Drinking water incidents due to chemical contamination in England and Wales, 2006–2008

Karthikeyan Paranthaman and Henrietta Harrison

ABSTRACT

Contamination of drinking water by microbiological and chemical agents can lead to adverse health effects. In England and Wales, the Chemicals Hazards and Poisons Division (CHaPD) of the Health Protection Agency provides expert advice on the consequences to public health of chemical contamination incidents affecting drinking water. In this study, we extracted data from the National Database on the type and nature of drinking water contamination events reported to the CHaPD between 2006 and 2008. Eighty-two incidents with confirmed chemical contamination were identified. Among the 70 incidents where data was available, 40% (28/70) of incidents related to contamination of drinking water provided by private suppliers, 31% (22/70) were due to contamination occurring close to the point of consumption (i.e. near consumer) and 29% (20/70) related to incidents where public water supplies were identified as the contaminated source. For the majority of incidents, little or no information was available on the critical exposure variables such as duration of contamination and actual or estimates of the population affected. Reassuringly, the levels of exposure in most incidents were considered unlikely to cause serious immediate or long term ill health effects. Recording of exposure data for reported contamination incidents needs to be improved.

Key words | chemical contamination, consumers, drinking water, incidents, private supplies, public supplies

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INTRODUCTION

The provision of safe drinking water, free of microbiological and chemical contaminants is an essential requirement for protecting public health. Although the quality of drinking water is generally good in the UK, occasional breaches due to microbiological or chemical contamination are not uncommon (Gray 2008). Prompt identification and timely reporting of such incidents to relevant authorities is vital to enable appropriate responses to minimise harm to the public. In England, water companies have a duty to inform the Drinking Water Inspectorate of potential or actual events affecting the quality and safety of drinking water as set out in the Water Undertakers (information) Direction 2004 (DWI 2004). While the DWI has the statutory responsibility for regulation and enforcement, the Chemical Hazards and Poisons Division (CHaPD) of the Health Protection Agency (HPA) provides expert toxicological advice on the risks and consequences to human health due to chemical contamination of drinking water. Regular review of such reported incidents is useful to monitor trends, to inform appropriate policy-making decisions and to assure the public of the safety of drinking water. In this report, we present the results of a review of all drinking water incidents with potential or actual chemical contamination that were referred to the CHaPD over a 3-year period.

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AIMS AND OBJECTIVES

The aim of this study was to review and describe drinking water incidents with chemical contamination reported to the CHaPD between 1st January 2006 and 31st December 2008. The review considered the number and types of incidents reported, the type of information gathered during and after the incident, and the recommended public health actions. The objective was to identify and describe the common and serious incidents of chemical contamination of drinking water reported to the CHaPD.

METHODS

Under the HPA's Chemical Incident Surveillance programme, all chemical-related enquiries directed to the five CHaPD centres (Cardiff, London, Birmingham, Newcastle and Chilton) are routinely logged on the secure online National Database. The National Database includes information on drinking water incidents with chemical contamination reported to all five CHaPD centres. A chemical incident is defined as "an acute event in which there is, or could be, exposure of the public to chemical substances which cause, or have the potential to cause ill health" (HPA 2005). The National Database was searched for records of water contamination incidents reported between January 2006 and December 2008. In addition, an e-mail request was sent out to the water leads for all CHaPD centres requesting information about any incident(s) that they may have dealt with which may not have been reported in the National Database. The data was collated on a spreadsheet (Microsoft Excel 2003) and descriptive analysis was performed.

RESULTS

A total of 201 records were extracted from the National Database during the 3-year period. Data was incomplete for 29 incidents. Fifty-three enquires related to either contamination of non-drinking water or drinking water that was not chemically contaminated and therefore excluded. A further 37 incidents with reported change in the physical characteristics of drinking water such as a change in taste, odour or colour were identified. However, since there was no laboratory confirmation of chemical contamination in these incidents and the advice provided was on general principles rather than specific chemical-related advice, these were also excluded. Overall, 82 incidents with confirmed chemical contamination of drinking water were identified.

