Mercury contamination incident


Abstract

Background The aim of this paper is to describe an incident where elemental mercury led to widespread contamination and the exposure of 225 individuals and confirmed toxicity in 19 individuals. The paper describes the incident and difficulties found in trying to assess the risk to individuals and to identify and decontaminate the residences involved.

Methods All individuals exposed to elemental mercury in the incident were followed up for 15 months.

Results Thirty-seven individuals were found to be ‘at risk’ and 13 were symptomatic of mercury poisoning. Five patients required chelation therapy. The incident was closed when the risk of poisoning and re-exposure was minimized.

Conclusion Incident management depends on early effective communication and collaboration between all agencies involved.

Keywords: chemical incident, environmental hazards, mercury

Introduction

This paper describes an incident where elemental mercury led to widespread contamination and the exposure of 225 individuals and poisoning of 19 individuals. It highlights some of the difficulties in incident management.

Elemental mercury is a heavy, silver, liquid metal with a high vapour pressure, which readily contaminates the air. In this vaporized form inorganic mercury can be highly toxic.1 Cases where elemental mercury contamination and poisoning have occurred in domestic residences are infrequent. In many of these cases poisoning has resulted from a spill in the home.2,3 Usually only a few residents are exposed and require treatment. The manner in which mercury droplets coalesce make it fascinating to play with and many of the most severe cases of reported mercury poisonings have occurred in young children.1,2,4,5 Mercury vapour is more dense than air and settles at ground level, thus only a few residents are exposed and require treatment. Two larger-scale elemental mercury poisonings affecting multiple dwellings have been identified in Florida9 and Scotland.10

Mercury toxicity

Although dermal exposure and ingestion of metallic mercury is unlikely to cause acute toxicity, mercury vapour is efficiently absorbed into the blood when inhaled11 and is rapidly distributed to the tissues. Significant mercury excretion occurs within a week following exposure and can be found in urine and faeces at low levels for months.12

Blood mercury levels higher than 35 μg/l and urine levels greater than 150 μg/l are considered toxic.13 Respiratory tract irritation, cyanosis, pneumonia, pulmonary oedema and, in some cases, death can result following mercury vapour inhalation.14 Exposure may induce flu-like symptoms, pyrexia, tachycardia and acute renal failure.14,15

The major chronic clinical effects of mercury vapour are on the central nervous system and the gastrointestinal tract. Conditions experienced may include weakness, fatigue, anorexia, severe salivation and gingivitis.6,16 At higher exposure levels,
mercurial tremor ('Hatter's Shakes')\textsuperscript{13} and acrodynia ('Pinks disease')\textsuperscript{17} may also develop. Chelation therapy with dimercaptopropanesulfonic acid (DMPS) is used to treat patients whose blood concentrations are above 100 µg/l and is vital where blood concentrations are above 200 µg/l.\textsuperscript{18}

The incident

One Sunday night in October 1997, between 5 and 10 litres of mercury in jars was allegedly stolen by several youths from a pallet manufacturer (formerly a scrap yard) in the Borough of Rochdale, Greater Manchester. Some of the mercury was split on an adjacent road and further spills were reported as the mercury was removed further away from the site, some apparently by wheelbarrow. The weight of the mercury would probably have been between 70 and 100 kg. The youths played with the mercury, throwing it and spitting it at each other. Following this many took it home.

The following morning Rochdale Environmental Health Department (REHD) was alerted to the spillage by the Fire Service. The pallet yard was very close to the borders between two health authorities and two local authorities, and mercury spills were subsequently found in both areas.

Booth Hall Children's Hospital (BHCH) was alerted to the incident at 12.30 p.m. by the police and advised to expect children with probable mercury exposure. The hospital contacted the National Poisons Information Service (London), which cascaded the incident to the Chemical Incident Response Service (CIRS). Information on the management of mercury exposed individuals was faxed to the hospital and local health authorities by CIRS. The latter notified general practitioners (GPs) in the area of the incident.

