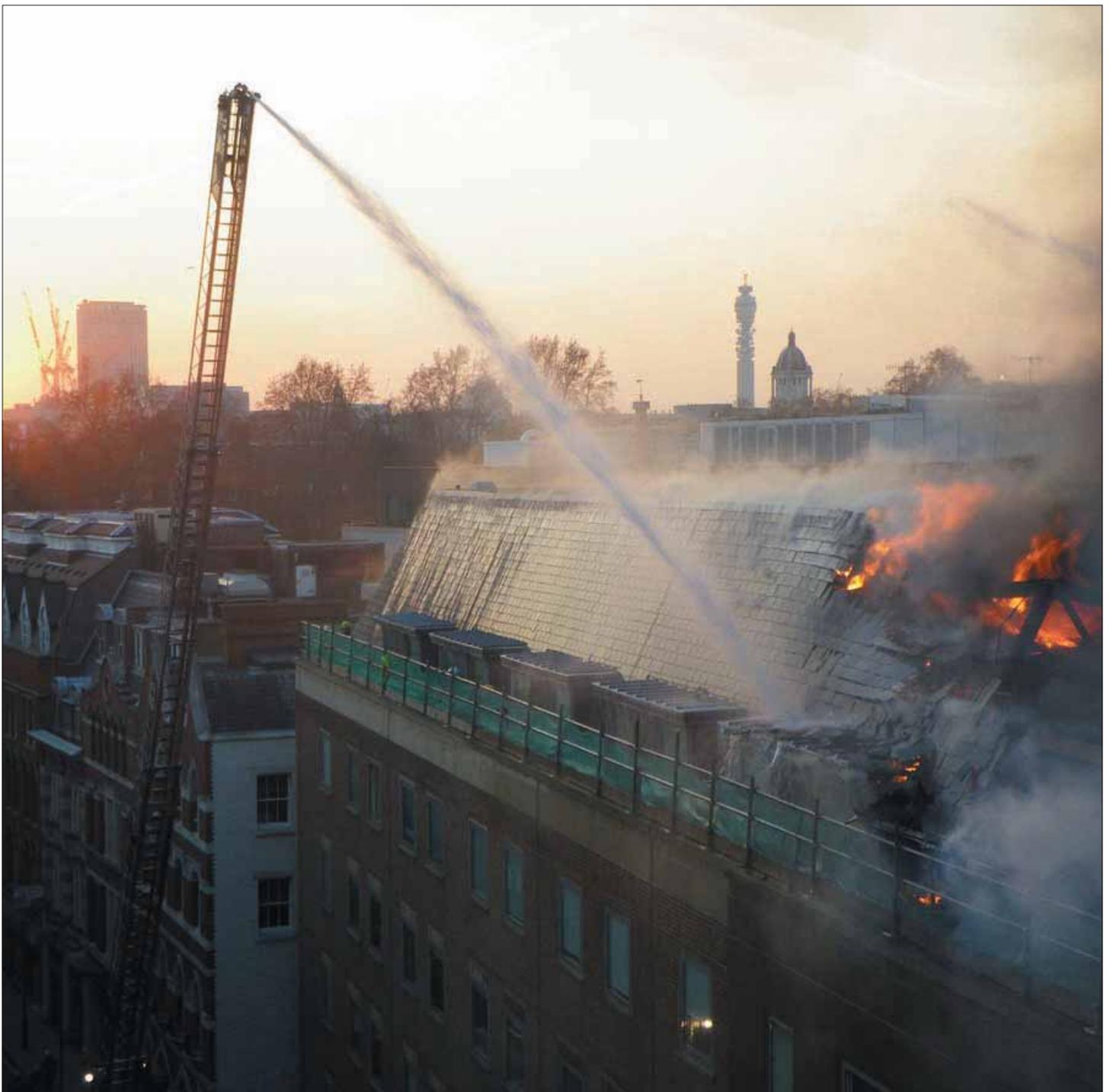


# Chemical Hazards and Poisons Report

From the Chemical Hazards and Poisons Division  
September 2009 Issue 15



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# Editorial

**Editor: Professor Virginia Murray**

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**Chemical Hazards and Poisons Division**

On the front cover we show a photograph of a fire in Chancery Lane, which is located close to the Health Protection Agency corporate office building. This fire offers us the opportunity to share the processes we can use for exposure assessment and subsequent risks of any adverse health effects. Other incidents included in this issue involve two related to importation of materials, one with exposure to aluminium phosphide in West Yorkshire and the other where multiple exposures were related to an imported slide in a playground in Hampshire.

Emergency planning and preparedness is particularly well addressed in this issue. Two exercises are reported. Operation Torch 2008 was the largest exercise of its type in Europe, it was a multi-agency, multi-national mass fatality simulation exercise and much is still to be learned but this provides a vital summary to show the type of developments occurring in the UK. The other exercise, Exercise Orpheus II, which took place in July 2008, tested response at a hospital Emergency Department and again provided invaluable evidence for further learning. Some of this learning has been actively used to develop the HPA-led Training the Frontline course, a pilot CBRNe course for emergency department staff. This course was run in March 2009 with support from the NHS London and the Department of Health. We are very grateful to the staff at the Emergency Department at Homerton Hospital for their enthusiastic participation and their evaluations of the course, which showed it was very well received. Now plans are afoot to run further courses and from this to develop distance learning materials to support more training more widely in the future.

Training is not enough and we are delighted to share the development of new research that is now taking forward our understanding of how we can improve our knowledge on decontamination. An overview of the HPA's Research and Development Programme on decontamination is provided. HPA has also been asked to work on the development of a guidance pack for primary care on managing self-presenters after a chemical incident, since little information is currently available in this area. This paper summarises our second round of iterations on this topic, sharing check lists that we now wish to receive feed back on from all colleagues who work in this area.

Natural hazards and climate change are pertinent topics as we head to Copenhagen in December 2009 and issues that relate to this are shared in a paper from the Met Office on the global threats of climate change. I was fortunate enough to attend the Second Session of the United

Nations International Strategy on Disaster Reduction Global Platform for Disaster Risk Reduction, in June 2009. Increasingly, work in finding ways to reduce risk from natural hazards through effective interdisciplinary science is being developed and a report from an international expert workshop in May 2009 is presented.

As a result of our on-going efforts to improve the service we offer our readers, the Chemical Hazards and Poisons Report pages of the HPA website now include a searchable index for articles in previous issues of the Report plus its predecessor, the Chemical Incident Report. In addition to hard copies, we are also launching an email version for the next issue to enable readers to go direct to articles of interest and share them with colleagues. The next issue of the Chemical Hazards and Poisons Report is planned for January 2010; the deadline for submissions is 1st November 2009 and Guidelines for Authors can be found on the website. Please do not hesitate to contact us about any papers you may wish to submit on [chapreport@hpa.org.uk](mailto:chapreport@hpa.org.uk), or call us on 0207 759 2871.

We are very grateful to Dr John Cooper, Mary Morrey and Andrew Tristem for their support in preparing this issue. Thanks also go to Dr Laura Mitchem, Dr Graham Urquhart, James Stewart-Evans and CHaPD Nottingham for their editing assistance.

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**Correction to issue 14:** Please note a correction to the article Haber's Law by RL Maynard in issue 14, page 50, column 2. The first line of the equation should read  $C^*t = k$ .

**Front cover image:** View of fire in Chancery Lane, courtesy of London Fire Brigade.

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# Incident Response

## A multiagency approach: the Chancery Lane Fire

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### Introduction

Early public health response following an acute event has been shown to allow effective management of an incident, and protection of both the general public and first responders<sup>1</sup>. This is particularly relevant in a city with a dense population. Prompt identification and collaboration with allied professionals allows this response to take place.

Following a large fire in central London that could be seen from the Chemical Hazards and Poisons Division (CHaPD) London office, this report shows how timely recognition of an incident allows for early co-ordination of a multi-agency response and subsequent health risk assessments.



Figure 1: View of fire from Health Protection Agency offices, Holborn Gate, London



Figure 2: Close up of fire (Source: London Fire Brigade)

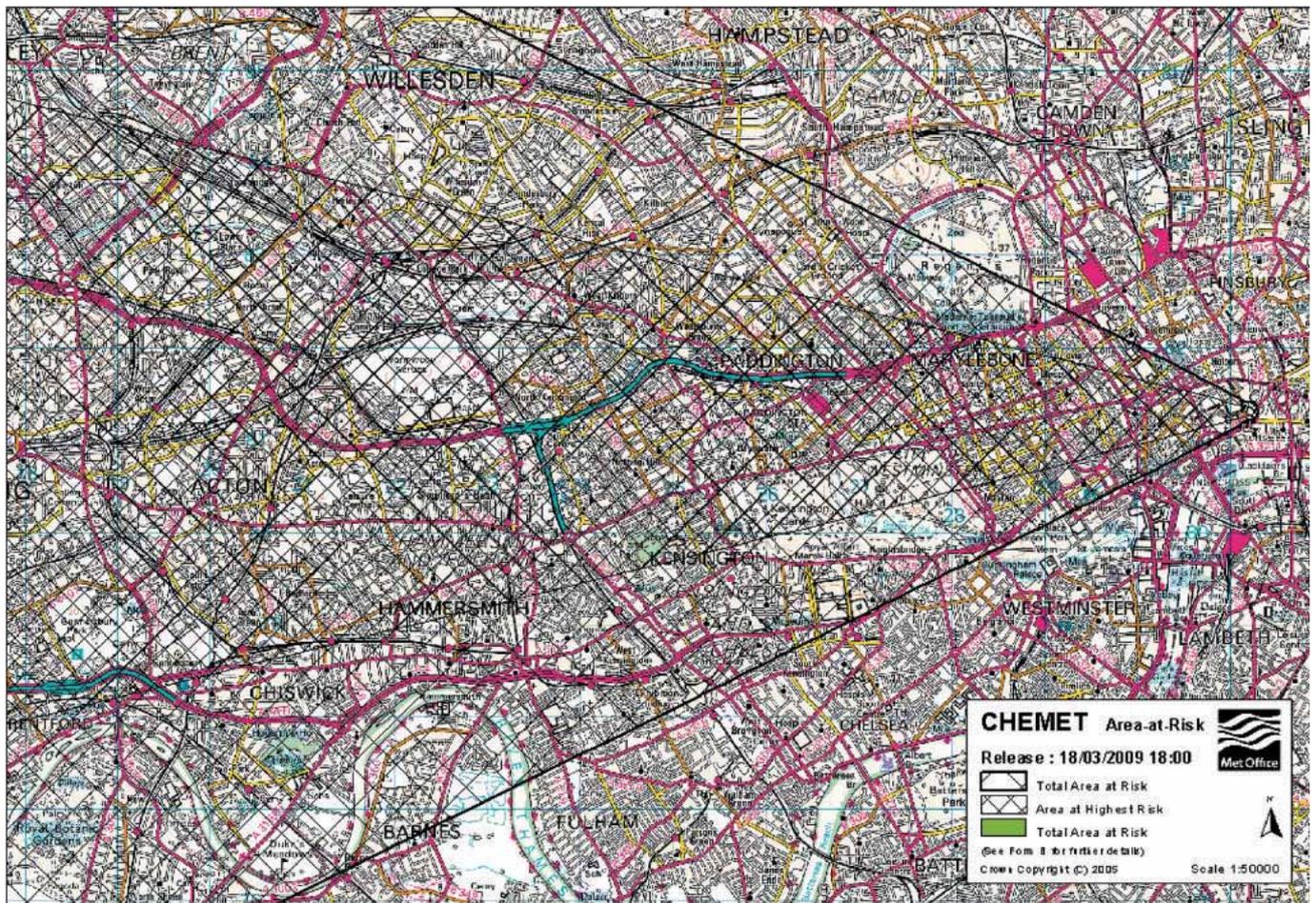
### Incident Summary

On Wednesday 18th March, 2009, at 15.50, fire and smoke were observed coming from a building on Chancery Lane from the windows of CHaPD at the Health Protection Agency in High Holborn (Figure 1). CHaPD contacted the London Fire Brigade (LFB) who confirmed that the fire was being attended to by six fire engines, or pumps.

By 16:45 the fire was confirmed to be in the five-storey Immigration and Appeals Commission building on Chancery Lane. No individuals were thought to be inside the building. The incident was now being tackled by 12 pumps with two aerial appliances. London Ambulance Service (LAS) responded by sending the Hazardous Area Response Team (HART), an ambulance and a Duty Station Officer to the scene and to attend Silver Command. The Metropolitan Police Service was also on scene. No casualties had been identified. By now the fire had generated significant media interest. A decision was made by LFB to evacuate the area within a half-mile radius due to the presence of cylinders in the building and concerns of a possible explosion. Approximately 200 people were evacuated in a largely non-residential area and cordons were put in place.

Early collaboration between CHaPD, an HPA Health Emergency Planning Advisor (HEPA) and a LAS Tactical Support Officer on scene allowed North East and North Central London Health Protection Unit (HPU) to be kept up to date on the incident.

At 19:00, the London Air Quality Network team at King's College London Environmental Research Group were notified of the fire. They responded by increasing the frequency of data collection from established Particulate Matter (PM) monitoring sites situated in the areas forecasted to be affected by the plume in the CHEMET (Figure 3).



**Figure 3: CHEMET of the plume associated with the fire**  
(Image: Met Office)

**Box 1: CHEMET**

The CHEMET Area at Risk Plume is produced by the Environment Monitoring and Response Centre (part of the Met Office) in response to a request from Fire, Police, Ambulance or emergency planning officers. It uses an atmospheric dispersion model taking into account wind speed and direction to predict where the smoke is likely to go. The hatched area in the centre of the plume represents 70% and the outer area where 95% of the plume is likely to go.

An update on the fire was received at 20:00 from Silver Command via HART. The hypothesised cause of the fire was bitumen work on the roof. Two propane cylinders had been removed from the building. No asbestos had been identified and no personnel attending the fire had reported adverse health affects.

In conjunction with the LAS Tactical Support Officer, the LAS Emergency Operations Centre and the HEPA, a plan was formulated to monitor any increase in calls due to symptoms in areas indicated by the plume prediction. Results overnight showed no increase in either ambulance calls or attendance to hospitals for respiratory illness local to the fire and plume.

The following morning, NHS Direct provided syndromic surveillance information for the London area to identify any unusual signals due to

the fire in Chancery Lane. Calls were analysed looking at three symptoms: difficulty breathing, coughing and eye problems. For each symptom, the total calls for London were compared against the total calls received in the whole of England. Calls received in London were then broken down into postcode areas to look for a trend matching the CHEMET prediction. Figures 4 and 5 show reports generated for difficulty breathing.

From the results provided, none of the symptoms monitored showed a significant rise in calls and when broken down into postcode districts, there did not appear to be any clustering of symptoms.

In addition to the information supplied by NHS Direct, the results from the London Air Quality Network suggested that due to the still weather across Greater London, there was a slight increase in PM10 levels that may have been due to the fire. This increase was mainly observed in the boroughs of Ealing and Hounslow. At the Acton Town Hall monitoring site in the London Borough of Ealing, the daily mean PM10 concentration (TEOM \*1.3) exceeded the EU Limit Value concentration of 50 µg/m<sup>3</sup> on 18th March. Initial analysis of measurements from the site suggests that these breaches may have been partly attributable to the plume from the fire. Exceedances were also detected in Camden. However, all of these monitoring stations are located some distance from the site of the fire making it difficult to interpret whether these exceedances are associated with the fire or the result of some other localised source. Additionally, it was a clear day and the direction of the plume was observed to be changing regularly, highlighting the difficulty with using modelling, particularly in urban areas. The incident also highlights the difficulties encountered in trying to monitor potential health impacts associated with changes in air quality, and in using fixed monitors and plume modelling to estimate likely exposures.

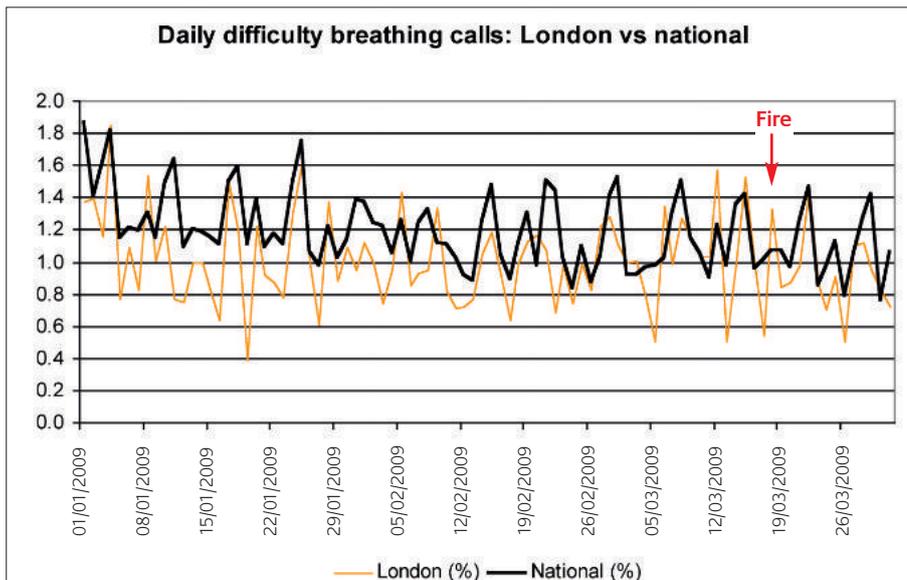


Figure 4: Daily 'difficulty breathing' calls to NHS Direct as a proportion of total calls

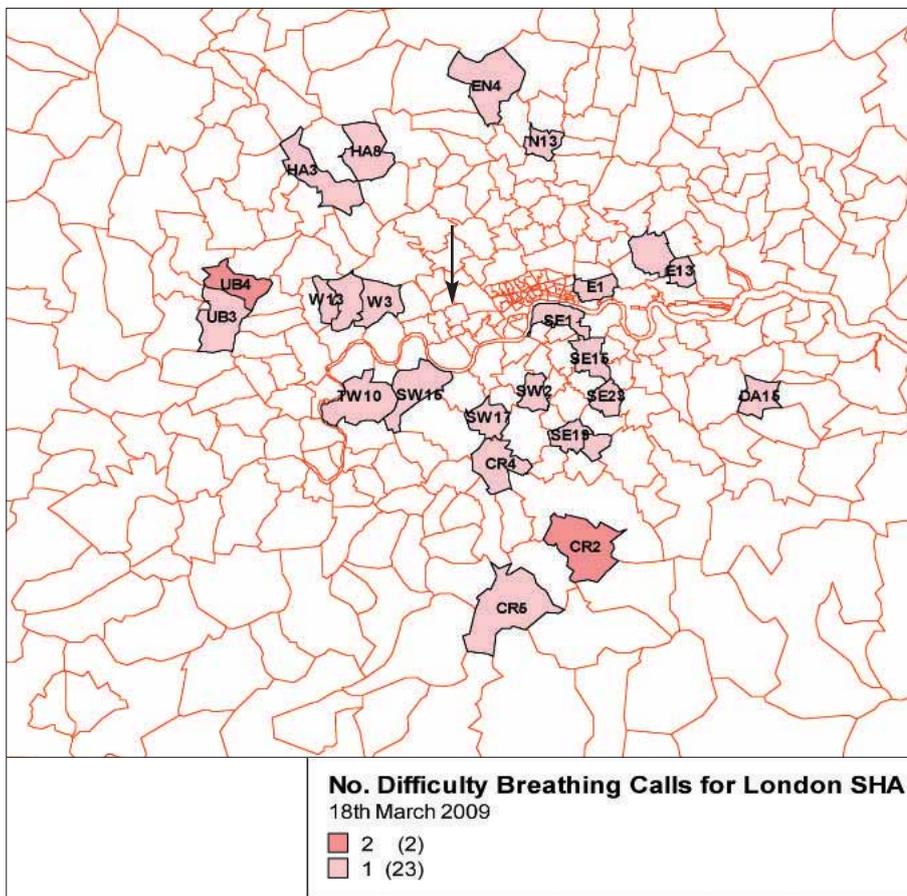


Figure 5: Difficulty breathing calls to NHS Direct in London on 18th March. These calls did not appear to cluster. The maximum number of calls in any postal district was two, in RB4 and CR2 respectively.

### Lessons identified from the incident

- a) Early notification of CHaPD can lead to rapid multi-agency involvement, allowing risk assessment based on environmental monitoring plus syndromic surveillance.
- b) During an incident, there is a need for good, early communication between the HPA and Ambulance both on-scene and at the Ambulance Emergency Operations Centre.
- c) Information can be rapidly generated when needed to allow surveillance of an incident and information communication to local HPUs, PCTs and HART.

- d) Secondary prevention strategies can be made based on this prompt information generated.
- e) Collation of information obtained provided reassurance that there was no increase in the specified symptoms due to the plume generated by the fire.

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# Close Encounters with Aluminium Phosphide in West Yorkshire

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## Introduction

West Yorkshire Health Protection Unit became interested in the possible public health implications of the use of aluminium phosphide as a fumigant as a result of several incidents taking place in the local area. These occurred at a variety of sites and involved the import in shipping containers of various products including:

- car service centre – tyres;
- High Street fashion central depot – clothing;
- DIY store - garden furniture.

As a result of these incidents, concerns were raised locally regarding the lack of knowledge of the chemical, its use as a fumigant, its toxic effects, and how emergency services should respond to this type of chemical incident, particularly hospital Emergency Departments.

This article describes three of the incidents in more detail, summarises the chemical and toxicological properties of aluminium phosphide, and discusses appropriate decontamination and waste disposal in relation to such incidents. The use of aluminium phosphide products in suicide attempts will not be addressed in this review; a previous article in the Chemical Incident Report describes a phosphine suicide case<sup>1</sup>.

## Use of aluminium phosphide as a fumigant

Aluminium phosphide is used as a pesticide / fumigant inside shipping containers, such as those in Figure 1. The process usually involves hanging sachets or impregnated strips inside containers before closure; tablets and pressed plates can also be used.

Shipping containers under fumigation should be labelled “UN 3359” under the International Maritime Dangerous Goods (IMDG) Code. The IMDG Code also requires warning signs on containers, and accompanying documentation describing fumigation method and date<sup>2</sup>. The standard requirements for the warning signs to be displayed are illustrated in Figure 2. Fumigation may occur in transit, with the fumigant chemical put in the container, the container vents sealed and fumigation occurring during the sea voyage. Alternatively, a container may be fumigated in the exporting location, prior to shipment, and then ventilated prior to loading on to a vessel. However fumigant gas may still remain trapped in the cargo and also fumigant residues may not have been removed; therefore these containers still pose a potential risk. Following fumigation, the correct procedure is to remove all surplus fumigant, ventilate the container, conduct monitoring, and when phosphine levels are below the Workplace Exposure Limit (WEL) issue a certificate of clearance<sup>3</sup>. The responsibility for ensuring the requirements of the IMDG Code are met lies with the shipper. Unfortunately shippers may fail to comply with the code and may not declare their containers are under fumigation, resulting in problems such as those detailed below when the containers are opened at the final destination. The Maritime Safety Committee of the International Maritime Organization has issued recommendations on the safe use of pesticides for fumigation of cargo on ships<sup>4</sup> and the Food and Agriculture Organization of the United Nations (FAO) publishes a web-based advice guide on successful fumigation with phosphine using solid metal phosphide preparations<sup>5</sup>.



Figure 1: Shipping containers. (Image courtesy of [www.simoncarruthers.org.uk](http://www.simoncarruthers.org.uk))

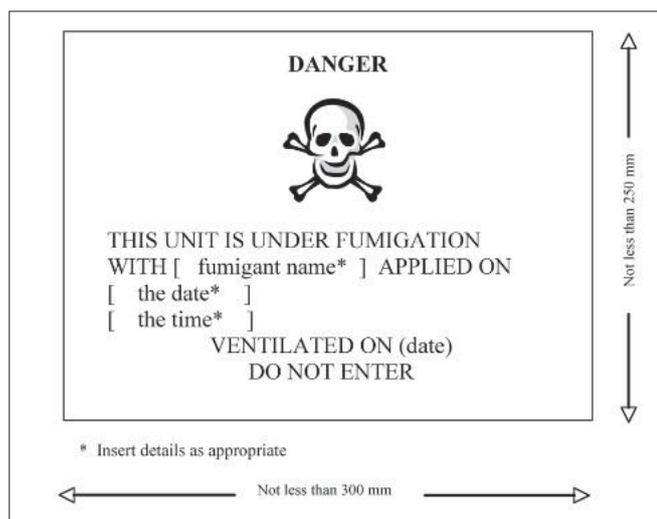


Figure 2: The standard requirements for the warning signs to be displayed on fumigated containers<sup>4</sup>

## Incidents

On the 1 November 2002 in Leeds, eight people self presented to the Emergency Department after exposure to 'Phostoxin', a fumigation material used in a shipping container of clothing from the Far East that was being unloaded at a High Street fashion retailer's distribution depot. The patients were decontaminated and kept under observation for six hours. In this case, a photocopy of the label was presented at the Emergency Department ensuring that accurate chemical identification and subsequent hazard and risk assessment could be conducted. The chemical sachets were also put in plastic bag under a secretary's desk back at the distribution depot pending advice on disposal.

A second incident occurred on 5 March 2007 in Elland, West Yorkshire. A man was exposed to aluminium phosphide at a tyre service centre after entering a container of tyres from China. The patient was taken by ambulance to the Emergency Department who sought advice from the National Poisons Information Service and the HPA on patient decontamination and risks to staff. The asymptomatic patient was decontaminated in a dedicated tent outside the hospital. A sample of the chemical had been taken to the Emergency Department and there were concerns about how to deal with this and also regarding disposal of shower water. There was also a follow up query to the HPA from Local Authority Environmental Health regarding decontamination of the container.

Other incidents have also occurred in recent years in West Yorkshire at DIY stores, relating to shipments of wooden garden furniture. One incident, in August 2002, took place at a large DIY store in Leeds following a delivery of furniture from Vietnam. During the unpacking of the furniture, cardboard tubes, used as protective packing and containing a white powder, were split, possibly exposing 19 people who were in the vicinity. The white powder was identified by the Fire Service as aluminium phosphide. The store was evacuated and those possibly exposed were decontaminated by the Fire Service prior to being sent to the local Emergency Department. No adverse health effects were reported.

To summarise, the methods of identifying that a patient presenting at an Emergency Department may have been exposed to aluminium phosphide from shipping container fumigation are:

- case history – patient describes entering a container prior to experiencing symptoms;
- smell – phosphine gas released from phosphides has a fishy / garlicky odour (see next section for further detail);
- fumigant sample or product packaging / information brought in by patient.

In response to the series of incidents experienced in West Yorkshire, efforts were made to establish local best practice and to instigate prevention work. The local port was contacted to ascertain procedures for identification and removal of fumigants in containers. Advice was also sought from the Health and Safety Executive about uses and procedures regarding the use of aluminium phosphide fumigants and associated health and safety risks.

The need for improvements in the understanding of industry to the response of this type of incident was identified, in particular to ensure that patients are transported by ambulance rather than self-presenting at Emergency Departments. As a HAZMED service is in operation in the West Yorkshire region, paramedics trained in chemical incident response will be able to assess the situation, conduct any necessary on-scene decontamination and liaise with the Health Protection Unit if appropriate, who can obtain specialist support from the Chemical Hazards and Poisons Division.

A previous article in the Chemical Incident Report<sup>6</sup> describes additional incidents resulting from the use of aluminium phosphide as a fumigant.

## Suggested recommendations for decontamination

For patients it is recommended that standard decontamination procedures are followed:

- remove contaminated clothing and double bag;
- brush hair and skin free of any solid residues;
- shower patient and store wash water, pending agreement with water company / Environment Agency over disposal to foul sewer.

To ensure the Emergency Department is not affected, the following precautions are recommended:

- any closed spaces need to be ventilated - phosphine will rapidly dissipate in open air;
- full personal protective equipment (PPE) including respiratory protection is required if solid residue is still present or the patient has ingested a significant amount of solid – there is no risk to hospital staff if the patient has only been exposed to gases;
- any contaminated clothing or samples of fumigant need to be disposed of by a licensed waste contractor (liaise with Local Authority / Environment Agency).

Decontamination of the shipping container may be required if the fumigant is not in packets which can be easily disposed of. The following precautions are recommended:

- entry by workers with gastight suits and breathing apparatus to investigate level of contamination;
- measurement of phosphine gas, e.g. with Dräger tube;
- collect any empty packages and powder residue and ensure appropriate disposal (liaise with Local Authority / Environment Agency);

## Chemistry and toxicology of aluminium phosphide and phosphine

Aluminium phosphide reacts with water vapour to produce the highly toxic gas phosphine. Although pure phosphine is colourless and odourless, impurities may result in a slight fish and / or garlic smell. The equation below describes the formation of phosphine from aluminium phosphide after interaction with water.



The boiling point of phosphine is -88°C, therefore it would be present in a normal atmosphere as a gas. Phosphine is slightly soluble in water, forming a neutral solution.

Close proximity to a source of phosphine is not required to be at risk of toxicity as phosphine gas can travel some distance as it is heavier than air (1.2:1).<sup>7</sup>

Inhaled or ingested aluminium phosphide releases phosphine into the respiratory tract and stomach which is rapidly absorbed and distributed round the body. Phosphine is irritating to the mucous membranes of the nose, mouth, throat and respiratory tract. Exposure to the eyes or skin may cause irritation; however, dermal exposure of phosphine or phosphides is not considered a significant route of exposure.

Phosphine is acutely toxic; the onset of symptoms is rapid following phosphine inhalation or the ingestion / inhalation of metal phosphides. Early symptoms of acute phosphine or phosphide exposure are non-specific and include respiratory problems, cough, headaches, dizziness, numbness, general fatigue and gastrointestinal disturbance (pain, nausea, vomiting and diarrhoea). Effects of exposure to higher levels of phosphine include pulmonary oedema, convulsions, damage to the kidney, liver and heart, and death. Symptoms usually occur within the first few hours of exposure, and most phosphine related deaths occur within 12-24 hours of exposure, usually as a result of cardiovascular damage resulting in collapse, cardiac arrest and heart failure. Deaths after 24 hours are usually as a result of liver or renal failure. Following inhalation exposure, the patient should be moved to fresh air and treated symptomatically and supportively.

In the UK, the Health and Safety Executive provide a Workplace Exposure Limit (WEL) for phosphine. The short term exposure limit (15 minute reference period) is 0.28 mg/m<sup>3</sup> (0.2 ppm), and the long term exposure limit (8 hour time-weighted average) is 0.14 mg/m<sup>3</sup> (0.1 ppm).

For further information on the health effects associated with phosphine exposure refer to the HPA Compendium of Chemical Hazards<sup>8</sup>.

- contain any contaminated wash water and arrange for appropriate disposal (liaise with Environment Agency / water company).

## Unresolved issues

- What actions need to be completed on arrival at a UK port to ensure shipping containers do not pose a risk to health, and who should conduct these?
- Are all containers opened at the destination port and, as containers under fumigation may be unlabelled, are there guidelines which are followed by shipping workers when opening containers?
- If containers are not routinely opened at the destination port, what, if any, guidance is available for the consignee of goods in shipping containers?

## Summary of lessons learned

- Aluminium phosphide is a widely used fumigant on a range of goods for shipping transport.
- The added costs and paperwork may contribute to containers under fumigation not being declared and properly labelled, resulting in unsuspecting staff at the final destination entering containers without taking necessary precautions.
- DO NOT ENTER SHIPPING CONTAINERS without verification that they are safe.
- Toxic effects from phosphine gas are likely to be immediate but may continue over several hours.
- Paramedics and Emergency Department staff attending the original patient(s) may also be affected through phosphine off-gassing - any closed spaces need to be ventilated.
- Decontamination is required if the powdered substance is present but not where exposure is to the phosphine gas only.
- Seek advice from Local Authority / Environment Agency / water company on disposal of aluminium phosphide powder, contaminated clothing, decontamination wash waters, etc.

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# Tears at playtime: An unusual chemical incident with multiple exposures related to an imported slide in a playground

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## Incident Summary

On a Sunday afternoon in March 2009 an ambulance was called to attend two children suffering with streaming eyes and sore throats in a park in Portsmouth. On arrival the ambulance crew started to develop similar symptoms. Ambulance control contacted the other emergency services and sought assistance from the fire service for decontamination of those affected on scene, whilst the police secured the area. At this stage it was noted that once removed from exposure symptoms abated, however the cause of the symptoms remained a mystery.

Over the next few days investigations carried out by the Health Protection Unit (HPU), Police and Local Authority (LA) revealed that the cause of this incident was more than likely associated with the slide in the playground. The slide had recently been imported from Germany and whilst at Calais the border police had filled the play equipment with tear gas as it proved to be a useful hideaway for people wanting to illegally enter the UK. Unfortunately, there was sufficient material remaining on the slide and its packaging to affect those working and playing nearby, and to trigger an in depth investigation of the incident.

## Details of the investigation

In the afternoon of Sunday 8th March 2009 an ambulance crew was

called to attend a park in Portsmouth where two children were suffering with streaming eyes and sore throats. Upon arrival the ambulance staff also started to suffer similar symptoms. Other emergency services arrived on scene and the Fire Service was requested to provide decontamination, and the Police cordoned off the site. The HPU was notified and after establishing that both children and crew had recovered without being admitted to hospital decided to conduct a full investigation to the cause of the incident.

The park is a main thoroughfare in the heart of the city of Portsmouth, a few minutes walk from the civic centre (Figure 1). Some members of Portsmouth City Council became aware of the incident very early on and were naturally concerned about the cause of the symptoms and looking further ahead, when the park could safely be reopened. Pressure was also put upon the HPU from the police who wanted to know when they could stand down their cordon officers. Unfortunately, establishing the facts of the case were slow due to a change of shifts for the emergency services and identifying those that had attended the site on the day of the incident.

A children's adventure play area was under construction within the park (Figure 2) and adjacent to the park a high rise building was also being renovated. Initial information was that no chemicals were stored at the adventure play site. The children (boys aged 13 and 9) had broken through the temporary mesh fence erected around the adventure play area to play in the unfinished park. They had been part of a larger group that sounded the alarm when symptoms started.

