Container contamination as a possible source of a diarrhoea outbreak in Abou Shouk camp, Darfur province, Sudan

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Diarrhoea is one of the five major causes of death in an emergency setting and one of the three main causes of death in children (Curtis and Cairncross, 2003). In June 2004, an outbreak of shigellosis was confirmed in Abou Shouk camp in the Northern Darfur province of Sudan. As water testing showed no contamination, it was assumed that post-collection contamination was happening. The decision was taken to launch a programme of mass disinfection of all water containers in order to break the contamination cycle. Diarrhoea figures from the clinics showed a fall in cases following the cleaning campaign. It is extremely difficult to obtain good and statistically rigorous data in an emergency setting, the priority being to intervene rapidly to prevent further cases of diarrhoea. However, the results do appear to indicate that the disinfection programme has had an impact on the prevalence of bloody and watery diarrhoea.

Keywords: container contamination, diarrhoea, displaced persons, prevention

Introduction

Diarrhoea in various forms is one of the five major causes of death in an emergency setting and one of the three main causes of death in children (Curtis and Cairncross, 2003). Outbreaks of diarrhoeal disease among refugees have been well documented: in 1986, during the ‘months of diarrhoea’ in Somalia, there were 5,352 cases in four months, resulting in 62 deaths (Mursal, 1986); and in 1994, an average crude mortality rate of 20–35 per 10,000 was associated with epidemics of both cholera and shigellosis among Rwandan refugees (The Goma Epidemiological Group, 1995).

In June 2004, the World Health Organization (WHO)’s Early Warning System (WHO, 2004) confirmed an outbreak of shigellosis in Abou Shouk camp in the Northern Darfur province of Sudan. The outbreak started in mid-May, and by the end of June, 1,340 cases of bloody diarrhoea had been reported, leading to 11 deaths. Of the 13 stool samples tested on 30 June, three tested positive for Shigella dysenteriae type 1 (WHO, 2004). This paper describes an intensive and rapid intervention by Oxfam GB to ensure that drinking water containers were disinfected in order to prevent post-collection contamination and looks at the impact that this intervention has had on morbidity figures.

Background

Darfur province lies in the western part of Sudan towards the Chad border. It is divided into three districts: North, South and West. The province has a history of both internal
conflict and drought. The present round of conflict started in early 2003. As of mid-
2005, 700,000 people have been internally displaced, and another 130,000 have fled to neighbouring Chad (ICG, 2004).

Abou Shouk camp is located on the edge of El Fashar town in north Darfur. Population figures vary as there is movement in and out of the camp, but it is be-
lieved that approximately 40,000 people live there (June 2004 figures). Unlike most camps for refugees or internally displaced persons (IDPs), this camp was planned and laid out before the IDP population was removed from an unsuitable site that was prone to flooding. This means that the overcrowded and unsanitary conditions so often associated with camps are not so much in evidence. It is also easier to map the area and to conduct house-to-house visits, since all households have a block and com-

Post-collection contamination of drinking water

It is now well recognised that the provision of clean drinking water at collection points is not enough to prevent water-borne diseases (Kaltenthaler and Drašar, 1996). Contami-
nation often occurs while water is being collected, including from the handpump nozzles themselves (Clasen and Bastable, 2003), from the use of dirty containers, or during storage in the home (Mintz et al., 1995). Other factors could be unhygienic water handling habits or the nature of the household environment, such as the presence of animals in the home (Jagal et al., 2003).

Although the washing of hands with soap is recommended as ‘the most effective measure to prevent transmission of Shigella’ (WHO, 1995), as demonstrated by several field studies (Curtis and Cairncross, 2003), behavioural change strategies take time to implement, especially in a large camp where soap may not be available and thus has to be distributed to all households first. To date, hand-washing studies have largely been conducted in non-emergency settings and show behavioural change taking place gradually over the course of a year or more. While hand washing is recognised as a vital component of hygiene promotion, a speedier intervention capable of generating instant results was deemed necessary for the Abou Shouk outbreak.