A press statement was released the same day alerting the public of the need to attend hospital following suspected exposure. By Monday evening, 76 children had attended the accident and emergency department at BHCH. As the average daily attendance at BHCH was 80 patients, this incident placed great pressure on the department, and nurse staffing arrangements were altered to allow normal functioning. Hospital management provided assistance with communications with the police, health authorities and the media.

The press release also stated that those involved in the incident should attend without fear of prosecution. However, problems arose in identifying the youths, their families and other possible exposed individuals over the next week. The press release led to the identification of a second, smaller mercury incident involving railway tilt switches; 22 children who were involved in this incident were followed up with the children from the main incident.

Incident management

A meeting of the agencies particularly involved with the incident was convened 11 days after the alleged theft when the scale of the incident became apparent. Bury and Rochdale Health Authority's Public Health Department (the health authority where the incident started) took the lead. A database of affected families and individuals was compiled and managed by staff from CIRS and Liverpool John Moores University under the direction of the Regional Epidemiologist. The 'incident working group' met regularly to evaluate and discuss progress. Other agencies were asked to attend as required.

Follow-up

The follow-up ran in two phases.

First phase

The first phase of response, investigation and treatment took two and a half months. During this time people thought to have had some contact with the mercury were traced.

A programme of investigation and assessment involving biological sampling of all potentially at risk (those who had had some contact with the mercury either directly or through the contamination of their home) was agreed between the health and local authorities, the hospital and CIRS. Individuals who could have been exposed but had not yet attended hospital were traced through identifying residents of houses where known exposed individuals lived or had visited. Where mercury concentrations in the blood were higher than 15 µg/l and mercury creatinine ratios in the urine were higher than 15 µg/g individuals were considered ‘at risk’ and were tested monthly until they gave two consecutive samples below these levels.

A total of 225 people were recorded to have possible exposure to mercury. Of these, 151 (67 per cent) were under 17 years old and were attending school. Twenty-six schools helped with the initial identification of individuals, and mercury was reported to have been taken into one of these schools on the Monday after the incident.

Thirty-seven individuals were found to have concentrations of mercury in their blood or urine that put them in the ‘at risk’ group. This group included an infant less than 1 year old (Table 1). A series of case studies from the ‘at risk’ group is given below, highlighting issues relating to the identification of individuals involved and their clinical management. Although 13 patients became symptomatic from the mercury poisoning it was decided through clinical assessment and analytical investigation that only five who had been seriously poisoned required DMPS chelation therapy. DMPS is the chelation of choice for mercury poisoning and few adverse health effects have been reported. They include nausea and rashes, which can be treated with steroids as required.

Case studies

Patient 1 (male 15 years). Patient 1 was apparently involved in the alleged theft of the mercury. On day 8 after the initial contamination, he provided a blood mercury sample of 329 µg/l. He
was hospitalized and treated with DMPS. His urine mercury levels reached a high of 2037 μg/l on day 22. Ten months after the incident his urine mercury levels were 10 μg/l.

**Patient 2 (male 17 years).** Patient 2 was apparently involved in the alleged theft of the mercury. He had direct contact with the metal on his skin. His clothes and the houses of his friends and family became contaminated as a result of his actions. Mercury levels in his blood (blood level 111 μg/l, on day 8 after initial contamination) and urine were high. The patient had a rash and reported feeling unwell but refused to be admitted to hospital. He was given chelation therapy, but by day 16 his blood mercury levels had risen to 162 μg/l. This increase was due to re-exposure. He was given an additional treatment with DMPS and his blood mercury levels then began to fall. Monitoring this individual was difficult as he did not reside at a fixed address. Seven months after the incident his urine mercury creatinine ratio was found to be 20 μg/g.