Regional breakdown

Seventy-seven incidents were reported from England with the remaining five incidents were reported from Wales during this 3-year period. Within England, the Eastern region had the highest number of incidents with 17 reports followed closely by 16 incidents from the South East. The South West, London and West Midlands region had 13 incidents each (Figure 1). Compared to the above, very few incidents

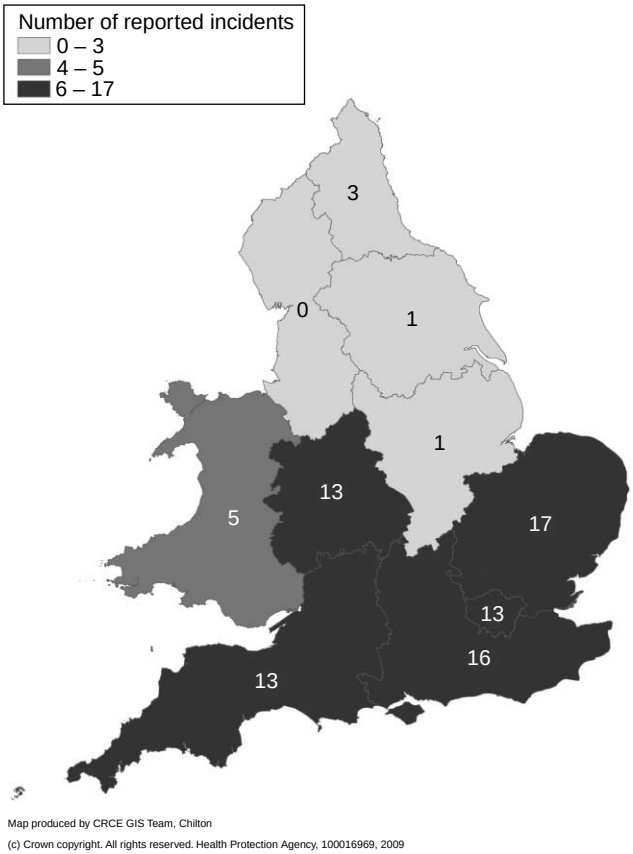

Figure 1 | Drinking water incidents with chemical contamination reported between 2006 and 2008.

were reported from the East Midlands, Yorkshire and the Humber, the North East and the North West regions.

Source and type of contamination

Among the 82 incidents where advice was sought, data on the source of contamination was available in 70 instances (Figure 2). Approximately 40% (28/70) of incidents related to contamination of drinking water provided by private suppliers, among which nitrates were the most commonly identified chemical contaminant. Nearly a third (22/70) was due to contamination occurring close to the point of consumption (i.e. near consumer), of which the majority were due to hydrocarbon contamination. Less than a third (20/70) related to incidents where public water supplies were identified as the source of contamination, with pesticide contamination identified as commonest cause.

Exposure data

In the vast majority of incidents, little or no information was available on the critical exposure variables such as duration of contamination and actual or estimates of the population affected. Although accurate numbers were lacking, the estimated numbers of potentially exposed persons were highest for those incidents with contamination of public water supplies and least for those involving private suppliers or local contamination of public supplies, as would be expected due to the distribution networks.

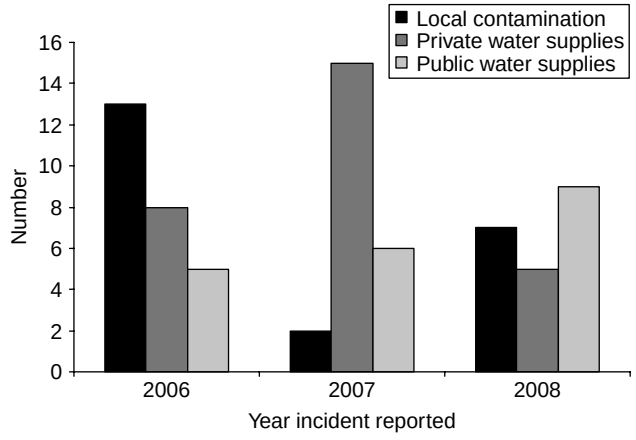

Figure 2 | Drinking water contamination incidents reported by year.

Public health actions

The CHaPD provided expert advice on the effects on exposure to identified chemical contaminants whenever this was made available. Depending on the type of chemical, levels of contamination and estimated exposure, the general measures recommended tended to be a 'Do not drink' or 'Do not use' notice to affected customers until appropriate remedial actions were undertaken and the water was confirmed to be fit for consumption. In the vast majority of incidents, the levels of contamination were considered unlikely to cause significant immediate or long-term ill health based on short-term exposures.