Chlorination has already been shown to be effective in reducing household diarrhoeal disease in Bangladesh (Sobsey et al., 2003), Bolivia (Quick et al., 1999), Saudi Arabia (Mahfouz et al., 1995) and Uzbekistan (Semenza et al., 1998), although some studies have been inconclusive (Jensen et al., 2003). These studies were all carried out in non-
epidemic situations. A study conducted in a Malawian refugee camp concluded that household contamination of drinking water significantly contributed to diarrhoea in the population and that, while chlorination was a cheap and effective way of ensuring potable water, the method was unpopular and therefore rarely used by the refugees (Roberts et al., 2001).

Drawbacks to chlorination include low acceptance by communities, the taste, reduced effectiveness in highly turbid water and the importance of issuing the correct dosage (WHO, 1997).
Methodology

The intervention presented here was not planned as a research study to measure efficacy; it was simply carried out to stop the diarrhoea outbreak. It was only after the intervention was completed that the authors considered it interesting enough to be written up. Hence, there are obvious gaps in terms of both the data collected and information about the situation. A control group would have been preferable, but this raises ethical issues with respect to research of disease outbreaks in IDP camps. Other authors have highlighted these matters and hence they are not discussed here (Black, 2003; CPOP, 2002).

Baseline data were collected two months prior to the intervention from a five percent (328 households) random sample of the estimated 6,900 households using questionnaires, which were then analysed on tally sheets. Admittedly, this is a small sample, but data were needed urgently to start a hygiene promotion intervention and a latrine programme. Lack of resources and qualified personnel were also constraints.

Results derived from the baseline data showed that: 65.6% (215/328) of all households consumed 11–15 litres of water per day; 79% (259/328) of households had water containers without lids; 46% (150/328) of households had dirty containers; and 98% (321/328) of people interviewed had no means of removing drinking water from the storage container in their shelter in a hygienic manner. A dirty container was defined as having one or more of the following: cracks, no lid and visible signs of dirt or slime on the inside.

As far as hand washing is concerned: only 27% of people (88/328) washed their hands after using the latrine; 17% (56/328) washed their hands after cleaning children’s bottoms; and 30% (98/328) washed their hands before preparing food. Given that questionnaires often prompt respondents to over-report desirable behaviour, the percentages may actually be lower.

Water situation and analysis

In Abou Shouk camp, there are 25 boreholes. Twenty-three of them are fitted with handpumps and two are fitted with submersible pumps and attached via a T45 Oxfam tank to tap-stands (six blocks of six taps). In May–June 2004, Sphere Project standards regarding water accessibility had still to be satisfied: around one-quarter of the population had to walk more than 500 metres to procure water (personal communication with Oxfam engineer).

Oxfam was not instrumental in providing water to the camp, but field staff members were concerned about the lack of water quality testing. ‘In addition to the baseline analysis of water sources, a regular monitoring programme of water quality at source will act as an early warning system for outbreaks of water related diseases, of which Oxfam GB has the means and capacity to respond’ (Oxfam, 2004).

After initial baseline testing, it was decided to analyse all 25 sources once every four weeks, making sure that all sites were tested before, during and after the rainy season in order to detect any contamination caused by the rains. The Oxfam Delagua Water
Testing Kit was employed for this purpose. The standard used was the Sphere/WHO maximum advisory level (MAL) of zero faecal coliforms in 100 millilitres of water.

In addition to the water points, a weekly random sample of the storage water of 50 households was also to be tested. Due to a shortage of experienced staff, however, this did not occur prior to the outbreak of disease. Therefore, no data are available.

By mid-May, Oxfam had carried out a baseline survey of 19 of the 25 water sources. Results showed that only one source contained one faecal coliform per 100 millilitres of water (the previous Sphere Project manual specified a MAL of less than ten faecal coliforms per 100 millilitres of water. According to the Sphere Project's Technical Focal Point for Water, Sanitation and Hygiene Promotion, Andrew Bastable, ‘while aiming for zero, anything below five faecal coliforms per 100 millilitres has been for many years the acceptable norm and therefore it is highly unlikely that such a low coliform count could be the cause of such an epidemic’. The remaining six boreholes were all over 60 metres deep and sealed, so it is reasonable to assume that there was no contamination. Routine inspection, though, revealed that most areas around the water collection points were unsanitary due to the presence of animal dung, flies and stagnant water. Many of the water containers placed in the water collection queue were situated directly on top of animal dung. The possibility of post-collection contamination was considered high.