As the investigation proceeded, further critical information came to light: two construction staff had been affected with similar symptoms approximately ten days previously.

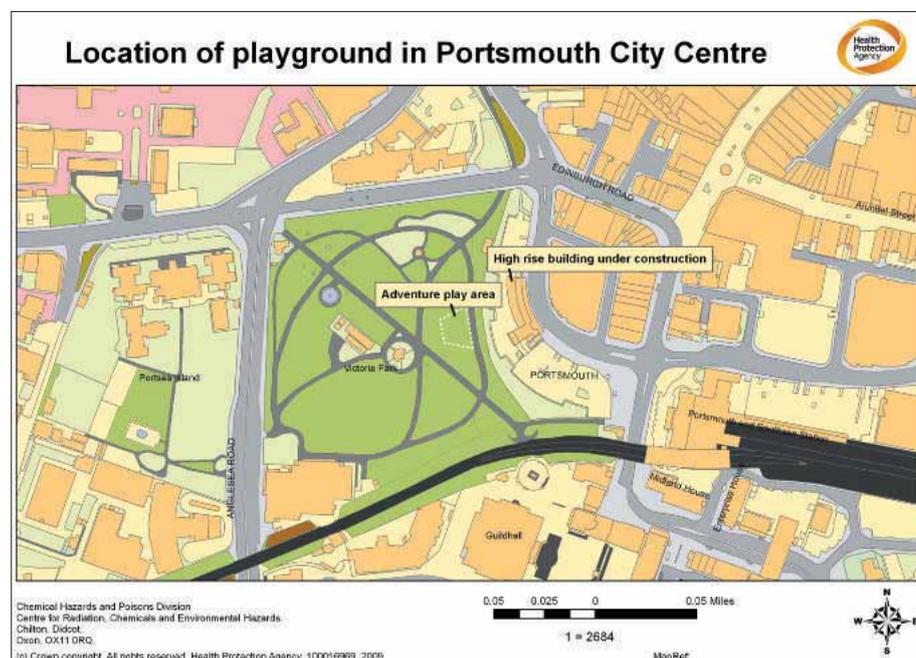


Figure 1: Location of playground in Portsmouth City Centre.

The HPU arranged a site meeting with an Environmental Health Officer (EHO) from Portsmouth City Council, as well as leisure services staff and the adventure park installation contractor. On arrival the area smelled strongly of diesel fumes which were coming from a generator inside a nearby building where construction work was underway. Suspicion that this building was the cause was further heightened by a report from the EHO that a motorcyclist had received medical attention after driving through a cloud of dust blown off the site. At this stage it was still unclear whether the two construction workers previously affected had been working on the adventure play area or the adjacent building. Following consultation with all the agencies involved it emerged that the building site nearby did not involve the use

of any chemicals and so was thought unlikely to be a source. Chemicals were found in the metal lockup for the adventure play site but these were limited to a drum of diesel together with a bottle of chemical labelled in German that was found to be a vegetable based wood preservative. However, Portsmouth has a legacy of land contamination and the prospect of a disturbed canister being the source of the problem was considered. To add to the range of possibilities there was an aviary with exotic birds in the centre of Victoria Park just yards from the children's play area.

A breakthrough in the investigation came from an interview with the play site foreman. Symptoms of burning nose and eyes had occurred when removing a plastic sheet covering a new tubular metal slide and again when moving the slide into position ten days previously. The plastic sheet had lain on the grass for a week before being sent back to the contractor's depot in a van. The operative taking the plastic out of the van also had similar symptoms. The foreman described a fine crystalline powder that had been on the plastic slide covering. The slide had been stored outside but no evidence of white powder could be seen on the ground or equipment on the site.

It was clear from the muddy footprints inside the slide and a toy motorbike discarded on the grass at the bottom of the slide that the children had been playing in that area. Close examination of the slide identified fine white crystals in the weld joints. Though the circumstances suggested something related to the slide was causing the problem, it did not seem to be a likely source of noxious substances. However the architects responsible for planning the play area were present and were asked to check with the German manufacturers whether there could have been some contamination remaining after production. A sample of the crystals was taken for analysis by the EHO.

A risk assessment of the situation suggested the likely source was known, and could be isolated, therefore it was decided to board up the slide and reopen the park the next day. Further action would depend on analysis results from the crystals. Shortly afterwards, Portsmouth City Council staff made contact with the play equipment supplier and were told that the German made slide was transported through Calais. Migrants had cut through the plastic slide wrapping in order to hide inside. Border police filled the slide with CS gas in order to prevent them from going back in. This was a highly plausible explanation for the source of contamination, CS gas being an



Figure 2: Playground under construction, showing new slide.

insoluble solid that can linger for some time on hard surfaces. Decontamination advice on CS gas was obtained from the Chemical Hazards and Poisons Division of the HPA and shared with the play area contractor who washed the slide in copious amounts of water.

The following day Hampshire Fire & Rescue Service tested the crystals with their DIM equipment – identifying a range of inert silicon minerals, indicating this could have been a manufacturing by-product. However some forms of CS spray (see Box 1) are siliconised in order to improve resistance to weathering and therefore might have been detected by the Fire Service equipment.

Satisfied that there was not continuing risk, Portsmouth City Council reopened the park to the public on Tuesday 10th March. They issued a press release about the incident and the story was carried in a local and national paper.

## Conclusions

An excellent working relationship with Portsmouth City Council was quickly established by the local HPA team, and the good communication and trust between the organisations proved essential to a successful resolution of the investigation. Though the analytical results did not confirm the specific hazardous chemical, there was sufficient evidence to suggest that CS was causing the problem.

Obtaining accurate information one day after the incident was delayed due to changes in front line responders which resulted in critical information not being available. At the time of the incident there was enough known to link the white powder, children and the slide but by the next day this information was lost. Expert input in a more timely fashion could have assisted in speeding up the investigation.

Having pre-agreed sampling arrangements would have been beneficial to aid in the risk assessment process. Whilst these exist for biological samples, further work is needed to prepare for future chemical events.

### Key learning points:

- timely notification of relevant HPA and external experts is essential when a chemical agent is suspected to be involved in an incident;
- CS crystals might not degrade in the environment, and can remain active for a long time after deposition;
- chemical contamination can spread between several locations and impact many people if appropriate environmental decontamination is not performed;
- seemingly inert non-hazardous materials can be contaminated with unlikely substances.

### Topics for further consideration:

- it is not known how often tear gas is used in this way to deter stowaways;
- the specific formulation of tear gas used in this case has not been identified;
- decontamination of items treated with tear gas could be considered;
- rapid identification of riot control residues might not be conclusive.

### Acknowledgements

Many thanks to Professor Rob Chilcott (HPA) for background information and references on riot control agents.

## Box 1: Riot control agents<sup>1,2</sup>

Irritant compounds have been used since conflicts began, but modern use probably began at the start of the 20th Century when ethylbromoacetate was used by the French police. Widespread use of irritating agents to control civic disturbances and protests in the 1960's (e.g. in Paris, Northern Ireland and the States) raised their profile and attracted greater public scrutiny and concern about health effects. Following the use of CS aerosols in Northern Ireland the Himsworth committee recommended riot control agents though acceptable to use should be done so with care<sup>3</sup>.

Riot control agents are designed to cause incapacitation without any permanent effects, and are often called irritants, harassing agents or tear gas, which is mis-leading as the active compounds are solid at room temperature. They all produce effects by sensory irritation and cause extreme discomfort or pain. There are three types of riot control agent: lacrimators (target the eye), stentators (sneezing and target upper respiratory tract) and vomiting agents. For most agents the onset of effects is rapid, but relatively brief (15 – 30 min) once removed from exposure. Though designed to incapacitate rather than kill a number of deaths have been putatively associated with exposure to irritating agents under certain conditions such as prolonged exposure and confined environments, and some underlying medical conditions might increase susceptibility to complications.

Riot control agents cause burning and irritation to the eye, skin, nose, mouth and airways; lacrymation, blepharospasm (closing of the eyes), photophobia, erythema (reddening of the skin), sneezing, coughing, chest tightness, mucous secretions, salivation, gagging and vomiting.

One of the most common and earliest agents used is CN (1-chloroacetophenone, Figure 3) which was first synthesised by Graebe in 1871 and is the active agent in Mace<sup>®</sup>. In 1928 Corson and Stoughton first synthesised ortho-chloro-benzylidene malononitrile (CS gas, Figure 4) which replaced CN, due to greater potency and less toxicity. Now CS is the compound most commonly used by military and law enforcement agencies. It is a white crystalline solid that is insoluble in water but does react with water becoming inactive. To improve the environmental persistence of CS, water resistant formulations were developed (CS1 a micronized powder with 5 % silica aerogel, and CS2 a

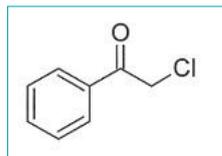


Figure 3: Chemical structure of CN gas (1-chloroacetophenone)

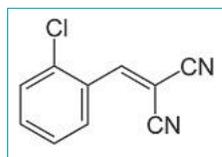


Figure 4: Chemical structure of CS gas (ortho-chloro-benzylidene malononitrile)

siliconised, microencapsulated form of CS1), which can last for several weeks in the environment and are not suitable for use to control civil disturbances.

The use of water to decontaminate can cause a greater burning feeling on the skin, soapy water might be more effective but may also increase symptoms. Rubbing the affected areas should be avoided. CS rapidly hydrolyses in alkaline conditions and therefore a bicarbonate solution will rapidly relieve symptoms. Guidance on the clinical management and health protection of people exposed to riot control agents including CS spray can be found on the Health Protection Agency website<sup>4</sup>.

Some police forces in England and Wales have been issued with personal CS canisters since 1996, which prompted some concerns and a statement by the Committees on Toxicity, Mutagenicity and Carcinogenicity of Chemicals in Food, Consumer Products and the Environment<sup>5</sup>. This report looked at the evidence and effects of CS spray (which includes the solvent methyl isobutyl ketone) and concluded that in general the appropriate use of CS spray did not raise health concerns. However concern was noted that there were no specific investigations or follow-up of exposed individuals and that certain groups might be more susceptible (individuals with bronchial asthma, chronic obstructive pulmonary disease or cardiovascular disease) and therefore further studies were recommended. Further discussion and debate has been published in relation to possible long term health implications of CS spray for example see references<sup>6</sup>.

Detailed descriptions on physical, chemical and toxicological properties of CN, CS and other riot control agents are available from references 1 and 2.

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# Assessing the health risk associated with Compact Fluorescent Light bulbs

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## Introduction

The UK Government announced at the end of 2007 an agreement with retailers and manufacturers to voluntarily phase out the sale of traditional light bulbs by the end of 2011, in favour of Compact Fluorescent Light bulbs (CFLs), or energy-saving light bulbs<sup>1</sup>. In March 2009, mandatory Europe-wide regulations were agreed to replace all incandescent bulbs with energy-efficient alternatives by 2012<sup>2</sup>. In the UK, this move will save an estimated 1.2 million tones of carbon in the UK by 2012<sup>3</sup>, an important step in the fight against climate change.

Although welcomed by many, this changeover has not been embraced by all. CFLs contain small amounts of mercury, a potentially toxic heavy metal, which has led some members of the public and the media to question the health and environmental repercussions of widespread use of CFLs, with headlines such as 'An energy saving bulb has gone - evacuate the room now!' and 'Broken low energy bulbs dangerous, says minister' appearing across the country<sup>4,5</sup>.

Compact fluorescent light bulbs are more robust than incandescent bulbs and breakages are rare. The mercury inside a CFL can only be released when it is broken, but despite reassuring messages and clean-up guidance from government departments, the Health Protection Agency (HPA) and other toxicology and health experts, some members of the public are still concerned. In addition, there seems to be confusion as to the health effects associated with mercury and ultraviolet (UV) radiation from CFLs<sup>5</sup>. In 2008, the Chemical Hazards and Poisons Division (CHaPD) gave advice to worried members of the public in thirteen broken CFL incidents.

In this paper, we provide an overview of the health effects associated with CFLs, including expert opinion on mercury release from broken bulbs, UV radiation and improper disposal.

## Exposure to mercury from CFLs and potential health risk

### Mercury content in CFLs

CFLs contain very small amounts of metallic (elemental) mercury averaging around 4 mg per bulb. The small amount of metallic mercury in CFLs is released as a vapour inside the bulbs and is needed for the bulbs to emit visible light. No mercury vapour is released into the surrounding environment during normal usage, but if the bulbs break, a small amount of mercury vapour may escape into the local environment. While the amount of metallic mercury is very much less than the mercury content of thermometers (typically 500 mg) or

barometers, vapour levels from broken CFLs can still reach detectable quantities in enclosed spaces.

### Toxicology of elemental mercury

This consideration of mercury health risks will focus on the health effects of elemental mercury, which may be released in vapour form from the bulbs. Box 1 summarises the exposure, uptake and health effects of elemental mercury – more detailed information of this and other forms of mercury is available in HPA compendium<sup>6</sup>. The concentrations described in Box 1 are 1,000 to 40,000 times greater than average concentrations likely to be experienced over a day following a CFL breakage, which experimental evidence has shown to be typically up to 0.8 µg/m<sup>3</sup> in the hour following break<sup>11</sup>.

### Box 1: Exposure, uptake and health effects of elemental mercury

#### Behaviour of elemental mercury

- Predominant route of exposure is by inhalation - approximately 80% of mercury vapour is rapidly absorbed<sup>7</sup>.
- Readily passes the blood-brain barrier and the placenta<sup>7</sup>.
- Rapidly distributed to all tissues, accumulates in the kidney, accounting for 50 and 90% of body burden<sup>8</sup>.
- Mercury vapour undergoes oxidation in blood and tissues to mercuric (Hg<sup>2+</sup>), which does not readily diffuse to other tissues<sup>7</sup>.
- Elimination predominantly occurs through the urine and faeces<sup>6</sup>.

#### Health effects of elemental mercury<sup>6</sup>

- Virtually non-toxic if ingested.
- Short-term inhalation of very high levels of mercury vapour causes coughing, breathlessness and chest tightness within a few hours of exposure.
- Long-term inhalation of elemental mercury vapour may cause damage to the central nervous system, the kidneys and oral cavity.
- There is no convincing evidence that elemental mercury (or mercury compounds) can cause cancer in humans.
- In workplaces, mild effects upon central nervous system functioning have been observed at concentrations above 50 µg/m<sup>3</sup>; hand tremors have been observed at concentrations of 100-200 µg/m<sup>3</sup>; serious symptoms of poisoning (chest pains breathing difficulties) arise at 1,000 - 40,000 µg/m<sup>3</sup>.

### Health standards for elemental mercury

Elemental mercury vapour arises in the general environment from a number of man-made activities, including mining of ore containing mercury, industrial processes, coal burning at power stations, manufacture and disposal of products containing mercury such as batteries and electrical switches, and accidental breakages of domestic items such as thermometers.

Mercury levels in outdoor air in Europe have been documented to be up to 0.006  $\mu\text{g}/\text{m}^3$  in remote areas, up to 0.005  $\mu\text{g}/\text{m}^3$  in urban areas, and may be up to 0.020  $\mu\text{g}/\text{m}^3$  in industrial areas. Higher concentrations may be found near industrial hotspots<sup>9</sup>.

There are very little data on background indoor air levels of mercury vapour, and concentrations will depend on availability of mercury sources in homes and other premises, for example the use of vacuum cleaners to clean up thermometer breakages can cause indoor air pollution<sup>9</sup>. However the likely predominant source of mercury vapour exposure for many in the general population is likely to arise from dental amalgam. Various estimates of inhalational exposure from amalgam have been made and these are summarised in a recent UK Environment Agency publication, where a mean estimate of 10  $\mu\text{g}$  mercury/day for adults is made<sup>10</sup>. It should be noted, however, that the use of mercury amalgam is declining as alternative material is used and this kind of exposure is now uncommon in young people.

A number of regulatory bodies have evaluated the implications for human health from these environmental emissions and have set standards for acceptable environmental exposure. These are presented in Table 1.

The range of long term values varies by 20 fold despite the values all being derived from the same occupational evidence of central nervous system effects in exposed workers from several different studies. Reasons for differences include different approaches in time scaling occupational exposures to environmental exposures and to differences in choosing uncertainty factors. The rationale for these differences is discussed in a 2009 UK toxicological collation document for mercury<sup>10</sup>.

### Mercury release from broken CFLs

Theoretically, if a only a fraction of mercury in a CFL (e.g. 1 mg) was to be released as vapour into a moderately sized (10m x 10m x 5m), unventilated room, concentrations of 2  $\mu\text{g}/\text{m}^3$  may be expected, and this may persist for a period of time if remedial action is not taken. This is above acceptable levels for mercury in ambient air (see Table 1), although it should be noted that these relate to average exposures over 24 hours or, in most cases, much longer.

Additionally, a significant amount of research has been conducted on the release of mercury vapour into enclosed spaces following the breakage of CFL bulbs. A particularly extensive piece of work was conducted in the US by the Maine Department of Environmental Protection<sup>11</sup>, which conducted a number of experimental trials involving the breakage of CFL bulbs in a small room. Important points from this study are summarised below.

- Concentrations of mercury vapour after the breakage of a single CFL bulb
  - Mercury concentrations in the unventilated study room air in the range of 0.2-0.8  $\mu\text{g}/\text{m}^3$  were observed during the first hour, before declining to levels around 0.1  $\mu\text{g}/\text{m}^3$  and lower shortly afterwards.
  - Very short excursions over 25  $\mu\text{g}/\text{m}^3$ , and sometimes up to 100  $\mu\text{g}/\text{m}^3$ , were observed in the first few minutes after breakage, but within 15 minutes levels fell to levels of 0.2-0.8  $\mu\text{g}/\text{m}^3$  noted above.
  - A short period of ventilating the room significantly reduced the mercury air concentrations after breakage.

### Significance of exposures from broken CFLs

A health criteria value of 0.2  $\mu\text{g}/\text{m}^3$  in ambient air has been adopted in the UK as a tolerable daily exposure for assessment of environmental health risks from mercury contamination of soil, and this is considered to be an appropriate value to judge the significance of exposures arising from breakages of CFLs<sup>10</sup>. In the recent WHO Concise International Chemical Assessment Document this was considered a tolerable concentration for long term exposure<sup>7</sup>.

Information provided in the Maine study<sup>11</sup> indicates that mercury concentrations in air can be at levels of 0.2-0.8  $\mu\text{g}/\text{m}^3$  for an hour after a bulb has been broken and so can exceed the air quality health criteria value of 0.2  $\mu\text{g}/\text{m}^3$ . However, as shown in the US study, by ventilating rooms and cleaning up debris, these elevated concentrations do not persist for a substantial amount of time and decline rapidly to lower ambient levels well below the 0.2  $\mu\text{g}/\text{m}^3$  level. As such, they do not therefore present an ongoing health risk, as long as action is taken. Rapid and properly conducted clean-up is necessary (as recommended in HPA advice in Box 2) to ensure that there is no continuing long term exposure to elemental mercury vapour, for instance from disturbance of mercury residues on carpeted areas.

While these mercury exposures, when averaged over a long time period, do not indicate any concerns about long term health risks, a question remains whether the very short term exposures, to the peak levels noted, are of any health concern. This is pertinent as it may take some time before clean-up is conducted and before people vacate affected rooms.

Acute Emergency Guideline Levels (AEGLs) for chemical contaminants in air are published by the US Environmental Protection Agency and these are considered to be appropriate values for judging the significance of short term elevated chemical exposures by the general population, including susceptible groups, such as children, the elderly, pregnant women, asthmatics etc. Only recently have values for mercury vapour been proposed<sup>12</sup> and these are shown in Table 2 below.

The proposed AEGLs values, while not yet finalised, are in line with already agreed US Emergency Response Planning Guidelines (EPRG), which are only set for one hour exposures. These identify a concentration of 2000  $\mu\text{g}/\text{m}^3$  for one hour as a level at or above which *"there may be irreversible or other serious long lasting effects or impaired ability to escape"* and a concentration of 4100  $\mu\text{g}/\text{m}^3$  for 1 hour as a level at or above which *"the general population could experience life threatening health effects or death"*<sup>6</sup>. These EPRG values can be considered to be equivalent to the 60 minute AEGL-2 and AEGL-3 values.

The maximum observed concentrations immediately following a CFL breakage in the Maine study<sup>11</sup> exceeded the long term health criteria value, but are an order of magnitude below the 10 minute to 1 hour AEGL-2 values and the 1 hour EPRG values. It is considered that possible short term exposure, even among susceptible groups such as crawling toddlers, would not be sufficient to give rise to concern about health effects. Room ventilation and clean up should however be initiated as soon as possible to minimise the potential for continued longer term release of vapours from mercury trapped in fabrics and floor coverings.

**Table 1: Maximum mercury vapour in air concentrations recommended by national and international regulatory bodies (in descending concentration order)**

AGENCY	Mercury in air ( $\mu\text{g}/\text{m}^3$ )	Basis for standard
WHO Air quality guideline for Europe <sup>9</sup>	1.0 (annual average)	Derived from occupation exposure studies showing low frequency of hand tremor observed in workers at 10-30 $\mu\text{g}/\text{m}^3$ with total uncertainty factor of 20: 10 for human variability and 2 for use of LOAEL*.
USEPA IRS Reference Concentration (RfC) <sup>22</sup>	0.3 (continuous lifetime exposure)	LOAEL of 25 $\mu\text{g}/\text{m}^3$ from occupational exposure studies converted equivalent continuous exposure of 9 $\mu\text{g}/\text{m}^3$ . Total uncertainty factor of 30:3 for deficiencies in data base and 10 for use of LOAEL.
WHO CICAD Tolerable concentration <sup>7</sup>	0.2 (long term exposure)	LOAEL of 20 $\mu\text{g}/\text{m}^3$ for slight but not clinically observable CNS effects in workers, converted to a continuous exposure value of 4.8 $\mu\text{g}/\text{m}^3$ . Total uncertainty factor of 30: 10 for variation of sensitivity in humans. 3 for use of an LOAEL for mild subclinical effects.
ATSDR Minimal Risk Level (MRL) <sup>13</sup>	0.2 (annual average)	Occupational study of CNS effect in workers exposed for 15 years to 26 $\mu\text{g}/\text{m}^3$ converted to continuous exposure of 6.2 $\mu\text{g}/\text{m}^3$ . Total uncertainty factor of 30: 3 for use of LOAEL, 10 for use variation in sensitivity among human population.
Environment Agency UK Inhalation Health Criteria Value <sup>10</sup>	0.2 (tolerable daily intake)	Value recommended after a review of value set by other agencies as the basis for a Health Criteria Value (HCV) for evaluating risk from contaminants in soil
EC Working Group on Mercury <sup>14</sup>	0.05 (annual average)	Occupational studies showing effects of Hg with a starting point for effect at 25 $\mu\text{g}/\text{m}^3$ . Total uncertainty factor of 500: 10 for conversion of occupational exposure to lifetime environmental exposures, 10 to account for individual susceptibility, 5 for use of LOAEL.

\*Lowest Observable Adverse Effect Level

**Table 2: Proposed Acute Emergency Guideline Levels (AEGLs) values mercury vapour<sup>12</sup>**

Proposed AEGLs values for Mercury vapour ( $\mu\text{g}/\text{m}^3$ )					
	10 min	30min	60 min	4hr	8hr
<b>AEGL-1</b>	NR	NR	NR	NR	NR
<b>AEGL-2</b>	3100	2100	1700	670	330
<b>AEGL-3</b>	16000	11000	8900	2200	2200
<b>AEGL-1</b>	The level of the chemical in air at or above which the general population could experience notable discomfort.				
<b>AEGL-2</b>	The level of the chemical in air at or above which there may be irreversible or other serious long lasting effects or impaired ability to escape.				
<b>AEGL-3</b>	The level of the chemical in air at or above which the general population could experience life threatening health effects or death.				

## Conclusions

The available evidence indicates that CFL breakages may give rise to detectable levels of elemental mercury in enclosed spaces, but these levels are not sufficient to be of concern in respect to immediate health risks for very short term exposure, even for susceptible groups such as toddlers and children. However, unless rooms where breakages arise are ventilated and appropriate clean up action taken, mercury vapour levels from residues on fabrics and floor coverings can build up in rooms. Effective cleanup fully eliminates this potential minor health risk.

Mercury vapour exposure from broken CFL bulbs is very low and is

likely to be much lower than exposures that could arise from breakages of other mercury containing items commonly found in homes, such as thermometers and barometers, which contain significantly more mercury. Additionally, exposures from CFLs are very much lower than estimated individual exposures arising from dental amalgam (10 $\mu\text{g}$  mercury/day) (this is equivalent to inhaling 0.5 $\mu\text{g}/\text{m}^3$  over one day making the usual assumptions). The UK Committee on Toxicity (COT), have concluded that there is no evidence to indicate that kidney damage was associated with mercury amalgams in healthy subjects or that the placement or removal of dental amalgam during pregnancy is harmful but in view of the inadequacy of the data, it

would be prudent, where clinically reasonable, to avoid removal or replacement of amalgam fillings during pregnancy<sup>15</sup>.

## Clean up recommendations for broken CFLs and advice to the public

As described previously, effective cleanup is necessary to eliminate any potential risk from exposure to mercury arising from CFL breakages. Guidance on appropriate and effective clean up is available on the HPA website and the key points are reproduced in Box 2.

Likewise similar advice in the form of a step by step guide is available on the HPA website for dealing with other domestic mercury incidents, such as broken thermometers, along with more background information and general advice about mercury spillages. The links are provided below.

### Broken CFLs:

- [http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb\\_C/1207293983993?p=1158313435037](http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1207293983993?p=1158313435037)

### Broken thermometers:

- [http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb\\_C/1195733821650](http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733821650)

### General advice on mercury spillages:

- [http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb\\_C/1195733760448](http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733760448)

## Ultraviolet radiation from CFLs

Exposure to ultraviolet radiation can cause particular problems for people suffering from some medical conditions, including Lupus. The Radiation Protection Division of the HPA published findings in 2008 showing that some CFLs can emit ultraviolet radiation at levels that, under certain conditions of use, can result in exposures higher than guideline levels<sup>16</sup>. This only applies in instances where people use single-envelope bulbs for over an hour within 30cm of their skin, and is not considered a widespread health problem. This issue has been reported in the media however, and is often confused with health effects from mercury<sup>5</sup>.

## Safe disposal of spent and broken bulbs

Both broken and intact spent CFLs should be disposed of as hazardous waste. CFLs are included under the Waste Electrical and Electronic Equipment (WEEE) Regulations, meaning that electronic goods manufacturers and retailers are required by law to finance and provide systems for householders to recycle their products<sup>17</sup>. In the UK, Recolight was set up by the lamp industry to manage this process. Most manufacturers have made agreements with local authorities to provide recycling facilities for CFLs.

Although under WEEE Regulations producers must inform customers of their responsibility to dispose of spent bulbs separately to household waste, there have been complaints that this is not well-known by the general public. There have also been concerns that

disposal systems are either not available or not easily accessible, raising questions about their environmental credentials: "Each time a bulb goes I now need to drive a 30min round trip to the recycling centre – Member of the public"<sup>18</sup>. There are no statistics showing how many CFLs are recycled in the UK, but figures from the US EPA suggest that 98% of CFLs currently go to general household waste, ending up in landfill or incinerators<sup>19</sup>.

### Box 2: How to deal with a broken CFL\*

In the event of an accidental breakage of a lamp, normal good housekeeping is required.

- 1 Take care to prevent injury from broken glass.
- 2 Vacate the room and keep children and pets out of the affected area. Shut off central air conditioning system, if you have one.
- 3 Ventilate the room by opening the windows for at least 15 minutes before clean up.
- 4 Do not use a vacuum cleaner, but clean up using rubber gloves and aim to avoid creating and inhaling airborne dust as much as possible.
- 5 On hard surfaces sweep up all particles and glass fragments with stiff cardboard and place everything, including the cardboard, in a plastic bag. Wipe the area with a damp cloth and then add that to the bag. Household cleaning products should be avoided during clean up despite the very small amount of mercury involved. See the next section for cleaning carpeted surfaces.
- 6 Use sticky tape to pick up small residual CFL pieces or powder from soft furnishings and then add that to the bag.
- 7 On carpeted surfaces, the above clean up procedure should apply, but minus wiping up with a damp cloth and more attention should be paid to residual CFL pieces or powder removal using sticky tapes.
- 8 The plastic bag should be reasonably sturdy and needs to be sealed, but it does not need to be air tight. The sealed plastic bag should be double-bagged to minimise cuts from broken glass.

\*[http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb\\_C/1207293983993?p=1158313435037](http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1207293983993?p=1158313435037)



Figure 1: Intact compact fluorescent light bulb. (Image courtesy of [www.simoncarruthers.org.uk](http://www.simoncarruthers.org.uk))



Figure 2: Broken compact fluorescent light bulb. (Image courtesy of [www.simoncarruthers.org.uk](http://www.simoncarruthers.org.uk))

The mercury from CFLs disposed of through proper recycling facilities can be recovered and re-used. Mercury from CFLs disposed of in other ways could be released to the environment, where it has the potential to damage health and the ecology. Most of the mercury vapour in a CFL, however, becomes bound to the phosphorescent coating of the bulb through its life, and only about 15% is available for release to air or leachate from landfills. Mercury released from CFLs in incinerators could also be released to air, although research has shown that overall, using CFLs reduces mercury air pollution as less fossil fuels – the greatest source of mercury emissions – are burnt for electricity<sup>20</sup>.

It is expected that as recycling schemes become more established, recycling rates of spent CFLs will increase in the UK. In addition, new legislation such as European Union regulations on CFL packaging information, due in on September 2010, should help spread the message on safe disposal of both broken and spent CFLs<sup>21</sup>.

### Lighting the future

Mercury is an essential part of fluorescent lamps. The mercury content has been reduced greatly over time to 4mg today, and new technologies are being developed to produce bulbs with materials that absorb mercury vapour<sup>19</sup>. However the future of energy-efficient lighting looks to be light emitting diodes (LEDs), which use even less energy than CFLs and contain no mercury.

### Conclusions

From the available evidence, there is no threat to public health from the low-level exposure to mercury as could arise from broken CFLs, provided that guidance is followed regarding cleanup of breakages and disposal.

Packaging of CFLs does not currently include clean-up information and it is safe to presume that many of the public do not realise they should be treating these bulbs any differently than the more familiar incandescent bulbs. The number of calls received at CHaPD from members of the public concerned about mercury exposure is not insubstantial, and is often a result of conflicting information available on the internet and sensational media stories. With continuing negative media coverage and increasing public accessibility to less robust sources of advice online, the HPA is likely to continue to receive more calls from concerned members of the public.

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# Lead in drinking water in new housing developments – sources of lead contamination other than lead pipes or solder

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## Introduction

Lead is neurotoxic and chronic exposure in children may lead to cognitive deficit, such as decreased IQ, an effect for which there is considered to be no threshold<sup>1</sup>. Lead exposure has decreased substantially since the 1960s<sup>2</sup> as a result of the use of lead being controlled or banned in sources such as petrol, paint, food, toys and drinking water.

Whilst lead can be found in drinking water as a result of dissolution from natural sources, its primary source in drinking water is from household plumbing systems where the pipes, solder, fittings or service connections contain lead. The use of lead pipes and service connections for drinking water pipes has been phased out since 1970<sup>3</sup>, the use of lead solder has been banned since 1987<sup>4</sup> and the use of lead as an additive in polyvinyl chloride (PVC) drinking water pipes was voluntarily discontinued from 2006 onwards. Brass fittings used in plumbing typically contain about 3% lead (this is added to improve the machining properties of the brass), although this is not generally considered a source of lead in drinking water.

The amount of lead dissolved from water pipes and fittings depends on a number of factors including the levels of chloride, dissolved oxygen, pH, temperature and water hardness and whether the lead is coupled to copper, which results in lead corroding more rapidly through galvanic corrosion. Water usage also has a major influence on lead concentrations with usage patterns having a direct effect on the contact time of water with the plumbing system and, subsequently, the time available for contamination to take place<sup>5-7</sup>.

Legislative measures have been in place for some time to limit the concentration of lead in drinking water. For example, The Water Supply (Water Quality) Regulations 2001 set a permitted concentration value (PCV) of 25 µg/l of lead in drinking water and this will be reduced to 10 µg/l in 2013. However, a number of incidents of high lead concentrations in drinking water in newly developed properties in Scotland and North Wales have recently been identified as a result of the illegal use of lead

**Table 1: Median lead in drinking water concentrations in properties in new housing developments in Torfaen, South Wales**

Sampling location	Median (range) lead in drinking water concentrations (µg/l)	
	Unoccupied properties (n=20)	Occupied properties (n=16)
Kitchen cold tap	2.6 (1.0–35.0)	0.5 (<0.5–1.6)
Bathroom cold tap	5.6 (1.7–112.0)	1.3 (<0.5–15.0)
Bathroom hot tap	13.5 (2.4–315.0)	0.7 (<0.5–17.0)

solder in pipe joints<sup>8,9</sup>. Following these incidents, the Chief Medical Officer and Chief Environmental Health Adviser for Wales requested additional data concerning high levels of lead in drinking water supplies to assess the scale and complexity of the problem<sup>10</sup>. As a result a study of lead in drinking water in housing developments in Torfaen, South Wales was undertaken to help assess whether high levels of lead in drinking water was a wider problem in new housing developments in Wales and identify potential sources of contamination.

## Methodology

Thirty-three properties were selected from recently completed housing developments in Torfaen, South Wales. Sampling was carried out in early 2008 in two phases, the first phase sampled in 20 recently completed but still vacant properties and the second phase sampled in 16 properties which had been completed and occupied within the last 12 months (three of which had been sampled during the first phase whilst unoccupied). First draw samples were taken from the kitchen cold tap, the bathroom hot tap and the bathroom cold tap. Samples were analysed for lead at a United Kingdom Accreditation Service (UKAS) laboratory using inductively coupled plasma mass spectrometry. In addition to this, investigations were carried out to test for the presence of lead in solder and brass joints using a colourmetric chemical indicator test (Plumbtesmo<sup>®</sup> swabs) and laboratory analysis of a sample of solder.