EXAMPLE INCIDENTS

Elevated aluminium in a public water supply

The CHaPD was contacted for advice on elevated levels of aluminium detected in a drinking water treatment reservoir. The contamination was caused due to disruption in power supply by a storm affecting the lime batching plant, which increased the water pH and triggered increased dosing of aluminium sulphate. The elevated aluminium levels in treated water triggered an alarm at 1,500 μg/L off site as the Water Treatment Works (WTW) was unmanned at night. The WTW supplied a few domestic properties directly and also fed in to a number of service reservoirs. A selection of properties fed directly from the WTW were sampled and found to have elevated levels of aluminium with the highest being 489 μg/L. The national standard is 200 μg/L. Levels at the service reservoirs were lower due to dilution by other unaffected water supplies. Testing showed that the levels of aluminium fell to the usual background level within a few hours. Following receipt of the results, the water company was advised that the elevated levels of aluminium were not of public health concern.

Elevated lead due to domestic piping system

A member of the public contacted the HPA due to elevated lead levels found in the drinking water supply. She had a 6-month old baby and had been living in the house for 7 months. The house was build around the year 1910 and

testing was carried out at the occupier's request after building work showed the supply pipe to be suspected lead. The tests carried out in an accredited laboratory showed a lead concentration of 7,800 μg/L. Following the results, the house water supply was declared as unsuitable for consumption and they were supplied with bottled water. None of the residents had any lead poisoning-related symptoms. Based on the information provided, blood lead surveillance testing for the infant child was strongly recommended. Arrangements were made for all supply pipes in the household to be replaced.

Elevated manganese from a private borehole

Following routine testing, a Local Authority identified elevated levels of manganese at the residence of a member of public. He was thought to have been exposed for two months by drinking water from his private borehole with a single drilling. He did not notice any difference in odour and colour of the water and was asymptomatic. A peak manganese concentration of 5,200 μg/L was found during repeated sampling. The Water Supply Regulations limit for manganese is 50 μg/L. It was estimated that the individual was potentially exposed to 0.72 to 5.2 mg/L of manganese depending on the quantity of water consumed. A review of published literature and guidelines confirmed that this level of exposure was not expected to cause any adverse effects. Appropriate remedial action to resolve the problem was undertaken.

Solvents contamination due to local factors

The CHaPD was contacted by a Local Authority for advice on health effects after tests confirmed the presence of 1,500 μg/L of tetrachloroethylene in drinking water. The samples were tested from a commercial property situated above a dry cleaning facility. On confirmation of contamination, 'Do not drink' notices were served to all potentially affected premises and alternative water supplies were provided. A restaurant in the same premises was advised not to use the water or stop operations until the problem was remedied. The contamination occurred due to defective pipe work connection at the dry cleaning facility. A letter to affected members of public was sent with detailed information on the acute and chronic health effects of the implicated chemicals.

Elevated aluminium from a private drinking water supply

A pregnant woman sought advice on the possible health effects following identification of elevated levels of aluminium in her private drinking water supply. The contamination was identified on routine testing by the Local Authority. Water sample results confirmed an exceedance of the standards for aluminium at 5,450 μg/L (reference value 200 μg/L) on a sample of water from the kitchen tap. There was no historical information available for comparison of levels. The duration of potential exposure to elevated levels of aluminium was thought to be up to 3 years. Toxicology advice confirmed that despite the concentration of aluminium exceeding water quality standards, the estimated total intake was many times below the levels at which effects were seen in animal studies. Thus although there was some uncertainty, adverse effects were not anticipated and medical follow-up for adults or children was not considered necessary.

Potential copper ingestion due to prolonged disuse

An incident affecting five children attending a summer camp was reported to the CHaPD after they had become ill with nausea and abdominal pain and self presented at the local hospital due to drinking 'blue-coloured' drinking water. The contamination occurred in an old building which was being used for the first time after a few months and the stored water had become blue tinged due to the copper pipes and tanks and the water left standing for many months. The children's symptoms were consistent with excessive copper ingestion, although laboratory confirmation was not available. The camp attendees were advised to stop drinking water and were put on bottled water. After the system had been completely flushed through, the water returned to its natural colourless state and the levels of copper were confirmed to be within the guideline values.

DISCUSSION

The study reviewed all incidents with suspected or confirmed chemical contamination of drinking water reported to the HPA between 2006 and 2008. The results demonstrate the disproportionate risks of chemical contamination of water provided by private suppliers. Private water supplies accounted for 40% of reported incidents in this study, although it is only used by up to one third of a million people in England (DEFRA 2008). It is well recognised that private water supplies are more prone to contamination compared to public water supplies. By using data on outbreaks of intestinal infectious disease, previous studies have highlighted the higher risk of microbiological contamination of private supplies when compared to public water supplies (Said *et al.* 2003; Smith *et al.* 2006). This study confirms a similar risk for chemical contamination of private water. Assuring the quality and safety of private water supplies is important because contamination by chemical or microbiological agents can lead to significant adverse health outcomes in consumers and are potentially avoidable by timely preventative actions. Although the overall quality of private drinking water is thought to have improved by the 1991 Private Water Supplies Regulations, it is commonly accepted that the monitoring mechanisms for implementation of the Regulations are inadequate or impractical for use (Said *et al.* 2003; DEFRA 2008). New measures have been proposed to address this issue by strengthening the regulations imposed on private suppliers and enhancing the powers of Local Authorities to take relevant preventative and enforcement actions (DEFRA 2008).