The epidemic

On 29 June 2004, aid agencies working in Abou Shouk held an emergency meeting to discuss the number of cases of diarrhoea (especially of bloody diarrhoea) being seen at therapeutic feeding centres (TFCs) and at the camp clinics (see Figure 1 below). WHO reported five deaths in week 25 and six deaths in week 27 (WHO, 2004). Adults and children were affected. Oxfam was asked to take the lead on controlling the epidemic.

In these early stages of camp administration, there was poor reporting of diseases. In the clinics, cases were not disaggregated by age or gender, nor were households or the affected proportion of each household recorded (despite the fact that households were numbered). TFC staff members did do some mapping of the camp and found that TFC cases came from all areas of the camp, making it impossible to pinpoint the source of the infection. However, other sources, such as uncovered food, could not be ruled out.

As only one water source had previously been shown to be contaminated and as cases came from all areas of the camp (making a John Snow-type of investigation difficult), it was assumed that post-collection contamination was taking place. The possible sources of contamination are listed below:

- from the use of dirty containers at water collection points or from having dirty hands;
- from the use of dirty dippers or cups in the household or from having dirty hands;
- from contaminated food or dirty utensils; and
- from using rags, wood and bamboo as stoppers instead of container lids.
It was decided to carry out a programme of mass disinfection of all water containers in order to break the contamination cycle. The rationale behind this was that, while it would be labour intensive for a short period, it would rapidly have an impact on diarrhoea morbidity rates. This quick intervention would be followed by a longer-term approach, such as the distribution of new water containers and a hygiene promotion campaign on hand washing, disinfection of household utensils and household water storage. Water point areas would also be improved. Disinfection of tap-stands and pump nozzles did not occur, as it would have had to be combined with a hand washing on site campaign to be effective. This was not only logistically challenging, but also unsustainable.

The container disinfection campaign
The target was to disinfect all water containers in each zone (made up of blocks of 20 households) of the camp. It was estimated that there were 7,000 households in the camp, each owning, on average, two containers for collecting or storing water. Community leaders were informed of the pending campaign and their assistance was guaranteed. Two staff members would be responsible for one block and would be expected to disinfect all water containers found in the households. At the same time, two people would stand at each water point to make sure that containers were disinfected and to implement the procedure if any had been missed at the household level. Chlorination was conducted as per WHO’s *Guidelines for the control of epidemics due to Shigella dysenteriae type 1* (WHO, 1995).

A vehicle was designated to drive around the camp with a loudspeaker emphasising in both Arabic and Fur the importance of disinfecting utensils in order to prevent the spread of diarrhoea and identifying the location of the ‘cleaning stations’. This was seen as information giving only and not as true explanatory hygiene promotion.

The advantages for this scenario were that:

- by going from house to house, all containers were targeted;
- information on the cleaning of other utensils (dippers) could be given where necessary;
- information could be collected on which zones had the dirtiest containers so that the hygiene promotion teams could later target these areas;
- the campaign would take a maximum of six days (for the whole camp); and
- people missed at the household level could be targeted at the water points.

Five percent chlorine solution was used to clean containers. Approximately 100–150 millilitres were added to every container, along with some small stones. The container was shaken vigorously if it was closed or scrubbed with a local straw broom if open. The idea behind the stones was that their abrasive movement would remove the dirt oxidised by the chlorine. Each container took approximately 15–20 minutes to clean. The chlorine was then dumped in a soak-away pit and the container rinsed with clean water before being refilled with one percent chlorine solution.
During the cleaning process, water containers were randomly selected for control of residual chlorine: the desired amount being, on average, between 0.3 and 0.5 milligrams per litre. (WHO residual standards are 0.2–0.5 milligrams per litre.) Results were fed back to the health coordinator and adjustments made accordingly. Containers were not randomly tested for faecal coliforms because, if residual chlorine is between 0.2–0.5 milligrams per litre, no bacteria will be present (MSF, 1994). In addition, only 18 samples per day can be taken with one Oxfam Delagua Water Testing Kit, and in the camp there was only one engineer with experience of Delagua testing.