## Results

The results of the analysis of the drinking water samples are presented in Table 1 and Figures 1 and 2.

Of the samples from the unoccupied properties, 15 (25%) exceeded the PCV of 25 µg/l and 20 (33%) exceeded 10 µg/l (the PCV due to come into force in 2013). In occupied properties, no samples exceeded the PCV of 25 µg/l and only four samples exceeded 10 µg/l. Re-sampling of the three previously unoccupied properties which were now occupied found substantially lower concentrations of lead in drinking water with none of these samples exceeding the 25 µg/l PCV; whereas all three properties had returned samples that exceeded the 25 µg/l PCV when unoccupied.

Results of the sampling showed that in 15 of the 20 unoccupied properties (75%) the kitchen cold supply returned the lowest concentration levels and that in 14 of the 20 properties (70%) the highest concentration was found in the bathroom hot supply. This suggests that water temperature may conceivably influence higher lead concentrations, together with contact time.

Colourmetric testing was carried out at plot 8, which had returned particularly high levels of lead in the water. The brass joints and fittings all tested positive for the presence of lead (n=3, Figure 3) but the solder joints (n=13) all tested negative. Subsequent laboratory analysis of a solder sample from one of these joints indicated the lead content of the solder to be <0.05%.

## Discussion

High levels of lead in drinking water were found in unoccupied properties in new housing developments in Torfaen, South Wales. Communication with Dwr Cymru confirmed that lead pipes are not in use in the mains water or connection pipes leading up to the developments<sup>11</sup>. Additionally, site developers reported that solder used in drinking water pipe connections complied with the relevant regulatory standards; this was confirmed by the use of colourmetric testing of solder joints and the laboratory analysis of a sample of solder. Colourmetric testing of brass joints and fittings was positive, suggesting that brass joints may be a source of lead in drinking water.

Levels of lead in drinking water in occupied properties were lower than those in unoccupied properties, suggesting that water usage patterns influence levels of lead in drinking water in newly developed properties. This is consistent with other research looking at lead levels in drinking water and usage patterns<sup>5,6,12</sup>. As a result, it is hypothesised that stagnation of the water in the plumbing system linked with galvanic corrosion of lead from brass joints resulted in high levels of lead in drinking water in unoccupied newly built houses. However, further research would be beneficial to better understand the potential contribution from corrosion of brass fittings to lead levels in drinking water.

The results suggest that occupants of newly developed properties may be exposed to high levels of lead in drinking water if the property was previously unoccupied, and that the lead levels will decline as water usage in the property increases. Whilst the public health significance of this exposure is likely to be minimal, brass fittings should be considered as a potential source of lead exposure when interpreting the results of drinking water analyses in newly developed unoccupied properties.

The Water Regulations Advisory Scheme recommend that plumbing systems which aren't going to be used are drained down after their final pressure test, although this isn't regularly complied with. As a precautionary measure, it is suggested that developers are encouraged to drain plumbing systems once tested and that new occupants are encouraged to flush the plumbing system before use to minimise unnecessary exposure to potentially high levels of lead in drinking water.

## Conclusion

High levels of lead in drinking water may occur as the result of the corrosion of lead from brass fittings and the stagnation of drinking water in the plumbing system. Whilst the public health significance of this is likely to be minimal, lead from brass fittings should be considered a potential source of contamination when interpreting drinking water analyses of

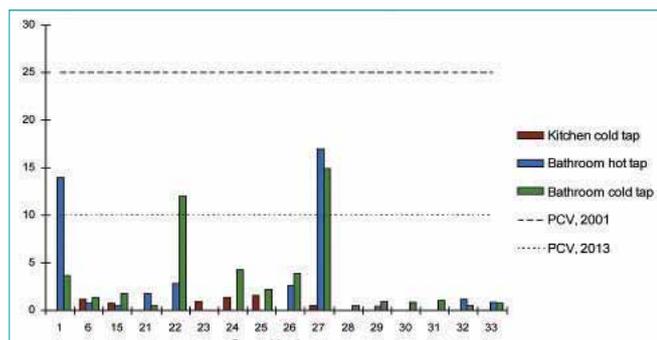


Figure 1: Lead concentrations in drinking water in recently completed, unoccupied properties in a new housing development, Torfaen, South Wales

samples from newly built, unoccupied properties and also from older properties which have been subjected to extended periods of stagnation. Occupants of newly built properties and those of older properties which are subjected to extended periods of stagnation should be



Figure 3: Colourmetric testing (Plumbtesmo® swabs) of brass fittings and joints (the purple colour indicates the presence of lead)

encouraged to flush the plumbing system before use to minimise unnecessary exposure to high levels of lead in drinking water. Further research would be helpful to better understand the potential contribution from brass fittings to lead levels in drinking water.

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## Acknowledgements

We gratefully acknowledge Torfaen County Borough Council for funding this testing programme. We also acknowledge the support of Alexander Capleton, Health Protection Agency, for his assistance in preparing this article.

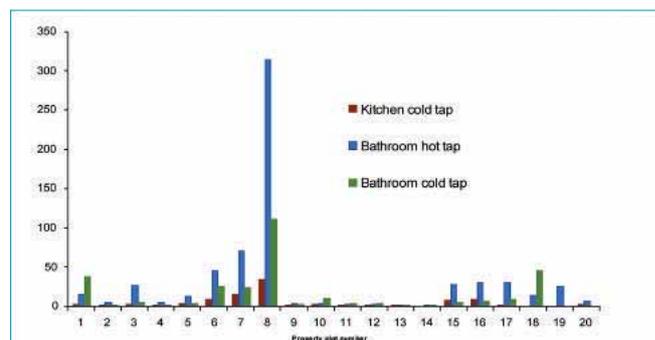


Figure 2: Lead concentrations in drinking water in recently completed, occupied properties in a new housing development, Torfaen, South Wales

# Emergency Planning and Preparedness

## Operation Torch 2008: multi-agency, multi-national mass fatality simulation exercise

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### Background

Operation Torch was a multi-agency, multi-national mass fatality simulation exercise hosted in the UK and staged at Crystal Palace National Athletics Stadium, London, in October 2008. It was funded by the European Commission through the European Civil Protection simulation programme. The University of Leicester Forensic Pathology Unit organised the exercise in collaboration with European colleagues and, from the UK, representatives from the Cabinet Office, Metropolitan Police Service, UK Disaster Victim Identification, Department of Health, Health Protection Agency (HPA), Defence Science and Technology Laboratory, National Policing Improvement Agency, London Fire Brigade, and the London Ambulance Service and their Hazardous Area Response Team (HART). Internationally, Operation Torch worked closely with European Disaster Victim Identification teams from Germany and the Netherlands and, for the first time on the UK mainland, provided an opportunity for two EU members' state police forces to be integrated into UK hot zone working teams.

### Exercise

The exercise was extensively planned and prepared and included a wide range of challenging elements designed to convey the potential seriousness and difficulty of any such response to a mass fatality incident.



Photograph 1: Model of fragmented contaminated casualty foot (© East Midlands Forensic Pathology Unit, University of Leicester)

The scenario was based upon a terrorist attack using an improvised explosive device which also incorporated the release of a lethal nerve agent. This allowed for the inclusion of fragmented contaminated casualties from the explosive effects (Photograph 1), contaminated casualties from the effects of the nerve agent, and non-contaminated casualties from a panic stampede. The exercise provided a chance to expose responding agencies to a near realistic scenario run in near real time over three days (Photograph 2). In addition it allowed for the contaminated temporary mortuary footprint to be trialled and adjusted in a realistic and confined setting, such as may be encountered following a CBRN event in a City Centre (Photograph 3). Thus it tested three response functions:

- command structure
- communications
- arena of operation.

In particular the site command and control tent and HART medical treatment extraction assessed:

- conventional body recovery using conventional mortuary and Disaster Victim Identification systems
- contaminated body recovery to a contaminated mortuary complex with body reception and storage, bag wash area, mobile computed tomography radiology, counter terrorist mortuary identification tent (Disaster Victim Identification), non-suspect identification tent and a safe undressing process.

The HPA's role was to contribute to the exercise planning. HPA supported the live play by providing scientific and health advice at Gold command (Photograph 4). The HPA also participated in Gold's Science and Technology Advisory Cell (STAC)<sup>1</sup> as required, and used the HPA's CBRN Incidents: A Guide to Clinical Management and Health Protection<sup>2</sup> as one of their sources of advice. Many HPA staff took the opportunity to visit the exercise scene as observers to see the systems and processes involved in managing fatalities and to understand how their advice might be called upon in a real event.

Operation Torch attracted in excess of 607 participants (observers, evaluators and players). It attracted visitors from 16 of the 27 member countries of the EU as well as visitors from Scandinavia, Australia, Singapore, and the USA. This was thus a groundbreaking international exercise.

Recommendations included:

- the need for further multi-agency, multi-national CBRN exercises to facilitate international exchange of ideas and knowledge
- the development of a standardised framework for sharing of information from such exercises and the lessons identified
- that large multi-agency exercises should include a Science and Technology Advisory Cell (STAC)<sup>1</sup>
- that health and safety issues for all staff involved in crisis response should be further considered.

## Conclusions

Lessons learned from this exercise may assist member states of European Community in considering their own planning for similar incidents.

A full report will be published in due course.



Photograph 2: Body retrieval process for non-contaminated fatality (© East Midlands Forensic Pathology Unit, University of Leicester)



Photograph 3: Part of contaminated mortuary complex with body storage (© East Midlands Forensic Pathology Unit, University of Leicester)



Photograph 4: 'Gold' at work (© East Midlands Forensic Pathology Unit, University of Leicester)

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# Exercise Orpheus II, 16 July 2008: Hospital Emergency Departments

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## Introduction

The Orpheus II exercise was part of the programme of multi-agency exercises, being delivered by the Health Protection Agency ERD, commissioned and funded by the Department of Health (DH). This programme includes an annual field exercise.

Orpheus II followed on from the scenario in Orpheus I on 05 March 2008<sup>1</sup>, which exercised the rescue of injured casualties from a crashed coach in the presence of a nerve agent (Sarin), their subsequent decontamination and transfer to hospital Emergency Departments. The exercise included other casualties who left the scene before decontamination and made their own way to the hospital.

## The scenario

Orpheus II took place on 16 July 2008 at a hospital in the South East. It was designed to test the management of contaminated casualties and worried well arriving at the emergency department (ED) of a large regional hospital.

Specifically at the hospital level the exercise was designed to investigate a number of operational and tactical level responses, including:

- crowd management
- patient welfare (before and after decontamination)
- clinical management (before and after decontamination)
- decontamination
- securing and controlling the site
- managing the controlled entry into the Emergency Department of patients not involved in the incident as well as casualties after decontamination.

The exercise involved all the emergency services and ran over a number of hours. Casualties with both major physical and toxic injury were managed as well as a considerable number of walking wounded and worried well. Many useful lessons were learned both in controlling the flow of casualties and maintaining strict triage and in the inevitable bottlenecks that occur when decontamination is required.

Staff from the emergency department of the hospital involved followed their own major incident plans and used their own protective suits stored in the department. Providing essential medical care while wearing the suits proved difficult as did communications between the ED control and the outlying

reception station for walking wounded and worried well. The exercise confirmed a requirement for CBRN (Chemical Biological Radiological Nuclear) training for ED staff. This has been addressed subsequently with the CHaPD-London CBRN pilot training course which was held at the Homerton Hospital earlier this year<sup>2</sup>. Specifically Orpheus II helped to identify the key competencies that are required by ED personnel in various posts.

## Conclusions

The disruption caused to an ED following a chemical release may be considerable and has major consequences for the continuation of normal daily activity. Orpheus II showed that it is possible to continue the activity of an ED in parallel with the management of a major chemical incident. Further exercises of this type will help to build the confidence of all emergency medical staff in managing what we must hope will remain an unusual situation.



**Figure 1: Exercise Control (EXCON) based at a sports centre. Centre also served as a holding area for casualties, who were deployed into the exercise in accordance with the Exercise Master Events List to add pressure to the hospital teams.**



**Figure 2: Casualty in moulage (makeup) in preparation for deployment to the exercise, to reflect realism.**



Figure 3: Cordon at hospital entrance.



Figure 6: Hospital decontamination.



Figure 4: Police cordon at hospital.



Figure 7: Casualties being decontaminated.



Figure 5: Casualty at the police cordon.



Figure 8: Model of a baby being treated at the hospital as part of the exercise.

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# “Training the Frontline” - the CBRNE Pilot Course for Emergency Department staff: March 2009, Homerton Hospital

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(On behalf of the CBRNE Emergency Departments Training Course Committee –

Virginia Murray (CHaPD HPA), Andy Wapling (NHS London), Simon Clarke (ED Consultant Frimley Park Hospital), John Simpson (ERD HPA), Nick Castle (Nurse Consultant Frimley Park Hospital), Trevor Marks (ERD HPA), Debbie Reed (ERD HPA), Chris Perry (DH), Steven Bland (ED Consultant RN/Portsmouth), John Black (ED Consultant Oxford), Russ Mansford (DH)).

## Introduction

In light of previous terrorist activity, and with the Olympics fast approaching, there is increasing interest in helping our frontline health services to be prepared and capable of dealing with a Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) event. Jointly organised by the Department of Health (DH), NHS London, and CHaPD (Chemical Hazards and Poisons Division) London of the Health Protection Agency (HPA), a new 2 day CBRNE training course for Emergency Department staff was piloted at Homerton Hospital, East London, in March 2009. This hospital is designated as the primary receiving unit for the 2012 Olympics. Each of the two days was divided between lectures in the morning and practical skill stations in the afternoon. A wide variety of topics was delivered by expert speakers, each of whom had considerable experience and knowledge in their respective fields. The pilot course was intended to assess not only the content, but also to determine what could be taught in the future by e-learning. We also needed to identify if there were any key areas necessary for an effective CBRNE response that the course did not cover. Twenty enthusiastic medical, nursing, and administrative emergency department staff voluntarily took part and provided feedback to help shape the course for the future.

## Topics covered

The content of the course was developed from work done by a previous Emergency Medicine Specialist Registrar (SpR), seconded to CHaPD, on CBRNE competencies required by different levels of staff in the Emergency Department<sup>1</sup>. The topics covered included:

### Lecture format

- CBRNE background
- clinical leadership and hospital response
- generic incident management
- management of the patient

- chemical hazards and incidents and specific chemical agent management
- biological hazards and incidents and specific biological agent management
- explosive/blast incidents and management
- mass psychogenic aspects.



Figure 1: Demonstration of putting on personal protective equipment (C Heggie)

### Practical skills stations

- correct use of personal protective equipment (PPE), communication skills and basic patient examination in PPE
- advanced life support skills in PPE
- triage scenarios
- toxidrome recognition
- tabletop exercise – preparing the Emergency Department for a CBRNE incident
- Ram Gene Radiation monitors
- obtaining information/sources of information.



Figure 2: Staff in personal protective equipment (PPE) suits (C Heggie)

## Methods of Evaluation

Each participant completed a pre and post course “best of five” question paper made up from a bank of questions submitted by each lecturer and reflecting their particular topic. This was designed to test each participant’s baseline knowledge prior to the course and note any improvement after the two days. Each day all participants were asked to fill in a detailed evaluation of each lecture and skill station, and also provide any generic comments about anything they found particularly good, or indeed anything they felt could be improved upon. These evaluations proved invaluable in developing the next stages of the course.

## Learning Points

### Pre-Course Learning

The HPA document “CBRN incidents: clinical management and health protection”<sup>2</sup>, available online, was identified as the course pre-reading. This information was disseminated to candidates too near to the course however, leaving them little time for any pre-course reading. This is an important factor when teaching CBRNE as candidates would likely feel more confident and comfortable having some prior knowledge, and it is a topic usually poorly represented in teaching curriculums.

### Lectures

The lectures attempted to cover a large number of training objectives and the feeling was that there were too many for the length of the course. There should also be more coordination between presentations by different lecturers as there was a certain amount of duplication. This is both unnecessary and tiring for participants. Overall however, participants reported that a fascinating range of topics had been covered, all of which were evaluated as useful, highly relevant, and of excellent quality.

### Multiple choice questionnaires (MCQs)

The majority of participants (85%) improved their score on the pre and post course MCQs, showing an improvement in knowledge over the two days. The MCQs were written by those delivering the lectures but it was felt that they did not closely match the content of the lectures, an area which requires improvement.

### Evaluation and assessment

A basic assessment of knowledge gain was provided by the MCQ element. There was however no assessment of clinical skills. Various difficulties arise when considering this point, e.g. what is the best way to assess competency for these skills; how to do it when the course includes such a wide ranging participant skill set; etc. This is one point being considered before the next pilot course.

### Teamwork

Emergency Departments rely heavily on teamwork, many examples of which were seen during the two days. Crucially this course was open to everybody in the department. Delegates included reception staff who may be the first point of contact for people presenting from a CBRNE incident, senior clinicians, and charge nurses who will treat the casualties whilst keeping themselves and the department safe. It is vitally important that future pilots continue to include this range of Emergency Department staff.

### Interagency links

One possibly unexpected very positive outcome from the course was the chance to advertise the HPA and the assistance it can provide to Emergency Departments. Delegates commented on the general lack of

awareness in EDs of what the HPA does and how it can help. A specific session on sources of information proved to be extremely well received.



**Figure 3: Attempting intubation in personal protective equipment (PPE)**  
(C Heggie)

## Conclusions

A CBRNE incident although rare, has the potential to be hugely disruptive to a modern Emergency Department. In current times, EDs are becoming exponentially busier. The centralisation of certain services such as Trauma and Stroke will undoubtedly increase these pressures. The potential closure of such a department due to a CBRNE incident would have huge implications on the continued provision of the requisite level of care. Understandably, issues such as CBRNE are often hidden amongst the plethora of targets that Emergency Departments are already bound to achieve. There is renewed interest in helping our Emergency Departments to be CBRNE prepared and confident that they have the skills to deal safely with such an event.

The CBRNE course fills the gap in training for Emergency Departments. It was well received and thoroughly enjoyed by participants and organisers alike. In simple terms it allowed the staff in the ED to take their day to day skills into the CBRNE environment, and identify the issues which evolve out of working in this unusual situation. *“(It was) really useful to try on the PPE suit and workout the limitations of wearing it”.*

The next steps in taking the course forward are to plan another two pilots to help fine tune the content and delivery as well as the assessment element over the two days. An afternoon workshop has already been held involving the course organisers which has identified the next steps to be taken and which hospitals should be involved. The course must be made more sustainable, with consideration given to the different ways of disseminating the information and eventually rolling the course out to departments in other regions across the NHS.

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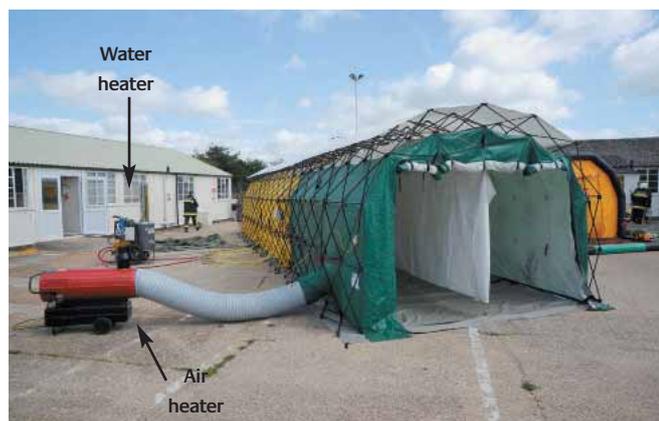
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# An Overview of the Health Protection Agency's Research and Development Programme on Decontamination

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## Introduction

The Health Protection Agency (HPA) plays an important role in preparing for incidents involving the deliberate release of hazardous substances and provides advice and practical resources to the emergency services and central Government during counter-terrorist operations. In order to maintain a contemporaneous and pertinent knowledge base on which to facilitate this important function, the Agency maintains an active portfolio of relevant research and development, one example of which is the current CBRN<sup>1</sup> decontamination programme.



**Figure 1: Standard UK mass casualty decontamination unit. This picture shows a view of the re-robe (green) chamber, which is supplied with heated air. The rear (yellow) chamber contains the shower units, which are supplied with heated water at a constant flow rate.**

The deliberate (or accidental) release of toxic materials may potentially result in exposure of a number of individuals. Fortunately, decontamination offers a relatively simple and generic means of mitigating the effects of a wide range of materials, be they biological, chemical or radiological in nature. In order to achieve this, the UK has specialist decontamination units which can be deployed to incidents at short notice. These units comprise showers through which large numbers of casualties can be processed (Figure 1). Whilst this response will undoubtedly be of benefit, the materials and protocols employed in such units require optimisation to ensure that maximum benefit can be realised under a variety of operating conditions. However, in certain cases simple washing may not be sufficient or practical. For example, some casualties may have contaminated, haemorrhaging wounds. Alternatively, others may be contaminated to such an extent that more urgent methods of cleansing need to be available. Furthermore, there are many questions which need to be addressed. For example, how long after exposure is decontamination of clinical relevance and what protective effects are afforded by normal clothing? The purpose of the current HPA Research & Development

decontamination programme is to examine a range of such issues and identify improved or new protocols where applicable.

The programme is divided into three main projects, each of which focuses on specific aspects of decontamination.

### 1. ORCHIS<sup>2</sup>

This project was conducted following recommendations arising from a previous study conducted by the HPA's Emergency Response Division (Centre for Emergency Preparedness and Response), which identified the need to develop an evidence-based approach to the further development and optimisation of UK mass casualty decontamination protocols. Specifically, the aim of the project was to further optimise current mass casualty decontamination procedures for adults and children through a randomised, controlled trial to test three empirical strategies, viz., provision of washing instructions, wash cloth and an extended showering time.



**Figure 2: Representative image of a volunteer prior to decontamination. "Contaminated" areas are indicated by red spots. Discs surrounding the volunteer are calibration standards and the white strips are for spatial calibration.**



**Figure 3: Mobile image analysis unit (converted horse box) used for performing whole body, fluorescent imaging.**



**Figure 4:** *In vitro* skin system used for assessing effectiveness of decontamination protocols. This image shows 18 “diffusion cells” each of which contains a section of skin sandwiched between two chambers. The skin surface is exposed in the upper chamber to a chemical contaminant. In this case, the upper chamber is a custom designed “shower unit” which provides a more realistic evaluation of mass decontamination procedures. Each shower unit is supplied by water which is heated to a specific temperature via an insulated copper tube (seen at the top of the picture connected to the back row of diffusion cells) at a set flow rate. The tubing from the lower part of the shower unit is directed into vials to collect the “dirty” shower water for subsequent chemical analysis. The lower chamber is filled with an appropriate fluid (such as buffered saline) and is analysed at regular intervals to enable a calculation of the rate at which the chemical contaminant has penetrated the skin. Each lower chamber is surrounded by a glass jacket through which heated water is circulated via a manifold to ensure that the skin surface is maintained at a constant temperature.

The effects of each treatment were quantified using novel methodology based on whole body fluorescent imaging (Figure 2) and involved 90 volunteers. Essentially, each volunteer was “contaminated” with an innocuous chemical which, while invisible under normal light conditions, fluoresced brightly when illuminated by an array of ultraviolet (UV) lights within a specially converted horse box (Figure 3). Digital images of each volunteer were acquired before and after decontamination. The difference in fluorescence measured between the images was quantified by image analysis and used to provide a direct measure of the efficacy of each treatment regime. One outcome of this study was the recommendation that a cloth flannel be provided to individuals prior to entering the decontamination shower. This simple, but effective strategy clearly indicates the value of performing controlled volunteer trials for optimising existing decontamination procedures.

## 2. ORCHIDS

There are two main elements to the ORCHIDS<sup>3</sup> project. The first seeks to evaluate and optimise the current mass casualty decontamination procedures of several European Union member states. The second will investigate the effects of disrobing, the protective effects/off-gassing characteristics of civilian clothing and novel methods for conducting immediate decontamination within an incident hot zone.

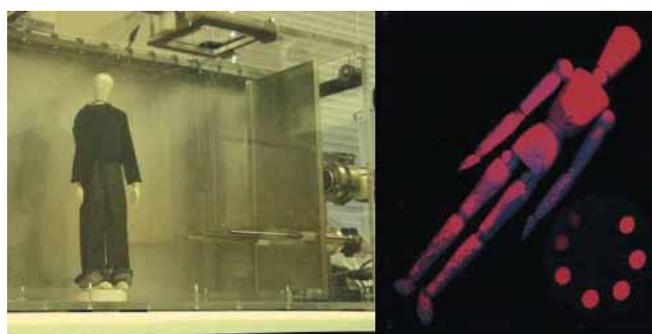
A variety of experimental techniques are required to fulfil the objectives of the ORCHIDS projects. The use of *in vitro* methods (Figure 4) allows for skin samples to be exposed to actual chemical warfare agents such as soman (GD), mustard gas (HD) and VX as well as simulants (less toxic surrogates) such as methylsalicylate and fluorescent particles prior to decontamination. Importantly, it is currently planned to use simulants in future volunteer trials and so an

understanding of how simulants behave in comparison with toxic chemicals will be critical to the interpretation of such studies. A mannequin exposure system has also been developed to investigate the effects of disrobing and off-gassing (Figure 5) and preliminary results have confirmed that, under certain conditions, disrobing is a highly effective and simple means of reducing exposure to hazardous materials. Further work is required to validate the mannequin model.

## 3. Clot and Clean

Perhaps one of the least understood aspects of decontamination arises from the initial management of contaminated, haemorrhaging wounds. There is currently no specific medical countermeasure available for the initial treatment of wounds compromised by the ingress of toxic chemicals and only very limited information on the toxicokinetics of substances via contamination of wounds. Existing skin decontamination systems are generally unsuitable for wound decontamination. Thus, there may be a delay between exposure of internal tissues to toxic

chemicals and the onset of wound decontamination protocols at a medical facility. While this may not be critical for some chemicals, wounds contaminated with fast acting materials may prove rapidly fatal. It is also important to consider that intoxication arising from chemical contamination of wound tissue will occur concomitantly with the physiological effects of physical trauma, viz., extensive and rapid blood loss (haemorrhage). The “clot and clean” project aims to assess the efficacy of commercial-off-the-shelf (“COTS”) products to simultaneously achieve haemostasis (stop blood loss) and neutralise toxic contaminants in wounds. Work to date has demonstrated that a number of products retain haemostatic function in the presence of toxic substances and can effectively sequester a range of chemical warfare agents both from the skin surface and within damaged tissue.



**Figure 5:** Mannequin exposure system. Image on left shows position of clothed mannequin within exposure chamber. The right-hand image (taken under UV illumination in the absence of visible light) demonstrates how contamination can be visualised on an unclothed mannequin using a red fluorescent tracer. The red circles in the bottom right hand corner are calibration standards which enable quantification of the amount of fluorophore to be calculated during image analysis.

## Collaborations

The work described above requires substantial effort, appropriate facilities and expertise across a range of disciplines. Effective collaboration is, therefore, key to the successful delivery of this programme of work and the Chemical Hazards and Poisons Division (CHaPD) is currently working with a number of partners. Within the HPA, we work intimately with the Emergency Response Department (ERD, now part of Local and Regional Services) at the Centre for Emergency Preparedness Response, Porton Down. Indeed, a large proportion of current research funding has been acquired through joint CHaPD/ERD bids. The staff at ERD have extensive experience of exercises and field trials and so provide invaluable support in the preparation and conduct of volunteer studies. In particular, the Behavioural Science Research Team provides a range of complementary skills which provide a fascinating insight into the psychological aspects of mass casualty decontamination. Outside the Agency, we work in close collaboration with the Defence, Science and Technology Laboratory (Dstl), which provides high containment facilities and access to highly trained staff who assist with the laboratory work. This relationship is of mutual benefit, as many aspects of civilian decontamination are directly relevant to the needs of the military. We also work in close partnership with other military establishments such as the United States Army Medical Research Institute of Chemical Defence (USAMRICD, based at Aberdeen Proving Ground, USA) Centre de Recherches du Service de Santé des Armées (CRSSA, Grenoble, France) and the Faculty of Military Health Sciences (FMHS, Hradec Králové, Czech Republic). As much of our work is based on the development of novel techniques or materials, we also have close collaboration with a number of academic institutes such as the University of Surrey, University of Birmingham and Cranfield University.

## Summary

Whilst decontamination may appear to be a relatively simple matter of showering under soap and warm water, there are many questions which remain to be answered and procedures which may benefit from rigorous scientific evaluation and optimisation. Hopefully, the programme outlined above will address these issues.

## Acknowledgements

The work described herein is supported by financial contributions from the Department of Health, European Union, US Department of Defense, UK Ministry of Defence and the Home Office.

## Acronyms

- 1 **CBRN**: acronym for **C**hemical, **B**iological, **R**adiological and **N**uclear; a term generally used to categorise materials which may cause adverse health effects following malicious release into the environment.
- 2 **ORCHIS**: acronym for “**O**ptimisation, through **R**esearch, of **C**hemical **I**ncident **S**howering”.
- 3 **ORCHIDS**: acronym representing “**O**ptimisation, through **R**esearch, of **C**hemical **I**ncident **D**econtamination **S**ystems”.

# Development of a guidance pack for primary care on managing self-presenters after a chemical incident

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## Introduction

Lessons learnt from past incidents have demonstrated the need to raise awareness of chemical incident management in primary care. General Practitioners (GPs) and their staff may be called upon to manage patients who have been exposed to chemicals at any time. However, because these situations do not arise very often, little specific experience and guidance may be available in the primary care setting.

The risk of a chemical incident occurring is difficult to quantify. In 2005, the Health Protection Agency (HPA) recorded more than 1,000 chemical incidents in England and Wales where there was a risk to public health, but there may be considerable under-reporting<sup>1,2</sup>, and this figure does not include many workplace accidents. The diversity of the incidents reported to the HPA also illustrates the wide range of substances that are likely to be released (Figure 1). Although small-scale accidental incidents are more common, the recent history of terrorist attacks worldwide and in the UK shows that the threat of large-scale chemical incidents or the deliberate release of a chemical cannot be ignored<sup>3</sup>.

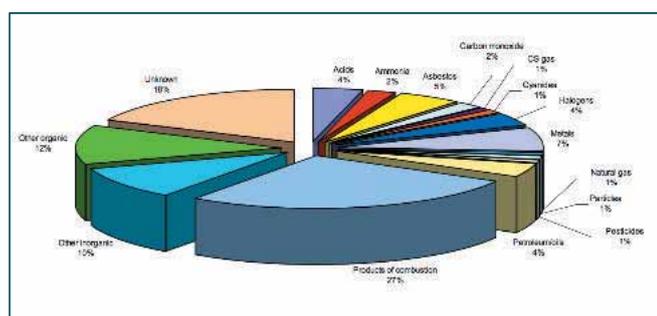


Figure 1: Types of incidents reported to Chemical Hazards and Poisons Division in England and Wales, 2005 <sup>1</sup>

Furthermore, past experience demonstrates that the response to a chemical incident may involve not only emergency responders, but primary care staff as well. The study of the London bombings in 2007 and especially the sarin attack in the Tokyo subway in 1995<sup>4,5</sup>, as well as table-top exercises\* illustrate how individuals and health services behave in the aftermath of a sudden incident where chemicals are involved or potentially involved<sup>6</sup>. Even when a chemical incident is well managed on-site by first responders, people may leave the scene

without coming into contact with emergency services and present at primary care centres as well as hospital Emergency Departments<sup>7,8</sup>.

Many such 'self-presenters' are likely to be 'worried well', but some may also have been exposed to chemicals and pose a risk of spreading contamination to staff and members of the public. Early intervention improves patient care and helps protect staff and the public. A guidance pack was therefore developed to provide practical information about managing patients from a chemical incident who self-present at a community health facility. The pack is primarily aimed at clinical staff from primary care centres such as general practice surgeries, walk in centres and minor injuries units. It aims to help primary care staff respond to any type of chemical release. The development and draft of this pack are presented here.

## Development of the guidance pack

The present guidance pack follows on from earlier work by Yung and colleagues who reviewed the evidence and lessons learnt about the management of chemical incidents in the community, particularly following the Tokyo sarin incident<sup>6</sup>. The authors highlighted the main issues that need to be taken into consideration and summarised the evidence that should direct guidance. Their draft framework for providing guidelines forms the basis for the present pack.

The pack also draws upon Health Protection Agency, Royal College of General Practitioners and British Medical Association examples of best practice and guidelines for incident management<sup>9,10,11</sup>.

The development of the guidance pack was an iterative and consultative process. A first draft was written in consultation with primary care clinicians, toxicologists, chemical incident specialists and emergency planning officers, including the authors. It consisted of background information about chemical incidents, operational fact sheets and scenario-based action cards. Three scenarios were created: Managing patients from a potential chemical incident without forewarning; Forewarning of a potential chemical incident; Deliberate release of a chemical.

A training workshop was organised with Wandsworth Primary Care Trust in London to pilot the draft pack. Participants included GPs, nurses, practice managers, healthcare assistants and managers from the local GP surgeries and walk-in centres, as well as primary care managers from the Trust. The objectives of the pilot workshop were:

- to improve participants' ability to safely manage patients who may have been exposed to chemicals and design their own incident response plan;
- to gain feedback on the guidance pack.

