Chemical Hazards and Poisons Report

From the Centre for Radiation, Chemical and Environmental Hazards
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Contents

Editorial

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This issue of the Chemical Hazards and Poisons Report provides papers on four different types of chemical incidents. Three of these incidents are particularly pertinent to the development of a UK chemical incident recovery handbook (which was announced in the January 2010 issue). In the first incident, the discovery of a piece of military ordnance in sand dunes at a beach in Wales and reported to the police by a concerned member of the public, resulted in the shell being disabled by Army Explosive Ordnance Disposal experts the same day; three days later, Public Health Wales was notified that two members of the disposal team were receiving hospital care for severely blistered skin (page 4). The second incident report describes the complex story of the withdrawal of pork products as a result of contaminated animal feed, resulting in a large scale incident that raised many challenging technical issues (page 6). The third paper summarises three case studies where asbestos contamination occurred in domestic, health care and education settings (page 10). Each of these events points to the need for the development of chemical incident recovery guidance.

As always emergency planning and response is key. In this issue we share four exciting developments that are likely to enhance our ability to prepare for the London 2012 Olympics. These are:

- the work of the HPA's Real-time Syndromic Surveillance Team, which reports that the combination of syndromic surveillance systems used to routinely monitor the emergence and spread of common infectious diseases in the community in 'real-time' can also be used to provide wider health surveillance support in national incidents, including in chemical and radiological emergencies (page 22)
- the development by the HPA of a method for estimating excess deaths quickly in relation to heatwaves, which can be applied to other events such as coldwaves or widespread air pollution incidents (page 46)
- the concept, developed by the Metropolitan Police, of a Joint Safety and Health Advice Cell, which should facilitate our ability to work together across the frontline and with other emergency responders including the NHS, to ensure the best use of safety and health expertise and resources during major incidents (page 27)
- the new CHEMET Service from the Met Office, introduced in August 2009, using the Met Office's state of the art dispersion model NAME III (the Numerical Atmospheric dispersion Modelling Environment). This represents a significant advancement in the sophistication of the modelling being used and means that the Met Office now offers a seamless dispersion modelling service, ranging from a few kilometres up to global scale events, such as volcanic eruptions from the Eyjafjallajökull volcano in Iceland (page 18).

With the Olympics approaching, are there likely to be health risks from firework displays? We include an article which discusses the legislation and acute effects from fireworks.

All previous articles from past issues of the Report plus its predecessor, the Chemical Incident Report, are listed with key words in a searchable index, available at www.hpa.org.uk/chemicals/reports. Our email version of the Report, directing professional groups to articles that may be of particular interest, has been well received. If you would like to be added to the e-mailing list, please contact chapreport@hpa.org.uk. The next issue of the Chemical Hazards and Poisons Report is planned for September 2010; the deadline for submissions is 1st July 2010 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, or call us on 0207 759 2871.

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Incident Response

Sulphur mustard incident, Swansea

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Incident summary

On 24th September 2009, a concerned member of the public reported to police the discovery of a piece of military ordnance in sand dunes at a beach in North Gower, Swansea. The shell was disabled by Army Explosive Ordnance Disposal experts the same day. Three days later, Public Health Wales was notified that two members of the disposal team were receiving hospital care for severely blistered skin.

The Ministry of Defence subsequently confirmed that the shell had contained sulphur mustard (commonly known as mustard gas) and considered it possible that a small amount of the thick and oily volatile liquid may have been released during the routine disposal of the device. The reported symptoms were consistent with exposure to the vesicant, sulphur mustard, a chemical warfare agent known to cause irritation and burns to skin, eyes and respiratory tract, potential reproductive effects, bone marrow depression and possibly respiratory tract cancer[1].

Sulphur mustard

Sulphur mustard exists as a liquid at room temperature, and forms a vapour that is heavier than air and may accumulate at low-points in buildings[1]. Under certain conditions (e.g. cold temperature), sulphur mustard may persist in the environment for many years. Its use has almost entirely been as a chemical weapon, since as early as 1917 to much more recent conflicts such as the Iraq/Iran war (1980s). Shells originating from the Second World War containing sulphur mustard were sometimes buried or dumped at sea, and these may constitute a risk to human health if they surface[2].

Following the release of sulphur mustard and other substances that could have been held within the device, there was potential for public exposure over a four-day period before the authorities were alerted. Consequently, a multi-agency Incident Response Team was promptly convened. The membership of this group comprised of representatives from key stakeholder agencies such as Public Health Wales, Health Protection Agency, National Poisons Information Service, Ministry of Defence, Welsh Assembly Government, Police, Local Health Board and Local Authority. The multi-disciplinary team quickly agreed a framework to deliver a co-ordinated public health response, which included:

Figure 1: Field monitor for sulphur mustard. Reproduced with permission from Defence Science and Technology Lab (DSTL).

- implementing immediate control measures by positioning a cordon around the potentially contaminated area and initially remediating it by removing materials that were either visually contaminated by sulphur mustard (or its degradation products 1,4-thioxane or 1,4-dithiane) or could be detected as being contaminated using field chemical agent detection equipment (Figure 1);
- undertaking a health risk and exposure assessment;
- dealing with wider decontamination issues;
- formulating a risk communication strategy which involved informing local healthcare professionals, developing press statements and giving media interviews to raise awareness about the incident and request that other potentially affected or concerned individuals identify themselves;

Figure 2: Incident site: Whitford Burrows, Gower. Reproduced with permission from Defence Science and Technology Lab (DSTL).

- considering the need for longer-term follow-up of those exposed;
- cleaning up the affected area and undertaking a comprehensive environmental sampling and analysis strategy (across 228 random sampling points) that demonstrated clean-up effectiveness with 99% confidence[3] (Figure 2).

The extensive clean-up operation was completed, and environmental sampling strategy report finalised, by 16th November 2009. A follow-up press statement was released to the media soon after this to confirm that the risk of exposure to sulphur mustard in the affected area was extremely low and that there was no need to restrict any recreational activities. The Incident Response Team was notified to stand down at this time too.

Discussion

Whilst in this instance, no other individuals were affected, the potential public health implications could have been significant.

The co-ordinated response delivered highlighted the wealth of specialist public health and toxicology expertise that exists in Wales, the commitment of partners to engage in acute incident response situations, and the added value of working collaboratively to protect public health.

This example is just one of many, helping the public health community in Wales to further develop collective skills and expertise in planning and preparing for, and responding to, chemical incidents where there are perceived, or actual, public health consequences.

Due to incidents such as these, sulphur mustard has been selected as one of the chemicals for the HPA UK Recovery Handbook for Chemical Incidents, a three year project due for completion in May 2012. The end product will be an online handbook in PDF format, which is intended to aid the decision making process for the recovery from chemical incidents, particularly major incidents[4].

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The Irish dioxin incident, December 2008

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On Saturday 6 December 2008, authorities in the Republic of Ireland initiated a withdrawal of all Irish pork products. This was the top story in the UK late evening national news[1]. The measure was taken following investigations into contaminated animal feed that had tested positive for dioxins (see Box 1) and polychlorinated biphenyls (PCBs) (see Box 2). As well as product withdrawal, a number of farms that had received feed from the affected supplier were restricted from supplying meat to the market. The scale and severity of the incident would ultimately lead to the global withdrawal and destruction of thousands of tonnes of meat products, together with the cull and disposal of thousands of pigs and cattle, all at a cost of several hundred million Euros[2]. It also triggered a significant police investigation into the original source of the contaminants that led to the largest dioxin incident in Europe since the Belgian feed crisis of the late 1990s[3].

The incident

Concern had first been raised in the Republic of Ireland in mid-November 2008, when a high level of 'indicator' PCBs was reported in a pig fat sample during a routine screening test. An investigation identified the suspected source as a feed ingredient produced from bakery waste. Biscuit and cake crumb samples were taken for full dioxin and PCB analysis, along with further suspect meat samples. Farms that had received feed from the supplier concerned were temporarily placed under restriction. In parallel to this work, a separate investigation was taking place in the Netherlands following a high dioxin result for a pork product made in France. As the product in question might have contained meat from several Member States, the investigation took some time. The source of the contaminated meat was eventually confirmed as the Republic of Ireland by the Dutch on the same day that the results of the confirmatory dioxin analysis were received in Ireland. Reported dioxin levels were up to around 300 times the regulatory limit of 1 pg WHO-TEQ/g fat set out in European regulations[4,5]. For an explanation of the units and terminology, see Box 3.

Although only 6-7% of pig farms in the Republic of Ireland were thought to have received suspect feed, their animals went through the same processing plants as about 70% of all Irish pig production and there was no means of tracing products back to individual farms, hence the decision to withdraw all Irish pork products. No pig farms in Northern Ireland had received suspect feed but some live pigs had been sent to the North for processing, so pork products from the Northern Ireland were also implicated. Finally, suspect feed had also been consigned to about ten cattle and dairy farms in the North, as well as a number in the Republic. Consequently, there were also concerns over beef and milk and these were also sampled.

Further investigations at the feed supplier indicated that the contamination arose as the result of using a PCB-containing transformer oil as fuel for a direct drying system during the feed production process. The analytical profiles of the contaminants in the feed were heavily dominated by tetra-, penta- and hexachloro-dibenzofurans, consistent with the burning of PCBs. This makes an important distinction with the previous Belgian incident, which involved the direct incorporation of PCB-contaminated oil into feed, since dioxins (which we use as a generic term for polychlorinated dibenzodioxins and dibenzofurans) rather than PCBs were the main contaminants of concern.

Box 1: Dioxins[11, 12]

'Dioxin' is often used as a generic term for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs), as well as for dioxin-like polychlorinated biphenyls (PCBs). The most toxic and well-characterised is **2,3,7,8-tetrachlorodibenzodioxin (TCDD)**.

- TCDD CAS number: 1746-01-6
- TCDD molecular weight: 322, empirical formula: $C_{12}H_4Cl_4O_2$
- Solid at room temperature, vapour pressure negligible at 25°C
- Low solubility in organic solvents
- Persistent organic pollutants, listed in the Stockholm Convention
- Main sources are industrial processes and combustion - by-products of smelting, chlorine bleaching of paper pulp and the manufacturing of some herbicides/ pesticides amongst others
- Ubiquitous in the environment, found at very low levels in plants, water and air
- Highly lipophilic, accumulates in fat-containing parts of the food chain
- Main route of human exposure is through the diet
- Tolerable Daily Intake oral 2 pg kg^{-1} bodyweight day^{-1}, estimated mean dietary intake 0.9 pg kg^{-1} bodyweight day^{-1}
- Tolerable Daily Soil Intake both for adults and children 0.4 pg kg^{-1} bw day^{-1}
- Short-term exposure of humans to high levels may result in skin lesions (chloracne) and patchy darkening of the skin or altered liver function
- Long-term exposure is linked to impairment of the immune system, the developing nervous system, endocrine system and reproductive functions
- TCDD classified by the World Health Organization International Agency for Research in Cancer as a 'known human carcinogen'
- Highest levels of these compounds are found in some soils, sediments and food, especially dairy products, meat, fish and shellfish.

From retained samples provided by the feed manufacturer, it was established that the contamination may have begun as early as August, so a considerable amount of contaminated product would already have entered the market and been consumed. A risk assessment by European Food Safety Authority concluded, however, that the risk to health would have been low[6].

It is beyond the scope of this article to discuss in detail the subsequent investigations and actions and, in particular, actions taken in the Republic of Ireland. However, many issues had to be addressed and resolved under considerable time pressure, some of which will be of relevance during the preparation of the forthcoming UK Recovery Handbook for Chemical Incidents[7].

Box 2: Polychlorinated biphenyls (PCBs)[13, 14]

- CAS number: 1336-36-3
- Empirical formula: $C_{12}H_{10-n}Cl_n$ (where ‘n’ ranges from 1-10)
- 209 different congeners are possible but only 130 have been identified in commercial products
- Synthetic aromatic chemicals that do not form naturally
- Oily liquids or solids, colourless to yellowish in colour and often crystalline
- Highly resistant to thermal degradation; fire resistant because of their high flash points (170- 380°C)
- Vapour is heavier than air but not explosive
- Lipophilic; lipophilicity increases with degree of chlorination
- Persistent organic pollutants, listed in the Stockholm Convention
- Used in the past as coolants and lubricants in transformers, capacitors and other electrical equipment as they do not burn easily and are good insulators; used as hydraulic fluids in mining equipment due to low flammability.
- Manufacture phased out in 1970s. Large quantities still remain in old equipment, which must be registered. Directive for decontamination and disposal to be completed by December 2010
- May enter the environment through accidental spills, fires, leaks, release from hazardous waste, uncontrolled disposal
- A main concern is that they are taken up by small aquatic animals and accumulate in fish and marine mammals potentially entering the food chain
- Twelve PCB congeners identified as ‘dioxin-like’
- Short-term exposure of humans to high levels may result in skin conditions like acne and rashes and in some cases liver damage
- Long-term exposure is linked to impairment of the immune system, behavioural alterations, impaired reproduction and birth defects
- No Tolerable Daily Intake for non dioxin-like PCBs due to limitation of data available
- Classified by the World Health Organization International Agency for Research in Cancer as ‘probably carcinogenic’

Management of contaminated materials

Meat and meat products

Urgent advice was needed on the handling and disposal of suspect pork and products containing it. A pragmatic decision was taken in the first week of the incident by European Chief Veterinary Officers that any composite products containing less than 20% suspect meat could be released to the market. All other food products had to be placed in quarantine by the affected food businesses, under the control of enforcement authorities, pending decisions on possible transfer back to suppliers and on disposal, raising additional issues such as who would cover the associated costs. Further complexity was added because, under animal by-product regulations, meat products rejected on the basis of exceedance of limits set out in EU legislation are deemed to be Category 1 material, for which the disposal routes are most stringent[8].