**Results**

The whole exercise took five days and it was estimated that 13,224 water containers had been disinfected: 88% of the estimated number of containers in the camp. The random residual chlorine in 172 containers revealed that the amount of chlorine remaining in the containers was, on average, 0.22 milligrams per litre.

There was general acceptance of the programme among the beneficiaries, although there were some initial complaints about the smell of the chlorine and fear that the water was being ‘poisoned’. General observation at water points a week later revealed that people were keeping their containers clean.

Reported numbers of cases of both watery and bloody diarrhoea, shown in Figure 1 below, were obtained from the non-governmental organisation (NGO)-run camp clinic. Treatment is free and the clinic serves a population of 43,000 people. The actual causes of the diarrhoea have been difficult to determine, as laboratory tests were limited and confirmed cases of Shigella were based on a few samples sent to Khartoum. There is no record of whether there was visible blood in any of these samples. Cholera can be ruled out, since there have been no reported outbreaks to date in Darfur.

**Discussion**

This study has several methodological flaws. However, even after taking into account the fact that the intervention was carried out in an IDP camp with limited resources and that there was a commitment to action rather than the collection of data, some conclusions can be drawn from the results.

There is a great deal of literature on prevention of diarrhoea by hand washing both after latrine use and after cleaning a child’s bottom and increased latrine use (Myo Han and Moe, 1990; Curtis et al., 2001; Curtis and Cairncross, 2003). Esrey’s (1991) now well-known 1985 study has shown latrine use and hand washing to be the most effective means of preventing diarrhoea. According to WHO’s *Guidelines for the control of epidemics due to Shigella dysenteriae type 1* (WHO, 1995), hand washing is the most important preventive measure. In an emergency in a large camp, though, soap distribution and an intensive hygiene promotion campaign need well-trained, supervised volunteers, and some time may lapse before people fully understand the messages and
start to change their hand washing habits. Jerrycan disinfection was labour intensive but produced almost immediate results. Additionally, involved staff required little training.

The rationale behind the disinfection campaign was that, while water from the actual source (in this case, wells) contained no significant microbial contamination, containers quickly became contaminated once removed from the source and kept in the home (Roberts et al., 2001; Mintz et al., 1995). As the well water had been tested, the likelihood of post-collection contamination was high. The team could have engaged in random testing of water containers, but a mass disinfection campaign was perceived as making better use of time and resources. This method has been employed in other countries, albeit not in an emergency setting (Jagel et al., 2003).

The morbidity data highlight a fall in the number of watery and bloody cases of diarrhoea before the campaign. However, the results of the Shigella tests and the reported deaths alerted agencies to the need for action. The number of watery and bloody cases of diarrhoea continued to decline immediately after the disinfection campaign. At this time, there was no increase in the scale of the hygiene promotion campaign, no alteration to food rations, no change in the weather (it was before the onset of the rains) and no marked increase in the number of latrines in the camp. Nor were new water carrying utensils or storage buckets for the household distributed.

**Conclusion**

It is extremely difficult to obtain good and statistically rigorous data in an emergency setting, as the priority must be to intervene rapidly to prevent further cases of diarrhoea.
The results of the disinfection programme, though, do appear to point to some impact on watery and especially bloody cases of diarrhoea. Of course, one could argue that the epidemic might have subsided without an intervention. In a camp of 43,000 people, though, it would be unethical to assume this and not to take action. As there appears to be little documentation on similar situations, no definite conclusion can be drawn. It will be interesting to see whether people in the camp continue to clean their utensils and whether morbidity rates for diarrhoea remain low. The next pre-rains season in July–September 2005, when the water table is low, will be a crucial time for possible epidemics.

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**References**


