergencies is timely and necessary as:

1) natural disasters and their impacts have been increasing in recent decades (due to increases in populations living in hazard-prone locations, unplanned settlements and environmental degradation, and climate change causing more intense hurricanes, higher rainfall intensities, drought, and heat-waves (UNISDR, 2006); and, 2) outbreaks where chlorine is a key infection control and disease management component are currently increasing or emerging, such as cholera (Gaffga et al., 2007) and Ebola. Additional research and program monitoring on disinfection in emergencies will assist in developing programs that can provide safe sanitation to populations affected by emergencies.

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