Food businesses who believed their products were unaffected also needed a means of positive release and advice was therefore required for the businesses and enforcement authorities about the analysis necessary to demonstrate compliance. Dioxin analysis is expensive and interpretation of the actual results can be far from straightforward.

Milk

Two dairy herds had potentially received contaminated feed although, in one instance, the farmer believed that the only exposure route was through use of the same shovel for contaminated feed going to other animals being used for clean feed for the dairy herd. Nevertheless, testing of milk in early January 2009 showed the milk from both herds to be non-compliant. Regular subsequent testing showed the dioxin levels in the milk to be falling, although at different rates. This raised a question of whether there might be a continuing low-level exposure. Unfortunately, there were insufficient resources to fully investigate this and both dairy farmers ultimately decided to have their animals culled under the compensation scheme.

Live animals

In Northern Ireland, about eight beef herds were affected. Analysis of meat from animals in the affected herds already slaughtered had shown dioxin levels of up to 500 times the regulatory limit, although not all samples were so high[9]. Nevertheless, it was very difficult to establish which animals may have been exposed to the most contaminated feed over the longest time. Given the long half-life of dioxins in cows (estimated at several months), it was inconceivable that meat from animals contaminated at the highest levels would achieve compliance within a realistic timescale. Cull and disposal was therefore identified as the preferred management option. However, although regulatory powers exist to seize and cull animals under certain circumstances (various diseases, detection of certain drug residues), no such powers exist for seizing live animals on the basis that their meat might exceed contaminants limits. The earliest opportunity to exclude potentially contaminated meat from entering the food chain arises at the slaughterhouse. Consequently, culling had to be on a voluntary basis which, in turn, meant that a suitable compensation package had to be agreed with farmers. This took several months. In the meantime, the animals continued needing to be fed and otherwise maintained. Once the cull was confirmed, there was the additional matter of disposal. In the event, rendering and high-temperature incineration was necessary due to the nature of the contamination.

In a few cases, farmers were confident that cohorts of animals had not been exposed to contaminated feed and a means of positive clearance was required, preferably without the need to slaughter the animals first. As blood samples would not provide sufficient material for testing, a relatively novel technique based on testing of pooled samples of fat taken by live biopsy was used and a number of animals were released on this basis. This was done in full consultation with the European Commission because placing further contaminated meat on the market could have had very serious consequences. In some instances, testing showed that animals had indeed been exposed and this raised further concerns about the reliability of information provided or whether there might have been other contamination routes.

Feed

When the incident broke, contaminated feed remained on a number of the farms. The material remaining was placed under restriction although it was not removed. This was a concern due to the risk of inadvertent use or accidental exposure of animals but it was several months before arrangements were finalised to transfer the feed back to the supplier in the Republic of Ireland. In addition, there were no validated methods available for the cleaning out of feed stores, transporters or handling equipment and it proved very difficult to get across to those involved how little of the most contaminated feed (low gram quantities) would need to remain to cause further non-compliances.

Slurry

The incident occurred in December and many affected animals were indoors. Consequently, a large amount of slurry had been collected, which would normally have been spread back on farmland. Because of the risk that this slurry might be contaminated, particularly if it contained undigested feed, farmers were advised not to spread it at least until it had been tested. Other than powers held by the Northern Ireland Environment Agency to protect water courses, there were no legal means of preventing spreading. The testing itself proved to be a major challenge as some of the tanks were very large (ca. 1,000m^3) and needed homogenisation before samples could be taken – an activity in itself hazardous. Because of the time and cost for dioxin analysis, a screening method based on marker PCBs was used to identify uncontaminated slurry, which the farmers were told they could spread. However, it was difficult to establish criteria for the release and spreading of slurry contaminated at a low level or to set a contamination level above which spreading should not occur. Information available from the UK Soil and Herbage Survey[10] suggested a low background level of dioxin in soil in Northern Ireland but a decision on the extent to which it might be acceptable to raise the level proved difficult to make because of the uncertainty of associated risks (reliability of the slurry analysis, different bioavailability of dioxins in the slurry and already soil-bound, existing condition of the soil etc). This led to further issues concerning storage and disposal.

While investigations were underway, slurry was, of course, still being generated. Some tanks were full and it was therefore necessary to find temporary storage facilities. In some cases empty slurry tanks were available on the farms but, more commonly, transfer by tanker was required to off-site storage. Ultimately, a method was needed for disposal of the contaminated slurry and a number of options were considered, including spreading on non-agricultural land, passage through a waste-treatment facility, rendering or dewatering and incineration. Although the latter would be the lowest risk option, it was also much the most expensive – and a cost that would tend to fall on the individual farmer.

Other technical considerations

One of the biggest challenges concerned analysis. In the case of the Belgian incident, contamination was almost exclusively by PCBs, and PCB/dioxin ratios were in the order of 50,000. This meant that normal PCB analysis was generally sufficient to support investigations. However, in the Irish incident the PCB/dioxin ratios were low (sometimes <100) and variable, and it was not possible to use PCB analysis as a screen without using a much more sensitive method (adding to time and cost) and regularly confirming results with full dioxin analysis. Full congener analysis for dioxins (which may cost £500-1,000 per sample) can take up to three weeks, although shorter turnarounds are possible in urgent situations, and there is limited capacity in terms of suitably accredited and experienced testing facilities. Cheaper and quicker bioassay-based screening methods are available for dioxins and are permissible under EU regulations[10]. However, when very short turnarounds are required, the cost does increase and these methods do not provide congener profiles, which are of particular importance during an incident investigation. Consequently, in a major incident such as this, it is important to establish analytical capacities and capabilities at an early stage and to ensure that those involved in investigating and managing the incident understand the various limitations and constraints of different methods.

Box 3: Analysis of dioxins and PCBs, terminology

There are seven dioxin congeners and ten furan congeners of health concern. All contain chlorine atoms in the 2,3,7 and 8 positions. There are also twelve dioxin-like PCB congeners. In order to allow simplified reporting, each congener is assigned a Toxicity Equivalency Factor (TEF) relative to the most potent congener, 2,3,7,8-TCDD (see Box 1). The TEFs have been assigned by the World Health Organization and endorsed by expert committees in the UK and Europe.

When a sample is analysed, the concentration of each congener is measured and multiplied by its respective TEF. The values are added together to give a single figure which is the Toxic Equivalent (or TEQ).

Limits for dioxins and dioxin-like PCBs are expressed in picograms per gram (pg/g), where a picogram is one part in 10^{12} or one million millionth of a gram. In meat and dairy produce, the limits are expressed on a fat basis and in fish on a whole weight basis.

The limits and TEFs are set out in reference 5.

Conclusion

This was a major incident that arose very suddenly, occurred on a very large scale and raised many very challenging technical issues. As a learning exercise for the recovery following chemical incidents, it will undoubtedly warrant further scrutiny.

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Asbestos: The hidden hazard in domestic, educational and health care settings

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Introduction

Asbestos is a general name given to a group of naturally occurring fibrous minerals that have crystallised to form long thin fibres. Asbestos fibres are strong, durable, resistant to heat, fire and chemicals, and they don't dissolve in water. Due to these physicochemical properties asbestos was extensively used as a building material (e.g. fire-proofing, insulation, and as floor and ceiling tiles) in the UK from the 1950s through to the mid-1980s. Inhaled asbestos fibres are known to cause a number of diseases including asbestosis and mesothelioma. Due to the risk posed to health following exposure to asbestos, the importation, supply and use of all asbestos products has been banned in the UK since 1999. However, due to its historic widespread use, buildings (including houses, factories, offices, schools, hospitals etc) constructed before 2000 can include asbestos containing materials. Generally, asbestos containing materials in good condition are considered unlikely to cause harm to health. However, asbestos fibres can be released and become airborne when asbestos containing materials are damaged. Because of this, occupational and environmental exposures still remain a risk where the materials are removed or disturbed without due precautions.

Under health and safety legislation employers have a duty to protect employees and members of the public. In addition to this there are Regulations dealing specifically with asbestos. The Control of Asbestos Regulations 2006 consolidates previous asbestos legislation to:

- prohibit the importation, supply and use of all forms of asbestos;
- continue the ban on blue and brown asbestos (from 1985) and white asbestos (from 1999); and
- continue to ban the second-hand use of asbestos products. It should be noted that the legislative ban applies to new uses of asbestos.

If existing asbestos containing materials are in good condition, they may be left in place, with their condition monitored and managed to ensure they are not disturbed. Further information on this can be found on the Health and Safety Executive (HSE)[1] website.

A summary of the frequency of asbestos incidents reported to the Health Protection Agency's Centre for Radiation, Chemical and Environmental Hazards (CRCE) is presented in this paper, together with a review of case studies and consideration of methods used to address public health concerns.

Background

Incidents involving asbestos are frequently reported to the Health Protection Agency (HPA). CRCE responded to 235 such incidents between 2004 and 2008, representing between 3 and 7% of all reported chemical incidents per year.

CRCE's national incident database was interrogated to identify the type of asbestos related incidents reported between 2004 and 2008. There are three primary incident types identified from the data: fires, releases/spills and deposits. Figure 1 illustrates the type as percentage of the total asbestos incidents reported to CRCE between 2004-2008 in England and Wales, while Figure 2 shows the breakdown of incident type per year.

Fires account for just over half of these incidents (57%). These are well documented[2,3,4] with guidance available to public health professionals[5,6,7].

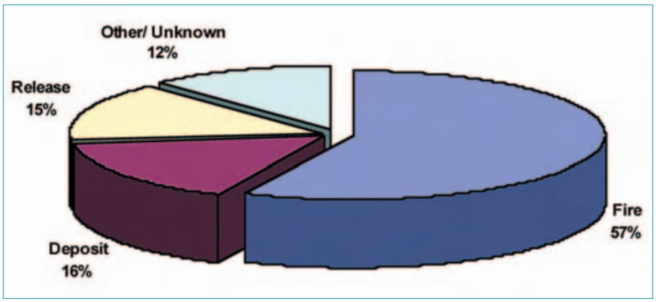

Figure 1: Asbestos incidents by type as percentage of the total asbestos incidents reported to CRCE for 2004-2008 in England and Wales (n=235).

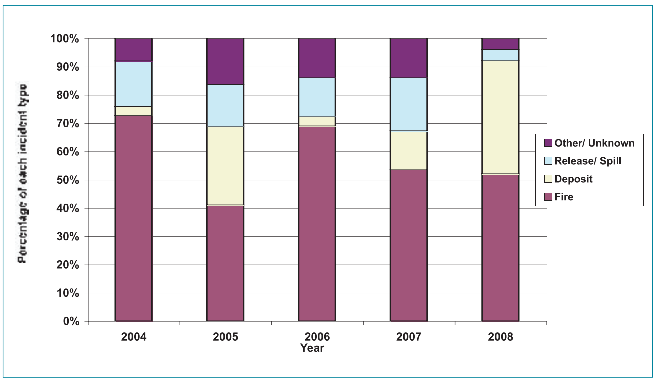

Figure 2: Asbestos incidents by type as percentage of the total asbestos incidents reported to CRCE for each year between 2004-2008 in England and Wales.

Further interrogation of the national dataset, illustrated in Figure 3, indicates that the location of incidents involving release, spill or deposit of asbestos or asbestos containing material are mainly in residential (32%), commercial (16%) and educational settings (13%).

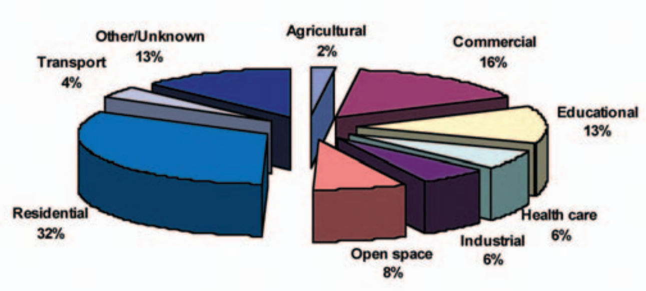

Figure 3: Location of incidents involving release, spill or deposit of asbestos or asbestos containing material reported to CRCE for 2004-2008 in England and Wales (n=101).