**Patient 3 (female 37 years).** Patient 3 became contaminated when the metal was brought into her home by some friends of her daughters. She was treated as an out-patient with DMPS because of high blood mercury levels (178 μg/l on day 15), but was admitted to hospital on day 27 as a result of the severity of her symptoms. By this time her blood mercury levels were decreasing (29 μg/l). She suffered from decreased sensation in her legs, rash, flu-like symptoms and displayed a tremor. Some of these symptoms may have been adverse reactions to DMPS treatment. She remained in hospital for 22 days. Her last blood sample taken before leaving hospital indicated her mercury level to be 17 μg/l.

**Patients 4 and 5 (female 10 years, male 14 years).** Patient 4 suffered the effects of mercury poisoning in the form of a widespread rash suggestive of acrodynia (Fig. 1), although her mercury levels were not high enough to warrant DMPS treatment (blood mercury: 39 μg/l). She was admitted to hospital for a period of 7 days for investigation and to prevent any re-exposure to mercury. A blood sample 23 days post-exposure showed her mercury levels were no longer a cause for concern (6 μg/l).

Her brother, Patient 5, refused to be admitted to hospital despite high blood mercury levels (78 μg/l). Remaining in his contaminated home resulted in an increase in his blood mercury levels.

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### Table 1 Aages and risk status of those involved in the incident

<table>
<thead>
<tr>
<th>Age at time of incident (years)</th>
<th>Not at risk*</th>
<th>Total</th>
<th>Symptomatic Hg poisoning</th>
<th>Chelation therapy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>6–16</td>
<td>126</td>
<td>25</td>
<td>10</td>
<td>3</td>
<td>151</td>
</tr>
<tr>
<td>17–25</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>26–35</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>36–55</td>
<td>26</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>&gt;56</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>188</td>
<td>37</td>
<td>13</td>
<td>5</td>
<td>225</td>
</tr>
</tbody>
</table>

*Blood mercury <15 μg/l and urine mercury creatinine ratios <15 μg/g.
†Blood mercury >15 μg/l and urine mercury creatinine ratios >15 μg/g.

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**Figure 1** Patient 4, showing wide-spread rash suggestive of acrodynia.
levels (maximum blood mercury level 103 \( \mu g/l \), on day 14). He received DMPS treatment as an out-patient. Two months after the incident his blood mercury level had fallen to 17 \( \mu g/l \).

**Second phase**

The second phase of the follow-up began when no further cases of acute exposure were expected. During this phase cases and properties were monitored until they were no longer a cause for concern.

Mercury levels were monitored in ‘at risk’ individuals. Urine samples were considered to be the most appropriate indicators of contamination in this period. Monitoring continued until two consecutive test results which were not considered ‘at risk’ were given. Individuals living in contaminated houses were also followed up until they gave two ‘low risk’ results and their houses ceased to be contaminated. Letters to be held in patients’ records were sent to the GPs (where known) of all 225 individuals involved, detailing the incident and test results.

Nine months after the incident 35 people remained in the ‘at risk’ group; eight remained because their homes were still contaminated and 27 because they had not provided the two urine tests required to remove them from this group.

**Environmental clean-up**

The mercury was spread to many areas including houses, shops, pathways, roads and grass areas. On the first morning of the incident (Monday) the Fire Service attempted to clear the mercury spillages using sand to coagulate the metal. However, this was unsuccessful and an environmental consultancy was contracted to carry out the clean-up. In areas where small amounts of mercury had been spilt flowers of sulphur were administered to convert it to a less volatile sulphide form. A pressure washer was used to wash the spillage from the road to the kerbside where it was removed and placed in drums for disposal.

Seventy-eight homes, identified as being possibly contaminated with mercury, were visited by Environmental Health Officers from the appropriate local authority. These were homes with residents claiming to have had some contact with the mercury. Evidence of mercury was found in 21 homes, which then required follow-up monitoring. Mercury vapour indicators were used to monitor these homes.