The workshop was well-received and lively. Participants reported learning valuable information and also provided the authors with

Figure 2: Action Card for managing patients from a chemical incident (Source: CHaPD(L), 2009; available from chemicals.london@hpa.org.uk)

<b>Action card</b>	
<b>Managing patients from a potential chemical incident</b>	
<b>RECOGNISE the nature of the situation</b>	
<ul style="list-style-type: none"> <li>• Recognise a potential chemical incident: <a href="#">[see Fact sheet A]</a> <ul style="list-style-type: none"> <li>• Unusual presentation or story</li> <li>• Patient tells you they were exposed to a chemical</li> <li>• Explosion, fire, leak, spill</li> <li>• Patient's clinical symptoms are unusual</li> <li>• Corroborating news on local or national media</li> <li>• Cascaded information from local Primary Care Trust/Health Board or Health Protection Team</li> </ul> </li> </ul>	
<b>MANAGE as an incident</b>	
<ul style="list-style-type: none"> <li>• Escalate the incident to senior clinician or practice manager</li> <li>• Implement your incident management protocol</li> </ul>	
<b>LIMIT THE SPREAD of contamination</b>	
<ul style="list-style-type: none"> <li>• Keep the 'potentially contaminated' patients in a pre-designated 'dirty' area to prevent secondary contamination of 'regular' patients and staff <a href="#">[see Fact sheet B]</a></li> <li>• Prevent vapours from spreading to other parts of the building: close doors, switch off air conditioning</li> <li>• Explain to patients and staff what you are doing and why</li> </ul>	
<b>MINIMISE EXPOSURE and risk to staff</b>	
<ul style="list-style-type: none"> <li>• Ensure all staff are aware of risk of secondary contamination</li> <li>• Avoid direct contact with potentially contaminated patients</li> <li>• Follow protocol to protect staff from exposure <a href="#">[see Fact sheet C]</a></li> </ul>	
<b>CARE OF THE PATIENT</b>	
<ul style="list-style-type: none"> <li>• Take a history of the exposure: likelihood of exposure, type of hazard, susceptibility of the patient, risk of secondary contamination <a href="#">[see Fact sheet A]</a></li> <li>• Plan how to manage different patients:           <ul style="list-style-type: none"> <li>→ 'Worried well' sent home with follow-up advice and emergency contact number</li> <li>→ Managing the seriously ill patient may involve measures to limit the spread of contamination and communicating this to ambulance/hospital staff</li> </ul> </li> </ul>	
<b>COMMUNICATE</b> <a href="#">[see Fact sheet D]</a>	
<ul style="list-style-type: none"> <li>• Contact your local Health Protection Team and Primary Care Trust/Health Board:           <ul style="list-style-type: none"> <li>→ For further information and guidance</li> <li>→ To report on the situation within your health centre</li> </ul> </li> <li>• Plan how you communicate the situation to your patients:           <ul style="list-style-type: none"> <li>→ Early and consistent messages may help your patients understand and reduce possible frustration at having their consultation delayed/cancelled</li> <li>→ Consider that 'regular' patients and staff may have concerns about their own family and getting home</li> </ul> </li> </ul>	
<b>MAINTAIN SERVICE CONTINUITY</b>	
<ul style="list-style-type: none"> <li>• Consider service continuity plans with your Primary Care Trust/Health Board:           <ul style="list-style-type: none"> <li>→ Can normal services continue? Where to refer patients of cancelling surgeries or 'locking-down' the premises?</li> <li>→ Refer to your Service Continuity Plan</li> </ul> </li> <li>• Sign-post new arrangements for patients (Sign on the door; Telephone messages)</li> <li>• Start planning long-term service continuity:           <ul style="list-style-type: none"> <li>→ Plan with your Primary Care Trust/Health Board to take into account what is happening to other local providers</li> <li>→ Functioning primary care is important to manage minor symptomatic patients and worried well, take load off hospitals that may already be dealing with heavy casualties, provide routine care and screening</li> <li>→ Plan the return to normal service</li> </ul> </li> </ul>	

much constructive feedback on how to improve the pack. In particular, the three scenarios were found to be confusing and a single generic action card was thought to be more useful. On the other hand, it was felt that the operational fact sheets should be developed further.

The guidance pack was then redrafted to take the feedback into account and a revised version was produced in consultation with all authors. The revised draft, which is presented here, is now ready for wider consultation within the Health Protection Agency and other national bodies.

## Description of the guidance pack

The 16-page long pack consists of a background information section, one action card, five operational fact sheets and a list of useful contact information.

The introduction and background information explains how the pack came about and summarises evidence and guidance on self-presenters' behaviour, secondary contamination and decontamination.

The Action Card provides a rapid overview of the steps required for effective management of patients who may have been exposed to a chemical (Figure 2). It aims to summarise good practice in responding to a generic chemical incident but has been tailored to the needs and specific context of a primary care setting.

The Fact Sheets provide further detail about specific aspects of chemical incident management:

- **Fact Sheet A:** How to recognise a chemical incident and take a history of patients' exposure
- **Fact Sheet B:** How to limit the spread of contamination
- **Fact Sheet C:** How to minimise exposure to staff
- **Fact Sheet D:** How to communicate effectively with other services and with the public
- **Fact Sheet E:** How to prepare for the eventuality of a chemical incident

We added an 'Emergency Hotbox' page which lists useful national phone numbers and information, including how to access TOXBASE and contact the National Poisons Information Service (NPIS) and the Chemical Hazards and Poisons Division (CHaPD) of the HPA for advice. The 'Hotbox' also has space for health centres to enter local information and site specific information.

## Conclusion and next steps

The project has been well-received by all the professionals that were consulted. The guidance pack appears to respond to a real need in primary care. It has been developed taking into account the expertise and views of primary care and specialist staff.

We now aim to share the draft guidance pack for consultation with other health protection and emergency planning divisions within the Health Protection Agency.

We also aim to present it to the Royal College of General Practitioners and the British Medical Association for advice on how best to

implement it for training of primary care clinicians. There has been some interest in adapting the guidance pack to the specific needs of other settings and other categories of staff, such as community pharmacies and specialist hospitals without an Emergency Department. For more information or to obtain a copy of the draft pack, please contact CHaPD-London on chemicals.london@hpa.org.uk.

\* 'Exercise Tamino', hosted by NHS London Emergency Planning simulated a terrorist release of sulphur mustard gas and involved primary and secondary care. 'Exercise Orpheus' hosted at the John Radcliffe hospital in Oxford by the Health Protection Agency on behalf of the Department of Health, tested the response of hospital and ambulance services, as well as a GP-led primary care centre, to a simulated deliberate release of sarin gas.

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## Acknowledgements

We gratefully acknowledge the constructive feedback we received from all participants to the pilot training workshop in Wandsworth on 20 January 2009, as well as from Dr Simon Clarke, Emergency Medicine Consultant; Prof David Baker, Medical Toxicology Consultant; Dr Simon Brown, GP; Dr Lisa Page, Psychiatrist; and Catherine Keshishian, Environmental Public Health Scientist.

# Environmental Science and Toxicology

## Direct delivery of predicted air pollution information to people with respiratory illness: an evaluation

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### Introduction

The prevalence and health burden of chronic obstructive pulmonary disease (COPD) is predicted to increase in the coming decade and will likely be the third leading cause of mortality in the world by 2020.<sup>1</sup> Asthma affects approximately 300 million people worldwide and an additional 100 million cases are predicted by 2025. Within the UK and Republic of Ireland, asthma exacerbations account for 75,000 hospital admissions and 1,300 deaths annually.<sup>2,3</sup>

Previous studies have shown that air pollution, particularly nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>10</sub>) may cause exacerbation of symptoms.<sup>4,5,6</sup> Recent research, however, has demonstrated that such pollutants can actually initiate the onset of asthma.<sup>7,8</sup>

A number of studies have shown that there is a lack of awareness amongst the non-scientific community concerning the linkage between air pollution and ill health.<sup>9-11</sup> It has been suggested that individuals with such illnesses are unsure of where to find air quality information and furthermore do not understand what it actually means for their health.<sup>12,13</sup> There is also the issue of whether air quality information is accessible and comprehensible.<sup>14</sup>

Consequently, there is a need to deliver air quality information to respiratory vulnerable population groups (generally the young and the over 50s) in a way which is easy to understand, simple to operate, and can be related to health.

### Air quality issues in London

Within London there are significant air quality issues. All London boroughs have stated that they will not achieve the UK NO<sub>2</sub> air quality standards for the protection of human health by the stated deadline. Furthermore, 28 councils have stated they will not meet the air quality standards for particulate matter less than 10 microns (PM<sub>10</sub>). 75% of councils have declared their entire borough an air quality management area. Consequently, air pollution and its effects on human health is of considerable concern within the London area.

The airTEXT service was set up in 2007 to cover all of London by the London Borough Councils following a two year trial of the service in Croydon (the largest London

borough by population). The aim of airTEXT was to allow the direct delivery of predicted air pollution warnings to people with respiratory or cardiovascular illnesses who live or work in London.

Messages are sent by email, text message (to people's mobile phones), or as a voice message to landline phones. Alerts are free and are only sent out when it is predicted that the next day air pollution levels would exceed the Department of Health's (DoH) 'moderate' banding. Alerts are not sent out when air pollution is predicted to be 'low' to avoid message fatigue. People are provided, either electronically or by post, with a copy of DoH health advice relating to each air pollution band (see Table 1).

Five thousand people signed up to the system as of March 2009. They registered by post or online and selected the location they wanted to receive alerts for. Alerts are issued geographically by London borough although more detailed information on a street by street basis is available via the airTEXT website.<sup>15</sup>

### airTEXT Operation

airTEXT predictions for the next-day air quality are undertaken by Cambridge Environmental Research Consultants (CERC). Predictions for the regional long-range transportation of air pollution are calculated using the French CHIMERE and PREVAIR models. This data is then combined with next day meteorological forecasts and provides the input data for the ADMS-Urban model produced by CERC. Emission data from approximately 30,000 emission sources across London is also fed into the model.

Once ADMS-Urban has generated its daily air quality predictions on a street by street level, the results are compared to the DoH air quality bandings and the decision taken to send out an air quality alert at either the moderate, high or very high level (see Figure 1). The information is also displayed on the airTEXT website (see Figure 2).

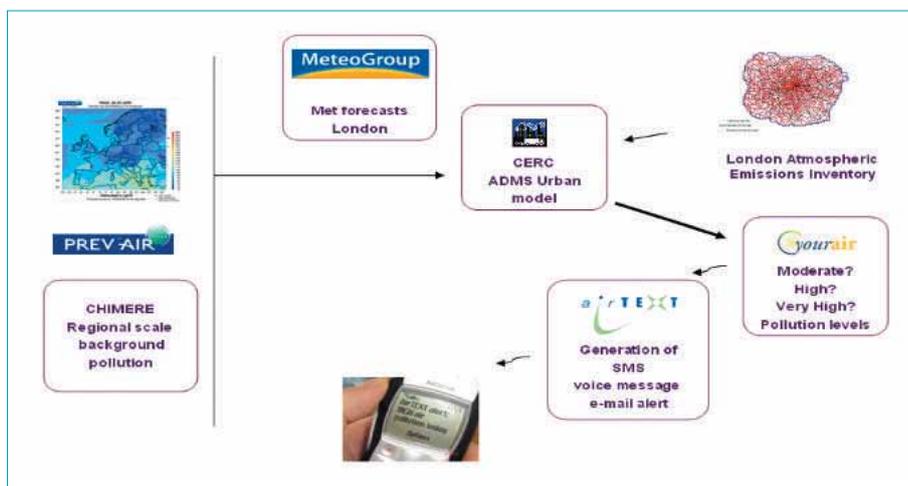


Figure 1: Predictive air quality forecasts for airTEXT alert generation.

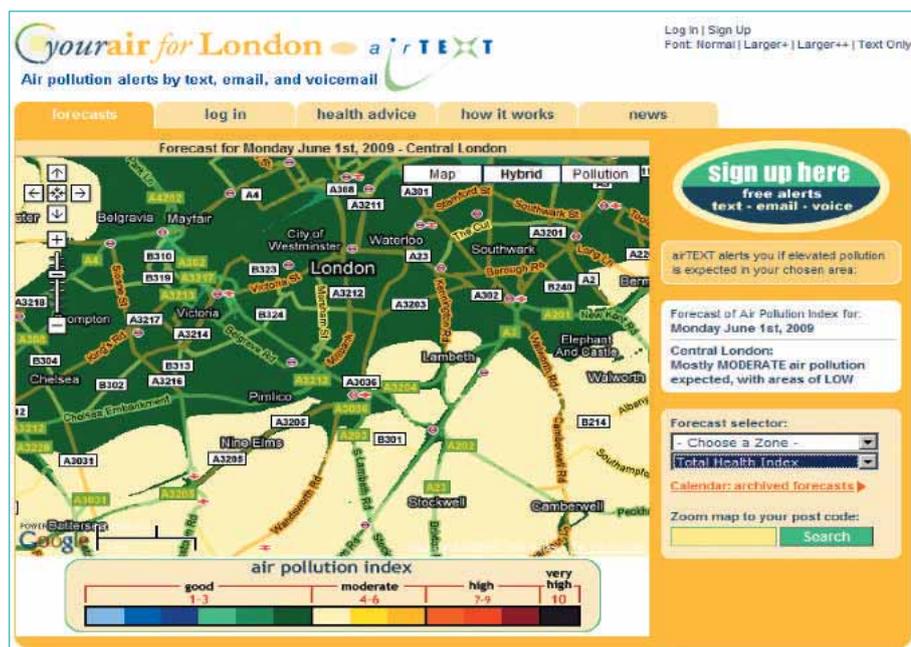


Figure 2: airTEXT website showing street-level predictions of all pollutants for the 1st June 2009.

Forecasts are area specific, and relate to local authority boundaries. An example message for 'very high' air pollution would be as follows:

*'VERY HIGH air pollution TOMORROW. Consider reducing exposure: spend less time outdoors and take reliever medication. If unwell contact your GP.'*

### airTEXT Evaluation

In order to assess the usefulness of airTEXT in reducing the health burden and increasing awareness of air pollution and its links with health, a programme of research was undertaken.

Focus groups were held in a range of locations targeting those with respiratory (asthma and COPD) illnesses. The majority of participants had COPD, were retired, and had classified their disease as moderate. Only one focus group had no airTEXT users, the remaining contained a mix of both airTEXT users and non-users. Of the airTEXT users, 45% received their message by mobile phone while 55% received airTEXT alerts via their home phone (landline).

Results indicated that participants are aware of, and affected by, a range of environmental triggers (see Figure 3). Unsurprisingly, airTEXT

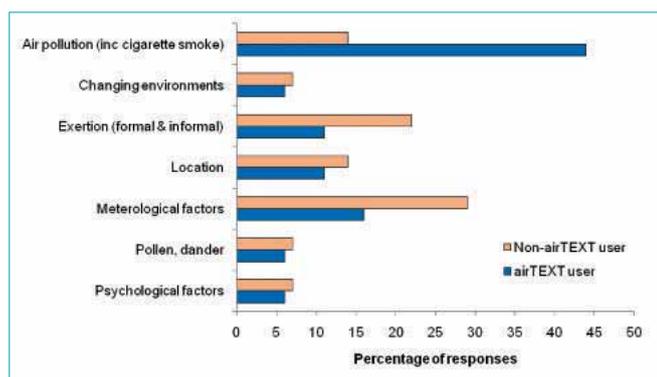


Figure 3: Environmental trigger factors

users were more aware of the link between their symptoms and air pollution compared to non-airTEXT users. Participants also identified triggers such as changing location and/or environments, which were not widely reported in the literature.

Similarly, knowledge of self-management methods was higher in the airTEXT user group. Both groups mentioned using exercise and medication as a way of managing their symptoms; however, airTEXT users were more proactive in identifying self-management techniques. It may be that airTEXT encourages participants to take more responsibility for their own health; however more research is required to investigate this issue further. Interestingly, neither group were aware of the existence of personal health management (action) plans. Again this finding is concurrent with current literature.<sup>12</sup>

Registration for the airTEXT service was considered easy or very easy by all airTEXT users. In terms of airTEXT operation, the timing and message content was satisfactory. Suggestions for improvement consisted of: targeting younger groups (children); providing messages in other languages; and extending the geographical area over which the scheme operates. The barriers to participation in airTEXT result from a lack of awareness or understanding of the relationship between air pollution and health rather than any operational problems.

Overall, the scheme has been widely welcomed and is seen as a useful tool in the management of participants' conditions.

*"I think it's [airTEXT] wonderful, it's precise, it's short but it's right to the point and you know exactly what you're going to expect"* (Hammersmith & Fulham, Female, Carer).

### Conclusion

Evaluation of the airTEXT service is at a preliminary stage and the issues raised in this paper will be further explored in the next phase of the research project, the results of which will be due out in spring 2010. However, the initial research has suggested that airTEXT allows greater:

- preparedness
- prevention
- empowerment.

Subscribers have a better understanding of the relationship between environmental triggers and their symptoms and are therefore more prepared and better able to plan activities. The messages remind people to take their preventative medication with them, reduce their exertion and/or avoid polluted areas on days with a pollution alert, therefore potentially reducing the number of acute exacerbations occurring and thus decreasing the financial burden on the NHS. Finally, users of the airTEXT service have reported that they feel empowered by the messages to take control of their illness, and thus

Table 1: Health advice for airTEXT participants by air quality bandings.

Health Band	NO <sub>2</sub> µg/m <sup>3</sup> (1 hr mean)	PM <sub>10</sub> µg/m <sup>3</sup> (Grav) (24 hr running mean)	Health Effects	Action
Moderate	287-572	50-75	You may notice mild health effects. You are unlikely to need to take any action but be aware of your symptoms. Take reliever medication with you as a precaution	You are unlikely to need to take any action but be aware of symptoms. Take reliever medication with you as a precaution. Talk to your doctor if you have concerns
High	573-763	75-100	You may notice significant effects such as wheezing or more difficulty in breathing or chest pains if you have a heart condition	Keep reliever medication with you as a precaution. You may need to increase dose of reliever medication – BUT NEVER EXCEED THE STATED DOSE. Consider reducing exposure by spending less time outdoors. Try to avoid strenuous outdoor activity. Talk to your doctor if you have concerns
Very High	< 764	< 100	You may notice a worsening of breathing difficulties or chest pains if you have a heart condition	Keep reliever medication with you. Increase dose of reliever medication if you are affected – NEVER EXCEED THE STATED DOSE. Avoid long periods outdoors. Avoid strenuous outdoor activity. Talk to your doctor if you have concerns

reducing the embarrassment they feel at suffering from symptoms in public. This in turn may allow them to participate more in community activities and improve their quality of life.

#### Acknowledgements

The author wishes to acknowledge that the views expressed in this paper are her own and do not represent those of the London Boroughs or the NHS. She would also like to thank Stephen Potter (London Borough of Croydon) and all on the London Air Quality Consortium for providing the opportunity to conduct this research.

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# A pilot costing study of carbon monoxide poisonings in London

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## Background

Carbon monoxide (CO) is a clear, odourless, poisonous gas which is produced by the incomplete combustion of carbon based fuels. In the UK, CO poisoning resulted in 8 deaths and over 200 non-fatal cases during the year of 2006/07<sup>1</sup>. The response to these incidents must be rapid to protect public health, which requires effective inter-agency communication<sup>2</sup>. A CO action card has been developed by the Health Protection Agency (HPA) to assist public health practitioners in the management of these incidents, and sets out roles and responsibilities of the respective agencies involved in a CO incident response<sup>3</sup>.

Although the health effects of CO poisoning are established, the economic burden which it creates has never been considered or evaluated. In a system where resources are limited, one must use economic analysis to identify, measure, and value costs to aid the decision making process. Fordham<sup>4</sup> has previously highlighted the importance of economic assessment as a tool for better decision making and efficient allocation of resources when addressing responses and strategies aimed at CO poisoning.

Costing studies are frequently used in health economics to identify and measure the total resources associated with a particular disease/intervention and, where appropriate, to express these in monetary and non-monetary terms. They provide useful information that can be used as the first step towards a full economic assessment of the costs and benefits of management options. Such options could include both preventive and interventional approaches to CO poisoning.

## Methods

We performed an observational cost of illness study which was intended to identify resource consumption and estimate costs relating to CO incidents that occurred in the London area between the 1st August 2007 and 30th June 2008.

The concept of costing has three elements<sup>5</sup>:

- identification of resource involvement;
- measurement of resources used;
- valuation of unit costs.

The scope of this particular costing was from a government and individual victim perspective (including private costs to individuals or their families etc).

## Data collection

Incidents were identified using the Chemical Hazards and Poisons Division (CHaPD) Surveillance System for Chemical Incidents. This enabled the identification of all reported CO incidents, confirmed and suspected, within London. It is thought that most suspected incidents are true incidents; however the presence of CO has not been confirmed either via environmental or biological sampling. It is also recognised that the number of CO incidents reported to CHaPD is an underestimation of the true number of incidents.

Data were collected in terms of quantity of resource used during individual incidents. Where individualised data extraction did not permit, assumptions based on expert opinion were made as to the likely resources used. Information with regards to individual agency involvement was also collected and recorded.



**Figure 1: Locations of carbon monoxide incidents reported to CHaPD London between 1st August 2007 – 30th June 2008 (where geographic data available)**

## Assignment of unit cost

A unit cost is the financial value of the expenditure incurred in producing a unit of a good or service at current levels of production. In theory, these can be average or marginal costs depending on the perspective taken, but marginal costs are more difficult to capture. In this study, unit costs (£ Sterling) were obtained from Unit Costs of Health and Social Care 2006<sup>6</sup>, for example, hospital emergency department admission = £110. Where the unit costs were unavailable, expert opinion was sought to estimate the likely cost of a particular resource. In order to cost an agency response (not including the emergency services which are included elsewhere), experts from each agency were consulted and gave estimates for the usual average time taken to log and respond to CO incidents. This was then multiplied by an average hourly rate of the professionals responding, using data available from the Office for National Statistics<sup>7</sup>. In an attempt to cost evacuations, average evacuation duration was estimated from available data and multiplied by an average hourly wage per evacuee.

## Costs

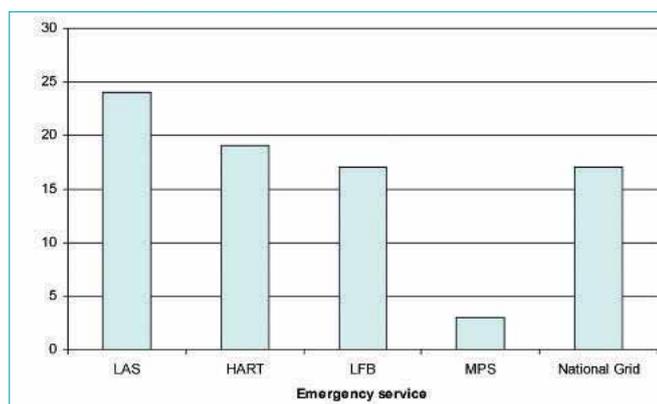
The analysis of costs was carried out from the perspective of the UK government. We calculated the cost by multiplying the resources consumed per incident by their unit costs. A total cost was then established for all 27 incidents that had occurred. Average (mean) costs per incident and per patient were then calculated. No discounting for future cost impact was used owing to the eleven month time frame of the study.

Patterns of resource consumption were then analysed and cost scenarios for specific incident types were created. These may be of great benefit in planning expenditure and budgets for front line staff, but also in future economic studies of alternative options for cost-effective strategies.

## Results

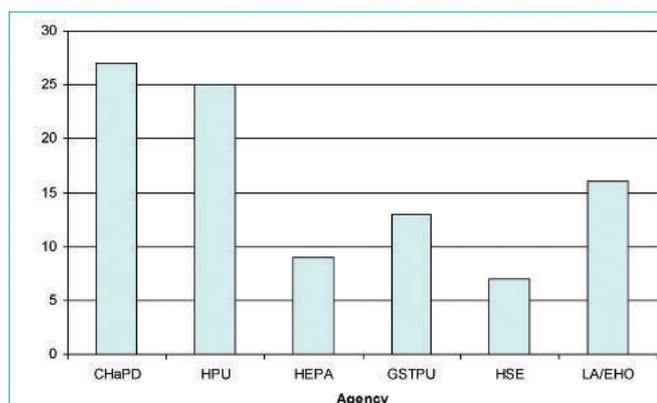
### Resources used

In total, 27 incidents were reported to CHaPD London within the London region between the dates of August 2007 to June 2008, of which 17 were confirmed CO poisonings. One incident was excluded from analysis due to inadequate data. The locations of the 26 reported CO incidents have been mapped in Figure 1. Interestingly, it was observed that most incidents occurred in areas of high social deprivation as measured by Townsend score at ward level.



**Figure 2: Reported emergency service attendance at carbon monoxide incidents, London 1st August 2007 – 30th June 2008.**

LAS: London Ambulance Service; HART: Hazardous Area Response Team; LFB: London Fire Brigade; MPS: Metropolitan Police Service.



**Figure 3: Agencies and personnel taking action during carbon monoxide incidents, London 1st August 2007 – 30th June 2008.**

CHaPD: Chemical Hazards and Poisons Division (HPA); HPU: Health Protection Unit (HPA); HEPA: Health Emergency Planning Advisor (HPA); GSTPU: Guys and St Thomas' Poisons Unit; HSE: Health and Safety Executive; LA/EHO: Local Authority/Environmental Health Officer

The attendance by emergency services during these incidents is shown in Figure 2. This illustrates that the majority of incidents consume a baseline standard of resources; e.g. an ambulance, Hazardous Area Response Team, Fire and Rescue service, and National Grid response but with very few requiring police attendance. In terms of health outcomes, 74 patients were reported to have been admitted to hospital emergency departments, 6 patients required treatment with hyperbaric oxygen, and 3 fatalities occurred. There were 164 people in total evacuated from places of poisoning. The agencies informed during each incident are shown in Figure 3.

### Costs

The calculated costs attributable to these CO incidents are shown in Table 1.

**Table 1: Cost of carbon monoxide incidents reported to the HPA in London, 1st August 2007 – 30th June 2008.**

Cost	£s 2008
Mean cost per incident	£3,308.97 (Min/max £284.66 - £10,005.32)
Mean cost per casualty*	£1191.23 (Min/max £227.25 - £6,856.44)
Total cost (n= 26)	£89,342.16

\*Casualty defined as persons taken to emergency department

The distribution around the mean is large and represents a significant variation in the nature of the incidents, their outcomes and the associated resource consumption. In our analysis we identified specific types of incident from which we could develop cost scenarios. These are shown in Table 2.

**Table 2: Cost scenarios for carbon monoxide incident types reported to the HPA in London, 1st August 2007 – 30th June 2008.**

Incident type	Total cost	Mean cost per incident
Incidents resulting in a fatality (n=2)	£10,475.01	£5,237.51
Incidents occurring in a public location (non-residential), with no fatality (n=2)	£12,292.98	£6,146.49
Incidents involving multiple properties, with no fatality (n=5)	£16,357.05	£3,271.41
Incidents involving isolated properties with no fatality (n=17)	£29,845.24	£1,755.60

## Discussion

This study demonstrates a clear economic burden associated with responding to CO incidents within London. Although the total cost is substantial, there seems to be a considerable variation between incidents. CO incidents are expensive for the variety of emergency services which respond to them. Clearly, some types of incident are more expensive than others; those resulting in fatalities or occurring in public places are much more expensive to deal with, whereas residential incidents, especially those with minimal casualties, incur the lowest cost. It should be noted that the costs presented in this study

are unlikely to be underestimates, as they are based on the information available to the HPA during the incident, and other agencies or work may have been involved that are not included.

As the structure of unit costs may be different in other parts of the country, in the absence of local data, it is difficult to extrapolate these results to produce an estimate of the economic burden nationally. However, these results suggest that public health initiatives which aim to reduce the incidence of CO poisoning are likely to produce significant savings in costs to government.

There is also emerging evidence of the long term health effects of CO poisoning, where neuropsychiatric complications may also be important. Although difficult to demonstrate, these complications could create long term economic consequences which also need to be considered. Therefore, a broader perspective on the costs of CO poisoning is perhaps required in future studies. This may need to assess the costs to society resulting from lost productivity, permanent disability, premature death, and the pain and suffering of the victims and their families. Further studies need to be undertaken to confirm longer-term effects.

This study represents the start of a wider economic assessment of CO poisoning. In order to determine the incremental cost-effectiveness of alternative public health initiatives, such an assessment must be continued using larger and more accurate data collection methods, preferably incorporating more specific economic as well as clinical information.

#### Acknowledgements

Professor Virginia Murray, Medical Toxicologist, CHaPD London

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# Health risk perception and environmental problems: Findings from ten case studies in the North West of England

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## Introduction

The complex interaction between environment and health has been widely highlighted and studied by many authors and it is now very well acknowledged. Nevertheless, risk perception is a mystifying element of this interaction. Diefenbach & Leventhal<sup>1</sup> remarked that *“it is not uncommon for a person to feel ill and complain about symptoms without any physical signs of a disease. In these cases, the medical model is unable to provide explanations that satisfy either patient or practitioner”*.

Public concern over any environmental health hazard may produce significant effects on the mental, physical and emotional wellbeing of the local population. The seriousness of these effects, amplified by media, is also a social and political issue and, often, risk perception rather than actual calculated risk has greater influence over priorities for health promotion and resources for intervention; as well as legislative agendas of regulatory bodies.

Today, organisations acknowledge the fundamental contribution that perception and communication have to risk management. Public health practitioners are expected to take a holistic approach and to understand the needs of the community; communicate with individuals and groups properly; and successfully involve the public in any relevant risk assessment.

## A survey of case studies

In 2007-2008, a survey on risk perception of environmental health hazards in the North West of England was carried out by the Environment and Sustainability team at the Centre for Public Health, Liverpool John Moores University, in cooperation with the Health Protection Agency North West. The project was developed as part of the annual workplan agreed for the Health Protection Agency's environmental and chemicals team North West.

The work aimed to provide public health practitioners with a useful report to assist in the practical management of public concerns in relation to potential environmental hazards.

Thirty public health experts in the North West of England were asked to submit case studies on the main areas of public concern, as determined by public health experts, including representatives from the three regional Health Protection Units and from the Chemical Hazards and Poisons Division:

- incineration of waste
- contaminated land
- odour and air contamination

- flooding
- non-ionising radiation
- asbestos
- cancer.

Seventeen cases were received and a content analysis was carried out to identify and explore the public risk perception in the region. This perception was then compared with best evidence available about health risks associated with each hazard. This included a review of 84 scientific documents.

## Lessons learned

There are some important lessons that have been learned through this work.

It is always difficult to determine whether certain symptoms are directly due to an environmental hazard or to the cognition of its risk, to distinguish between real and imaginary symptoms, to understand to which extent the background - local environmental and social factors - plays a significant role in these symptoms. However, the work identified a number of key issues useful to understand community concerns and develop strategies to manage environmental risks more effectively.

- Despite the fact that regulators may legally have to focus on calculated risk, public perception and concerns may sometimes be more important in determining priorities for health promotion and intervention.
- Regulatory bodies and agencies often debate on whether public concerns are justified, and whether any hazard actually exists. However, public concern may produce significant effects on mental, physical and emotional well-being of a population.
- The health and social effects of anxiety and stress arising from awareness of a potential environmental hazard are not systematically reported nor easily measured.
- Estimation of community anxiety and stress should be included as part of every risk or impact assessment of proposed plans that involve a potential environmental hazard. This is true even when the physical health risks may be negligible.
- Public reaction to an environmental hazard relates more to the feared consequences of exposure, rather than the likelihood of exposure.
- A 'precautionary approach' gives regulatory bodies confidence, but may highlight knowledge gaps and trigger new concerns (i.e. the public may overreact to precautionary measures justified by uncertain but still negligible risks).

- Unfamiliar or incomplete information may lead people to form their own inaccurate though 'consistent' mental picture of the situation.
- Inadequate communication about a new proposal or environmental hazard can invoke anger in the community.
- In general, the use of statistics is not the best way to communicate about risk with members of the public.
- Risks associated with new technology are usually considered less acceptable than natural risks, such as flooding.
- Regulatory bodies are not always trusted by the public.

The report presents a selection of case studies, followed by a short commentary providing evidence to consider in similar situations. It also contains a list of references organised both by author and topic, to facilitate the search for useful resources on each specific topic.

The full report, *Health Risk Perception and Environmental Problems*<sup>2</sup>, and an executive summary are available at <http://www.cph.org.uk/publications.aspx>

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# The epidemiology of nuisance complaints in the area of Eastleigh Borough Council 2003-2008

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## Introduction

Legally, nuisance can be of two types, common law and statutory nuisance. Common law is law that has not been passed through Parliament; it has developed through legal precedent. Many complaints may satisfy common law nuisance criteria but not necessarily those of statutory nuisance. However Local Authorities are required to deal with statutory nuisance only. Their regulatory power is underpinned by the Environmental Protection Act 1990. This act defines the types of problem that can be dealt with as a statutory nuisance and they are summarised as follows:

- the condition of land or property, e.g. bad state of repair
- smoke
- fumes or gases from a private dwelling
- dust, steam, smell or other effluvia from business premises
- an accumulation or deposit, e.g. rotting household rubbish
- the place or manner in which an animal is kept
- noise.

The Clean Neighbourhoods and Environment Act 2005 added two more statutory nuisances to this list:

- statutory nuisance from insects
- statutory nuisance from artificial light.

There is no exact legal definition of a statutory nuisance; for action to be taken, the nuisance complained of must be, or be likely to become, prejudicial to people's health or interfere with a person's legitimate use and enjoyment of land<sup>1</sup>.