Case studies

CRCE (Nottingham) have dealt with a number of incidents within its supra-regional area (East Midlands, Yorkshire and Humber and the North East) where the release of asbestos fibres within educational, healthcare and residential settings has raised concerns amongst staff, pupils, service users and homeowners. Several case studies are set out in the sections below.

Asbestos minerals are found within the environment at very low levels due to naturally occurring sources or from the damage of materials containing asbestos. A key factor in the risk of developing an asbestos-related disease is the total number of fibres inhaled. Typically, asbestos poses the greatest risk to those who work with (or near to damaged) asbestos or asbestos-containing materials (e.g. miners, those producing asbestos containing products or tradespeople) as they are likely to be exposed to much higher levels of asbestos fibres in air than the general population.

One-off, single exposures of short duration such as that which may occur during a fire are considered to be of low risk to health[6]. In the cases presented, potential exposures have been of short duration (e.g. several hours to several weeks) and although exposures are likely to be higher than background levels and longer than a single one-off exposure, the risk is not considered that much greater provided that adequate clean-up is undertaken.

Case study 1

Asbestos contamination of residential flats during renovation work

A local authority's renovation (via an arms-length management organisation responsible for housing stock) of a complex of 28 flats involved the replacement of doors and windows. During the work, windows were removed and associated waste materials were taken through each flat, communal areas (e.g. hallways, stairwells) and the grounds for disposal, potentially depositing dust and debris. Three weeks after completion of the work, asbestos was discovered by another contractor within the common areas and flats, who notified the local authority. The asbestos was determined to be from soffit boards damaged during the renovation work.

The local authority (LA) immediately established an Emergency Control Centre and contacted the HPA and the Health and Safety Executive (HSE).

The LA arranged for a specialist asbestos company to undertake air sampling and collect swab samples from a number of the flats. Advice from the specialist company confirmed that air sampling results were negative and that the initial risk to residents was low. However further analysis of swab samples taken from internal surfaces of the flats revealed that there were areas of gross asbestos contamination.

Residents were evacuated and internal surfaces (e.g. window sills, worktops, furniture surfaces, soft furnishings) and the internal air of the flats were systematically sampled to determine the extent of contamination as some of the flats were not part of the renovation work programme. Sampling methodology considered whether a flat was partially contaminated or grossly contaminated. The sampling results also informed what measure of decontamination was necessary and what items would need to be removed and disposed of.

Inventories of residents' belongings were recorded in the contaminated flats and items which posed a risk to health were either professionally cleaned or disposed of as hazardous waste. Microwaves, washing machines and electrical items with internal fans (which could draw contaminated air into the device and subsequently expel contaminated air) were typical of items removed for disposal. Carpets and soft furnishings were also removed and replaced and the flats were subject to professional decontamination by a specialist asbestos contractor.

Re-sampling was undertaken to validate that the decontamination process was acceptable and the flats were refurnished and residents allowed back to their properties.

Case study 2

Asbestos release in a health care setting

Building work was undertaken within a hospital to install a new alarm system. Asbestos warning signage was present but not heeded resulting in the deposition of dust and debris within rooms and corridors of the buildings, including areas continually used by staff and patients. The building work lasted for six weeks before concerns were raised. It was estimated that approximately 2,500 people (staff, contractors, patients and service users) could have been exposed during this period.

Potentially contaminated areas of the hospital were immediately closed as a precaution; staff and patients were relocated elsewhere within the hospital complex. A programme of sampling was initiated, including the taking of swab samples from internal surfaces by a specialist contractor; these showed the presence of asbestos fibres. Further, more detailed sampling and assessment was undertaken to determine the extent of contamination and to inform the decontamination required.

Case study 3

Exposure to asbestos within an educational setting

Work to replace existing windows within a primary school led to the disturbance of asbestos containing materials and the release of fibres into the school environment. The affected areas, including classrooms and corridors were closed pending assessment and cleanup.

Sampling was undertaken by consultants following the closure of the affected areas to determine the extent of the contamination. Contamination was found to be widespread following significant uncontrolled disturbance of the materials surrounding the removed windows. A detailed retrospective risk assessment was undertaken using the monitoring data to determine the potential exposure of staff and pupils to airborne asbestos fibres and make a numerical assessment of their likely risk of ill-health as a result of the exposure.

During the incident a great deal of concern was raised by staff and parents; effective risk communication to all concerned was essential and this was addressed using a multi-agency approach involving the education authority, Primary Care Trust (PCT) and HPA. One of the key roles of the multi-agency group was the interpretation of the retrospective risk assessment to ensure that the main messages were clear, evidence based and timely.

Discussion of case studies

A number of similar investigations and risk assessments were undertaken in each of the case studies:

- environmental sampling (air sampling and swab sampling) and analysis to identify the presence, quantity and type of asbestos to inform the health risk assessments;
- decontamination and clean-up of affected areas, including surfaces, fixtures and fittings (e.g. soft furnishings, electrical goods) etc;
- re-sampling and analysis to validate decontamination; and
- where exposure was significant, retrospective exposure assessments for individual groups at risk (e.g. staff, pupils, patients, homeowners, visitors, etc) were completed by specialist consultants.

These cases presented both public health and occupational health issues. As such a multi-agency response was necessary involving: HPA, Primary Care Trust (PCT), local authority, and Health and Safety Executive (HSE) or employers' occupational health provider.

A number of lessons identified are listed below.

- Risk perception is key: the public health risk from short-term exposures of this nature are much lower than occupational exposures where workers are exposed to higher levels of fibres in air, over longer periods.
- Swift public health advice and risk communication is important to address the health concerns of those exposed. Together with a timely multi-agency response (including press/media releases), is essential to ensure a consistent response to managing the public health concerns of such an exposure event.
- Any investigation and risk assessment needs to consider all potential exposure pathways including the potential for any asbestos released to have spread to adjacent areas.
- Asbestos is the single greatest cause of work-related deaths in the UK. The HSE's "The Hidden Killer" campaign[8] launched in October 2008 aims to raise occupational awareness of asbestos. As these case studies show, tradespeople need to be more mindful of asbestos containing material, as their work can put them and the wider public at risk from exposure to asbestos.

Conclusions

Effective multi-agency measures taken in facilitating a clean-up, risk assessment and risk communication of asbestos incidents are discussed to demonstrate that these can minimise public anxiety where incidents involve short or protracted exposure.

The Centre for Radiation, Chemical and Environmental Hazards are often required to provide advice to front-line public health practitioners responding to incidents involving the release of asbestos. Within the HPA, guidance and toolkits are available to assist the public health response to asbestos releases from large scale fires[4,5,6], however there is currently a dearth of guidance for non-fire related incidents and related clean-up. Whilst there are long-term projects and work plans in place to address some of these gaps, such as the UK Recovery Handbook for Chemical incidents[9], there is still a need for public health incident management toolkits to enable HPA responders and other partners to assess potential risks during asbestos incident management

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Casualties from acute poisonings and the potential for secondary contamination: A case study and risk assessment tool

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Background

Casualties and fatalities who have ingested poisonous substances, either deliberately or accidentally, have the potential to contaminate the people and environment around them. Levels of concern for those potentially exposed but not necessarily showing symptoms can be great. It is vitally important in such circumstances to systematically consider all potential sources, pathways and receptors to inform the risk assessment, identify those at greatest risk and ensure appropriate risk reduction strategies are utilised.

During a recent incident in London, a matrix was developed to help with the risk assessment process in these situations.

Incident

In the early hours of one morning in January 2009, the Centre for Radiation, Chemical and Environmental Hazards (CRCE) and North West London Health Protection Unit were notified of a possible malicious chemical poisoning of food. Following ingestion of a homemade curry in their home the previous evening, two adults had fallen acutely ill with profuse vomiting. Both adults were taken to hospital, where one died in the emergency department that night. The other was admitted to the intensive care unit and made a complete recovery over the following days.

The initial cause of the poisoning was unknown but heavy metals, organophosphates and the oleander plant were considered. During the course of the incident, it was postulated that aluminium phosphide (a rodenticide) may have been available to the people involved; this appeared to be consistent with the toxidrome of the patients at that time. In addition, evidence of cyanide was discovered at the home so possible involvement of hydrogen cyanide was also considered at the outset, leading to significant media speculation regarding the possible involvement of cyanide[1]. The accurate detection and identification of specific chemicals in a domestic environment can often be affected by the presence of extraneous materials. Therefore, it is always important to maintain an open mind when receiving initial information on "contaminants" identified at an incident. In this case, it is conceivable that non-hazardous volatile chemicals (e.g. aromatic ingredients used in food preparation) may have caused a false positive for cyanide.

The initial possibility of either hydrogen cyanide or aluminium phosphide involvement gave cause for concern about possible secondary chemical contamination in a number of areas, including the hospital. There were also concerns about possible secondary exposure of nine police and four ambulance staff. In order to facilitate an evaluation of the risks, scientists from CRCE developed an ad hoc risk assessment matrix (Table 1), to provide a step-wise assessment of all locations and individuals potentially affected.

In this case, the driver of the car in which the patients were brought to hospital was deemed to have had the highest level of exposure, having been in a confined space with the two patients potentially off-gassing. This driver was assumed to be a 'sentinel' case and the fact that (s)he was assessed and found to be well provided reassurance for those emergency service staff with more limited exposure that had concerns about possible health effects.

The poison used was finally identified as Indian aconite: plant material derived from the roots of the *Aconitum* species. Aconite contains a mixture of toxic compounds, most notably aconitine, a potent toxin which can affect the heart and nervous system. In its pure form, aconitine is extremely toxic and has been found to be fatal following ingestion. The toxic components of aconite may also cross the skin and so handling preparations can cause mild effects such as tingling of the skin, headache, nausea and palpitations.

Media information on the case can be found at BBC News[2].

Discussion

The greatest risk from secondary contamination will be if there is a source (e.g. an off gassing patient or vomit) in a confined environment (e.g. room or vehicle), as any hazardous chemicals can build up to harmful levels. The risk assessment matrix tool was useful in providing a systematic approach for evaluating the potential risks at each location via all exposure routes, for each set of potentially exposed individuals. Emergency responders at Gold Command also found its simple format useful, describing potential exposure scenarios and thereby informing the decision making process in very stressful circumstances.

The tool has been adapted to facilitate its broader use in other incidents involving a chemical with the potential to cause secondary contamination through off-gassing of the affected individuals as well as their bodily fluids, particularly where individual(s) have been brought into a clinical setting.

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2 **BBC News. Curry poisoning woman found guilty of murder. Available at: http://news.bbc.co.uk/1/hi/england/london/8492936.stm (10 February 2010)**

Table 1: Risk assessment matrix for secondary exposures from chemically-contaminated casualties/fatalities

Location	Source	Pathways	Receptor(s) - including all occupational contacts	No. of persons involved	Risk level*	Other details
Site of poisoning e.g. house, hotel	Original source of poison	Ingestion Inhalation Dermal	Residents Visitors First responders			
	Poisoned meal/drink	Ingestion Inhalation Dermal	Residents Visitors First responders			
	Contaminated crockery etc	Ingestion Inhalation Dermal	Residents Visitors First responders			
	Patients	Inhalation Dermal	Residents First responders			
	Vomitus/body fluids	Inhalation Dermal	Residents First responders			
In transit e.g. ambulance, private vehicle, taxi	Patients Vomitus/body fluids	Inhalation Dermal	Driver Other passengers			Consider contamination of drivers', passengers', paramedics' clothes.
Hospital – arrival area	Patients Vomitus/body fluids Clothes/effects	Inhalation Dermal	Paramedics etc. who assist upon arrival			Consider contamination of paramedics' clothes.
Hospital –Emergency Department, other departments e.g. intensive care Route and contacts for each patient	Patients Vomitus/body fluids Clothes/effects	Inhalation Dermal	Hospital staff with direct contact - ie clinical responsibilities, close, prolonged contact Hospital staff with passing contact - in vicinity of patient(s), body fluids, clothes or other effects, using equipment contaminated with body fluids Other patients in vicinity of contaminated patients while in hospital Cleaners and laundry staff Police Others involved in investigation			Consider contamination of paramedics' clothes. Consider whether PPE was used. Ensure that standard infection control procedures - i.e. gloves, aprons but no masks - are followed. Trace those potentially involved in clean up.
	Contaminated hospital equipment	Inhalation Dermal	Cleaners Future patients Future users of equipment			Equipment used to treat patients should be disposed of under normal infection control procedures. Remaining equipment, such as ventilators, should be decontaminated prior to re-use or disposed of.
	Contaminated bed sheets	Inhalation Dermal	Laundry staff			How have contaminated sheets been stored (bagged/double bagged)?
Repeat risk assessment for each hospital department involved and for each patient						
For fatalities: viewing room, mortuary	Vomitus/body fluids	Inhalation Dermal	Nurses Pathologists Coroner Staff involved with preparing body			Are staff aware that it is a chemically contaminated body? Has the body been bagged/double bagged?
	Off gassing from body	Inhalation	Nurses Pathologists Coroner Staff involved with preparing body Anyone else present at the morgue, such as family members viewing body			
Ambulance/ car used to transport patients to hospital	Vehicle (no vomitus present) Vehicle (vomitus present)	Inhalation Inhalation Dermal	Future users of the car Cleaners Future users of the car			Ventilate car before re-occupying. Assume high risk if car has not been ventilated and vomitus is present - breathing apparatus should be worn during decontamination of car.