Contamination in some of these homes was exacerbated because residents used vacuum cleaners to clear up mercury spill on carpets. The agitation and heating of air involved in vacuuming results in mercury vaporization and consequently, the exposure of others.\[^5\] Clothes contaminated by mercury spills and from mercury being carried in pockets were also identified. Washing machines and tumble dryers became contaminated as efforts were made to clean these clothes. These machines have a similar effect to vacuum cleaners of encouraging vaporization of mercury. Some contaminated machines gave very high mercury vapour level readings (\( >100 \mu g/m^3 \)) (Table 2). Contaminated machines and their internal parts, along with other household soft furnishings, could not have been decontaminated, because of the lack of solvent that would remove the mercury without destroying the articles.

All potentially contaminated properties were monitored using a Shaw City mercury vapour monitor until they were no longer thought to be a risk; i.e. all mercury vapour readings were \(<10 \mu g/m^3 \). This was decided by the Incident Team as a level below the occupational exposure level of 25 \( \mu g/m^3 \) and that could reliably be determined using a mercury vapour monitor. However, where residents refused to relinquish items without receiving compensation, contaminated items remained in homes. By September 1998, funds had been made available by both local and health authorities to remove and replace the remaining contaminated items. A total of 1.5 tonnes of contaminated material was removed by the environmental consultants from the environment and properties for appropriate disposal in toxic waste landfill.

**Incident closed**

The incident was closed on 12 January 1999, 15 months after the original incident occurred. The Incident Working Group was satisfied that the risks to individuals had been eliminated or reduced as far as possible.

**Discussion**

This incident has raised many issues regarding the management of chemical incidents, particularly where health authority or local authority boundaries are crossed. Multi-organization coordination and co-operation are paramount in all incidents but

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**Table 2. Contaminated items found in households**

<table>
<thead>
<tr>
<th>Items lost to follow-up while still contaminated</th>
<th>Contamination reduced to acceptable levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. replaced or removed from households</td>
<td>No. removed from follow-up while still contaminated</td>
</tr>
<tr>
<td>Carpets</td>
<td>5</td>
</tr>
<tr>
<td>Washing machines</td>
<td>10</td>
</tr>
<tr>
<td>Vacuum cleaners</td>
<td>11</td>
</tr>
<tr>
<td>Suites</td>
<td>1</td>
</tr>
<tr>
<td>Chest of drawers</td>
<td>1</td>
</tr>
</tbody>
</table>
especially so in a cross-boundary situation. Emergency procedures do exist to manage major chemical incidents. However, in this incident, the scale of the problem was not apparent for some time and the incident was never formally declared a major chemical incident.

Identification of those affected and those requiring follow-up depended on both biological and environmental monitoring. There are no environmental standards for non-occupational exposures to mercury so environmental monitoring was based upon interpretation of the best information available. Biological information was conducted within guidelines set by the Incident Working Group, based on information provided by CIRS.

Variation in the accessibility of budgets between the different agencies and uncertainty regarding whether agencies were responsible for compensating individuals led to a delayed response in some circumstances. One of the main reasons that the incident continued over such a long period of time was the contamination of the vacuum cleaners and washing machines. Information advising people against the use of these appliances where mercury has been spilt could have been publicized more effectively. This may have avoided some of these appliances becoming contaminated and may have also minimized exposure to residents. Where severely contaminated appliances could not easily be decontaminated they should ideally have been removed immediately. This would have eradicated the risk of continuing exposure in these houses and would have been more cost effective than the continual monitoring of the properties by environmental health officers.

The follow-up of individuals from this incident was particularly difficult as some children provided false addresses when they attended the hospital on the first day, and in one case the patient was of no fixed abode.

It was not possible to calculate accurately the total costs of this incident, but the costs of the mercury blood and urine tests alone were £10 000 and costs to one local authority were estimated to be of the order of £40 000.

**Conclusion**

Incident management depends on early effective communication and collaboration between all agencies involved. This incident has highlighted the problems in identifying incidents in their early phase. The lack of evidence-based guidelines for non-occupational biological and environmental monitoring made this incident difficult to manage and follow up.

**References**


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