A substantial proportion of chemical contamination of drinking water incidents were due to a leak or spill close to the point of consumption. In the majority of such cases, the contamination occurred due to poor insulation or breach of the pipe carrying water from main public water distribution system within the property of the consumer and therefore such incidents usually affected only a small number of individuals. Timely identification of any leaks or spills of chemical substance and any subsequent change in the physical characteristics of water is essential. When this is supported by access to rapid testing for potential contaminants with institution of appropriate remedial actions, any potential harm to public health can be minimised.

As would be expected, the number of public water contamination incidents was relatively low. Among the twenty reports of public water chemical contamination reported over the 3-year period across England and Wales, expert assessment of each incident at the time concluded that they were unlikely to cause significant short or long-term adverse health effects in consumers. It is important to remember that the potential for harm is higher in contamination of public water suppliers due to the much higher number of consumers who could be exposed by a single serious incident. The consequences of the Camelford incident in 1988 where 20,000 consumers were exposed to high levels of aluminium and other chemicals due to the accidental pollution with 20 tonnes of aluminium sulphate system serve as a chilling reminder of the dangers of public water contamination by accidental or deliberate events (Rowland *et al.* 1990; COT 2005). In order to minimise the risk to consumers, water companies are now required to use a risk assessment framework for identification of all actual and potential hazards arising anywhere in the water supply system from source to consumer tap. This is followed by monitoring of the control measures to reduce or mitigate unacceptable risks by the Regulator (DWI 2009).

The lack of adequate exposure data for most incidents is a cause for concern. While individual factors such as poor data entry might have played a role, it is far more likely that such exposure data were not available in the first instance. The lack of adequate exposure data precludes the ability to carry out long-term epidemiological studies to assess adverse effects of exposure to rare chemicals that might be difficult to evaluate in laboratory studies. It might be worth considering the need for a national register to collect information on the exposed individuals and their contact details to facilitate follow-up studies when required.

The data presented in the study are subject to a few limitations. First, the actual number of chemical incidents might be much higher than those for which advice was sought from the HPA and reported in this study. Identification of chemical contamination of water requires testing and notification to the relevant authorities. Contamination of private water supplies or disruption of public water systems at the end-user level might not be recognised in the absence of change in physical quality of water such as colour, odour or taste. Even when a physical change is

identified, such incidents may not always be reported to the relevant authorities unless the consumer is sufficiently concerned about the quality and safety of water. Public or private suppliers of drinking water are required to notify the Regulator, either the DWI or the relevant Local Authorities, of all suspected or actual incidents affecting the safety and quality of water supplied to consumers. While there is a good working arrangement between the DWI and the HPA for sharing information on all drinking water-related incidents, there is no robust system for all Local Authorities to systematically inform the HPA and therefore this aspect of the data can be incomplete. Finally, it is possible that some incidents might have been reported to the HPA but not entered on to the National Database or data were entered wrongly. While such data entry bias is always possible in any surveillance system, it is considered unlikely to be significant enough to invalidate the findings. The HPA can be approached for advice by a number of sources such as Public Health authorities, water companies, Local Authorities, DWI and other organisations. This unique model of reporting incidents can be considered a strength of the HPA data as other surveillance systems such as the DWI notifications and data from individual water companies are unlikely to capture incidents occurring due to local contamination near the point of consumption or contamination of private water supplies.

CONCLUSIONS AND RECOMMENDATIONS

Considering the amount of drinking water consumed by the population, the number of incidents with confirmed chemical contamination was relatively small. Among the reported incidents, private water supplies were commonly implicated, highlighting the need for tighter regulation to assure the safety and quality of such water provided to consumers. Although no significant adverse health effects were observed or expected in the vast majority of incidents, a few serious incidents raised concerns and highlighted the dangers of chemical contamination of drinking water. Improved recording of exposure data such as the estimated number of consumers affected, duration of contamination and chemical testing results is essential to identify any short or long term health effects in consumers when accidental or deliberate contamination by specific chemicals are reported to public health authorities.

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