*Low/Medium/High: Depends on the level/concentration (i.e. proximity or enclosed space) and duration of exposure. May be different for each route and pathway of exposure.

Remembering Sharon and Rebecca – investigating leukaemia and chemical pollution in Cheshire

Alex G Stewart on behalf of the incident team
Cheshire and Merseyside Health Protection Unit

The Incident Team:

Rupert Adams,	Vale Royal Borough Council
Russell Keenan,	Alder Hey Children's Hospital
George Kowalczyk,	Health Protection Agency, Centre for Radiation, Chemical and Environmental Hazards
Hugh Lamont,	Health Protection Agency, North West Region
Wendy Meredith,	Central Cheshire Primary Care Trust
Lorraine Shack,	North West Cancer Intelligence Service (formerly Merseyside and Cheshire Cancer Registry)
Alex Stewart,	Health Protection Agency, Cheshire & Merseyside Health Protection Unit

Background

The deaths of two young girls in a small community in Leftwich, Northwich, Cheshire, from acute myeloid leukaemia (AML) in 2004 and 2005 led to an intensive public health investigation that covered the epidemiology of AML and possible effects of the local environment.

Concern was raised by the parents and doctor who attended both girls since:

- AML is uncommon in children (50 cases per year in England)
- both girls suffered from the same rare subtype of AML, AML M7 (acute megakaryoblastic leukaemia)
- the girls died one year apart after similarly short illnesses
- they were of similar age when they died
- they had lived in houses with adjoining gardens
- clusters of AML are unusual.

A multi-disciplinary Incident Team, chaired by the Director of Public Health (Central Cheshire Primary Care Trust), was established, with membership from the HPA (Chemical Hazards and Poisons Division; Local and Regional Services), Vale Royal Borough Council, North West Cancer Intelligence Service and Alder Hey Children's NHS Foundation Trust, where the girls were treated.

Through regular and frequent public meetings with the residents of the 24 houses on the estate where the children had lived, the Incident Team remained very aware of community concerns, particularly when it was discovered that the estate had been built in the mid-90s on an old, unregistered landfill which had been levelled in the 1970s.

Methods

The Incident Team was guided by two very clear principles: firstly, that the local community should be fully informed and wherever possible, involved in the investigation; secondly, that the team would keep a collective 'open mind'.

The team knew that it was unlikely that the cause of the children's illness would be discovered. Instead, it set out ensure so far as was possible that living on the estate was safe, by reviewing the epidemiology of AML and AML M7, routine Public Health information, the environment (landfill and other land records, ionising and non-ionising radiation, indoor and outdoor air quality, water supply) and anything else that appeared relevant to the residents (this included phone masts, foot and mouth burial sites and local memories).

The residents were involved throughout in the epidemiological studies and environmental surveys, including design, analysis and interpretation of all results. They also appointed the environmental consultant.

Results

Information was freely available to and from the residents. All environmental results were shared with residents in printed form at the same time that they became available to the Incident Team. Because of the personal and sensitive nature of health data, epidemiological information was summarised and orally presented to the residents by the Incident Team at the next residents' meeting, held 6-weekly initially.

Considerable thought and effort went into explaining all the findings, putting them in proper context, exploring any danger that existed, engaging the community in shaping the interpretation, and developing the risk assessment process. Residents were encouraged to explore the data and ask questions that helped direct the investigation.

Cancer registry data for the North West from 1997 to 2003 identified only two local cases of AML, both of which were in adults. No other case of childhood cancer in any child who had been resident on the estate between 1997 and 2003 was identified in the national Oxford Cancer Registry. There was no unusual patterning of cancer (all cancers, leukaemias, by age and sex) locally as compared with the Primary Care Trust or Cheshire and Merseyside.

During a detailed review, the general health of the community living on the estate of 24 houses was unremarkable (death certificates, hospital admissions, NHS Direct calls, Congenital Abnormalities Register, compared to Cheshire and Merseyside) and an agreed review of GP records of long-term residents showed no diagnosis that could be attributed to landfill toxins or stress from the investigation.

Air monitoring inside houses (benzene, toluene, ethylbenzene, and xylene) and "top 10" volatile organic compounds) did not show any levels of concern; outside air quality was acceptable. Similarly, drinking water did not show any contaminant levels of concern while ground water contaminants were within acceptable parameters. Soil contaminants found were typical of those at many contaminated sites in the UK.

The main problem found was from the landfill gas with its potential risks of explosion (methane) and asphyxiation (carbon dioxide) compounded by the failure of the under-floor membranes that had been fitted when the houses were built. It was found on investigation that these gas membranes were not fully functioning in any of the estate houses.

All twenty four houses on the estate were owned and managed by a Social Housing Landlord. When the council made a formal determination of land as contaminated, to remove the risks of explosion and asphyxiation, the landlord undertook remediation work: replacement of gas membranes under the ground floors of every house, improvement of the ventilation systems of the walls and the under-floor voids (rigorously tested for gas integrity) and excavating contaminated soils from some gardens. Nothing of significance was discovered by physical or chemical examination during the remediation phase.

A draft press statement was discussed and agreed at each residents' meeting before release to the local media, since the press were seen as key partners in helping the team and residents explain complex issues to the wider public.

Discussion

The investigation came to four important conclusions:

- no cause for the girls' AML was found
- no environmental link to AML was found
- there were no significant health risks to adults living on the site
- there had been no health effect from the contamination under the estate.

Leukaemia is the most commonly diagnosed cancer in children with about 350 cases per year in children in England aged under 15 years at diagnosis[1] (with 31 deaths in England in 2007[2]).

Of these 350 cases, only 50 cases are AML, a rare sub-type of leukaemia[3]. AML presents with varying symptoms including tiredness, infections and bleeding, usually over a short period; it is commonest in older adults.

AML M7 is one of a number of different subtypes, representing about 10% of all AML patients. It is not usually possible to find a cause for AML or AML M7 in an individual patient, especially children. Risk factors in children include Downs Syndrome, high energy radiation exposure and a family history. Neither of the girls had any of these risk factors. No previous cluster had been identified.

Several risks factors have been investigated, including exposures to hydrocarbons, pesticides, alcohol use, and cigarette smoking, but without clear evidence of a role. Otherwise, the causes are unknown[4], although a recent report strengthens the idea that the domestic use of pesticides may play a causal role[5].

The effects of deprivation, infection and antenatal exposures remain unclear. The landfill was unlikely to have contributed to the girls' deaths since the levels of chemicals found were not dissimilar to many other sites across the country.

Known risk factors in adults include previous exposure to chemicals including benzene and some chemotherapy agents, particularly etoposide, some rare blood diseases including aplastic anaemia and Fanconi's anaemia. None of these were relevant in the girls.

Box 1: Recognition and awards

- **Speech to the Contaminated Land: Risk Assessment Conference, 2008:** The speech to the conference by Mr John Watts, the father of one of the girls, recounting his experiences of the investigation in the light of the death of his daughter, was very well received by the delegates. Many commented that it opened their eyes to aspects of their professional work that they had not considered before.
- **Assessment for Charter Mark status, February 2008:** During the reassessment of Vale Royal's Charter Mark status the assessor identified as best practice the way the consultation had influenced service delivery.
- **Brownfield Briefing Remediation Innovation Awards, 2007:** Two Remediation Innovation Awards - Best Conceptual Design; Best Verification Project[7].
- **National House-Building Council guidance, March 2007** work at the site has contributed to the latest national guidance on gas protection measures for houses.
- **North West Public Health Awards, 2008:** "A model of partnership and peer process in the context of uncertainty, fear and initial mistrust. Exemplifies individual and collective responsibility and the values of openness and transparency. A lesson for government."

Suspicion and mild hostility towards the investigating agencies at the outset of the investigation was replaced by friendship and co-operation between the local community and the agencies involved through concerted efforts and regular public meetings, which addressed the wider context and residents' concerns[6].

Even though the residents did not always feel that the investigation had allayed their concerns, they recognised that it was not for want of trying – a tribute to all parties concerned.

Confidentiality was addressed by limiting the public meetings to residents, removing identifying information from minutes and discussing issues and investigations openly before action was taken. The community was very comfortable with explanations of why data was not being shared. Members of the Incident Team gave media interviews, but did not discuss any personal issues.

The open-door policy of the Council for all partner organisations and residents of the estate, through a known and respected Council representative, allowed discussion of questions or concerns at any time and helped build trust. One of the parents provided the same service to the residents.

The inclusion of a social scientist in the multi-agency Incident Team would have further enhanced some of the interactions between agencies, consultants and the community, allowing timely and professional analysis and reflection on the strengths and weaknesses of the ongoing investigation.

The investigation and remediation received several awards (box 1).

A full copy of the report with detailed results is available from alex.stewart@hpa.org.uk

Lessons recognised included:

- Community engagement at all levels of an investigation is not only desirable but essential and this report describes how it can be made possible.
- Community engagement, therefore, goes well beyond communication of findings and consultation on processes.
- The community can understand anything professionals can; they just need clear explanations using plain language and careful description of complex issues.
- Professionals need to listen to and accept the position of the community as valid, relevant, essential, important and contributing to both process and outcome.
- Professionals should not assume that only they have an understanding of risks.
- A senior point of contact showing honesty and integrity is of first importance.
- Very little should be confidential between those investigating and those being investigated.
- Engagement in the real world is time consuming; do not underestimate the commitment required or the benefits reaped.
- Tracking the costs of public health investigations to identify expenditure by agency and category of investigation (e.g. epidemiology, environmental investigation, meetings) should be considered; costing of this nature is hardly ever done but should be more routine.
- The benefits of including expertise in social sciences in the multi-disciplinary membership of future Incident Teams investigating big incidents.

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Emergency Planning and Preparedness

The New CHEMET Service from the Met Office

Met Office

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Introduction

The release of chemicals into the atmosphere has the potential to cause significant harm to both people and the environment. During incidents, the UK Met Office offers specialist weather advice and air pollution forecasts to assist UK emergency responders in the management of chemical releases. In the event of an incident involving hazardous chemicals, local police and fire services will contact the Met Office Environment Monitoring and Response Centre (EMARC) via a dedicated 24/7 emergency phone line. Typical scenarios would be a spillage or fire at a chemical plant, or a road traffic accident in which a hazardous substance has either escaped or been ignited. The police, fire and other responding agencies have specific procedures for dealing with incidents involving hazardous substances. They need to know how the fumes or plume might spread once released into the atmosphere in order to determine any hazardous areas, people within who may need sheltering or evacuating during larger incidents and attention during subsequent clean up operations.

On contacting EMARC the customer is provided with instant telephone advice in the form of a simple short-range prediction of the anticipated behaviour of the plume. Within 15 minutes this is followed by a full CHEmical METeorology (CHEMET) report. CHEMET reports consist of two parts. A brief text forecast, called a CHEMET form B (see Appendix 1), which details relevant meteorological parameters and an Ordnance Survey map overlain with a plume which shows the main 'area at risk' from the dispersing pollutant. CHEMET reports are faxed and/or emailed and/or made available through a Met Office website to the relevant emergency services, and to relevant government agencies, including the Health Protection Agency.

The spread of fumes or a plume is dependent on the weather. For short range events typical of those dealt with through CHEMET local variation in the wind speed and direction are usually the most important meteorological elements. Rain at the scene can also be a significant element as it can 'wash' the chemical out of the atmosphere leading to higher concentrations on the ground. The rate at which a plume spreads is also affected by atmospheric stability.

History

CHEMET plumes have, from 2004 to Aug 2009, been produced using the Gaussian plume model ADMS (Atmospheric Dispersion Model Simulation). With ADMS, the forecaster would seek to provide a site specific wind speed and direction by considering observed winds from a nearby station, together with an estimation of winds at the site. This would then be compared with the 10 metre wind data from the UK Numerical Weather Prediction (NWP) model. From this a single wind speed and direction would be selected for a three hour period based on model and observational data, and this entered into the ADMS system for a specific grid position. This would enable the production of a plume from the selected wind velocity and other stability parameters. The selected plume was then plotted on a map of the site.

While this was an advance on the hand-plotting method that preceded it, more recent advancements meant that this approach could be further improved.

The New CHEMET Service

In August 2009 the CHEMET service was updated and plumes (see example in Figure 1) are now produced using the Met Office's state of the art dispersion model NAME III (the Numerical Atmospheric dispersion Modelling Environment[1]). This represents a significant advancement in the sophistication of the modelling being used for CHEMET and means that the Met Office now offers a seamless dispersion modelling service ranging from a few kilometres up to global scale events such as volcanic eruptions or nuclear disasters using the same world class dispersion model.