## Relationship between Nuisance and health

The environment is a wider determinant of health. In essence, anything that affects the person that does not come from within could be classed as an 'environmental factor'. People who are socially and economically disadvantaged often live in the worst environment<sup>2</sup> and various studies have been carried out to look at the relationship between the deprivation status of an area and the health of the people living in it. People living in the most deprived 10% of areas in

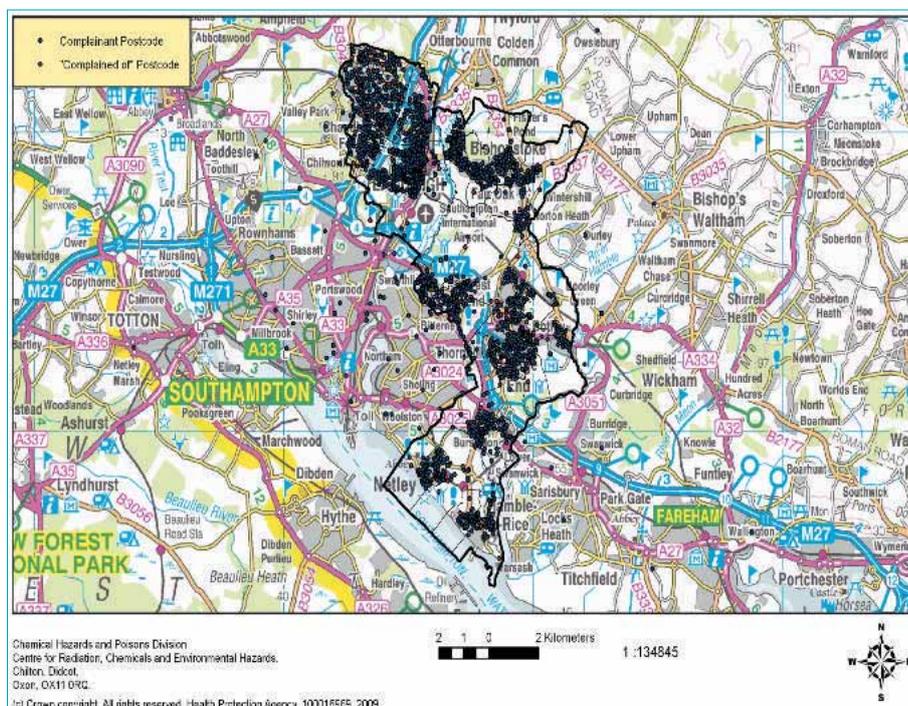


Figure 1: Nuisance complaints in Eastleigh District (2003 to 2008)

England experience the worst air quality, for example they experience 41% higher concentrations of nitrogen dioxide from transport and industry than the average<sup>3</sup>. People living in deprived areas also tend to have less access to green space and adequate housing. The Environment Agency position statement 'Addressing Environmental Inequalities'<sup>2</sup> recognises that 'the quality of the environment' can vary between different areas and communities.

These findings mirror other studies which have looked at the role that deprivation plays in health outcomes in cardio vascular, maternal and child health. All of this goes to highlight that inequalities continue to exist in our society in spite of repeated efforts to address the disparity.

Nuisance is an important indicator of the wellbeing of a community. While the concept of well being still requires a suitable definition, satisfaction with the general environment or levels of anti-social behaviour in a community are used as indicators of well being. Data on complaints generated from a community can help identify local issues, monitor trends and be used to bring about improvements via strategies to deal with locality specific problems, for example via future planning considerations and regeneration schemes.

## Aims of this study

- To describe the epidemiology of nuisance related complaints made to a local authority.
- To examine if there is a relationship between deprivation, as measured by the IMD 2007<sup>4</sup> (Index of Multiple Deprivation) scores,

and the rate of complaints in a small population area, lower super output area (LSOA).

- To specifically identify a relationship between noise related complaint rates and deprivation as measure by the IMD 2007 scores for LSOAs.
- To use results of this study to support further research, implement changes to the recording of complaints and assist efforts to improve the health and well being of the population affected.

## Need for the study

The Health Protection Agency (HPA) is an independent body which protects the health and well-being of the population<sup>5</sup>. Health protection includes preventing and controlling infectious diseases; reducing the adverse effects of chemical, microbiological and radiological hazards; and preparing for potential or emerging threats. The HPA's role is to provide an integrated approach to protecting UK public health through the provision of support and advice to the NHS, local authorities, emergency services, other arms length bodies, the Department of Health and the Devolved Administrations.

While our environment is much healthier than in previous generations and continues to improve, environmental quality varies between different areas and communities<sup>5</sup>. 'Health Protection in the 21st Century: Understanding the Burden of Disease; preparing for the future' identified health inequalities as a priority area of work for the HPA. Understanding the characteristics and distribution of vulnerable populations in communities and their relationship with environmental factors is a fundamental element towards taking this forward. In addition, this intelligence is important in supporting the NHS in its role to assess the potential public health impacts of policies and industrial processes such as those that need authorisation under various regulatory regimes, for example Environmental Permitting.

The above report proposes that this function is to be achieved via:

- A commitment to develop an effective national environmental public health tracking system that links environmental, health, exposure and social factors such as deprivation to develop effective public health actions to prevent or control chronic and acute diseases linked to hazards in the environment.
- Work with other key agencies to develop research into an improved understanding of environmental health inequalities and the most effective ways of addressing them.
- Work with other key agencies to ensure strategies for tackling health inequalities recognise environmental factors and ensure that communities are supported and involved in decisions that affect their local environment.

A key responsibility of the Environmental Health and Risk Assessment Unit (part of CHaPD) is to lead on environmental inequalities for the HPA, assessing the distribution of environmental inequalities, the significance of these and the implementation of interventions.

While previous studies have looked at the relationship between health outcomes and deprivation<sup>6,7</sup>, there was no evidence apart from anecdotal, which examined the links between deprivation and well being, particularly well being affected by environmental factors.

Studies have demonstrated that Integrated Pollution Prevention and

Control (IPPC) sites are distributed unequally in England and over 42% of children who live within 1 km of a part A1 process are in the most deprived quintile compared with 7% from the least deprived<sup>5</sup>. A few studies have looked at odour complaints from people living in close proximity to landfill sites<sup>8</sup>.

An opportunity to look at nuisance related complaints made to a local authority arose out of the availability of computerised records extending back over five years and the desire to address the paucity of evidence on a link between the deprivation status of a region and well being affected by perceived nuisance. The study was proposed to test the hypothesis that people living in more deprived communities were likely to face a higher burden of 'nuisance'.

## Methodology

### Literature review

Noise related complaints make up the bulk of nuisance complaints to a local authority. A Market and Opinion Research International (MORI) survey conducted in 2003 on behalf of Department for Food, Environment and Rural affairs DEFRA9 revealed the following:

- Many people, close to two in three (63%), hear noise from their neighbours to some extent. Annoyance is experienced by less than half (46%) of those who hear noise, or close to one in three (29%) of the population as a whole.
- Neighbour noise is therefore a problem that can arise under certain circumstances and in specific 'risk areas'. These risk areas include high density housing, rented accommodation (in both the social and private sectors), areas of deprivation and urbanity. In contrast, the profile of those not concerned by neighbour noise is consistent with circumstances which would be expected to limit exposure, for example detached housing, high home ownership and residence in rural/suburban locations in some of the least deprived areas nationally.
- Community cohesion is a significant factor in neighbour disputes. When residents feel involved in the community they are more likely to share a willingness to intervene for the common good. Intervention based on shared expectations and support of neighbourhood social control has been defined as 'social efficacy'. Examples include community groups which come together to articulate local concerns and lobby local authorities, or neighbours supporting each other informally in response to any ad hoc issues that arise.

### Raw data

Data were requested from the Head of Environmental Health for Eastleigh Borough Council, who provided five years of data pertaining to complaints made to the unit. Data on the postcode of the person complaining and the postcode of the offending premises were provided. Data on the gender of the complainant were not usable as it was not possible to differentiate if the person making a complaint was affected personally or was complaining on behalf of someone else or an organisation. However, over a thousand postcodes were missing along with missing data and mistyped entries. Using details of the property, street names and house numbers, missing postcodes were searched for manually using the online Royal Mail Postcode finder tool with a completion rate of over 75%.

### Analysis

Simple descriptive analysis was carried out initially to examine yearly trends, the proportion of different categories of nuisance

complaint and robustness of the data. This was followed by the use of geographic information systems to map postcode data on complainants and complainees, assign them to small geographic areas within the Borough, and create maps and other information to help investigate the relationship between deprivation and nuisance.

## Results

### Descriptive epidemiology

As shown in Figure 2, for the period 2003-2008, the bulk of complaints were noise related. These complaints outnumbered all other categories by a ratio of 2:1. The category of ‘accumulations’<sup>10</sup> was the next highest source of complaints.

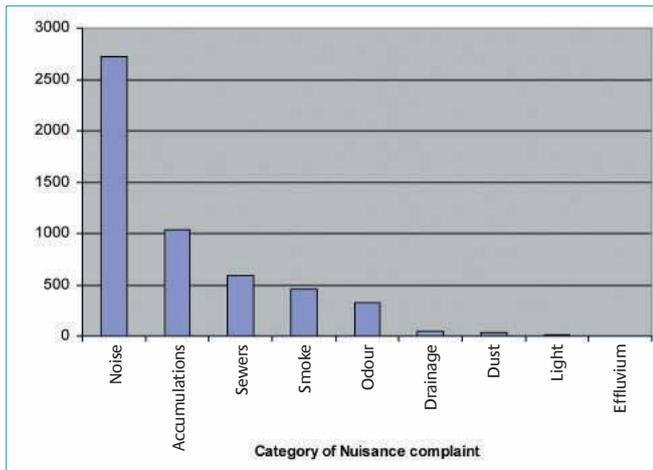


Figure 2: Total number of nuisance complaints in Eastleigh Borough Council for the period 2003-2008.

The number of complaints year on year did not show any significant variation over the period of the study, as shown in Figure 3.

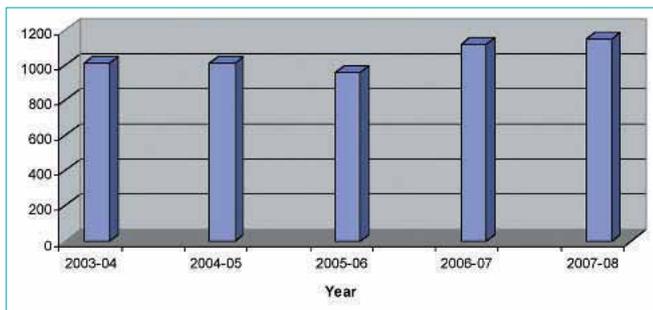


Figure 3: Trend of noise related complaints received by Eastleigh Borough Council for the period 2003-2008.

The trend in the number of noise related complaints, sub divided into the various categories, showed no noticeable variation over the period of the study. Airport related noise ceased to be recorded beyond the first two years of the study period. Within the broad category of noise related complaints, music and animals were the most common source as seen in Figure 4.

### Hypothesis testing

We aimed to look for a trend between the rate of complaints per head of population and deprivation as measured by IMD 2007 scores at the LSOA level. This was done by calculating a rate per 1000 population based on the number of complaints generated from within each individual LSOA (n=77).

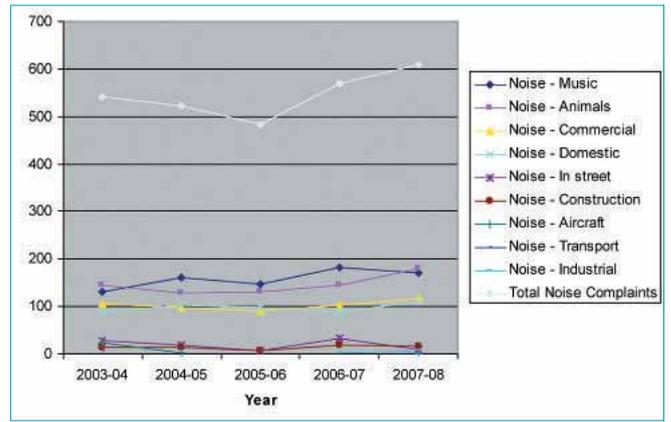


Figure 4: Trend of noise related complaints received by Eastleigh Borough Council, 2003-2008.

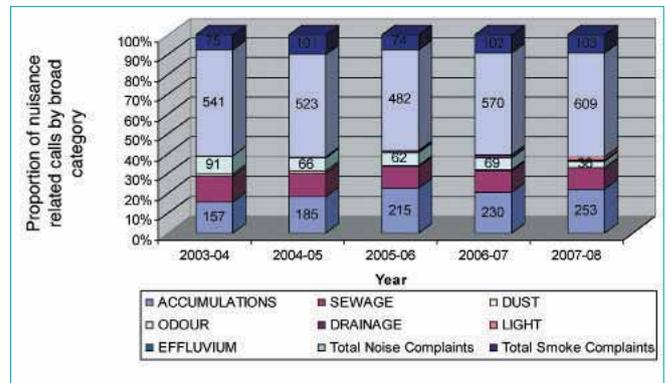


Figure 5: Proportion of all nuisance related calls per year in Eastleigh Borough Council, 2003-2008.

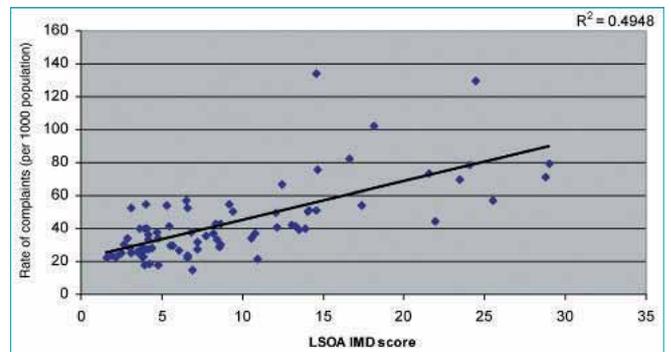


Figure 6: Scatter plot showing relationship of rate of complaints per 1000 population with deprivation measured by IMD 2007 scores at LSOA level.

An increasing rate of complaints per head of population was reported for more deprived super output areas (SOAs). By grouping the LSOAs into quintiles, it becomes evident that the most deprived SOAs generate the highest rate of complaints, as shown in Figure 7.

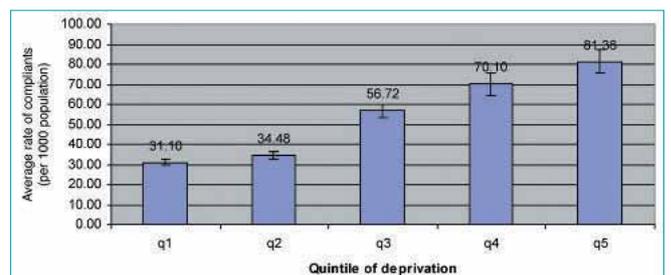


Figure 7: Relationship between quintile of deprivation and average rate of complaints, where q1 is least deprived and q5 most deprived.

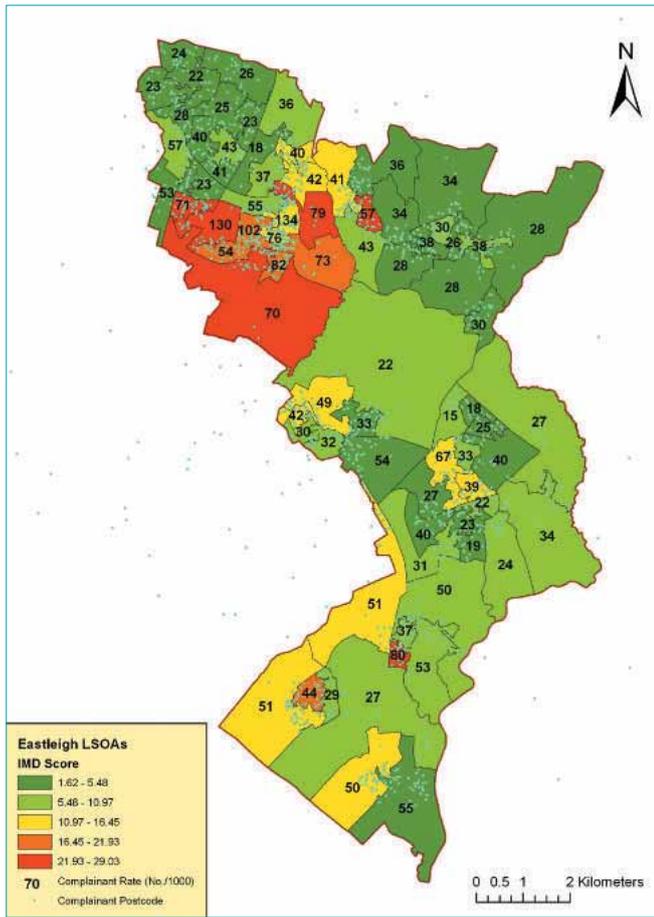


Figure 8: Eastleigh LSOAs thematically mapped by IMD quintile, with complainant rates and mapped postcodes.

The map shown in Figure 8 illustrates that the LSOAs with the highest deprivation scores generate the highest rate of nuisance complaints per head of population.

**The relationship between noise related complaints and deprivation**

A total of 2725 noise related complaints were made to Eastleigh DC over the period of 2003 -2008. We were able to map 2599 complaints to their postcodes.

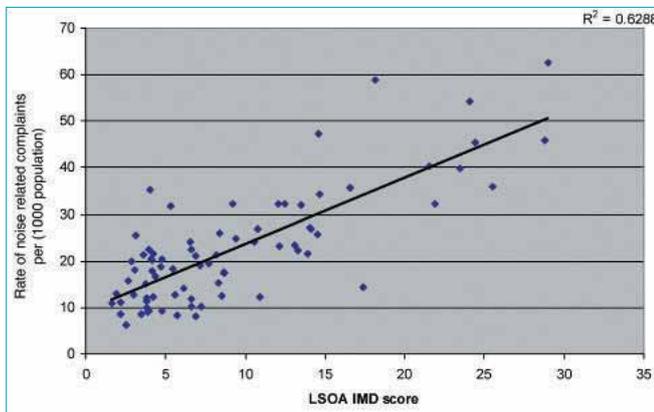


Figure 9: Scatter plot depicting rate of noise related complaints and IMD score.

The scatter plot of LSOA level noise related complaints in Figure 9 again demonstrates a linear trend between level of deprivation and

rate of noise related complaints which persists when analysed by quintile of deprivation in Figure 10.

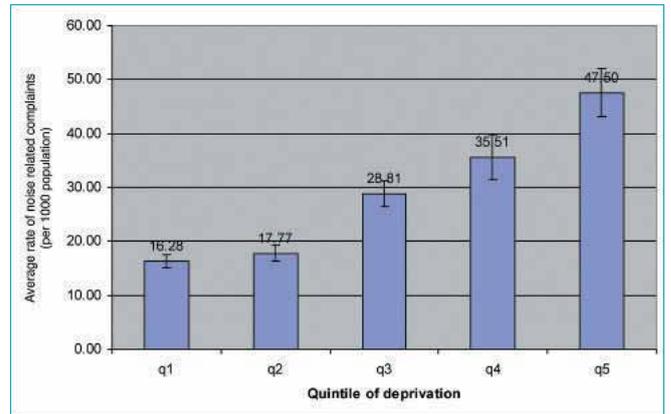


Figure 10: Bar diagram depicting relationship between quintile of deprivation and rate of noise related complaints, where q1 is least deprived and q5 most deprived.

**Discussion**

No one should be seriously disadvantaged by where they live and this is the vision behind the National Strategy for Neighbourhood Renewal<sup>11</sup>. Local authorities and the NHS have worked together via public sector agreements and local strategic partnerships in an attempt to correct the adverse health outcomes of people living in more deprived areas over the last few years. Deprivation in a region tends to be characterised by badly managed local environments and a failure to tackle anti-social behaviour which creates unstable communities.

This study looked into one determinant of local environment: nuisance. Complaints related to nuisance over a five year period and deprivation status of LSOA areas were mapped and the results demonstrated a clear relationship between the most deprived SOAs and a higher rate of complaints per head of population. This relationship persisted when examined for noise related complaints separately.

**Limitations**

There are a number of limitations to this study.

- Accuracy of data: Data was recorded over a period of five years by different individuals and is therefore susceptible to changes in recording behaviour and the manner in which complaints may have been coded. Postcodes have changed over the years and this would account for some missing data.
- The problem of potential “ecological fallacy”: When we use aggregated individual-level data, we apply conclusions drawn at group level to individuals. The deprivation status of an SOA does not necessarily reflect deprivation status of an individual complainant within that SOA. Hence, we could have instances in which a nuisance complaint is instigated by an individual who is not socio-economically deprived but lives in a deprived neighbourhood.
- Possible spatial autocorrelation in the data: No account is taken of possible spatial autocorrelation in the nuisance rates by LSOA, whereby rates of neighbouring areas are likely to be more similar than rates of areas further away from each other, due to underlying spatial processes. This may have the effect of overemphasising any relation between deprivation and nuisance found through regression analysis.

- Effects of scale have not been considered, e.g. by examining whether patterns and relationships in nuisance rate change depending on what level the data is aggregated to.
- Boundary effects have not been considered, i.e. effects which might be picked up by considering neighbouring areas outside the boundary of Eastleigh Borough Council.

### Recommendations

By recognising some of the limitations of this study, we feel that the following recommendations can be made based on our observations detailed above.

- Share the results of this study with the Local Authority and the Primary Care Trust: recognition of the link between environmental nuisance and deprivation. This will hopefully feed into future planning considerations as well as regeneration projects.
- There is a need to standardise methods of data collection around environmental complaints. This requires action to be taken via local Environmental Health forums and the local Health Protection Unit.
- Interventions exist for many health protection hazards. However, when aimed at an individual level these are likely to be preferentially taken up by those groups who already enjoy the best health and so could actually widen inequalities.

It is therefore important that public health organisations continue to press for community-level actions in matters relating to environmental health. It is equally important that when interventions are aimed at individuals, they are specifically targeted at the groups that need them most, working with them to provide services that are relevant to their way of thinking and integrated into a holistic package. As many of the highest risk groups are politically unpopular, the need for clear public health advocacy on their behalf is paramount.

### Acknowledgements

David Ralph, Principal EHO, Eastleigh Borough Council and Matthew Palmer, Senior HPP at HIOW HPU for providing us with the data. Dr. Giovanni Leonardi, CHaPD, for assistance with data analysis.

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# Land contamination and public health

**Dr Christopher Johnson, Senior Environmental Scientist,  
Chemical Hazards and Poisons Division, Cardiff**

*“The last hundred years have seen a massive increase in the wealth of this country and the well-being of its people. But focusing solely on economic growth risks ignoring the impact – both good and bad – on people and on the environment. Had we taken account of these links in our decision making, we might have reduced or avoided costs such as contaminated land or social exclusion.”*

Former Prime Minister Tony Blair <sup>1</sup>

## Introduction

Land is a valuable but finite resource. It is part of our natural capital and its use is an important determinant of population health and wellbeing. However, the historical changes in the use of land make the issues surrounding the recycling of previously-developed land of major interest to public health practitioners. Previous land uses can introduce the potential for chemical and in some circumstances radiological contamination depending on the sites previous use. The resulting problems associated with land contamination and with site dereliction, can affect communities and impact on public health. The problem in many cases goes deeper than simple exposure of the public to toxic contaminants. Meeting this challenge will be an important area of community health improvement in the 21st century.

This article explores the key public health topics related to public interaction with their environment, and introduces some of the tools available from the Health Protection Agency (HPA) to help to public health professionals fully understand this area.

## Legacy of Previous Land Use

Brownfield land, also officially referred to as previously developed land (PDL), is land that which has been previously occupied by a permanent structure or fixed infrastructure. The recycling of such ground is a major aspect of UK sustainable development policy, where in England 60% of new homes should be built on land which has been previously used<sup>2</sup>. However, a number of issues exist regarding the redevelopment of brownfield sites, including the possibility of contamination of the site. Therefore ensuring change of land use should not have a detrimental effect on human health becomes an important aspect of public health protection in communities.

Land contamination is primarily a legacy of our industrial heritage. Contamination occurs through the deliberate or accidental release of chemicals, or simply through industrial usage. Although there is now a much greater understanding of the environmental impacts of industry, land is still becoming contaminated through the accidental release of chemicals and other human activities. Therefore, it is important to acknowledge that this represents an ongoing threat to human health, rather than just a legacy issue. Furthermore, it is important to

acknowledge that the presence of chemicals in land does not only result from anthropogenic sources (e.g. industrial activity, road traffic). Many chemicals found in land come from the underlying geology (e.g. naturally occurring arsenic in Jurassic Ironstones) or from other natural events (e.g. forest fires cause release of some persistent organic contaminants).

The traditional tools that local authorities have for dealing with land contamination issues are principally the planning system, and Part 2A of the Environmental Protection Act 1990 (henceforth Part 2A). The purpose of the Part 2A legislation is to ensure that land does not cause significant harm in its current use. The parallel function of the planning system is to ensure that land is safe, fit for purpose and as a minimum should not cause significant harm in its proposed use. This twin pronged approach allows local authorities to regulate ongoing development, and ensure clean up where development has previously occurred. The regimes although distinct are closely related, such as in England where Planning Policy Statement 23<sup>3</sup> requires that as a minimum the land after redevelopment should not be able to be determined as contaminated land under Part 2A in the future.

Despite specific legislation designed to address legacy contamination the majority of remediation of land affected by contamination is handled through the planning regime. Recent studies by the Environment Agency (EA)<sup>4</sup> and the Scottish Environmental Protection Agency (SEPA)<sup>5</sup> have shown that the progress in management of land contamination using Part 2A is dwarfed by the use of the planning regime. Between 2000 and March 2008, 13,396 sites in Scotland were examined under Part 2A, whilst only 13 sites (53 hectares) were determined as contaminated land<sup>5</sup>. This work is mirrored in a study for England and Wales where there were 659 determinations in England and 122 in Wales using Part 2A between 2000 and March 2007<sup>4</sup>. However, it is worth noting that many of these determinations are identified as single properties, and therefore a number of determinations can result at one site. This makes it likely that only 100-150 locations have been determined, and are being managed using the contaminated land legislation<sup>4</sup>. This level of contaminated land management has to be compared with that achieved through the planning system. SEPA reports that in addition to 13,396 sites investigated a further 13,400 sites are likely to have been examined for planning purposes between 2005-March 2008<sup>5</sup>. From these 13,400 sites, 1864 hectares of land were remediated in Scotland under development management compared with 53 Ha determined using Part 2A. For England and Wales the situation is similar, with local authorities reporting 90% of contaminated sites managed by planning or voluntary means<sup>4</sup>. It is also important to note what receptors were believed to be at risk from the contamination identified. With the exception of special sites (a particular category of site, where regulation is the responsibility of the Environment Agency (or SEPA in Scotland) the majority of determinations in England and Wales were determined as a result of potential risks to human health<sup>4</sup>. For those sites determined in Scotland, the majority related to pollution of water <sup>5</sup>.

This difference reflects the separate purposes of the two approaches. In order for the land to be determined as contaminated land under Part 2A, contamination has to present an unacceptable risk to a receptor. This presents a powerful tool for protecting health from exposure to chemicals. However, Part 2A is only used to manage land where there is an appreciable risk in its current use. The upshot of this is that it is not the levels of contamination that are the main issue, but the magnitude of the exposure. Consequently restricting access can be a valid strategy for managing the risk. Whilst this is not a practical or acceptable solution for residential land, it remains a cost effective option for vacant or derelict land which can be fenced off to prevent public contact with contaminated materials. It is left to voluntary redevelopment to progress the remediation of these sites further returning them to beneficial use. This allows land to fall through the gap between regulatory regimes especially where land can be removed from the scope of Part 2A, but no economic driver exists to return the land to use.

## Public Health Challenges

Whilst much of the public health attention is directed at sites investigated under Part 2A, as this legislation explores sites where current exposure to chemicals which may be harming health, it has been demonstrated by the data presented that the chemical contamination of land is mainly reduced through redevelopment controlled by the planning system. However, we must also consider the impact of the land which falls between the regimes. Brownfield land as well as being a source of potential chemical exposure and environmental pollution, has a visual impact and can make an area look run down and neglected. This has an associated economic impact, reducing property prices and making the area less attractive to visit, live and invest in. Brownfield land is disproportionately located in areas of economic and social deprivation. Land dereliction therefore can be shown to contribute to environmental injustice and may also further exacerbate socio-economic health inequalities in these communities<sup>6</sup>. Therefore, when considering the health impact of previously used land we must learn to consider more than just the degree of chemical exposure. Measures to restrict access may result in land dereliction, which may also have a significant effect on health of surrounding populations. This is especially important as the impact of perceptions of risk to health can be as real as the toxicological health risks from contaminated land<sup>7</sup>. Such perceptions are likely to be affected by issues such as dereliction and access.

Furthermore, it must be considered whether we can continue to rely on economic development to drive the required land regeneration: as economic drivers reduce, the number of sites falling between regimes increases. Remediation of low-value previously developed land sites within communities, especially those which may be contaminated with low levels of pollutants, often poses specific challenges as there are few financial incentives to remediate. However, recent data suggests that management of land contamination is susceptible to changing economic climate. With reduction in the housing sector, redevelopment of contaminated sites will be impacted upon. Contraction of the sector was highlighted by a recent report which suggested work at laboratories analysing soil samples taken during contamination investigations had reduced by as much as 35-40% in the last year<sup>8</sup>. It is likely that redevelopment based remediation will be reduced as it increases the costs of land recycling. Therefore, land where

exposure to contamination is limited, may not present a current threat but may not be a viable redevelopment option because of the need for remediation. This can provide a barrier for reuse of derelict sites, and increase the number of sites which are not being remediated by either process. In addition to the potential adverse impact of these derelict sites at the heart of communities, the presence of derelict or contaminated sites can have significant social impacts on affected communities. Previously developed land, which is not considered to be fit for development may provide people's only usable open space. Removal of access may impact the health of the communities around it, and the community's perceptions of their quality of life.

It is therefore important that the public health community recognise the contribution of land to the overall wellbeing of communities, and health in the broadest context. It is important that we fully understand the public health impact and benefits of non-economic regeneration in providing potential open spaces within communities. Furthermore, it is incumbent on the public health community to drive the need to provide sustainable remediation options, which allow small areas of land to be returned to use for the benefit of the community. Regeneration of these sites as green space is equally important to regeneration as housing, as returning the site to use is likely to improve the physical environment, as well as the social environment - by enhancing people's quality of life, improving perceptions of the area and contributing towards environmental justice. This aspect of the role of land within communities will become increasingly vital where economic development slows, and pressures on the housing market increase.

## Guidance Available to Public Health Professionals from the HPA

The HPA plays an important role in supporting the public health community in advising on land contamination issues. One of the principal objectives of the HPA is to ensure that public health advice given is both consistent and in line with the best knowledge available; where evidence is equivocal or lacking, the HPA can draw upon expert consensus opinion. Furthermore, by regular evaluation of the involvement of the HPA in contaminated land, the Chemical Hazards and Poisons Division (CHaPD) is able to identify trends and thus identifies areas where public health guidance may be required.

Parallel to this the HPA also plays an active role in providing advice, alongside the EA and the Food Standards Agency (FSA), in the production of new technical documents and revisions to the non-statutory guidance, relating to both chemical and radiological contamination of sites. Specialists within the HPA, provide a central source of expert advice on the health effects of chemicals or radiation which may have contaminated land and other environmental media. This advice is available to allied agencies and local authorities as well as health professionals.

Using this experience and expertise allows the development of a wide range of supporting material to assist public health professionals understand the issues surrounding land contamination. A primer titled "An Introduction to Land Contamination for Public Health Professionals" has recently been launched on the HPA website to offer a basic guide to the legislation and processes for management of land contamination. Further technical advice is being developed and published through

a series of Contaminated Land Data Sheets, which support the HPAs chemical compendia series. These will offer toxicological, chemical and public health information on a range of common contaminants. Additional advice on practices in contaminated land risk assessment is also provided by the Contaminated Land Clarification Note series.

These documents will be available on the contaminated land pages of HPA website [www.hpa.org.uk/land](http://www.hpa.org.uk/land)

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# A capture-recapture analysis of two incident surveillance systems: Chemical Incident Surveillance System and South West Environmental Surveillance System in the South West region of England

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## Introduction

The release of toxic substances during a chemical incident may constitute a threat to human health. However, there is relatively little evidence available as to the circumstances under which different substances constitute a real threat. In order to get a better understanding of the magnitude and effects of chemical incidents, surveillance systems have been set up to gather information on incidents of public health significance. The information gathered may enable analysis of the frequency and scale of the incidents, of the effects associated with different types of incidents and the variety of agents involved. This information can then be used to generate hypotheses. These hypotheses can be studied further and when there is enough evidence, may allow users to implement changes to prevent future incidents, to evaluate the effects of these changes and to address training needs.

An ideal surveillance system must be sensitive enough to apply to small exposures as well as major incidents. It has been shown that minor incidents, which would not normally come to the attention of more than one regional agency may, over time, constitute a greater source of ill health than rare major incidents, which attract a lot of attention<sup>1</sup>. A good surveillance system must, therefore, include information from multiple agencies and sources, such as emergency services and local authorities<sup>1,2</sup>.

The first European environmental public health surveillance system was set up in Wales in 1993<sup>3</sup>. This system has been replaced by the current Health Protection Agency (HPA) surveillance system, the Chemical Incident Surveillance System (CISS). CISS captures reports on chemical incidents in England and Wales by collating information reported to the Chemical Hazards and Poisons units by local authorities, emergency services, the Met Office, the Drinking Water Inspectorate and Health Protection Units (HPUs), as well as proactively scanning media sources. In order to evaluate the feasibility of multiagency surveillance where local agencies, such as Fire Services and Local Authorities, report directly via a web-based service, the South West Environmental Surveillance System (SWESS) was set up as a pilot project. Initiated in 2005, and based on the Scottish Environmental Surveillance System (SEISS), the SWESS runs in parallel with CISS.

We used capture-recapture analysis to investigate how sensitive these surveillance systems are. The capture-recapture methodology was originally developed in the biological sciences to measure the population size of different animal species. This can be done by, for example,

marking and releasing all fish caught in a fishing trip in a lake and then returning to the lake to fish again. The population size is then estimated by looking at how many fish on the second trip were marked, i.e., how many of the fish caught on the second trip were recaptured fish that had been caught on the previous fishing trip. With knowledge of the number of fish caught on each trip and the proportion of recaptured fish on the second trip, the number of fish not caught in either sample can be calculated and thereby also the estimated total population size.

In medical sciences, this methodology is more often used to measure how complete two sources of information are, i.e. how sensitive they are at capturing the events they are supposed to capture. This can be done as the total population can be estimated as mentioned before. The sensitivity of an information source is, therefore, the same as the proportion of the total estimated population captured by the information source. Capture-recapture analysis may only be used to compare and evaluate the completeness of information sources provided that four main assumptions are fulfilled: the population needs to be closed; individual events need to be identifiable; each individual event must have the same probability of being included in each sample group (in this case in each surveillance system); and capture in the second sample needs to be independent of capture in the first. As CISS and SWESS have similar inclusion criteria and have been running in parallel, it was decided that such a capture-recapture analysis should be performed as part of a review of the two surveillance systems.