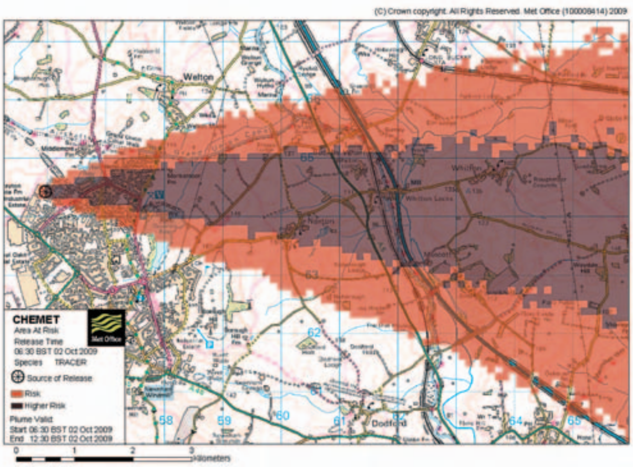

Figure 1: A 6 hour CHEMET area at risk plot showing NAME III's ability to model changes in wind along the path of the plume. The smaller (inner) area, coloured dark brown, is the area of higher risk, and the larger (outer) area, coloured orange, indicates the total area at risk. This plume is illustrative and does not represent a real event.

NAME III

NAME III utilises a Lagrangian approach to determine the location of a plume. Pollutants are represented by a large number of model 'particles' which are released into the modelled atmosphere at the source location(s). These particles are affected by the local wind speed, atmospheric turbulence (see Figure 2), precipitation, and other processes. Each model 'particle' can have its own characteristics, represent different compounds, chemicals and real particulate sizes, and can be affected by temporal and spatial variations in the meteorology including turbulence and loss processes such as precipitation. This enables NAME to simulate highly complex dispersion events.

The resulting air concentration and deposition data (Figure 4) are presented on grids covering the area of interest. The values of averaged and integrated air concentration and wet, dry and total deposition, within each of these grid boxes is determined by counting the number of model particles which pass through each grid box (Figure 2) during the time(s) of interest. Due to the fact that only a limited number of model particles are released for any given simulation (because the time a simulation takes to run increases with the number of particles) the concentration of adjoining output grid boxes, while representing the variation due to the plume's movement, can also vary due to statistical noise. This is manifest in plumes appearing 'spotty' with individual grid boxes having a different colour to all those surrounding it. CHEMET has been set up so that this noise does not affect the robustness of the results. However, given the tight time constraints of the CHEMET service it is not possible to release enough particles to eliminate the noise entirely.

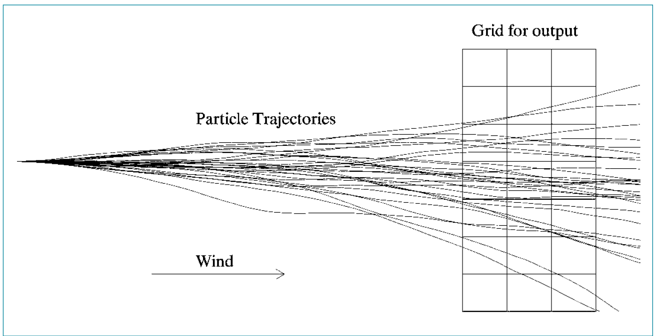

Figure 2: Possible paths of particles released from a point source as viewed from above.

Met Data

Three-dimensional met data from the Met Office's UK 4 km resolution NWP forecast is used automatically by NAME III. This is more efficient than previously possible and allows the model to take into account temporal and three-dimensional spatial variations in the meteorology including wind direction, atmospheric stability and precipitation. Forecasters also refer to the current surface observations and compare these to model output. On rare occasions when the surface observations differ from the NWP data, it is also possible to run NAME III using observational met data. This feature also enables the forecasters to run NAME III for exercises where a specific set of artificial meteorological conditions are required.

Output

The main output from NAME III as used in the CHEMET service is an area at risk plume plotted on an Ordnance Survey map (Figure 1). Knowledge of the amount of pollutant released (often unknown until after the event) is not required for this type of plot. Grid boxes where the air concentration is within one standard deviation of the maximum air concentration at the same distance from the source are coloured dark brown. These form the area of higher risk. Grid boxes where the air concentration is within two standard deviations of the maximum air concentration at the same distance from the source are coloured orange. The brown and orange squares together form the total area at risk. The edges of the plume appear uneven and sometimes grid boxes within the higher risk area appear to have a lower risk. This is because a limited number of particles are released and part of the motion of each particle is random. Places of lower risk within a higher risk area should not be assumed to be safer.

Figure 3 illustrates this and three other more 'complicated' area at risk plots that are now possible due to the greater sophistication of the new modelling system.

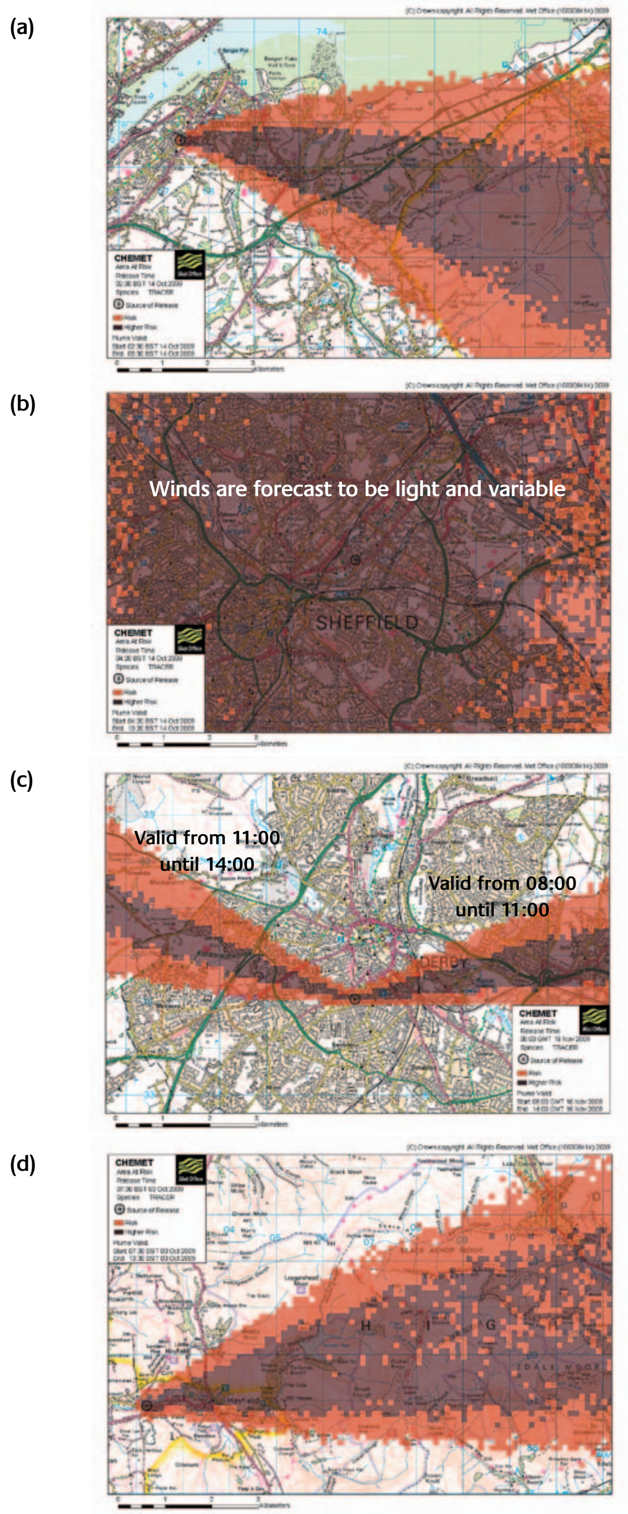

Figure 3: Examples of CHEMET area at risk plumes. These plumes are illustrative and do not represent real events.

- **a Wind direction changes slowly over 3 hour period resulting in a curved plume.**
- **b Low wind speed with variable direction so the plume spreads in all directions.**
- **c Wind direction changes a lot during forecast period. Validity times for individual plumes are indicated on map**
- **d 'Spotty' plumes. This is not an error. Places of lower risk within a higher risk area should not be assumed to be safer.**

Default CHEMET Forecast

The default CHEMET forecast consists of a Form B and an area at risk plot from a three hour NAME III prediction. Due to the lack of information available during the early stages of an incident the CHEMET response is initially based on a set of default inputs:

- Source strength 1 g/s of TRACER
- Source horizontal dimensions: 0 m
- Source height: 0 to 1 m above ground level.
- Source duration: 3 hours
- Forecast length: 3 hours
- Output area: approximately 10 km of downwind travel.

Within the new CHEMET service it is possible to alter all these inputs when and if such information becomes available. For example it is possible to produce output for 122 g/s of sulphur-dioxide released at a height of 120 m.

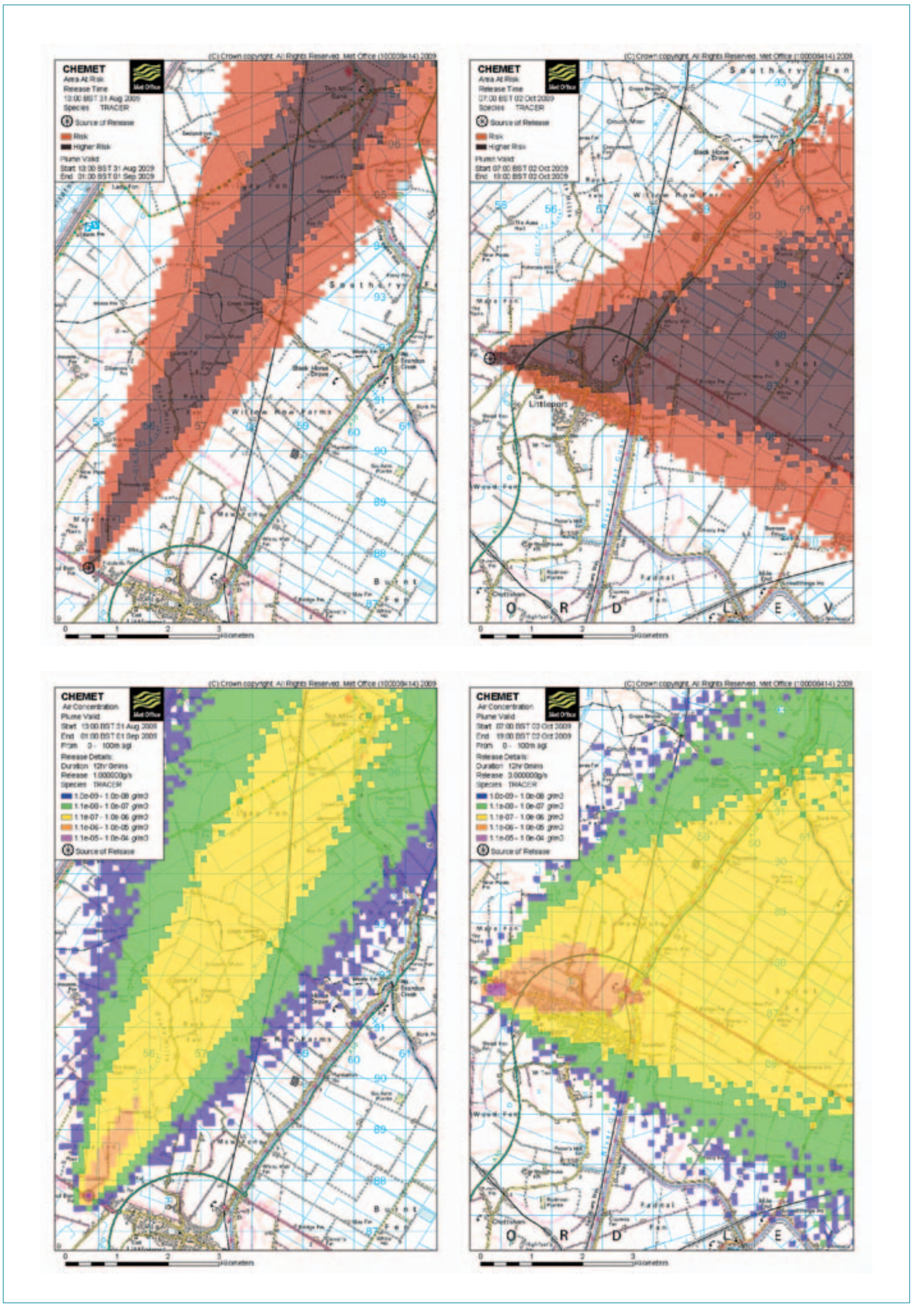

Figure 4: CHEMET Area at Risk and Air Concentration plots produced during the Littleport tyre fire during different meteorological conditions. Area at risk and air concentration are averaged over a 12 hour period.

Longer Range Forecasting

With model data used directly and more flexibly it is now possible to accurately produce individual CHEMET plumes for different durations; from one hour up to 12 hours or more, taking into account all the changes in the evolving meteorology. It is further possible to produce multiple plumes for planning purposes or during events that are expected to be protracted in duration over time periods of up to five days ahead. For example, ten 12 hour forecasts could be issued at once to provide a complete 5 day forecast.

Recent tyre fire incidents in September 2009 at Wem in Shropshire and Littleport in Cambridgeshire have highlighted the usefulness of this new service in providing accurate five day forecast data to the local authorities and emergency services. Tyre fires can release harmful chemicals into the environment and can be difficult to tackle safely. Since the application of water to extinguish such fires can result in the release of additional hazardous pollutants, fire officers used CHEMETs to determine a suitable, 'safest' weather window when the wind direction was blowing the smoke away from populated areas. Additionally, the Health Protection Agency, Environment Agency and local authorities used concentration and deposition information (see next section) to assess health impacts and to determine where to place monitoring equipment. Two examples of 12 hour plume forecasts produced during the Littleport fire, one in relatively strong wind conditions and one in lighter, more variable wind conditions can be seen in Figure 4. The provision of detailed and accurate plumes and forecasts was a great help to emergency planners in these recent events.

Additional Output – CHEMET Pro

In addition to the production of area at risk plots, NAME III (using estimates of the amount of each chemical released) produces outputs of time averaged and integrated air concentrations and wet and dry deposition (Figure 4). The air concentration and deposition plumes can be useful to agencies such as the Health Protection Agency, for example, to determine the impact on human health in the area surrounding the incident, and can also be compared to any observations taken nearby. It is important to note that the actual source strength is vital for interpreting concentration and deposition values.

All of these outputs are available overlaid on Ordnance Survey maps for every CHEMET including the standard default run, though they are not currently sent to all CHEMET recipients by default. To differentiate this data from the standard CHEMET area at risk plots the concentration and deposition plots are referred to as CHEMET Pro.

Future Developments

How can we expect NAME III and the

CHEMET service to improve in the future?
With the upgrade of the Met Office's supercomputer, the resolution of the UK forecast model is being increased, in the near future, from 4km to 1.5km. At this scale there will be a better representation of small scale land surface features such as hills and mountains and the way the wind flows around them. This will improve NAME III's ability to predict the dispersion of pollutants in hilly terrain.

Even with this increase in resolution some small features are not modelled as well as we would like. Therefore work is in progress to include some of these features in NAME III, for example by adding an advanced urban model. Additionally, there are plans for NAME III to use radar measurements of rainfall for the UK. Radar rainfall rates are updated every 15 minutes, so as an event unfolds, it will be possible for NAME III to more accurately determine the amount of a pollutant 'washed out' and deposited. In addition to this NAME III is constantly undergoing a program of scientific development that ensures the continuing improvement of the Met Office's dispersion predictions.

Information about the CHEMET service

The CHEMET and CHEMET Pro reports are provided in conjunction with specialist advice from the UK Met Office. If you would like more information about the service please contact the Met Office Customer Centre by using the phone number(s) or e-mail address given below.

Tel: 0870 900 0100 or 01392 885680
E-mail: enquiries@metoffice.gov.uk

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Appendix 1

CHEMET Forecast

Tel: 0870 900 0100 www.metoffice.gov.uk

EXAMPLE EXAMPLE EXAMPLE EXAMPLE EXAMPLE EXAMPLE EXAMPLE Page 1 of 2

Form B ('Area at Risk' Map to follow) **(Ref: MO43)**

Forecast Issued on Wednesday, 30 September 2009 at 16:47

1	To:		of			Service
2	From	Duty Forecaster	Environment Monitoring And Response Centre (**EMARC**)			
3	Met Office Contact Numbers:	**Tel:**	**FAX:**			
	e-mail:					
	FORECAST PERIOD	From	08:30 22/10/09	To	18:30 22/10/09	Date/Time
4	Forecast for incident at:	Pan Peninsula Developments 1 Millharbour 537704 179609				
	Release Time	22/10/09 08:30				Local
5	Surface wind direction **From:**	West	**To:**	East		Compass point
	From:	280	**To:**	100		Degrees
6	Surface wind speed:	18				km/h
7	Most likely effect of forecast weather conditions on plume behaviour:					
	Horizontal dispersion:	Moderate	Vertical dispersion:	(a) Moderate		
				(b) Upward		
8	Remarks:					
	SPECIALIST FORECAST INFORMATION					
9	Total cloud amount:	4				oktas
	Height of lowest significant cloud:	2000				feet
10	Air Temperature	8				°C
	Relative humidity	50				%
11	Precipitation (type and intensity)	Nil				
12	Depth of mixing layer	400				metres
13	Mean wind in mixing layer:					
	Direction **From:**	290	**To:**	110		Degrees
	Speed	25				Km/h
14	Air Stability	D	(A = Unstable, G = Stable)			

Syndromic surveillance in the Health Protection Agency

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Introduction

In the UK, a combination of syndromic surveillance systems are used to routinely monitor the emergence and spread of common infectious diseases in the community in 'real-time'. These systems are also used to provide surveillance support in national incidents, including chemical and radiological emergencies, which have the potential to affect community health.

The Health Protection Agency (HPA) Real-time Syndromic Surveillance Team (ReSST) is a small team that coordinates a number of syndromic surveillance systems, based in the HPA West Midlands, but providing a national surveillance service[1]. The ReSST provide routine surveillance bulletins throughout the year but also, in the event of any large public health incidents, can provide daily surveillance analyses, interpretation and reports to aid local/national incident teams in responding to those incidents.

What is syndromic surveillance?

Syndromic surveillance systems monitor 'symptoms' rather than laboratory confirmed diagnoses of disease, thus providing information at an earlier stage of illness (pre-diagnosis) so that action can be taken in time to reduce the impact of disease. Syndromic surveillance systems are designed to capture data that are already collected for other purposes. Over the last decade, the use of syndromic systems has increased across the world: the origins of the recent increase in the use of syndromic surveillance can primarily be traced to the United States, where the use of data from secondary healthcare facilities for sentinel surveillance is relatively common (though systems are rarely national). The response to the threat from (bio)terrorist activities, particularly since the events on 11 September 2001 ("9/11") has increased the frequency of such systems, which are now common in individual states[2]. Elsewhere, other syndromic systems have been developed: in Europe, France has a range of syndromic systems incorporating emergency department visits (Oscour) and general practitioner (GP) episodes, to monitor a range of infections including influenza and norovirus and also the impact of heat waves[3,4].

The syndromic surveillance systems of the HPA

Within the HPA, there are now several syndromic surveillance systems that have been established and tested. Two systems that are coordinated by the ReSST are the 'HPA/NHS Direct' and 'HPA/QSurveillance' systems. In addition, the ReSST work closely with the Research and Surveillance Centre (RSC) of the Royal College of General Practitioners (RCGP), which coordinates the Weekly Returns Service (WRS), a sentinel GP network that has been in operation for over 40 years[5].

Routinely, surveillance bulletins are produced from each system on a weekly basis[6]. These bulletins aim to provide a summary of the recent trends of a range of syndromic indicators with added interpretation to put these findings in context with other relevant evidence. The syndromes/indicators monitored routinely are intended to provide surveillance of a wide range of situations including infectious disease activity, chemical incidents, and deliberate biological release incidents. In this respect, the systems are very flexible and able to respond to and provide surveillance support across a number of different scenarios.

In the following section, each system is described in more detail.

HPA/NHS Direct Syndromic Surveillance System

The HPA/NHS Direct Syndromic Surveillance System utilises the symptomatic phone calls received at NHS Direct from members of the public, where the presenting symptoms are assessed in order to provide advice to the patient on any further medical attention that is required. Previous work has demonstrated the usefulness of NHS Direct data in monitoring infectious diseases, in particular to provide early warning of increased community-based activity over other more traditional surveillance systems[7,8]. Calls are received on a daily basis and analysed according to reported symptoms e.g. cold/flu, vomiting. Calls are routinely analysed by aggregating calls into each syndrome, and calculating as a percentage of the total number of calls received. Call outcomes are also recorded and provide a breakdown of the advice provided to each patient. Call outcome data can provide some indication of severity; for example, an increase in the proportion of callers advised to visit an emergency department may suggest increased severity of disease.

In the event of call numbers increasing across any syndrome or region it is important to determine the significance of these rises. A series of control charts are used to monitor significant rises in the numbers of calls received. Control charts are routinely calculated by assuming that calls follow a Poisson distribution with the total calls as an offset: a model is fitted to each region and symptom separately[9]. The model takes into account call variation caused by seasonal trends, weekends and bank holidays (all variables that influence the number of calls received at NHS Direct). A value above the 99.5% confidence interval limit is considered to be unusual and would merit further investigation of data.

HPA/QSurveillance National Surveillance System

The HPA/QSurveillance National Surveillance System is a GP based system co-ordinated by the HPA in collaboration with the University of Nottingham and EMIS (a supplier of GP software across the UK)[10]. The HPA/QSurveillance system collects anonymised morbidity data for a range of clinical indicators including respiratory and gastrointestinal. The QSurveillance database is one of the largest of its kind, collecting data from over 3,400 GP practices, covering a population of over 23 million (representing almost 38% of the UK population). Data are routinely collected on a weekly basis as cases (consultations), denominator populations and incident rates per 100,000 patient population. In the event of a major national incident e.g. the influenza A H1N1 2009 pandemic, data can be collected on a daily basis to improve the timeliness of the surveillance. Data are routinely analysed by age groupings and also at country, Strategic Health Authority (SHA) and Primary Care Trust (PCT) level.

In order to determine the significance of rises in clinical indicators reported at country, SHA or PCT level, standardised incidence ratios (SIRs) are calculated routinely. Using the UK incidence rate as the comparator, the aim of this method is to identify countries/SHAs/PCTs with excessively high or low rates of illness on any given week/day. This method applies incidence rates to a stratified population estimate to provide the expected number of cases occurring in the population of interest. This is then compared to the directly observed number of cases within this population. Upper and lower 95% confidence limits are applied to the ratio and those incident rates considered significant are presented in the bulletin tables as highlighted cells to emphasise the significance of the result.

RCGP Weekly Returns Service

The RCGP WRS has continually reported GP-based morbidity data for over 40 years[11]. This surveillance system is based upon a network of 100 practices (approximately 500 GPs) covering a total patient population in excess of 900,000[12]. The network is located across England and Wales; data are reported and analysed on a twice weekly basis. GPs involved with the WRS are encouraged to maintain a high quality of data recording to ensure that each episode of disease is recorded, that new episodes of disease are differentiated from repeat consultations and that the correct diagnostic codes are recorded. These procedures ensure that the data recorded by the RCGP GPs are of high quality and as a result of these stringent data quality procedures, the RCGP WRS is considered the ‘gold standard’ of sentinel GP reporting across Europe. The RCGP is renowned for its work on respiratory diseases, especially influenza and has established, in collaboration with the HPA, an annual integrated microbiological sampling programme to swab patients presenting with influenza-like illness to understand the profiles of the influenza viruses circulating in the community[13].

Case studies

Over recent years the ReSST have been involved in contributing to the surveillance response for a diverse range of national and local incidents. Some individual ‘case studies’ are presented below:

1. Buncefield Oil Storage Depot explosion and fire

In the early hours of 11 December 2005, there were a number of large explosions at the Buncefield Oil Storage Depot, Hemel Hempstead, Hertfordshire[14]. The resulting fire engulfed a large proportion of the site, burning for several days emitting large clouds of black smoke into the atmosphere (figure 1). Most of the Buncefield site was destroyed during the incident.

The ReSST were contacted on 12 December and asked to provide daily syndromic data reports on indicators relevant to the effects of inhalation of smoke/toxic chemicals that might have resulted from the smoke plume. The areas most affected by the resulting smoke plume were monitored for potential impact on the local communities using daily HPA/QSurveillance system respiratory indicators (upper and lower respiratory tract infections, pneumonia, asthma admissions, severe asthma, wheeze) and daily NHS Direct calls (cough and difficulty breathing syndromes). During this period of enhanced surveillance we were able to provide reassurance that there were no detectable population-based effects on the communities most at risk from exposure to the smoke plume.

This incident provided the first experience of using daily GP-based data and also illustrated the potential for using GP surveillance data at PCT level, thus enabling more complete enhanced population based surveillance at a local level.

Figure 1: The Buncefield Oil Depot fire, December 2005. © Chiltern Air Support Unit.

2. The Chancery Lane Fire

On 18 March 2009, a large fire started in the five-storey Immigration and Appeals Commission building on Chancery Lane, London. There were no reported casualties identified from the fire, but due to the location of the fire, within a busy commercial district of Central London, it generated significant media interest. The close proximity of the fire to the HPA Central Office (Holborn Gate) (figure 2) ensured that specialist HPA teams were able to respond with immediate effect[15].

On 19 March the ReSST worked closely with the HPA Centre for Radiation, Chemical and Environmental Hazards to identify the syndromic surveillance requirements for this incident. NHS Direct calls for difficulty breathing were monitored across London; there were no discernable rises in the number of calls or any evidence of clustering of calls around the Chancery Lane area, or across the path of the resulting smoke plume[15]. This incident demonstrated the benefit of close collaboration across HPA divisions to provide a multi-factorial response to an incident.