## Methods

Data on all registered incidents in the South West region of England in the time period 2006-2007 were extracted from the CISS and the SWESS databases. The data were sorted according to the reporting source and the type of incident. This information was then used to identify those that fulfilled the inclusion criteria for the study. The two surveillance systems had their own inclusion criteria, as detailed here:

**For incidents registered on the CISS:** "An acute event in which there is, or could be, exposure to chemical substances which cause or have the potential to cause ill health."

**For incidents registered in SWESS:** "An acute incident or chronic exposure in which there is or could be exposure to the public to substances, which cause, or have the potential to cause, ill health via the release of any agent into the environment, by any pathway" or "A situation involving one or more persons with medical signs or symptoms actually or potentially associated with an acute or chronic exposure to an environmental agent, known or unknown."

In order to get comparable samples, the inclusion criteria for the capture-recapture analysis differed slightly.

- 1 Only reports that were covered by both the SWESS and CISS inclusion criteria were included. This removed microbiological, non-chemical and chronic incidents.

2 Incidents reported via media scanning and members of the public were excluded as the validity of these reports was known.

Once the incidents for inclusion were identified, capture-recapture analysis was performed on the extracted incidents.

## Results

The initial set of reports came from 12 different sources. CISS received most of its reports from within the HPA, the emergency services and the media, while SWESS received most of its reports from the emergency services, within the HPA, and local authorities (see Table 1). In general, information on the type of incident, incident setting and substance(s) involved was more complete and detailed in SWESS than in CISS. It was more difficult to identify information on CISS and in seven reports, data on the source of the report could not be found.

**Table 1: Sources of reports on incidents registered in the CISS and SWESS databases for the South West Region in 2006 and 2007**

Reported by	CISS	SWESS	Total
Drinking Water Inspectorate	3	-	3
Emergency Services	34	121	155
Environment Agency	5	15	20
Harbour Authority	-	1	1
Health Services	7	10	17
HPA	69	47	116
Local authorities	6	35	41
Maritime and Coastguard Agency	1	-	1
Media	34	-	34
Member of Public	5	-	5
Poison Information services	5	-	5
Water Company	1	-	1
Not specified	7	-	7
<b>Total</b>	<b>177</b>	<b>229</b>	<b>406</b>

In total, 37 media reports and 5 reports from the public reported in CISS and 15 incidents reported in SWESS were excluded from the current study as they did not fulfil the criteria for inclusion. The remaining dataset contained 352 reports; 138 from CISS and 214 from SWESS. Most of these reports related to fires, leaks and spills (see Table 2). The most common settings for incidents were residential, commercial, industrial and agricultural (see Table 3).

**Table 2: Type of incidents recorded in the CISS and SWESS databases for the South West Region in 2006 and 2007 that fulfilled the inclusion criteria for the capture-recapture analysis.**

Incident type	CISS	SWESS	Total
Deposit	4	21	25
Explosion	2	6	8
Fire	57	68	125
Land	1	-	1
Leak	17	56	73
Natural Occurrence	-	3	3
Other	20	-	20
Release	17	20	37
Spill	15	38	53
Unknown	5	2	7
<b>Total</b>	<b>138</b>	<b>214</b>	<b>352</b>

**Table 3: Settings for incidents recorded in the CISS and SWESS databases for the South West Region in 2006 and 2007 that fulfilled the study inclusion criteria.**

Incident setting	CISS	SWESS	Total
Residential	34	49	83
Commercial	30	49	79
Industrial	19	33	52
Agricultural	16	20	36
Open Space	8	20	28
Health care	11	9	20
Recreational	-	13	13
Educational	5	6	11
Other	9	-	9
Transportation	2	5	7
Water Supply	-	7	7
Unknown	4	3	7
<b>Total</b>	<b>138</b>	<b>214</b>	<b>352</b>

There were uncertainties associated with reporting the incidents according to the type of substance involved as the same compounds may have been classified under different titles. However, the greatest numbers of reports were for products of combustion, petroleum/oils and asbestos (see Table 4).

**Table 4: Extract from the database showing the substances most commonly involved in the incidents registered in reports to the CISS and SWESS databases for the South West Region in 2006 and 2007 that fulfilled the study inclusion criteria.**

Incident material	CISS	SWESS	Total
Products of combustion	56	25	81
Petroleum/Oils	9	25	34
Asbestos	-	29	29
Other Inorganic	22	-	22
Other Organic	17	-	17
Chemical	-	15	15
Ammonia	2	11	13
White Powder	-	9	9
Halogens	8	-	8
Acids	4	2	6
Metals	6	-	6
<b>Total reports in database</b>	<b>138</b>	<b>214</b>	<b>352</b>

Only 42 reports fulfilling the inclusion criteria were reported to the CISS and SWESS databases for the South West Region in 2006 and 2007. CISS included an additional 138 reports that were not captured by SWESS, and SWESS included an additional 214 reports that were not included in CISS. The results of the capture-recapture calculations based on these numbers estimates that the number of events missed by both systems during the study period was 1097. Extrapolating from this, the sensitivity was 16% for CISS and 23% for SWESS.

## Discussion

This investigation compared two surveillance systems for chemical incidents with similar inclusion criteria. The main difference between the systems was the way they were notified about incidents. CISS actively scanned different sources to find incidents to include, while agencies involved in incident management actively reported directly

to SWESS. Due to this difference, excluding reports that did not fit the study inclusion criteria had a greater effect on the CISS sample than on the SWESS sample. However, the remaining samples were similar with regard to the type of incidents, the incident settings and substances involved (see Tables 2 - 4).

In general, the information provided by the SWESS database was more complete and it was easier to trace who had reported an incident than in CISS. This makes it easier to interpret and evaluate the functionality of the surveillance system.

The results of the capture-recapture analysis indicate that only a minority of incidents had been recorded by both systems. The estimated sensitivity for both systems were low, although the sensitivity of the SWESS was higher than that of the CISS. As a result, the estimated number of incidents missed by both surveillance systems was high.

The results of the capture-recapture analysis suggest that both systems are poor at detecting incidents. Alternatively, the results may indicate that the samples are not valid to be compared by a capture-recapture method. It should also be noted that using different inclusion criteria for this analysis to those that are used in the two surveillance systems may limit interpretation of the results; the results of the analysis can only reflect the completeness of reporting for those reports covered by the study inclusion criteria

So did the sample pools from these surveillance systems meet the required criteria for capture recapture analysis? The population under investigation fulfils the criteria of being a 'closed population' as it was made up of all chemical incidents in the South West region of England during a specified time period. All incidents were easily identifiable. Each surveillance system seems to have been independent, as few incidents were reported to both. More than half of the incidents reported to both systems had been reported by different sources and the rest may well have been reported by different people in different parts of the same source organisation. Therefore, the main uncertainty is whether or not reports had the same probability of ending up in both samples. This is difficult to investigate and presents a major concern regarding the validity of the study. Therefore, the results of the study should be interpreted with caution.

Although it is debatable whether a capture-recapture analysis was the most appropriate method to use in this study, the results are still valuable for discussing the completeness of the two surveillance systems. It would appear that both the CISS and SWESS surveillance systems have rather low sensitivity, with SWESS as the more sensitive system. In general, CISS misses incidents that do not come to the attention of the HPIUs or the media. SWESS seems to miss reports from certain parts of the South West, suggesting that services in these places do not report to the system. The information in the reports made to SWESS was also more complete and more readily available for analysis.

The key to improving the completeness of these surveillance systems lies in educational efforts to encourage reporting into the systems and by making the systems user-friendly. Incident surveillance systems such as the two investigated in this study can make a great contribution to public health by directing efforts towards the greatest need. However, completeness of the data is of major importance for the decisions to be correct. Therefore, efforts to improve reporting to these systems need to be a priority regardless of the type of system used in the future.

### Acknowledgements

We would like to thank Lorraine Stewart, Rebecca Gay and Emer O'Connell at the Health Protection Agency Chemical Hazards & Poisons Division, as well as Rebecca Close and Eirian Thomas at the Health Protection Agency South West for providing the data and support during the study and for editing the report.

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# Elevated Concentrations of Nitrate & Nitrite in Drinking Water: A Public Health Advisory Note

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## Background

Nitrate is a soluble form of nitrogen that is naturally present in the environment. It is produced during the decay of vegetable matter in soil and may be added as a fertiliser to arable land. Rainfall washes nitrate from the subsoil into ground and surface water and this can give rise to elevated concentrations in drinking water. The latter process can take

many years, or even decades, depending on the geology of the area. Water companies regularly test for nitrate and nitrite in mains water supply, as do local authorities in private water supplies <sup>1,2</sup>.

## Public Health Interventions

Current UK drinking water standards for nitrate and nitrite<sup>3,4</sup> are intended to protect bottle fed infants from infantile methaemoglobinaemia (IM), or blue baby syndrome. This is a condition in which the ability of the blood to carry oxygen to the tissues of the body is impaired. Bottle-fed infants up to 6 months and in particular those under 3 months are considered to be most susceptible. Regulatory standards which protect this vulnerable subgroup also cover the rest of the population<sup>5,6</sup>.

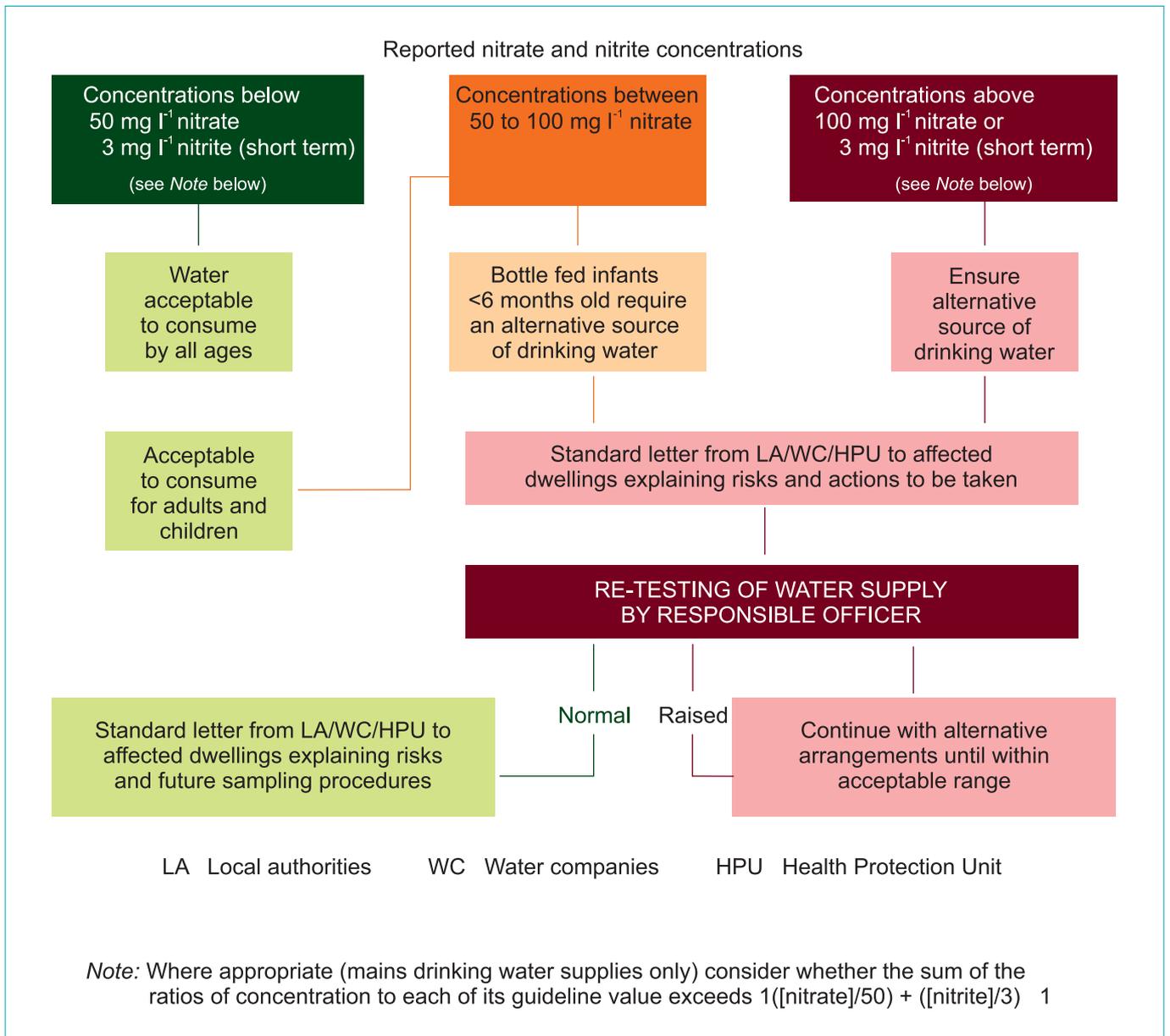


Figure 1: Response to elevated concentrations of nitrate and nitrite in drinking water.

Dorset and Somerset Health Protection Unit (HPU) received a number of enquiries about nitrate and nitrite concentrations in private drinking water supplies. This prompted the development of a public health advisory note (PHAN), to address public health concerns related to elevated concentrations of nitrate and nitrite in drinking water. It aims to promote consistency in dealing with exceedances in both private and public water supplies.

The advisory note encourages Health Protection Units to:

- consult with the Local Authorities, the Environment Agency and Water Companies to determine the extent and frequency of nitrate and nitrite exceedances in drinking water in their area,
- agree when and how nitrate failures will be reported to the Health Protection Units,
- where failures occur, encourage the development of a consistent multi-agency approach in both response and intervention across all agencies, based on best practice,
- work in partnership to improve the management and control of nitrate in the environment. Relevant partners may include Water Companies, Local Authorities, the Environment Agency, the Food Standards Agency, Primary Care Trusts and others.

## Public Health Advisory Note

When nitrate concentrations exceed 50 mg/l, the PHAN advocates that public health advice is appropriately disseminated to any at risk groups within affected households, as indicated in figure 1 below. It also makes the following recommendations.

- Bottle fed infants up to the age of 6 months should be given readily diluted liquid formulae, or feeds made from an alternative low nitrate water supply.
- If bottled water is used, ensure a sodium concentration of less than 200 mg/l.
- Except for bottle fed infants, the general population may use water that contains 50-100 mg/l nitrate.
- The general population should not consume drinking water with concentrations in excess of 100 mg/l nitrate or 3 mg/l nitrite. An alternative water supply should be used until the chemical and bacterial quality of the mains or private water supply complies with the appropriate UK drinking water standard.
- Absorption via the skin is extremely low, so the water can still be used for bathing and washing.

The material has been prepared jointly by Dorset and Somerset Health Protection Unit and the Environmental Health and Risk Assessment and Toxicology Units of the Chemical Hazards and Poisons Division. The full PHAN can be accessed via the HPA intranet.

## References

- 1 **Drinking Water Inspectorate: Consumer Concerns - Nitrate, April 2003**
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- 4 **The Private Water Supplies Regulations 1991 SI No. 2790**
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# HPA Project Updates

## The Children's Environment and Health Strategy for the United Kingdom

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### Summary

The Health Protection Agency (HPA) published the Children's Environment and Health Strategy for the United Kingdom (UK) in March, 2009. The Strategy makes recommendations on measures necessary to reduce the environment-related burden of disease amongst children and young people, to ensure that they grow up in an environment that nurtures good health and well-being. This article provides an overview of the Children's Environment and Health Strategy for the UK and its development.

### Introduction

Children and young people can be more sensitive to environmental influences on health than adults. This is because they have different levels and patterns of environmental exposures to adults, their biological systems and organs are still developing, and also as a result of their behaviour and lack of awareness of environmental hazards and risk<sup>1</sup>.

In 2004, the World Health Organization (WHO) developed the Children's Environment and Health Action Plan for Europe (CEHAPE) to help reduce the burden of disease and injury amongst children that is attributable to environmental risk factors. Each of the 53 countries in the WHO European Region, including the UK, signed the CEHAPE and committed to develop national children's environment and health action plans.

### Why do we need a Children's Environment and Health Strategy for the United Kingdom?

Children and young people (under 19 years of age) represent a substantial proportion (about 25%, 14.8 million) of the UK population<sup>2</sup>, the majority of whom experience excellent health and well-being. Whilst it is difficult to quantify the burden of disease directly attributable to environmental factors, it is well established that the environment can have a significant impact on health and well-being, particularly amongst children<sup>1</sup>. In the UK, the leading causes of mortality and morbidity experienced by children and young people include a number of conditions which are significantly affected by environmental factors. For example, the environment can have an influence on gastrointestinal disease (through clean water and food), respiratory health (through air pollution), obesity, unintentional injuries, and mental health and well-being. Environmental factors have also been implicated in the

causation of congenital abnormalities. Given the potential influence of the environment on many aspects of child health in the UK, there is a real opportunity to improve children's health by ensuring that they live in a clean and healthy environment which nurtures good health and well-being.

### Developing the Children's Environment and Health Strategy for the United Kingdom

The HPA was commissioned by the Department of Health and the Department for Environment, Food and Rural Affairs to develop a Children's Environment and Health Strategy for the UK. This was undertaken on behalf of the Interdepartmental Steering Group on Environment and Health, which comprised a range of Government departments, Agencies and the Devolved Administrations.

In 2006/07, a review was undertaken to assess the status of the environment-related burden of disease amongst children in the UK<sup>3</sup>. This evaluation was used to identify areas where children's health could be improved by better managing exposures to environmental hazards and/or promoting environments that facilitate good health and well-being. This review was used as a basis for developing the Children's Environment and Health Strategy.

The Strategy underwent a public consultation in spring 2008. Over 100 consultation responses were received from a wide range of organisations and individuals, including academics, charities and campaign groups, government departments and agencies, local authorities, primary care trusts and professional organisations. Overall, the Strategy was well received, with strong support for the recommendations put forward and the overall approach of the Strategy<sup>4</sup>.

### What do children and young people think and want?

An integral aspect of developing the Strategy has been the involvement of children and young people to ensure it addresses their needs and priorities. During the development of the Strategy, a number of consultation exercises were organised to find out what children and young people think about the environment and the effect it has on their health.

One of the highest priorities for young people was mental health, which was considered a key component for good health and for being happy. Obesity and healthy eating, lung cancer, asthma, allergies, air pollution and being safe were also identified by young people as areas of top concern. Ideas for change included banning smoking, improving access to clean, green safe spaces and better access to affordable leisure facilities. Younger children's concerns included the standard of school toilets and access to drinking water in schools; both were seen as important issues in this age group.



Figure 1: Exposure to environmental tobacco smoke continues to be a significant issue



Figure 2: Children and young people were also concerned about the standard of school toilets

### The Children's Environment and Health Strategy for the United Kingdom

The Children's Environment and Health Strategy for the UK was published in March, 2009. Overall, the Strategy aims to provide a comprehensive and strategic approach to addressing environmental risk factors in order to protect and improve children's health and well-being throughout the UK. The UK, through a wide range of initiatives and policies, has already addressed many of the key areas identified within CEHAPE and, as a consequence, is in a good position relative to other countries in the WHO European region. As such, the Strategy aims to strengthen and complement policies and activities already undertaken by Government departments, the Devolved Administrations, local and regional authorities and the National Health Service. The principal areas considered in the Strategy are highlighted in Box 1.

## Box 1: The Children's Environment and Health Strategy for the United Kingdom

### Water, sanitation and health

The United Kingdom (UK) has an excellent public water supply and high standards of sanitation provision. Additionally, bathing water quality has improved substantially over the past 10 years, with high compliance with the relevant standards. Priorities include:

- improving hygiene (including hand-washing), access to drinking water and sanitation facilities in schools;
- ensuring compliance with the drinking water standard for lead; and
- assessing the impact of water poverty on child health and well-being.

### Accidents, injuries, obesity and physical activity

Injury remains a leading cause of death and hospital admission amongst children in the UK, although deaths and admissions are amongst the lowest of developed nations. Overweight and obesity is a growing public health problem; in 2004, approximately a third of boys and girls were either overweight or obese. Priorities identified include:

- ensuring adequate surveillance of injuries;
- ensuring adequate surveillance of levels of overweight and obesity; and
- developing easy and safe access to well maintained green and open spaces.

### Indoor and outdoor air pollution

Outdoor air quality in the UK has improved substantially over the past few decades and is generally very good, although there remain some areas (mainly in cities) where not all the relevant standards are met. Our understanding of indoor air quality is less well developed, although the recent ban on smoking in public places in the UK will result in reductions in children's exposure. The priorities identified include:

- developing a coordinated policy approach to indoor air quality;
- further protecting children from exposure to environmental tobacco smoke; and
- improving understanding of acute and chronic carbon monoxide poisoning.

### Chemical, physical and biological hazards

- Children's exposure to hazardous chemical, physical and biological agents has been decreasing. Particular success has been seen in reductions in exposure to lead, some persistent organic pollutants (e.g. dioxins), and a decrease in unintentional poisonings. However, some areas of concern remain, particularly the continued rise in skin cancer amongst young adults. Areas identified as priorities include:
- improving surveillance and understanding of childhood poisonings;
- ensuring a coordinated approach to monitoring chemical exposures;
- improving sun protection behaviour amongst children and young people;
- ensuring children are fully taken into account in emergency planning exercises; and
- ensuring children are protected from noise, particularly in educational settings.

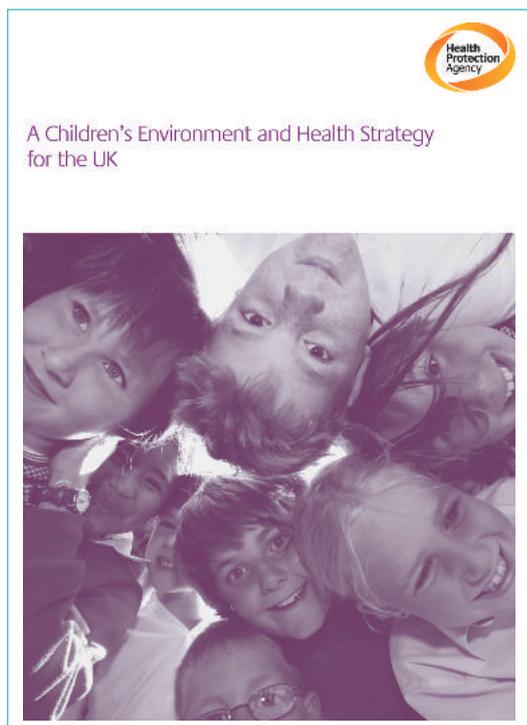


Figure 3: A Children's Environment and Health Strategy for the UK (available on request from [cehape@hpa.org.uk](mailto:cehape@hpa.org.uk))



Figure 4: Improving surveillance and understanding of childhood poisonings has been identified as a priority

### Over-arching issues

A number of over-arching issues were identified that impact on all of the key areas of the Strategy. Ensuring inequalities are addressed and that children in lower socio-economic groups are not disadvantaged was an important issue, but considering settings (e.g. the home, outdoors or the school) was also considered important, rather than necessarily taking a hazard based approach. Sustainable development

and its links with child health is also mentioned, as is taking into account emerging issues, such as climate change and new technologies (e.g. WiFi and nanotechnology), and considering the impact of the environment on the mental health and well-being of children and young people.

### Moving forward – taking action to improve children's health

The recommendations made in the Strategy will need to be addressed at a local, regional and/or national level. Different approaches will be taken to address these recommendations within England, Northern Ireland, Scotland and Wales. In order to encourage uptake of the recommendations, a coordinated approach will be required. This will take account of on-going initiatives and policies and avoid duplication or overlap of efforts. The HPA, in particular through the Local and Regional Services, will take forward relevant recommendations (e.g. contributing to good hygiene in schools through a hand-washing initiative) aimed at reducing the environment-related burden of disease and injury amongst children and young people.

The UK, along with the other 52 countries in the WHO European Region, is due to report back on progress in meeting its commitment to CEHAPE at the next WHO Ministerial Conference on Environment and Health, to be held in Italy in 2010.

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### Acknowledgements

The Health Protection Agency gratefully acknowledges the funding provided by the Department of Health and the Department for Environment, Food and Rural Affairs to undertake this work. We also gratefully acknowledge the input of the Interdepartmental Steering Group on Environment and Health for providing advice, comments and assistance in developing the Strategy and the input of children and young people throughout the Strategy's development.

Copies of the Children's Environment and Health Strategy are available on request from: [cehape@hpa.org.uk](mailto:cehape@hpa.org.uk)

# British Paediatric Surveillance Unit (BPSU) study on elevated blood lead concentrations in children

## Elevated blood lead in children project group\*

### Background

Public health interventions have succeeded in removing many sources of lead from the environment with resultant decreases in mean population blood lead levels in the UK. However, a small proportion of children may continue to be exposed to harmful levels of lead, usually in the home. There are currently limited data in the UK and Ireland on the incidence and/or sources of significant lead exposure. Exposure to lead in children has been associated with a range of adverse health effects from encephalopathy to clinically apparent or sub-clinical neurodevelopmental impairment. A recent case series indicates that obstacles may be encountered in the effective and timely management of cases<sup>1</sup>.

### Aims and objectives

The core surveillance objectives and aims of this study are:

- To report the incidence of clinically diagnosed blood lead concentrations  $\geq 10\mu\text{g/dl}$  in children in the UK and Ireland, including distribution by sex, age, ethnicity and clinical presentation.
- To describe the management and short-term outcomes at one year after diagnosis of elevated blood lead concentrations ( $\geq 10\mu\text{g/dl}$ ).
- To report the proportion of cases in whom a source of exposure was identified and to describe the main sources of exposure to lead in these children.
- To raise awareness among paediatricians about the clinical presentation and management of lead exposure in children, including the involvement of clinical toxicologists and public health and environmental health professionals in contact-tracing and exposure remediation.

### Methodology

The proposed project will include all children <16 years of age with elevated blood lead levels ( $>10\text{mg/dl}$ ) on the BPSU monthly notification card for a period of two years. Paediatricians will be sent a 12-month follow-up questionnaire for each notified case. To ensure maximum capture of cases, the proposal includes parallel reporting from the Supra-Regional Assay Service (SAS) trace metals laboratories, clinical toxicologists across the UK (via their professional network), and the National Poisons Information Service. The project has been approved by the Executive Committee of the British Paediatric Surveillance Unit (BPSU) and subject to research ethics approval is scheduled to commence in November, 2009.

### Key benefits for public health

Identified cases of clinically recognised elevated blood lead concentrations represent preventable morbidity, hospital admissions and irreversible cognitive impairment with resultant impacts on individuals, family and society.

The study will increase awareness and understanding of continuing clinically relevant environmental lead exposure amongst children and will inform health policy, including clinical guidance for paediatricians managing cases and the dissemination of information about lead to parents and the public.

Data gathered during this surveillance study will enable us to estimate the incidence of clinically recognised elevated blood lead concentrations in children in the UK and Ireland, report the distribution in the population and describe the possible sources of environmental exposure. These findings would inform health promotion policy, and the development of clinical guidelines for paediatricians for the investigation and management of such cases in future. Follow-up data obtained through the 12 month questionnaire would enable us to describe short-term outcomes, including changes in blood lead concentrations, and the involvement of wider professionals in remediation of the source of exposure, information that would inform future health protection strategies.

The lead action card<sup>2</sup>, developed by the HPA, outlines a “best practice” approach to the management of clinically recognised cases and demonstrates that the identification and subsequent remediation of exposure requires joint working between clinicians and HPUs. An additional benefit of the study would be to increase awareness amongst paediatricians that public health practitioners have a crucial role to play in the management of such cases including the coordination of environmental sampling, liaison with environmental health officers and subsequent remediation of source. It is also hoped that this will help to open the debate on other environmental hazards to children in the UK and form the basis for future studies which may further quantify lower levels of exposure to environmental trace elements through cross-sectional population-based surveys and audit the health protection response to environmental contaminants affecting children.

### Key benefits for HPA

#### Pilot for the use of the BPSU for surveillance of chemical exposures.

A significant proportion of BPSU projects are HPA-led; however, all current HPA programmes relate to infections. Institutional experience of the BPSU within CHaPD will facilitate the development of a BPSU project should this need to happen within a short time frame, as with a CBRNE incident.

#### Improve operational response

Evidence from the case series indicates that there is scope for improving the public health response to cases of chronic exposure to lead in children. The project will provide data for the development of evidence-based guidance for CHaPD and LaRS, for Local Authority management of cases via the Chartered Institute for Environmental Health, and for the Royal College of Paediatrics and Child Health via Prof. Alan Emond. The project will act as a pilot for the use of parallel reporting from the laboratories, building this relationship ahead of roll-

out of the European Pilot for Biomonitoring (led by Dr Ovnair Sepai, HPA). The project will use parallel reporting from NPIS and clinical toxicologists; optimising linkages with these professionals will be of benefit both to CHaPD and to the HPA as a whole.

#### **Supports capacity building of CHaPD surveillance and environmental epidemiology**

One of the aims is to produce incidence data for elevated blood lead concentrations in children for the UK and Ireland, which may be used as an Environmental Health Indicator. This information is not currently available so these results will be of interest in planning services for children with elevated blood lead concentrations and will also be of International interest. The outcomes link directly to the HPA's Children's Environmental Health Action Plan for Europe programme.

#### **Supports HPA inter- and intra-agency working, and improved liaison and information sharing with Devolved Administrations and the Republic of Ireland**

The project team is multi-disciplinary and the project will involve intra- and inter-agency working. This project is an excellent demonstration of cross-LaRS and CHaPD collaborative working, and has the explicit support of the HPA NIEH group. The BPSU covers the whole of the UK and the Republic of Ireland. The Public Health consultants' environment specialist group in the Republic of Ireland has been approached and agreed to support the proposal.

#### **Supports the corporate aim to strengthen the front line and engage with the public**

Public consultation is one of the requirements of any BPSU study. Agreement has been reached with the Head of the HPA Public Engagement Panel that consultation will take place through this system. Ideally, the HPA website should be a 'one-stop-shop' for all health related information around non-infectious hazards such as lead, and this information should be developed in consultation with the end-user (parents, or parents-to-be). Currently, the "information for parents" section of the HPA website includes links to infections such as measles but not to non-infectious hazards.

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# Geographic Information Systems: developments in the Chemical Hazards and Poisons Division

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## Introduction

Geographic Information Systems (GIS) are used for integrating, storing, editing, analysing, and displaying geographically-referenced information. Most data we deal with in our roles as environmental health protection specialists have a spatial element to them: where symptomatic patients reside; where an event took place; where the exposed people are or have been; and so on. Using GIS, it is possible to combine large amounts of data, visualise them in interactive maps and interrogate them in a spatial manner which otherwise would be extremely difficult. Such analyses provide valuable knowledge and information in a variety of circumstances, ranging from risk assessments in high pressure situations such as when responding to acute chemical incidents, to spatial analysis of disease patterns in epidemiological research.

Outputs from GIS are now routinely used in many sectors, for example by the Environment Agency in the What's in your Backyard facility<sup>1</sup> and by the Office for National Statistics within the Neighbourhood Statistics service<sup>2</sup>. The use of GIS to integrate health datasets with other geographic data is common practice, both within the NHS and by academic units. For example, mapping datasets such as Hospital Episodes Statistics, geodemographic and public health data, such that the spatial patterns can be visualised, can expose inequalities in health service provision and inform the commissioning of services<sup>3</sup>, and health profiles based on geographic regions display differences in health status across England<sup>4</sup>.

The aim of this article is to provide an update with regard to GIS developments that are now available to the Chemical Hazards and Poisons Division (CHaPD) of the Health Protection Agency (HPA). But first, a few words about GIS in the HPA.

## GIS in the HPA

The GIS team in the HPA's Local and Regional Services' Emergency Response Department (LaRS ERD) in Porton Down leads corporate GIS activities in the HPA. The team was originally formed to develop and apply GIS to tackle emerging infectious disease threats and other types of emergencies - including those posed by bioterrorism. Its function has now expanded to support HPA Emergency Response and to provide an Agency-wide GIS mapping and support service.

Acting as Pan Government Agreement "Liaison Officer" on behalf of the HPA, the GIS team receives the full range of digital mapping datasets available under the Agreement. Other datasets (e.g. environmental, health, demographic, service location and infrastructure) are also acquired on an ongoing basis for health

protection - and these are incorporated into several replicated centrally managed GIS databases. Access to the GIS database is made available to GIS users at different Agency sites via GIS desktop software. Web based mapping applications and services are soon to be launched. Data are also distributed to non-connected users as custom map extracts. The team represents HPA interests such as negotiating on new dataset agreements with the Department for Communities and Local Government (DCLG); attending meetings of the Intra-Governmental group on Geographic Information (IGGI) and Association for Geographic Information (AGI); and keeping abreast of GIS technology and developments.

## GIS in CHAPD

CHaPD operates from eight offices throughout England and Wales, each serving a specific geographic region, with its headquarters co-located with the Radiation Protection Division (RPD) in Chilton, Oxfordshire. Together, CHaPD and RPD make up the Centre for Radiation, Chemical and Environmental Hazards (CRCE). GIS has been used in CHaPD for a number of years by a handful of users mainly, it is fair to say, in isolation on individual projects. For example, CHaPD-Nottingham uses GIS to map the location of environmental hazards such as COMAH (Control of Major Accident Hazard) sites in their region, CHaPD-London has used GIS for exposure assessments during research projects<sup>5</sup>, and CHaPD-Chilton has used GIS for research into environmental inequalities<sup>6</sup> and the periodic analysis of populations potentially exposed to chemical incidents<sup>7</sup>.

## Developments to date

The power of GIS is fully recognised in CRCE, and in summer 2007 initial steps were taken towards increasing its availability and use through a joint business case with the team based at Porton Down, which would benefit both centres. A project was initiated that was to extend the GIS capability existing at Porton Down to CRCE. This was achieved through introduction of a mirrored server at Chilton in Autumn 2008. The new CRCE GIS server is an exact replica of the server in Porton Down, resulting in great benefits to both sites: CRCE GIS users now have direct access to the myriad datasets available to HPA; newly developed customised GIS tools can be shared easily across the two centres; and resilience has been secured whereby if the LaRS ERD server should go down, users can connect to the CRCE server and vice versa - invaluable in the case of an emergency situation. The GIS environment is managed by the LARS GIS team - but CRCE users have flexibility to develop GIS tools for their own requirements. The installation of the mirror server and the recruitment of a dedicated GIS scientist in CHaPD-Chilton have opened the door for coordinated GIS development work within the Division (CHaPD), Centre (CRCE) and cross-Centre (CRCE/LaRS ERD).