Figure 2: View from HPA Holborn Gate offices of fire in Chancery Lane fire, 2009.

3. Flooding across Central England

During June and July 2007 there were record rainfalls across the UK that resulted in severe flooding across parts of Northern and Central England. On 20 July 2007, the ReSST was asked to provide daily surveillance support to the incident teams responding to the flooding across parts of Oxfordshire and Gloucestershire (figure 3). Aside from the direct risks to the population from flooding (e.g. drowning, injury) there are further potential public health impacts including increased levels of diarrhoea and vomiting (exposure to untreated sewerage in flood waters), increased levels of asthma, wheeze, eye problems (exposure to moulds/spores that develop after flood waters have receded and buildings are 'drying out') and increased numbers of insect bites (increased insect numbers associated with stagnant water).

Figure 3: Flooding in Oxfordshire, July 2007.
© Health Protection Agency, Jane Bradley.

The enhanced surveillance across these regions included the use of postcode district level analyses of NHS Direct call data, which was able to monitor call volumes across areas particularly affected by flooding. Results demonstrated that apart from a rise in 'information calls' received by NHS Direct, i.e. calls from patients not reporting symptoms but requesting health information, there were no unusual rises in syndromes across flooded areas, thus providing reassurance to the incident teams that there were no significant effects to the local communities in terms of acute illness.

4. Influenza A H1N1 pandemic 2009

On 27 April 2009 the first reported cases of influenza pandemic virus were reported in travellers returning from Mexico[16]. The following months saw the first influenza pandemic for over 40 years sweep with rapid speed across the world. In the UK, during the containment phase of the pandemic, the emphasis of the response was on identifying and treating individual cases and tracing and treating their contacts. Following the national decision to move to the treatment phase, the spotlight fell on syndromic surveillance systems to provide the only source of data available for estimating national case numbers, identifying local hotspots, and determining when the pandemic had peaked (figure 4). The ReSST provided a daily pandemic bulletin from 27 April 2009 to 28 January 2010, presenting data from the HPA/QSurveillance and HPA/NHS Direct systems, and ultimately the National Pandemic Flu Service (NPFS). The provision of daily data at PCT level was particularly valuable due to the unusual nature of spread of the pandemic virus: even within individual SHAs, there was a diversity of intensity of activity and thus these data were extremely useful in determining hot spots to influence local policy. In the midst of the surveillance requirements, in collaboration with NHS Direct and HPA Centre for Infections colleagues, a programme of NHS Direct self sampling was established to enhance the ability to detect community and non-travel related cases[17].

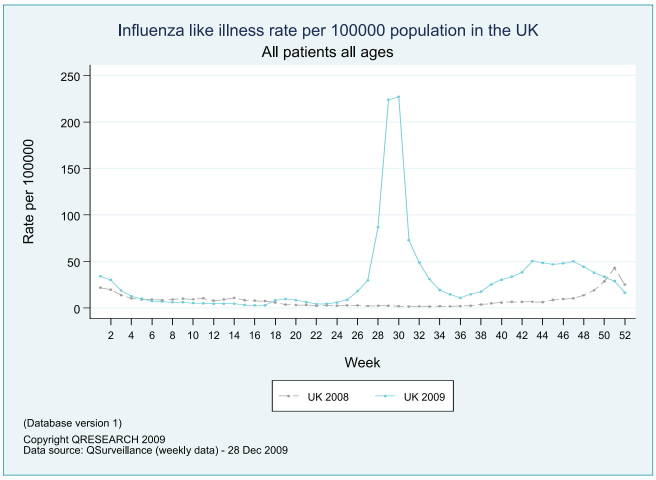

Figure 4: HPA/QSurveillance system GP consultations for influenza-like illness in the UK during 2009: the peak of the first pandemic wave was reached during week 30.

5. *Cryptosporidium* contamination of water supplies

On 25 June 2008 *Cryptosporidium* oocysts were detected in a reservoir supplying the water to large areas of Northamptonshire[18]. The ReSST were asked to provide enhanced syndromic surveillance of those affected areas to determine any possible impact of the contamination on the local communities. The real-time surveillance of gastrointestinal symptoms revealed a 'spike' in NHS Direct diarrhoea calls, and also a small increase in GP consultations for diarrhoea in PCTs affected by the contaminated water. The interpretation of these results was difficult due to the potential influence of media reporting of the incident on the healthcare seeking behaviour of patients. However, the syndromic surveillance systems were able to detect this relatively small outbreak and to provide reassurance on limited impact across the local community[19].

6. Heat-health watch surveillance

During summer months the ReSST monitor syndromes/indicators sensitive to heat related morbidity. This work inputs to the Department of Health's Heat-Health Watch system which operates across England and Wales[20]. The Heat-Health Watch system comprises four levels of response based upon threshold maximum and minimum temperatures across all regions of England and Wales. At the 'green' level 1 (Long-term Planning and Summer Preparedness) the ReSST provide a weekly update on those syndromes and indicators relevant to heat related morbidity e.g. heat/sun stroke. When temperatures are approaching or have reached thresholds levels, the yellow level 2 (Alert and Readiness) and amber level 3 (Heat Wave Action) are triggered and the ReSST provide daily heat wave bulletins presenting the surveillance data to detect the effects of the heat on the health of the community (figure 5). In the event of a red level 4 (Emergency) being triggered, i.e. a heat wave for four or more days in two or more regions, ReSST would carry on producing data to enable emergency planners to continually assess the impact of the heat wave on public health.

During the European heat wave of 2003 France experienced approximately 15,000 excess deaths from heat-related causes during a 16 day period[21]. This event emphasised the need to monitor the impact of heat waves in 'real-time' providing early warning of potential problems to enable a quick response to limit the associated morbidity and mortality. With meteorological predications of hotter and dryer summers associated with global warming, these heat waves could become a more common occurrence in the UK. An assessment of the impact on mortality of the summer 2009 heatwave in the UK can be found on page 46; details of heat wave action planning can be found on page 48.

7. G-20 Summit in London

During the period 29 March to 2 April 2009 the G-20 Summit was hosted in London. The high profile nature of this meeting resulted in a requirement to ensure that there were no deliberate release events or other incidents affecting the location of the meeting and neighbouring areas. During this period, daily NHS Direct and QSurveillance data were analysed, and data and interpretations were presented in a daily bulletin to provide reassurance that all syndromes and indicators were within seasonally expected levels.

Current and future developments

The future work of the ReSST is currently focused on preparing for the London 2012 Olympics. During the Olympics, there will be a national requirement for enhanced surveillance, particularly in London, but also at other Olympics venues across the country to ensure that any unusual outbreaks of disease or other incidents can be detected in real-time. The ReSST work streams associated with 2012 Olympic preparations include:

- Strengthening the robustness of current syndromic surveillance systems by improving statistical methods in order to enhance the ability to detect small outbreaks at local level and provide clarity about the size of incidents which could be detected by such surveillance.
- Developing novel presentations of data in 'dashboard' formats to enable communication of real-time situation reports to local response/planning teams.
- Developing new syndromic surveillance systems, which has been highlighted as a surveillance requirement for the Olympics. Work is being undertaken in the ReSST to obtain further relevant datastreams and establish other new syndromic surveillance systems including real-time data from: hospital emergency departments (accident & emergency), out-of-hours GP services, NHS 'walk-in-centres', and sales of over-the-counter medications.

All of these developments should ensure that the syndromic surveillance capacity of the HPA is showcased during the 2012 Olympics as one of the most comprehensive syndromic surveillance systems in the world.

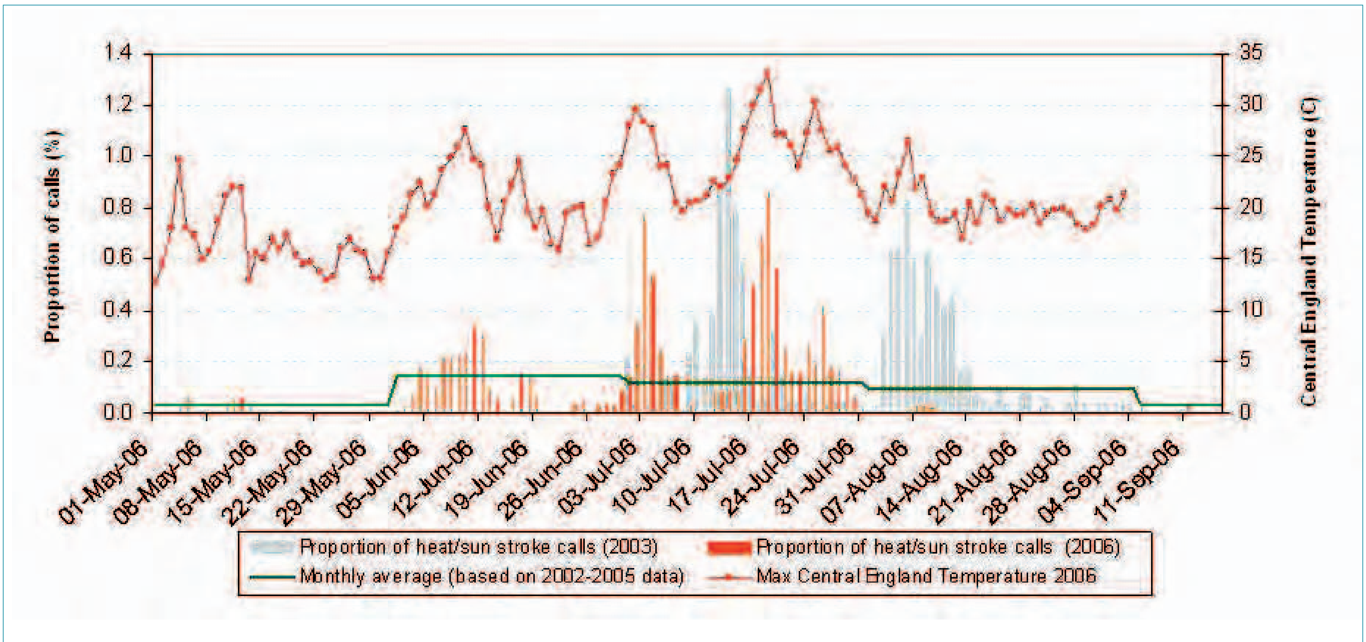

Figure 5: Daily NHS Direct 'heat/sun stroke' calls as a proportion of total calls for the 2006 heat wave against 'heat/sun stroke' calls recorded during the 2003 heat wave. Also illustrated are the monthly average of the proportion of 'heat/sun stroke' calls (based upon data recorded over 2002-2005) and the daily maximum Central England Temperature.

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The concept of a Joint Safety and Health Advisory Cell

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The concept of a Joint Safety and Health Advisory Cell

In the event of major or critical incidents a wide range of physical, psychological and safety hazards may be faced by both the public and emergency service responders. The police and other blue light services responding to these incidents need to quickly identify and manage hazards during the initial operational response, with their primary focus being the care and safety of the public. Only when this initial response has successfully concluded, can the business of the police or other investigation agencies truly start, along with scene recovery, eventually leading to a state of recovery and return to normality.

The police role during a major incident is often one of co-ordinating the emergency services and other agencies. In order to achieve this, a Gold - Silver - Bronze command structure is used by emergency services to establish a hierarchical framework for the command and control of major incidents and disasters. These three levels manage the Strategic - Tactical - Operational response to an incident respectively[1].

The Gold Commander is in overall control of their organisation's resources at the incident. They will not be on scene but at a force control room, known as Gold Command, where they will formulate the strategy for dealing with the incident – including the strategy for safety. The Silver Commander is the senior member of the organisation at the scene, in charge of all their resources. They decide how to utilise these resources to achieve the strategic aims of the Gold Commander; they determine the tactics used. At the scene of the incident, they will work in proximity and harmony with other organisations' Silver Commanders. In practice where there are multiple scenes, the police Silver is often co-located with Gold; although their roles remain separate. Multiple Bronze Commanders directly control resources at the incident and will be found with their staff working on scene. If an incident is widespread geographically, different Bronzes may assume responsibility for different areas. If complex, differing Bronzes can command differing tasks or responsibilities at an incident.

Safety support and advice from agencies involved in responding to an incident must therefore appropriately integrate into this command structure and work together to achieve Gold's strategy safely (so far as is reasonably practicable).

Any major incident irrespective of the cause, whether naturally occurring such as the 2004 tsunami in South East Asia, accidental like the Buncefield explosion in 2005, or a deliberate act of terrorism such as the 7 July 2005 London bombings (7/7), can present an immense and diverse range of operational challenges, all of which need to be managed appropriately if the safety of staff and the public is not to be put at unacceptable risk. Examples of such challenges are listed below.