## Future aspirations

CHaPD aims to widen GIS accessibility for all its scientists through collaboration with the LARS ERD GIS team. At present only the Chilton

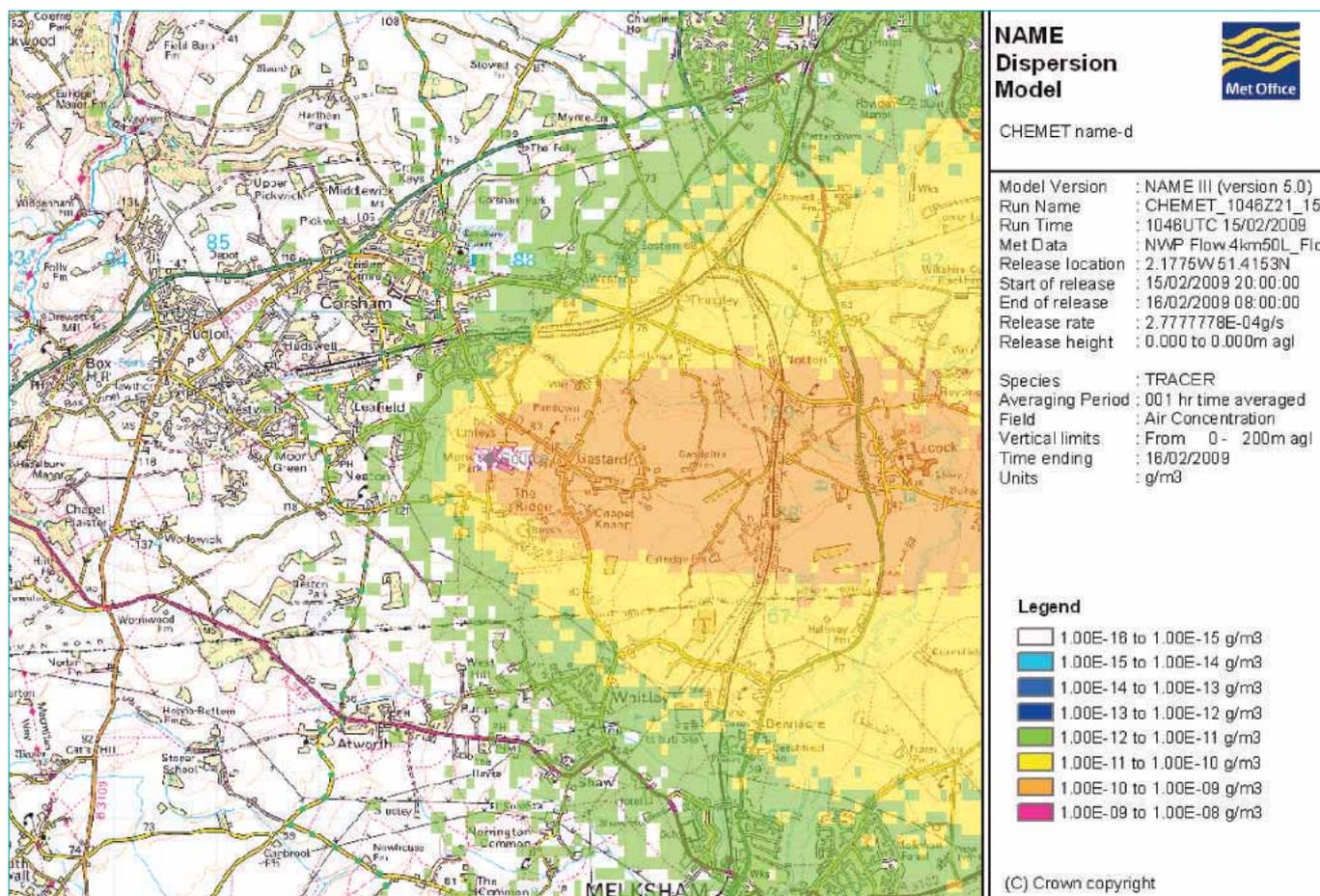


Figure 1: Plume dispersion modelling results from the Met Office (© Crown copyright, Met Office)

office has direct access to the GIS capability, via the mirror server. Therefore, in the first instance, GIS support can be provided from Chilton to the CHaPD regional offices. In the future, it is hoped that CHaPD and LaRS ERD will work together to deliver a GIS capability to all CHaPD offices by either or both of the following means: direct access to the LaRS ERD GIS servers using ArcGIS desktop software; or access via a web-based application. There are pros and cons with both options.

The former means that the regional office will have access to the same mapping data and GIS functionality as Chilton (and LaRS), with the analytical power of desktop GIS. This comes at a cost, since a full, up to date ArcGIS licence would be required for each user and good HPA network capability is necessary, which may require upgrading to cope with such use. Users would also require a certain level of GIS expertise to use the software, though it is hoped that additional customised tools will be built collaboratively by the LaRS ERD team and CHaPD GIS scientist to carry out the most common tasks required.

The latter option would give easy access to a customised web-based application, available anywhere via a URL (website). Functionality would be limited by the number of customised tools developed and placed on the site, however, it is envisaged that it will be tailored to serve the exact requirements of CHaPD scientists, particularly for incident response purposes. This option is cheaper for the end user (free!) since no licences are required, and easy access to the tools via a web connection means it would be ideal for out of hours incident response when scientists are working away from the office. The CHaPD chemical incidents web mapping application will benefit from developments LaRS ERD are making towards deployment of an Agency wide web mapping application. The two applications will

share the same underlying mapping data and a number of common mapping functions.

The usefulness of GIS for managing a chemical incident has led to a project, currently underway, to incorporate GIS functionality into the Division’s web-based chemical incident database, used to log information about an incident in real-time. This service will aid staff to identify populations at risk and identify key organisations by an improved understanding of the geographical location of the incident. It is envisaged that GIS will not only be used for the risk assessment process, but will store and retrieve useful information such as emergency out of hours contact details for both HPA and partner organisations. A series of GIS demonstrations has been held where scientists were able to feed in their particular requirements for the developments of GIS functionality specific to CHaPD requirements.

### Recent examples of GIS in CHaPD

GIS use within CHaPD can be categorised broadly into two main types: emergency preparedness and response; and Environmental Public Health Tracking (EPHT).

#### Incident response

CHaPD responds to chemical incidents on a daily basis. These range from small contained incidents which are unlikely to have public health implications, such as mercury spills from broken thermometers in the home, to large uncontained incidents, such as chemical fires emitting large plumes, or leaks and spills that escape into public places with potential large public exposures. The role of



### Monk's Park site showing locations for sampling - closeup

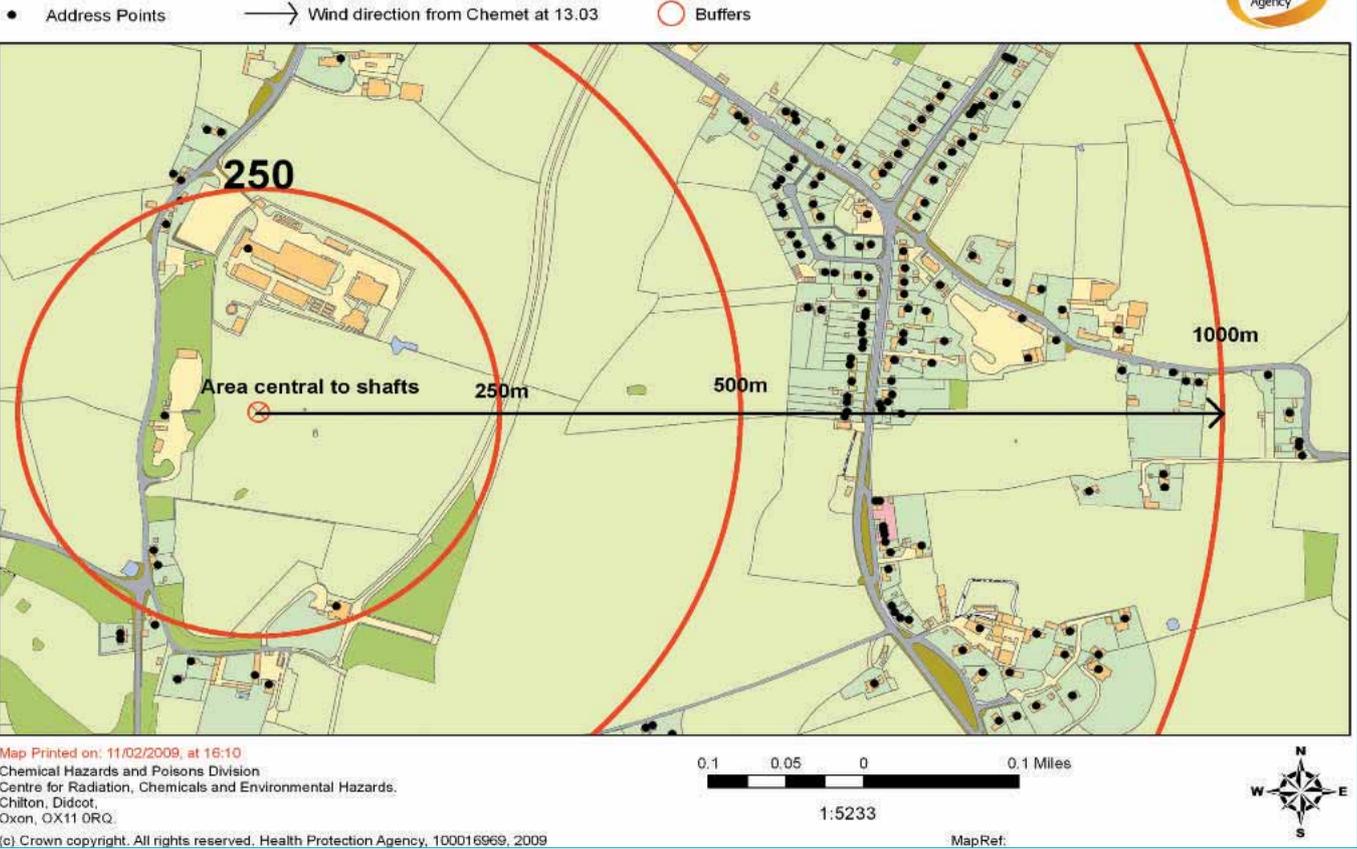


Figure 2: Map showing distance in metres from the source of the plume to residential populations in the direction of the plume.



### Morpeth: flood zone and historic landfill sites

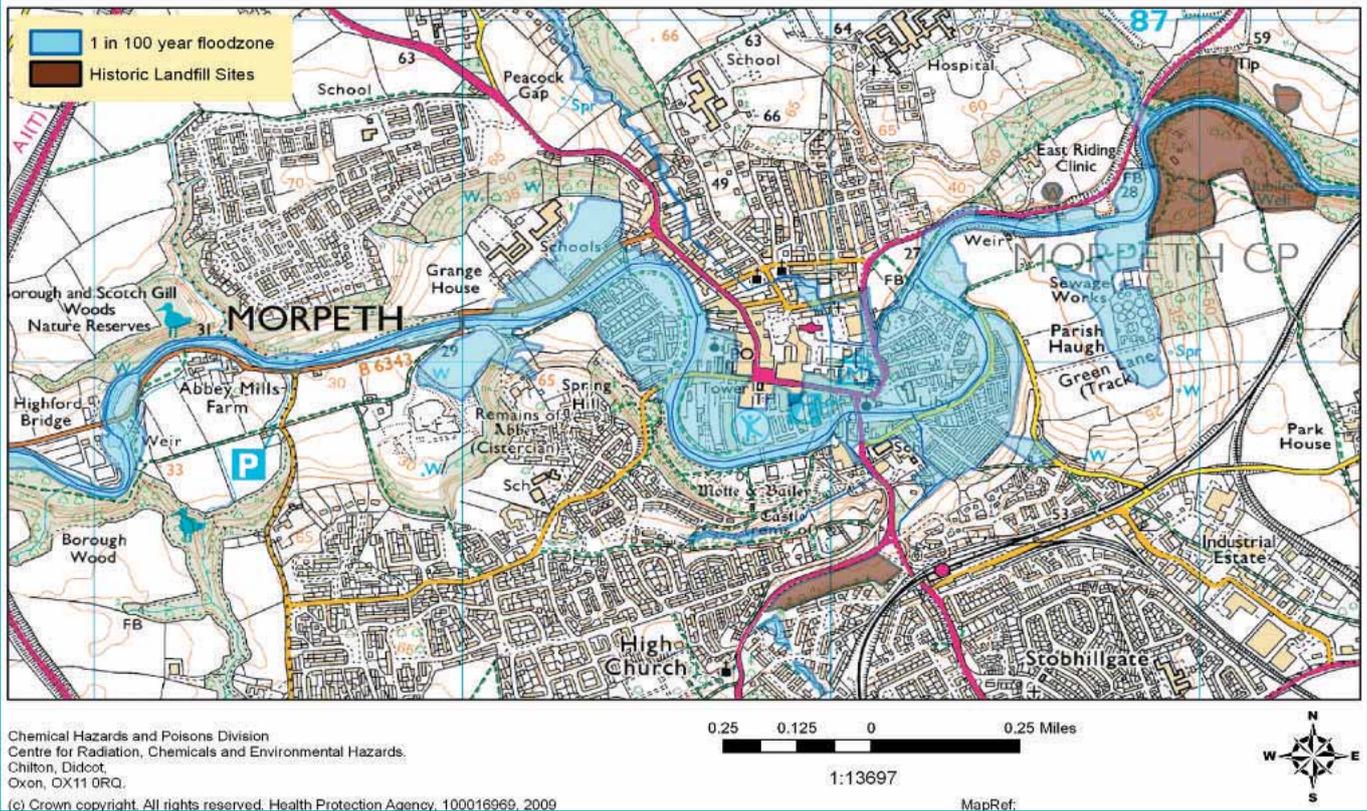


Figure 3: Map depicting the extent of the 1 in 100 year flood risk zone along with the position of historic landfills. (Flood zones and historic landfill data provided by the Environment Agency, copyright Environment Agency, 2009)

CHaPD in such incidents is to provide support and advice to aid risk assessments by those at the front line, including staff in HPA Health Protection Units. Such acute incident response requires rapid identification of the location, being able to visualise the scene, the surroundings, sensitive receptors and likely population exposure risks. GIS is a tool which can provide a picture of the scene to aid in this risk assessment process. Locator tools in the GIS can find the exact location on an interactive map, and layers of additional information can be added as required. For example, one can: plot the direction of travel of any plume associated with the incident; estimate the potential population around the incident and potentially within the plume; plot locations of vulnerable groups such as nurseries, primary schools, hospitals; and locate other hazardous sites in the vicinity which may be at risk should the event increase in size. The potential resident population within a possible evacuation zone can be visualised and enumerated.

The map in Figure 1 was produced by the Met Office in response to an underground fire in an old mine currently used as a storage depot. The fire was, at this time, contained underground, and a risk assessment was being undertaken to assess the potential public health implications should the plume be vented above ground. The Met Office modelled the likely direction and spread of the plume. The map in Figure 2 was produced by CHaPD, to ascertain where air quality sampling might be needed during venting to confirm/confute the presence of contaminants in the air and assess likely population exposure. In the future, through partnership working with the Met Office, it is hoped to be able to import their modelled plume data directly into HPA's GIS, so that all the relevant information can be combined in one comprehensive map.

### Emergency preparedness

In September 2008, Morpeth (Northumberland) suffered severe flooding. The CHaPD unit providing support requested maps to illustrate the possible extent of the flood and to highlight any chemical hazards that might be affected or disturbed by the flood water (Figure 3). By having instant access to the GIS databases, which store information on chemical hazards, it was possible to create maps of the area immediately. From the information held by HPA it could be identified that there did not appear to be any hazardous chemical operators in the area, that the sewage treatment works was potentially under threat from flooding (middle right), and that the historic landfill sites in the area were potentially outside the area at risk from flooding. This map, together with other risk assessment tools and local knowledge were used by the HPA and other multi-agency responders to consider potential risks from chemical contamination during and after the flooding event.

### Environmental Public Health Tracking

EPHT involves "the ongoing collection, integration, analysis, and interpretation of data about environmental hazards, exposure to environmental hazards, and health effects potentially related to exposure to environmental hazards"<sup>8</sup>. It includes dissemination of information learned from these data.

GIS is ideal for the combination of data on environmental hazards and exposures, potentially-related diseases, demographic, environmental and geopolitical data. The GIS environment allows sophisticated spatial and temporal analyses to identify, source and quantify the impact of environmental health exposures and facilitates targeting and monitoring of interventions.

As part of its EPHT programme, CHaPD has piloted, in the West Midlands, the use of different methods of surveillance of environmentally related disease using GIS including indirect standardisation, kernel density contouring and statistical control charts. For example, indirect standardisation applies the age-specific disease rates of the standard population to the study population to give an expected level of activity based on the assumption that the experience of the study group is the same as that of the standard population. Indirect age sex standardised ratios stratified by deprivation and 99% confidence limits were calculated for Super Output Areas using the West Midlands Region as the reference population. Areas with significantly elevated or reduced disease rates can be mapped and should be targeted for further in depth investigation to ascertain whether there may be environmental factors leading to these 'anomalies', which require intervention.

### Further information

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### Acknowledgements

Thanks are extended to CHaPD and LaRS ERD colleagues who provided helpful comments in the preparation of this article. Also to the Met Office for Figure 1 and Leslie Jones of CHaPD for Figures 2 and 3.

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# Natural Hazards and Climate Change

## The global threats of climate change

**Rob Varley**  
**Director of Government Services, Met Office**

### Introduction

Climate change has been described as the world's greatest threat to human health<sup>1</sup>. It poses risks that have the potential to affect every person, in every country, in every aspect of our lives unless urgent and decisive action is taken.

Reducing carbon emissions is the only way to mitigate the risks and limit the effects of climate change. Evidence shows we are already locked in to significant warming, however, so we must also make plans to adapt to the effects of the warming which will inevitably occur<sup>2,3,4</sup>.

To ensure an effective response, decision makers must have a clear understanding of global warming and the threats at stake. As a world leader in climate research, the Met Office plays a central role in this field. Our pioneering work, led by some of the world's foremost experts and supported by state-of-the-art technology, is helping to shape an ever clearer picture of what effects climate change could have on our lives.

### The present reality

To begin to understand the potential threats of climate change, we must first understand the current position. Temperatures provide the clearest proof and globally the average annual temperature has risen by more than 0.7°C over the last 100 years<sup>5</sup>. Observations show temperatures are continuing to increase, having risen by about 0.15°C per decade since the 1970s. This has resulted in the 17 warmest years on record occurring in the last 20 years<sup>6</sup>.

Signs of this change in temperature can already be seen. There has been some glacial melting, and Arctic summer sea-ice cover has shrunk by about 20% over the last 30 years. There has been a 10% reduction in snow cover since the late 1960s. Sea levels around the UK have risen 10cm since 1900 and the rise in recent decades has been faster than previously observed.

Weather patterns have also begun to change. In our own part of the world, the mid-latitudes of the Northern Hemisphere, precipitation has increased by nearly 1% per decade during the 20th century. Heavy precipitation events have increased by 2-4% in the latter half of the 20th century. The number of days we experience frost in Northern Europe has also decreased<sup>2</sup>.

Evidence shows these changes are well beyond natural climate variance. They are being driven by the emission of greenhouse gases (GHGs), mainly from the burning of fossil fuels. Levels of carbon dioxide, methane, and nitrous oxide are now much higher, and increasing at a much faster rate, than at any time in the last 600,000 years<sup>2,7</sup>.

### The future prognosis

In order to reduce the risks posed by climate change, it is clear that swift and significant reductions in GHG emissions are vital. Despite an increasing international focus on this area, however, they have continued to rise thus far. Existing international targets aim to halt this increase and begin decreases over the next decade, but these are challenging objectives.

Met Office research shows that even with rapid reductions in emissions over the next decade there is a 50% chance global temperatures will rise more than 2°C. Vicky Pope, head of climate change advice at the Met Office, said this forecast was based on emission reductions which would be difficult to achieve. She said: "The science tells us that we should continue to work to reduce the chances of global temperature rises going above 2°C. However, if the world fails to make the required reductions, it will be faced with adapting not just to a 2°C rise in temperature but up to 4°C or more by the end of the century."<sup>8</sup>

This level of temperature rise could lead to further problems which exacerbate climate change, known as positive feedback. Examples of this include drying out of rainforests such as parts of the Amazon<sup>9</sup>, which would greatly increase fire risks – potentially unleashing huge quantities of stored carbon. Melting of permafrost in Siberia would also see high concentrations of carbon stored within the permafrost released as methane, a highly potent GHG<sup>10</sup>.

Even if temperature increases are limited to 2°C, this would constitute the biggest change in our climate for at least 10,000 years. Many societies and ecosystems will struggle to adapt to the rapid changes, as access to water, food production, health, and use of the land and environment are all threatened<sup>3</sup>.

### The global threats

Global weather patterns will be fundamentally changed by climate change. Put simply, a warmer climate means warmer weather, but there will also be other changes. Precipitation in some areas will decline sharply, while it will increase elsewhere. This will affect river flows, with some rising to dangerous levels, while others will dwindle or dry out<sup>11</sup>.

Higher temperatures will cause glaciers, permafrost and sea-ice to melt, raising ocean levels. Thermal expansion, where oceans expand as temperatures warm, will add to these increases. Extreme weather events, such as storms and tropical cyclones, are also expected to increase in magnitude due to a warmer climate<sup>12</sup>.

These various changes in climate and weather could result in serious consequences for populations across the world:

**Heat and heat waves** – already hot climates could become uninhabitable as temperatures increase. Even in more temperate

climates, such as Northern Europe, the number and intensity of heat waves is set to increase significantly. This will put pressure on a range of areas:

- health services will see surges in demand as people suffer the effects of heat;
- maintenance costs for transport networks could soar as the heat threatens the integrity of the infrastructure;
- energy consumption could spike as people turn to air conditioning to stay cool;
- demand for freshwater may rise beyond supply.

**Flood** – sea level rises, changes in precipitation patterns, and a greater number of extreme weather events could all increase the number of flooding incidents. Some coastal areas could become permanently uninhabitable, while others will face regular flooding.

**Drought** – changes in precipitation patterns and river flows could see some areas face acute water shortages, particularly those which are already water stressed – according to Oxfam, more than three billion people in the Middle East and the Indian sub-continent could be facing acute shortages of water<sup>12</sup>. Areas which rely on rivers fed by glacial melt could see shorter term rises in water levels, but as glaciers disappear, levels would become more variable.

**Famine** – increasing temperatures will change agricultural productivity levels. Some areas will see increases in their yield, while others will see decreases which could bring about localised food shortages.

Disruption caused by flooding or other extreme weather events may also disrupt food supplies, creating humanitarian crises.

**Disease** – we have already seen vector-borne diseases from hot climates begin to spread north as temperatures increase, such as the cattle-infecting bluetongue virus. This trend is set to continue under global warming. Met Office research shows there will be an increase in the area of potential malarial zones by up to 25%. Increased incidences of flooding and drought could also create conditions for disease to spread<sup>13</sup>.

**Political tension and war** – climate change will put pressure on food and water supplies, and could force millions of people to migrate. This could create political tensions which may even break out into conflict. Oxfam predicts there could be more than 150 million environmental refugees by 2050, largely due to climate change.

**Biodiversity** – up to 30% of known species are likely to be at an increased risk of extinction if temperatures rise by 2°C.

## UK impacts

A focus on Europe and the UK brings a more specific picture of the threats of climate change. A 2°C rise averaged across the globe will actually result in a 3°C rise in Europe because large land-masses warm more than oceans. This brings us to a 3°C rise over Europe by 2050.

To put that into context, the record breaking summer experienced across Europe in 2003 led to 30,000 heat related deaths, put stresses on health services, transport and energy infrastructures, and water supply. The summer average temperature rise that year was about 3°C; exactly the same as climate projections say will be normal over Europe by the 2040s. So heat waves such as experienced in 2003 could happen every other year by the 2040s<sup>14</sup>.

Climate models suggest the UK will experience far drier summers and far wetter winters under climate change. Even in summer, however, there will be a much greater chance of heavy and localised rainfall – which will increase flooding risk. In 2007, floods caused an estimated £3 billion of damage in the UK and caused severe disruption to the country<sup>15</sup>.

Coastal flooding will also be a concern with ocean level rises and an expected increase in the magnitude of storm surges by up to 1 metre by 2080. This could create the need for domestic migration, aggravating population density issues. This could be further exacerbated by inward migration pressures from those areas which have been affected more seriously by the warming climate, further straining our infrastructure and availability of resources<sup>16</sup>.

## Conclusion

Just as there's no avoiding climate change, there are no quick-fix solutions to the problems it engenders. It will take many years to make the necessary changes to reduce risks and adapt to what is to come. The Met Office is helping today, however, by using our knowledge and expertise to provide tailored advice to help governments, businesses and individuals make informed decisions about their future.

## Case studies: Adapting to the threats of climate change

Here are just a few examples of the ways in which the Met Office is helping people prepare for the future:

### EP2 – impacts on the energy industry

Met Office scientists worked with experts from several UK energy companies to see how climate change would affect power generation, distribution, transmission and demand, helping develop practical applications and business strategies for a changing world. This resulted in a range of tailored advice, from how changing wind patterns will affect the potential of wind power, to modelling future soil changes and their impact on cables. An energy and climate change industry group has now been set up to share the latest knowledge.

### DWP – policy and services in a changing climate

The Met Office advised the Department for Work and Pensions (DWP) on how the demands on their services could change and compiling a range of measures to help them adapt for the future. Examples of findings included the potential need for a shift from the current cold weather payment, issued to help vulnerable people pay heating costs when it's particularly cold, to hot weather payments, helping people pay for air conditioning bills during heat waves. The advice highlighted key areas for the department's future planning.

### TE2100 – flooding and climate change

Climate science from the Met Office played a key role in the Environment Agency's study into future flood risk in the Thames Estuary. Glacial melting, thermal expansion of the oceans, changing precipitation patterns and the future number and intensity of storm surges were all factored into calculations of worst case scenarios for sea-level rises and flood risk. These provided vital benchmarks for the ensuring flood defences can cope with the changes, helping the Environment Agency continue to plan flood investment management with confidence.

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# Second Session of the United Nations International Strategy on Disaster Reduction (UN ISDR) Global Platform for Disaster Risk Reduction (16-19 June, 2009), Geneva Switzerland

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**Global Platform for Disaster Risk Reduction**  
Second Session, Geneva, Switzerland  
16 - 19 June 2009



The Second Session of the Global Platform for Disaster Risk Reduction in June was a superb and fascinating meeting providing exciting opportunities for multi-disciplinary and multi-sectoral working<sup>1</sup>. Relatively few medical professionals were in the audience of over 2,000 participants, which included 146 government, 54 international UN groups, 43 non-governmental organisations (NGOs) and 50 permanent mission representatives, but all were able to share expert experience with our colleagues. It brought together a wide cross-section of the global disaster risk reduction community, including heads of State, senior ministers, UN agencies, NGOs, scientific and technical experts, and others (Photograph 1).

Under the slogan 'invest today for a safer tomorrow', a key focus at the event was close scrutiny of the linkages between climate change adaptation, poverty and disaster risk reduction. The Platform took place in a context of growing alarm about global climate change and increasing disaster risks. In the opening high-level panel of the Global Platform, political leaders, including heads of State and heads of Governments, highlighted in stark, unequivocal terms that reducing disaster risk is critical to managing the impacts of climate change and avoiding an erosion of social and economic welfare. The programme revolved around plenaries, both formal and informal, special events, roundtables, the market place to show the work of many groups, statements from all the countries represented and media issues.

Reports were presented of work completed from the previous two years following the first Global Platform in 2007. These included the report from the UN ISDR Science and Technical Committee on which I am fortunate enough to sit as the UK representative. The report on 'Reducing Disaster Risks through Science: Issues and Actions' was well received and it was apparent that UN ISDR wishes for considerably more scientific and technical input by this committee over the next two years<sup>2</sup>. Indeed the Global Platform highlighted the importance of education and sharing knowledge, including indigenous and traditional knowledge, and ensuring easy and systematic access to best practice and tools and international standards, tailored to specific sectors, and to necessary cross-border data. It also stressed the necessity for investment in research and development and higher education, and for the more effective integration of science and technical information into policy and practice.

The main five High Level Panel discussions held over the four days focused on progress in implementing the Hyogo Framework for Action (HFA)<sup>3</sup> priorities by addressing financing disaster risk reduction through safer institutions to accelerating community resilience and recovery. Panellists were drawn from Governments, international financial institutions, UN and civil society to identify gaps and challenges and recommend ways forward to accelerate action at all levels.

- Increasing Investment for Risk Reduction<sup>4</sup>
- Reducing Disaster Risk in a Changing Climate<sup>5</sup>
- Enabling Community-Led Resilience Through Preventive Action<sup>6</sup>
- Safer Schools and Hospitals<sup>7</sup>
- Building Back Better: Disaster Risk Reduction and the Recovery Opportunity<sup>8</sup>

I was fortunate enough to be the moderator for the 4th Plenary Platform on Safer Schools and Hospitals (Photograph 2). Five superb speakers<sup>9</sup> developed the theme from the concept note<sup>10</sup> of the need for global safety of schools and hospitals. The speakers were:

- Dr Carmencita Banatin, Director of Health Emergency Management Staff in the Department of Health, Philippines
- Mr Gérard Bonhoure, General Inspector, Ministry for National Education, France
- Ms Laura Gurza Jaidar, General Coordinator of Civil Protection, Mexico
- Mr Sulton Rahimov, Head of the State Commission and Emergencies and Environment, Tajikistan
- Dr Eric Laroche, WHO Assistant Director-General, Health Action in Crises

In addition, Ms Zoubida Allaoua, Director of the World Bank, launched 'Guidance Notes on Safer School Construction'<sup>11</sup>. With the help of our presenters and valuable comments and questions from the floor, consensus for the concept note was achieved and the work will be taken forward.

At the conclusion of the Global Platform, a Joint Statement by the six members of the ISDR Management Oversight Board, The Way Forward<sup>12</sup>, was made. The six members include the World Bank, International Federation of Red Cross and Red Crescent Societies (IFRC), UN Environment Programme (UNEP), UN Development Group (UNDG), World Meteorological Organization (WMO) and Office for the Coordination of Humanitarian Affairs (OCHA). They state that there is a critical window of opportunity open globally to make 2010 the year of investment and action. They added that in order to halve the number of deaths from disasters and to reduce significantly economic losses by 2015, targets should be set as listed below.

- 1 By 2010, establishment of clear national and international financial commitments to disaster risk reduction, for example to allocate a minimum of 10% of all humanitarian and reconstruction funding, at least 1% of development funding, and at least 30% of climate change adaptation funding to disaster risk reduction.

- 2 By 2011, a global structural evaluation of all schools and hospitals and by 2015 firm action plans for safer schools and hospitals developed and implemented in all disaster prone countries with disaster risk reduction included in all school curricula by the same year.
- 3 By 2015, all major cities in disaster prone areas to include and enforce disaster risk reduction measures in their building and land use codes.

The Board recommends that to achieve these targets it requires development of comprehensive national disaster risk reduction programs; inclusion of disaster risk reduction in all national strategic initiatives, such as Poverty Reduction Strategies and National Development Plans; development of minimum safety net programs in the poorest and most vulnerable communities to increase basic resilience; and strengthening of early warning systems linked to strong community empowerment and preparedness.

The Board states that they will give full support to those who need it – by committing the six Board members' networks, resources and know-how (World Bank, IFRC, UNEP, UNDG, WMO, OCHA).

This was indeed a very important and committed outcome to a dynamic conference, with clear and important deliverables.



Photograph 1: Opening plenary of the Global Platform, Geneva, 16 June 2009



Photograph 2: Panel on High Level Plenary on Safer Schools and Hospitals, 18 June 2009

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# Finding ways to reduce risk from Natural Hazards through effective interdisciplinary science: report from an international expert workshop, May 2009

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## Background

A recent Nature Editorial (14 May 2009 'Bracing for the unknown')<sup>1</sup> called for scientists to 'rigorously assess the limits of their knowledge and communicate them to officials and the public' and to 'use a broad set of tools to prepare for hazards – a strategy that will make communities more resilient to different kinds of threat'. This is a clear call to arms for researchers to widen traditional perspectives on scientific research in natural hazards. The assumption here is that this will increase preparedness and thus reduce the loss of life and income associated with natural disasters.

This latest plea for an increased emphasis on widening perspectives, in tandem with a new honesty between researchers across disciplinary boundaries, is at the front of a 'tsunami' of initiatives designed to catalyse interdisciplinary work in this field. These stem from the shared belief that this provides the most effective form for research in this field. New strategies include the International Council for Science (ICSU)<sup>2</sup> and Integrated Research for Disaster Reduction (IRDR)<sup>3</sup> initiatives and much of the emphasis in the European Union Seventh Framework Programme (FP7) Natural Hazards program<sup>4</sup> is focussed on interdisciplinary work.

Yet little in the way of a blueprint currently exists for a shared methodological framework. This arises, in large part, from trying to integrate predominantly quantitative understanding of processes, probabilities and magnitude of natural hazardous phenomena with social scientific perspectives on the central importance of social, political, economic and cultural processes in risk characterisation and communication. There are few examples of genuine integration of these different theoretical and methodological approaches and the temptations to conduct apparently interdisciplinary research in parallel, but without informing one another's advances are great. These issues could be impeding progress in the field. Until the most effective way to conduct interdisciplinary research becomes clear there is little chance that the real potential for translating improvements in the characterisation and communication of risks into significant reductions of economic and human loss will be realised.

## International workshop

With these challenges in mind the UK Natural Environment and Economic and Social Research Councils and Department for Environment, Food and Rural Affairs sponsored a two-day expert workshop on 'The characterisation, communication and mitigation of risks arising from multiple hazards'. Thirty-one natural scientists, social scientists and 'end-users' from Europe, Canada and Indonesia met with the broad intention of discussing the next steps in defining an interdisciplinary research agenda that maintains a

strong focus on broadening, developing and evaluating methodological frameworks that can be used to reduce risk and curb losses in the face of natural hazards.

This was organised around a programme of nine invited presentations, revolving discussion groups and an expert elicitation individual exercise. The presentations and consequent discussion were used to define a common starting point across the variations in understanding of hazard, risk and vulnerability, learn about the state of the art in different disciplinary methodologies and, most importantly, explore examples of good interdisciplinary practice both from within the field of natural hazards and from other fields focussed on environmental change. These examples were then used to inform discussion on the second day. Three key themes were identified and explored: 'How do we integrate natural and social science methods and techniques?'; 'How well aligned are the basic research and policy relevant agendas?' and 'How do we define excellence in multi-hazards research?'. The content of the topics was deliberately overlapping. Discussion around this overlap, along with any reinforcement or contradictions in the data from the individual exercise, was used to identify the key foci to stimulate progress in interdisciplinary research in this area. These were:

### 1 The need for a co-productive approach.

The strongest endorsement that emerged at the workshop was for the sharing of knowledge and values between science, technology, experts, policy makers and civil society from the beginning and throughout a research project. Improving communication between differing disciplinary 'silos' and ultimately breaking them down emerged as a clear target for early progress in this area. Similarly, the need for this work to be 'problem driven', with a clearly identified geographical target (context and scale), was felt to be a requisite for successful new research in this area.

### 2 The importance of time.

A fundamental requirement of the co-productive approach is the time involved to share knowledge. The most successful examples of interdisciplinary research reviewed at the workshop featured a significant component of time set aside to allow for differing practitioners to learn from one another and to develop and evolve new research strategies throughout the course of the project. The complexities involved in bringing basic research into a closer orbit with shaping and informing policy and increasing societal resilience also had important demands on time. The implicit tension between the increased effectiveness of longitudinal studies in this field and the typical life-cycle of research grants was also uncovered and discussed.

### 3 Tension between traditional research excellence and research focussed on reducing loss.

The need to redefine 'excellence' in research was a recurring theme across discussion groups. New guidelines are needed to ensure the quality of programmes designed to increase societal resilience and preparedness. For fair assessment these standards

need to be appropriate to an interdisciplinary style of research and promoting effective science. Excellent interdisciplinary science could be defined as that which shows some combination of innovation in the practice of science and in the relationship between traditional disciplines, demonstrates technological advance or where the potential for uptake and active use of the research for risk reduction is high. Studies of this type should contain work that is sufficiently novel that it could be published in well regarded disciplinary journals.

## Conclusion

Clear evidence emerged at the workshop for the value of interdisciplinary research in producing advances in scientific understanding that are also effective in reducing loss. The most significant barriers to rapid progress in this field are the institutional inertia lying behind existing funding frameworks, and the compartmentalisation of research areas. With time and just a little patience in re-organising the way things work, rapid progress could be made in the genuine realisation of research programs that significantly improve mitigation and response to natural hazards.

### Acknowledgement:

Thanks to UK Natural Environment and Economic and Social Research Councils and Department for Environment, Food and Rural Affairs for providing financial support for the workshop.

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# Conferences & Workshops

## Asbestos contamination in soil: Highlights from a British Occupational Hygiene Society (BOHS) Seminar

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### Introduction

This BOHS technical seminar was held in February 2009 in London at the Society of Chemical Industry and attracted a full house of around 100 participants. The seminar dealt mainly with technical aspects of asbestos in soil, including analytical and geochemical elements but also offered an insight into forthcoming guidance on how asbestos contamination of soils might be addressed in the UK. Guidance is currently being developed by the Environment Agency (EA) with technical support from the Health and Safety Laboratory (HSL).

A summary of some key points relating particularly to public health aspects is presented in this review. Full copies of all presentations given at the seminar can be viewed on the BOHS web site at <http://www.bohs.org/eventDetails.aspx?event=166>

### Naturally occurring asbestos and other asbestos type fibres

Dr John Addison of the Institute of Occupational Medicine (IoM) gave two enlightening presentations. In the first, concerning naturally occurring asbestos, he questioned why in some localities there are high mesothelioma rates but without a history of asbestos industry or usage, citing a 2004 publication by Hamilton *et al* entitled "High incidence of mesothelioma in an English city without heavy industrial use of asbestos". Dr Addison speculated that other fibrous minerals (e.g. actinolites) are known to occur naturally in some locations (as in the South West England area covered in the Hamilton *et al* paper) and that mining etc and could also be a contributory risk factor for the local population.

His second presentation focussed on different asbestos type minerals; over 20 were mentioned, some of which could be linked to asbestos-like diseases. The following examples were cited.

- Fluoro-edenite (amphibole); elevated mesothelioma rates found in Sicily.
- Vermiculite; elevated asbestos-related disease rates around Libby mine, USA (both in miners and residents). Processing of Libby mine vermiculite had occurred all over the USA so there has been widespread contamination from this mined source.
- Rutile; a fibrous form of titanium dioxide (note TiO<sub>2</sub> is often used as a control dust in inhalation toxicity experiments), which has very durable, long, thin fibres.
- Erionite (a zeolite); highest mesothelioma rates in world in Turkey – not known to have been used in UK.

The presentation highlighted that many analytical technicians may mistake some of these fibre types for asbestos when they are not; and

that only asbestos is a regulated fibre. Dr Addison concluded his presentation by suggesting that it may not matter what the mineral is for ill health to occur – but perhaps all that is needed is the mineral's durability and the ability to form long thin fibres.

### Cambridge Rights of way study

Dr John Cherrie (again from the IoM) spoke about the Cambridge Rights of Way study which IoM had been heavily involved with, and he compared the results of the Cambridge work with a study conducted in Goor, Netherlands<sup>2</sup>. Goor is a town close to an asbestos manufacturing facility and waste asbestos was given away freely to the local population and put to a variety of uses in the locality. In a population of around 120,000, there were 28 cases of mesothelioma in women, of which only a few could be linked to possible workplace or work clothing exposure – this represented 22 excess cases in the community over 13 year period, possibly arising from environmental exposure to asbestos.

In the Cambridge study, where similarly, asbestos fragments had been used to construct farm tracks, paths and roads. Monitoring, exposure modelling and risk assessment carried out by IoM concluded there was a very low risk from the environmental exposure to asbestos. However, only 100 people were potentially exposed.

For the Cambridge work, IoM had developed a model for predicting asbestos fibre concentrations in air based on soil characteristics (friability, type) and weather patterns, which showed adequate comparability with monitoring results of the field study. Applying this IoM model to Goor, the cumulative exposure was estimated to be 0.11 fibre-years/ml. This translates to about 10 excess deaths over a lifetime in a population the size of Goor and so still leaves many deaths in Goor unaccounted for. It raises the question whether current risk assessment models underestimate risk at low levels of asbestos exposure.

### Asbestos in soil - monitoring, analysis and dustiness testing

Dr Gary Burdett from HSL also gave two presentations, one describing highlights of the 2008 Johnson Conference, a bi-annual gathering of experts in asbestos analysis and sampling and a second presentation on current developments in the UK on a methodology for assessing health risk from asbestos in soils.

Speaking about the Johnson Conference, Dr Burdett mentioned some interesting studies of assessing human behaviour on sites contaminated with asbestos and the innovative use of robotic "activity based sampling", e.g. simulating exposures during activities such as pram pushing (both for adult and baby), energetic sports activities etc, to try to obtain "realistic" fibres-in-soil to fibres-in-air information. Dr Burdett commented that the fibre size distribution

in air is not the same as fibre size distribution in soils. Geological mapping of asbestos contamination is being attempted in the USA using remote imaging spectroscopy, which can identify amphibole contamination from the air, but as Dr Burdett noted, not all amphibole minerals are asbestos.

In a later presentation he described work being carried out at HSL examining the factors influencing the relationship between asbestos soil levels and fibres in air concentration. Assessing the “dustiness” characteristics of soil was an important (but not exclusive) factor in the assessment process. Other factors to be considered included fibre durability, soil type, moisture content, unbound fibres, asbestos type etc. This technical work commissioned by the EA would form the scientific background to the guidance being prepared.

In respect of dustiness testing, the rotating drum method (European Standard EN15051) is the recognised procedure. Dr Burdett commented that dust levels of asbestos in air from soils can vary by five orders of magnitude. For instance, a level of 0.001% amosite fibres in soil can generate 0.2f/ml in air (e.g. higher than UK occupational exposure limit), while asbestos fragments in soils generate much lower level of fibres in air. Importantly though, fragments degrade with time (“big bits become little bits”) and so may be capable of releasing more fibres as they age. Consequently, risk assessments for asbestos containing materials (ACMs) in soils may only be valid at the time at which they are conducted, i.e. they are estimates of current risk and may not accurately predict future risk.

At the current environmental asbestos in air guideline of 0.001f/ml, a 20 year exposure gives a lifetime cumulative fibre dose of 0.02f-years/ml. This, as Dr Burdett pointed out, is three orders of magnitude below where the knowledge of quantitative human epidemiology ends (i.e. there are no epidemiological studies of cumulative doses below 10f-year/ml), and so there is much uncertainty around risks at these low level exposure estimates.

Dr Burdett also commented on Dutch risk assessment values for asbestos in soils, which were set at 0.1% for bound asbestos, and 0.01% for unbound asbestos. These were numerically quite high and were due to Dutch dustiness studies yielding much lower results than had been obtained in the UK by IoM – concentrations of 0.1f/ml in air had been generated from 0.001% asbestos in the UK, whereas similar levels had been produced from an asbestos soil concentration of 1% in the Dutch studies.

## Comments

A wealth of information was presented in some very well illustrated talks, which are well worth accessing from the BOHS website. Dr Burdett’s “integrated retained dose samplers” are particularly innovative!

(see [http://www.bohs.org/resources/res.aspx/Resource/filename/1341/contaminated\\_land\\_risk\\_assessments\\_\\_\\_garry\\_burdett.pdf](http://www.bohs.org/resources/res.aspx/Resource/filename/1341/contaminated_land_risk_assessments___garry_burdett.pdf))

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# Carbon Monoxide Poisoning – Whose problem is it? A workshop aimed at improving multi agency response in the North West, 18th November 2008

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Carbon monoxide (CO) is a colourless, tasteless, odourless, toxic gas produced by the incomplete combustion of gas or fossil fuels. Accidental exposure to CO kills on average 50 people a year in England and Wales and is responsible for 200 cases of recorded non fatal injury<sup>1</sup>. This is likely to be a significant underestimate of the problem.

Experience in the North West has identified some issues with the response to CO incidents including:

- confusion over the roles of the responding agencies, including which agency leads,
- failure to identify CO incidents,
- potential ongoing CO exposure if the source is not identified,
- lack of a systematic surveillance of CO incidents, so the true incidence is unknown.

The 'Carbon Monoxide Poisoning – Whose problem is it?' workshop was organised by the North West Health Protection Units (HPUs) and the Chemical Hazards and Poisons Division (CHaPD) Birmingham office to identify gaps in the current response to CO incidents, improve each agencies' understanding of their and others' roles and responsibilities, and help identify improved processes and thus improve the multi-agency response to such incidents in the North West.

The workshop, held at the Gujerat Hindu Centre, Preston, was attended by approximately 100 delegates including Local Authority Environmental Health and Housing Officers, the Health and Safety Executive (HSE), Fire and Rescue Services, Police, North West Ambulance Service, Accident & Emergency, Primary Care Trust and Health Protection Agency public health professionals. The day was supported by representatives from CHaPD, London Ambulance Service Hazardous Area Response Team (HART), the Council of Gas Detection and Environmental Monitoring (COGDEM), Bedford Scientific Ltd, the HSE and the Carbon Monoxide Consumer Awareness Alliance (COCAA).

## Presentations

Presentations ran alongside the workshop sessions. These provided an overview of the different agencies' roles during a CO incident, and current initiatives and proposals aimed at reducing CO incidents and exposure. Symptoms of CO poisoning were detailed along with current statistics and surveillance of CO poisoning. The need to improve incident surveillance through environmental and patient monitoring and the need to increase public and clinical awareness of potential CO hazards were also highlighted. Speakers on the day included Professor John Reid, Unit Director of Cheshire & Merseyside

HPU, George Kowalczyk, CHaPD (Birmingham), David Nice from London Ambulance HART, Dorothy Shaw for the HSE and Dr Isabella Myers, CHaPD (Chilton).

## Workshop sessions

Two workshop sessions were held. The first aimed to identify agency roles and responsibilities during a CO incident through discussion of different scenarios based on actual incidents. The second workshop, the key event of the day, aimed to capture initiatives to prevent CO incidents and to improve the multiagency response, management and investigation of CO incidents in the future. Suggestions for future partnership working initiatives were also requested. The main issues identified were: detection, notification, surveillance, intervention strategies and education. Key points and suggestions from each issue are detailed below. The report detailing full feedback from the workshop on the day will be published on the HPA website.

## Detection

The following points were suggested.

- First responders, including Environmental Health Officers should wear personal CO alarms to detect the presence of CO in premises they enter. This would improve the identification and reporting of CO incidents while protecting emergency staff.
- Hospitals should introduce patient monitoring to identify CO exposure. This would screen patients and also identify those with chronic exposure.
- An algorithm is required for accident and emergency staff to identify the symptoms of CO poisoning.
- Rapid identification of CO incidents requires critical questioning by ambulance control call centres. There is a need to link calls from the same or nearby locations that may indicate a CO (or other chemical) incident. Action cards and training for call centre staff are also required.
- Fire services carrying out home visits and undertaking a Fire Risk Assessment could also perform a CO risk assessment. Potentially they could fit CO detectors along with the smoke alarms currently fitted.
- CO alarms should be mandatory in public buildings such as hotels and restaurants and travel companies should be encouraged to promote CO alarms for use on holiday.

## Notification – Multiagency response

The following points were suggested.

- A mechanism needs to be developed to improve the multiagency response to CO incidents, in particular non-major incidents, to ensure appropriate agencies are involved. A multi-agency algorithm and action card detailing notification procedures, contact numbers and roles and responsibilities for each organisation is required.

- The HPA should have a co-ordinating role during CO incidents, liaising with NHS clinicians, laboratories and the relevant enforcing authority, either Local Authority or HSE. Confusion can arise over the appropriate enforcing authority during an incident, and this needs to be addressed.

## Surveillance

The following points were suggested.

- There is a need to improve recording of CO incidents through the collation of all agency surveillance data.
- Chronic CO exposure needs to be identified and reported.
- The HPA could develop a surveillance system, for example high blood carboxyhaemoglobin results identified at hospital laboratories, which could be notified to HPUs.

## Intervention strategies

The following points were suggested.

- Landlord schemes should promote CO detectors. Potentially it should be mandatory for landlords to provide CO alarms.
- Current CO strategies and campaigns aimed at the public need to be reviewed. The public receive information from various organisations and agencies. There is a need to ensure future local campaigns are effective and complement and support existing national strategies.
- CO campaigns should involve all stakeholders to ensure a co-ordinated approach and cohesive message is delivered. Local 'CO networks' could be developed to improve the efficiency of campaigns and initiatives and ensure best practice is shared across the region.

## CO awareness / education needs

### Medical practitioners

It was suggested that:

- There is a need to increase the awareness of Accident and Emergency staff, GPs and NHS direct staff about the risks of CO and the symptoms of CO exposure. Delays in diagnosis often arise as the symptoms of CO poisoning are non specific and for example can be similar to flu.
- Ambulance crew, paramedics and ambulance control room staff require training on the signs and symptoms of CO.
- Accident and Emergency staff require regular CO awareness refresher training.

### Public

The following points were suggested.

- Benefits of installing CO detectors at home need to be highlighted to the public.

### Local Authorities and PCT community staff

The following points were suggested.

- Awareness training is required for Local Authority Environmental Health Officers and PCT community staff such as health visitors who visit properties and have regular contact with families and the elderly.

### Hotel, leisure and catering industry workers

The following points were suggested.

- Hotel, leisure and catering industry workers, including travel companies, need to be aware of the risks of CO poisoning and symptoms.

## Evaluation results

The workshop generated valuable discussion, which attendees felt provided a lot of ideas and information they would take away and disseminate to colleagues. New contacts were made and the day provided attendees with an appreciation for the work of other agencies involved in CO response. In particular it was felt the need to improve multiagency response to CO issues needs to be addressed. Attendees requested:

- additional workshops,
- more information on the incident and clinical management of CO incidents,
- information detailing initiatives within non-domestic settings, for example hospitals and care homes,
- feedback on local work, initiatives and partnership working.

## Next Steps

The NW HPUs are looking to organise a further CO workshop to support CO awareness week, 16th November 2009 and update partner agencies of recent progress.

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# In Question: Global Health Security

## An interview between Dr David Heymann and Edward Stourton

### **John Amos, Health Emergency Planning, London**

An evening event hosted by the medical charity Merlin at the Frontline Club in Paddington on 16 June 2009 gave attendees a chance to hear from Dr David Heymann, the Head of the new Centre on Global Health Security at Chatham House and Chair of Health Protection Agency Board. Dr Heymann was interviewed by Edward Stourton, Broadcaster and Merlin Patron on the subject of Global Health Security. This fascinating emerging area was discussed at length with questions from the audience to address specific challenges and areas of interest.

A large portion of the evening focussed on the question – What is Global Health Security? There seemed to be two main view points on this. Firstly the model of collective security against health crises was discussed; increasing port health and planning for CBRN incidents both accidental and deliberate. The second closely related but very different approach was the idea of working towards individual health security – better access to medicines, vaccines and other health goods – especially in developing countries. Both these models protect individual and collective health through investing in international aid programmes for disease surveillance and response; and by increasing access to pharmaceuticals, vaccines, and general public health programmes.

A series of related issues were raised by members of the audience during the evening, which highlighted the globalisation of health issues. Climate change, obesity, migration of healthcare workers, military healthcare, the role of non-governmental organisations in sustainable support and corporate responsibility of companies in the healthcare sector, particularly pharmaceuticals, was discussed in relation to the prevention arm of global health security.

I left with a feeling that this new approach to a host of existing and long term issues is going to be challenging. Climate change, emerging diseases, CBRN (Chemical Biological Radiological and Nuclear) terrorism and obesity are all huge and crucial challenges. A continued international approach and a realisation that these issues are crucial to economic and potentially physical security over the coming decades are increasingly important. Global health security is certainly an area to watch with great interest and an area to get involved in at any opportunity for anyone working in health protection.

# Upcoming conferences and meetings of interest

## Best of the Best – Chartered Institute of Environmental Health, September 2009



Best of the Best is the UK's most successful environmental health conference. It provides people working in the environmental health community with important updates and information on the latest research, innovation and developments in the environmental and public health field. Over two and a half days, delegates will be offered up to 50 sessions, workshops and project case studies in an informal and interactive atmosphere.

Best of the Best takes place from 21-23 September 2009 at East Midlands Conference Centre, Nottingham.

For more information, see [http://www.cieh.org/events/best\\_of\\_best\\_09.html](http://www.cieh.org/events/best_of_best_09.html)

## Chemical Detection Systems for Security Applications - Future Needs and New Technologies, September 2009



This meeting will discuss the types of future chemical attack that will need vigilance; research into analytical technologies and methods for prevention, detection, mitigation, and remediation; and new analytical instrumentation suitable for the task. The event will provide a picture of the evolving market needs of key players in the security sector; showcase advanced technologies and new products; provide a networking opportunity for instrument companies, academics, government, security forces, police and all other interested parties; and help stimulate the formation of consortia to bid for funding knowledge exchange projects. It is aimed at those working in government, emergency services, researchers, academics and industry professionals.

Chemical Detection Systems for Security Applications takes place on 20 September 2009 at the Institute of Physics, London.

For more information, see <http://www.qi3.co.uk/archives/1971>

## HAZMAT 2009 – HAZMAT/CBRN Responders Conference, October 2009



The 5th annual HAZMAT/CBRN Responders Conference will offer a variety of first responder, emergency leadership and training topics. The conference will enhance knowledge and abilities in hazard planning, decision making and response when faced with complex incident management situations found with HAZMAT and CBRN incidents. It will also provide insight into current thinking and emerging technologies related to HAZMAT/CBRN response. The conference is aimed at Fire & Rescue Services, Police Forces, Emergency Medical Services, Environmental Agencies, Local authority, People with Civil Contingency responsibilities, Military, Private Industry responders, Spill response organisations and any responder that may become involved in a hazmat or CBRN incident.

HAZMAT takes place from 13 to 14 October 2009 at the Hilton Hotel, London Stansted Airport.

For more information, see [www.hazmatconference.com](http://www.hazmatconference.com)

## The Emergency Services Show, November 2009



The Emergency Services Show is the UK's premier emergency services event for promoting multi agency collaboration. The Show brings together all relevant organisations, people and equipment suppliers from across the civil protection community with the ultimate aim of improving public safety. There is a free to attend Exhibition and Networking Zone. The conference will provide an insight into current strategic thinking and the practical methods of improving co-responding. Presentations will be delivered on past, present and future challenges faced by the emergency services and their partners.

The Emergency Services Show takes place from 24-25 November 2009 at Stoneleigh Park in Warwickshire.

For more information, see <http://www.theemergencyservicesshow2009.com/>

# Training Days for 2009 to 2010

The Chemical Hazards and Poisons Division (CHaPD) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2009-2010 programme is being developed to offer basic and more detailed training, along with the flexibility to support Local and Regional Services initiatives as requested.

Training events are available to people within the Health Protection Agency and to delegates from partner agencies, such as local authorities, the NHS and emergency services.

Date	Title	Length of event	Level of event*	Venue
24 September 2009	How to Respond to Chemical Incidents	One day	1	Holborn Gate, London
1 October 2009	Incidents during transport of hazardous materials	One day	2/3	Holborn Gate, London
5 November 2009	Carbon Monoxide Workshop	One day	2/3	London
TBC	Operational Lead Workshop	One day	2/3	Holborn Gate, London
9-13 November 2009	Essentials of Environmental Science	Five days	3	King's College, London
24 November 2009	Understanding Public Health Risks from Contaminated Land	One Day	2/3	Holborn Gate, London
15-19 February 2010	Introduction to Environmental Epidemiology	Five days	3	London School of Hygiene & Tropical Medicine
31 May- 4 June 2010	Essentials of Toxicology for Health Protection	Five days	3	King's College, London
TBC	Odours Workshop	One day	2/3	Holborn Gate, London

\*Please see Table 1 for details of competency levels

## Planned one day training events for 2009 include:

### How to Respond to Chemical Incidents

24th September, Holborn Gate, London

**For all staff on the on-call rota including Directors of Public Health and their staff at Primary Care Trusts, other generic public health practitioners, Emergency Department professionals, paramedics, fire and police professionals and environmental health practitioners.**

#### Aims:

- to provide an understanding of the role of public health in the management of chemical incidents
- to provide an awareness of the appropriate and timely response to incidents
- to provide an understanding of the interactions with other agencies involved in incident management.

#### Educational objectives:

- to be aware of the processes for health response to chemical incidents
- to be aware of the type of information available from CHaPD, London to help the health response
- to be aware of the resources available for understanding the principles of public health response
- to be aware of the training needs of all staff required to respond to chemical incidents.

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

### Incidents during transport of hazardous materials

1st October, Holborn Gate, London

**This course is designed for those working in public health, paramedics, fire and police professionals and environmental health practitioners who may have to respond to incidents arising from the transport of chemicals.**

#### Aims:

- to provide an understanding of the transport of hazardous materials in the UK
- to provide an awareness of the public health outcomes from incidents during the transport of hazardous materials
- to provide an understanding of the interactions with other agencies involved in transport incident management.

#### Educational objectives:

- to be aware of the processes for response to transport incidents
- to be aware of the information available from the 'Hazchem' labelling of transported chemicals.

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

# Training Days for 2009 to 2010

## Carbon Monoxide Workshop

5 November, London

**For health and other professionals with responsibility or interest in carbon monoxide awareness and risk reduction, including: Local HPA – HPU & regional, CHaPD, Local authorities: Environmental Health, housing, and others involved with awareness-raising and prevention of carbon monoxide poisoning, Health and Safety Executive, Toxicology – clinical and poisons.**

### Aims:

- carbon monoxide surveillance, reporting and mortality in England
- methods used for biological and environmental monitoring of carbon monoxide (CO), their potential and limitations
- emergency and local response to CO incidents
- government, regulatory, health service and other programmes to prevent CO exposure and toxicity
- local-level Programmes to raise awareness of, minimise, or eliminate CO poisoning
- research initiatives to enhance information about clinical aspects of CO toxicity and/or effective interventions to prevent it
- how to identify local-level priorities for CO awareness-raising, prevention and research.

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

## Operational Lead Workshop

TBC, Holborn Gate, London

**For local authority, HPA and HPU, NHS staff, and others involved with management/prevention lead cases.**

This day is aimed at local authority Environmental Health Practitioners, but will also be of interest to public health and health protection professionals.

The day will focus on the operational environmental public health response to cases of lead toxicity, including:

- roles and responsibilities of local authorities and environmental health, public health and health protection, and other partners
- lead 'action card' for Environmental Health Practitioners
- environmental investigation for lead
- biological sampling
- legislation for the investigation and management.

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

# Training Days for 2009 to 2010

## Understanding Public Health Risks from Contaminated Land

24th November, Holborn Gate, London

**For Consultants in Health Protection, CCDCs, CPHMs and Specialist Registrars in Public Health Medicine and Local Authority Environmental Health Officers**

This day aims to provide delegates with an understanding of legislative and organisational framework underpin contaminated land risk assessment and how to provide an appropriate timely response in relation to public health risks.

### **Aims:**

- to understand the role of public health in the management of contaminated land investigations
- to raise awareness of the appropriate and timely response to contaminated land investigations
- to understand the interaction with other agencies involved in the investigation and management of contaminated land.
- to review the principle and current issues relating to the management of contaminated land incidents and investigations including:
  - the toxicology underpinning derivation of tolerable concentrations
  - Soil Guideline Values
  - the local authority perspective on implementing Part II A
  - the risk assessment process
  - the nature of public health risks from contaminated land and risk communication.

### **Educational objectives:**

- to understand by using incident examples the process for public health response to contaminated land issues
- to understand by using examples and case studies the type of information and the limitations of the risk assessment models provided to public health from other agencies regarding contaminated land
- to understand by using incident examples the roles and responsibilities of the different agencies involved in investigating and managing contaminated land

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

## Odour Workshop

November, Holborn Gate, London

**This event will be run in collaboration with the EA when the updated H4 odour guidance document has been published.**

**This course is designed for those working in public health, health protection or environmental health and who have an interest in odour related incidents (chronic and acute).**

The day will focus on odour, its regulation, the management of odour related incidents and how odour can affect public health, including:

- roles and responsibilities of local authorities and environmental health, the Environment Agency, public health and health protection
- investigating and managing odour related incidents
- odour checklist
- environmental monitoring and modelling of odours
- public response to odours.

There will be a charge for these events; please see page 79 for booking details. A maximum of 40 places are available.

# Training Days for 2009 to 2010

## Planned training one week training courses include:

### Essentials of Toxicology for Health Protection

1-5 June 2010, King's College, London

**This course is designed for those working in public health, health protection or environmental health and who have an interest in or experience of toxicology and public health protection and would like to develop their skills.**

The aims of this short course are to summarise the key concepts in toxicology, toxicological risk assessment, exposure assessment, and to examine the scope and uses of toxicology and tools of toxicology in local agency response to public health and health protection issues. Training sessions will use examples of real incidents to demonstrate how toxicology may be applied in the context of health protection. The course will also provide an understanding of the limitations associated with the lack of data on many chemicals, chemical cocktails and interactions. The course will provide an understanding of the advantages and difficulties of multi-disciplinary and multi-agency working in toxicology and the use of strategies for communicating risks associated with the investigation of toxicological hazards.

The fee for this course will be around £600. A maximum of 30 places are available.

Participants will receive a CPD certificate, or may elect to submit a written assignment and take a test to receive a formal King's College London Transcript of Post Graduate Credit.

Please see page 79 for booking details about this event.

### Essentials of Environmental Science

9th-13th November 2009, King's College London

**This course is designed for those working in public health, health protection, environmental science or environmental health and who have an interest in or experience of environmental science and public health protection and would like to develop their skills.**

The aims of this short course are to summarise the key concepts of environmental science, the study of the physical, chemical, and biological conditions of the environment and their effects on organisms. The course will concentrate on the basics of environmental pathways - source, pathway, receptor - and consider the key issues in relation to health impacts of air, water and land pollution and the principles of environmental pollutants and impacts on health. Environmental sampling will also be covered: its uses and limitations for air, land and water, leading to a consideration of environmental impact assessment and links to health impact assessment. Awareness of the main environmental legislation will be provided along with an understanding the process of determining environmental standards, what standards are available, how to access them and how to utilise them. Sessions will be based upon examples of incidents associated with health protection which may lead to adverse health effects. The course will also provide an overview and understanding of the advantages and difficulties of multi-disciplinary and multi-agency working in environmental science, and the use of strategies for communicating risks associated with the investigation of this science.

The fee for this course will be around £600. A maximum of 30 places are available.

Participants will receive a CPD certificate, or may elect to submit a written assignment and take a test to receive a formal King's College London Transcript of Post Graduate Credit.

Please see page 79 for booking details about this event.

# Training Days for 2009 to 2010

## Introduction to Environmental Epidemiology

15th-19th February 2010, London School of Hygiene and Tropical Medicine

**This course is designed for those working in public health, health protection or environmental health and who have an interest in or experience of environmental epidemiology and would like to improve their skills.**

The aims of this short course are to summarise the key concepts in environmental epidemiology, to explore the key concepts in exposure assessment and cluster investigation, to examine the scope and uses of environmental epidemiology in local agency response to public health

and health protection issues. The course will also show how to explore study design and the practical consequences of choices made when planning and undertaking an environmental epidemiological study. This will include an appreciation of the influence of finance, politics and time constraints on the choice of study, to review the advantages and difficulties of multi-disciplinary and multi-agency working in environmental epidemiology, and to use strategies for communicating risks concerning investigation of environmental hazards.

The fee for this course will be around £600. A maximum of 30 places are available.

Please see page 79 for booking details about this event.

**Table 1: Competency levels (HPA Workforce Development Group)**

Level	Professional	Example	Examples chemical & environmental competencies
1	General public health	DPH on call, responsibilities for population public health protection	Safe on-call. Triage enquiries, answer simple enquiries, conduct basic investigations & advise on health protection measures Know when and where to seek advice and pass on enquiries
2	Generic health protection	CCDC & health protection specialists	Competence across all fields: communicable disease, chemicals/environment, radiation, emergency planning Safe on-call and second/third on-call advice & operational support Lead local investigation of chronic environmental health concerns
3	Specialist health protection	Regional Epidemiologist Environmental Scientist Toxicology Scientist	Specialist chemical/environmental scientists, engineers, epidemiologists or public health practitioners
4	Super specialist	Named individuals in specialist divisions and teams	

## Booking Information

Regular updates to all courses run by CHaPD can be found on the Training Events web page: [www.hpa.org.uk/chemicals/training](http://www.hpa.org.uk/chemicals/training)

Those attending CHaPD courses will receive a Certificate of Attendance.

**For booking information on these courses and further details, please contact Karen Hogan on 0207 759 2872 or [chemicals.training@hpa.org.uk](mailto:chemicals.training@hpa.org.uk)**

### Other training events

CHaPD staff are happy to participate in local training programmes and develop courses on other topics. To discuss your requirements, please contact Karen Hogan on 0207 759 2872 or at [chemicals.training@hpa.org.uk](mailto:chemicals.training@hpa.org.uk)

**If you would like to advertise any other training events, please contact Karen Hogan.**

# Essentials of Toxicology for Health Protection

a handbook for field professionals

This is the first book aimed at a wide range of professionals in environmental public health, including:

- health protection consultants
- public health specialists and trainees
- public health practitioners
- environmental health practitioners
- environmental scientists
- staff of the emergency services
- the water and waste industries
- other industrial and regulatory bodies.

#### Section 1 - Fundamentals of Toxicology

provides a general introduction and explains how toxicological information is derived.

#### Section 2 - Applications of Toxicology

considers exposure assessment, susceptible populations, the medical management of chemical incidents, and sources of toxicological data.

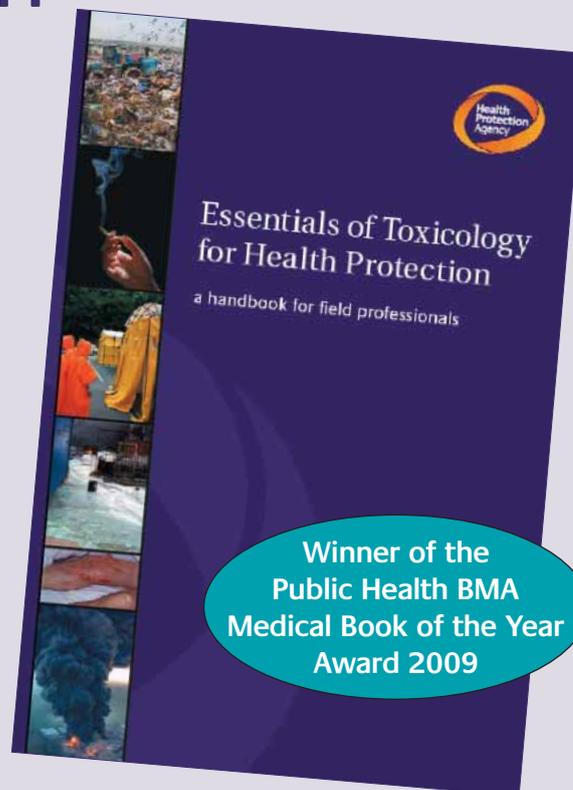
#### Section 3 - Environmental Toxicology

considers pollutants in air, water, and land, food contaminants and additives, and exposures to toxic agents in the workplace.

#### Section 4 - A Review of Some Toxic Agents

discusses a selection of important toxic agents: carbon monoxide, pesticides, heavy metals and trace elements. It also considers traditional medicines and the deliberate release of toxic agents.

A chapter on basic medical concepts and a glossary are included as appendices for those readers who don't have a background in medicine, biology or the health sciences.



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