- The incident may be spread over multiple scenes across a wide geographical area, requiring rapid assessment to reassure both staff and public safety, which can place a strain on both investigative and safety resources.
- The hazard may be complex such as 7/7, where there was a range of chemical, asbestos and confined space gas hazards, or of a novel nature such as the polonium-210 poisoning of Alexander Litvinenko in 2006.
- The scenes themselves may present a challenging operating environment such as a non-permissive environment, including confined spaces, adverse environmental or climatic conditions, scenes where the local infra-structure has been destroyed, or scenes with difficult access and egress.
- There may be differing health and safety exposure standards/controls for emergency staff and the public, requiring both interpretation and careful briefing to both groups if confusion and concern is to be avoided.
- A large number of agencies may be involved in response, with the police or fire service as the lead agency that has the responsibility for defining overall safety management protocols on site.
- The safety of staff and the public is also likely to be a key mission driver and this may take priority over any criminal or causational investigation.

To demonstrate the need for a formal structure to manage the safety consequences of a major or critical incident, two specific operational incidents are explored in this paper: Operation Theseus (7/7 bombings in London) and Operation Whimbrel (the investigation into the murder of Alexander Litvinenko).

Operation Theseus: The July 2005 London bombings

The July 2005 London bombings rapidly resulted in 'major incidents' being declared by the emergency services. Aside from the tragic loss of life and injuries, first responders faced an array of potential health and safety related hazards, which included a broad spectrum of physical, chemical, biological, ergonomic and psychological hazards.

In the aftermath of the explosions, in order to quantify the hazards faced, scene hazard profiling was undertaken by the emergency services on the London Underground network, which included visual/photographic inspections of train carriages and airborne asbestos fibre monitoring at underground stations.

After the initial response to the incident, an 'Environment Group' was set up outside of the Gold Strategic Coordinating Group, in order to share safety information from environmental/occupational hygiene sampling and to evaluate the response to the incident. This group consisted of personnel from organisations such as London Underground/Transport for London, Chemical Hazards and Poisons Division of the Health Protection Agency (HPA), and the Metropolitan Police Service (MPS)[2,3]. This Environment Group, which was led by the HPA and Police, became a pre-cursor for the Joint Safety and Health Advisory Cell (JSHAC) concept. The Group agreed strategies for "reassurance" occupational hygiene monitoring and sampling during the recovery phase of the incident, prior to the reopening of the underground network to the public. Post incident, the work of the Environment Group was used to reassure emergency responders, forensic staff and public; the actual risk associated with potential release of hazardous material from train carriages was assessed to be negligible[4].

Operation Whimbrel: The investigation into the murder of Alexander Litvinenko

Alexander Litvinenko died in University College Hospital, London on Thursday 23 November 2006. Tests established that Mr Litvinenko had a significant quantity of the radioactive isotope polonium-210 in his body.

A Consequence Management Gold Group was chaired and hosted at New Scotland Yard by the Metropolitan Police Service.

The criminal investigation identified possible crime scenes, which in turn led to the survey of possible polonium contaminated sites. Where polonium-210 was detected, each site was assessed and action taken depending on the level of contamination and the nature of the surface contaminated. Atomic Weapons Establishment (AWE) acted as the Radiation Protection Advisor to the MPS and provided radiological advice to assist the police in their investigation. The HPA provided advice and support on public health issues to MPS, local authorities and other agencies throughout the remediation process. In addition the HPA also supported the AWE environmental monitoring process. The HPA also took the lead in providing public reassurance.

The safety of operational staff and public was from the start of this operation set as a key mission requirement by the Gold Commander. Issues impacting on the management of this strategy are listed below.

- Multiple scenes across London were being identified daily. Scenes required rapid radiological assessment to reassure the public.
- Novel nature of the hazard involved.
- To further complicate matters, owing to differing radiological standards for occupational and public exposure, a number of conflicting early briefings by different agencies caused concern among police staff – whilst the messages were correct, the target audiences were different.
- A large number of agencies, some with regulatory responsibilities, were involved, including numerous police departments, HPA, National Health Service, Local Authority, Government Decontamination Service, Environment Agency, Health and Safety Executive, AWE etc.
- The police service had crime scenes to manage whilst liaising with different agencies on issues such as future scene handover for decontamination and recovery.

To support the safety and health assessment of the police investigation, a Joint Safety and Health Advisory Cell (JSHAC) was set up (initially referred to as the Investigation Safety and Health Advisory Cell (ISHAC)), in order to co-ordinate consistent and timely safety advice to Gold and to support the police forensic activity at the scenes. The JSHAC consisted of an operationally relevant multi-agency core of investigative, forensic, health, safety and medical professionals; including the AWE and HPA. In practice this meant that Gold and the sub-command levels received agreed cross agency advice on safety and health related matters; it also promoted and helped inform understanding of the operational pressures, challenges and requirements affecting safety of the different stakeholders involved.

The Terms of Reference for the JSHAC on this operation included the following:

- disseminate and assess scene radiological monitoring data from the stakeholders involved in the response to the incident
- disseminate and assess scene safety and health information
- collect and disseminate advice from the investigation Radiological Protection Advisor
- monitor, and where appropriate, advise on the investigation risk assessment process and safe systems of work
- provide advice to Gold.

The JSHAC was chaired by the Police; the outputs pertaining to achieving the operation and its strategy were fed to the Police Gold and the operational investigative Bronzes at multiple scenes. In addition the JSHAC took the lead and produced practical guidance, standard operating procedures and risk assessments for a number of challenging tasks including the following:

- forensic investigation of a potential radiological scenes
- general forensic investigation
- post mortem
- collection, transportation of radiological samples.

This guidance had to be innovative, responsive and maintain pace with the tempo of the operation to facilitate the rapid identification and the forensic exploitation of scenes. It is fair to say that JSHAC on this operation became instrumental and effective in this high profile operation, which had public and staff safety as a key mission requirement. The scientific advice and support became a key component to supporting the development of the operational risk assessments and safe systems of work.

Operational/Organisational learning and JSHAC model

The requirement for a JSHAC was universally endorsed by all law enforcement and partner agencies in a post Operation Whimbrel debrief by London Resilience[5]. The resounding message was that operational stakeholders should agree safety related science, standards and protocols early in the operation in order to provide the Gold and sub-commanders with, as far as practicable, a unified view from the agencies involved as to the operational safety assessment.

It was considered that a JSHAC type multi-agency approach should include the responsibilities outlined here.

- Support Gold in setting the strategy for safety.
- Support implementation of the operational plan and the development of safety options to support informed operational decision making.
- Co-ordinate oversight of safety and health advice/support at all levels (Gold Command to front line staff) and all phases of an operation (immediately to advise on hazard profile, support assess/monitor hazards and activity, recovery and clean up).

This should include early safety support to scenes once any rescue and life saving mission is complete. Including:

- access information to support and deliver detailed hazard profiling of the scene
- supporting the development of scene risk assessments and management of hazards
- supporting the development of scene safe systems of work
- provision of pragmatic safety advice for what can often be a dynamic changing scenario and environment
- where required, the provision of occupational hygiene monitoring, quantifying the health risks associated with the potential exposure to any hazardous materials and validating safety measures adopted including personal protective equipment (PPE).

A typical JSHAC structure for the future modelled on this experience from 7/7 and the Alexander Litvinenko incident is shown in Figure 1.

It is essential that the JSHAC is comprised of an operationally relevant multi-agency core of operational, health, safety and medical professionals that is able advise on the health, safety and aligned operational issues to both the Gold Command and staff on the ground, providing all with timely, effective and operationally relevant health and safety advice. A key source of that advice will be from the Scientific and Technical Advisory Cell (STAC) and other scientific advisors, to ensure that the scientific/technical advice informs the health and safety risk assessment process and safe systems of work. Therefore a collaborative working relationship will need to be established between the STAC and JSHAC; the extent of collaboration and joint membership between these two groups will clearly depend on the nature and scale of the operation.

Paramount to this is that the joint safety support and advice from all the agencies involved must therefore appropriately integrate into the Gold Command and Control structure. This will ensure that there is "one voice" and an "informed" tactical decision making process, providing timely and consistent safety critical strategy, information and instruction to all those affected or dealing with the incident. The JSHAC concept provides a mechanism to achieve this.

Conclusion

There are numerous benefits to be gained from a formal process such as the JSHAC when managing health and safety at major incidents. Working together in a formal joint multi-agency way on safety can only serve to promote professional and effective collaboration on difficult safety issues, ensuring the best use of safety and health expertise and resources. All of this enhances the safety of the operational response and informs the decision making process to the benefit of those responding. Such collaboration on safety becomes a mission enabler and the risk is reduced to our most important asset – staff, and ultimately the public.

Learning from these operations and the concept of a JSHAC is of value to all occupational services for front line emergency responders, NHS professionals and others involved in casualty management and site recovery.

Figure 1: A typical JSHAC structure

Acknowledgements

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Environmental Science and Toxicology

An introduction to the Health Protection Agency's Toxicological Review of the Products of Combustion

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A comprehensive review of the toxicology of combustion products was conducted to support the Health Protection Agency (HPA) strategic goals through Programme 2: 'To protect against the adverse health effects of acute and chronic exposure to chemicals, poisons and other environmental hazards'. This document is the fourth in a series of Reports from the Centre for Radiation, Chemical and Environmental Hazards (CRCE) based on research of the scientific and toxicological literature available. This article summarises key messages contained in the *Toxicological Review of the Products of Combustion*; the full report and others in the series can be found at: http://www.hpa.org.uk/HPA/Publications/ChemicalsPoisons/ChemicalResearchReports/.

Generation of toxic products

CRCE is frequently requested to provide advice on the health effects arising from incidents due to fires. The purpose of this review is to consider the toxicity of combustion products. Following smoke inhalation, toxicity may result either from thermal injury, or from the toxic effects of substances present. This review is primarily concerned with the effects arising from toxic combustion products, and not thermal injury.

The pyrolysis and combustion of materials can result in the generation of many toxic smoke products which cause irritation, incapacitation, systemic toxicity, asphyxiation and may be lethal following acute exposures. Some of the common toxic chemicals which may be present in a fire effluent include asphyxiant gases, such as carbon monoxide (CO) and hydrogen cyanide (HCN), irritant gases such as hydrogen chloride (HCl), oxides of nitrogen (NOx), acrolein and phosgene, and complex molecules such as polycyclic aromatic hydrocarbons (PAHs).

The amounts of toxic products evolved during combustion vary with the type of combustion, the availability of oxygen, the temperature and the materials involved. Therefore, the conditions of combustion will affect the severity of the adverse health effects in those exposed to the products of combustion. This is a complex area and there is the potential for generation of a huge range of pyrolysis products depending on the nature of the fire and the conditions of burning. Although each fire will have individual characteristics and needs to be considered on a case by case basis, there are commonalities, particularly with regard to the most important components relating to toxicity. The review aims to identify generalisations which may be made regarding the toxicity of common products present in fire smoke, with respect to the combustion conditions (temperature, oxygen availability, etc.) and materials involved, focusing largely on the adverse health effects to humans following acute exposure to these chemicals in smoke.

The document is intended as a scientific review of the toxicology of combustion products and does not cover the detailed precautions that may be appropriate in specific circumstances. However, most of the key chemicals involved are covered in the CRCE Compendia of Chemical Hazards, which contain a section on incident management. This section of the Compendia provides information that may be needed by health professionals during a chemical incident, including information on hazards and precautions that may be appropriate (e.g. the Chemicals Hazard Information and Packaging for Supply (CHIP) classification, risk phrases and safety phrases).

The generalisations identified during the course of this review enabled some estimates and conclusions to be made about the likely products formed during fires of specific classes. Although the actual products of combustion generated during a fire will vary in each individual situation, knowing which products are likely to be formed under certain combustion conditions may help to inform the risk assessment process when assessing the risks to public health from a fire.

Toxicology of products of combustion

The hazards associated with exposure to combustion products fall broadly into the categories of: asphyxiation, irritation, mutagenicity, carcinogenicity and reproductive toxicity. The first two groups, asphyxiation and irritation, often become evident during exposure and are likely to improve reasonably rapidly following removal from the exposure. It is these components of smoke which are likely to cause immediate adverse health effects.

Asphyxiant gases produced during combustion can give rise to narcosis (deep stupor or unconsciousness) due to depression of the central nervous system. Chemical asphyxiants prevent the normal uptake of oxygen by tissues by interfering with specific elements in oxygen delivery and metabolic processes. Thus carbon monoxide and hydrogen cyanide are chemical asphyxiants. Simple asphyxiants are physiologically inert gases that, if inhaled, displace oxygen from the alveoli and lead to hypoxia (inadequate oxygen supply). Carbon dioxide, nitrogen and methane are considered to be simple asphyxiants. Breathing a reduced concentration of oxygen also has this effect, but is not considered as a simple asphyxiant. Exposure to these combustion products at sufficient concentration or duration of exposure can lead to unconsciousness and eventually death, due to tissue hypoxia.

The injury following exposure to an irritant gas depends upon the chemical involved, its concentration, the exposure duration and its solubility. However, the initial effect of exposure to these irritant gases is likely to be sensory irritation. Irritation of the eyes will cause pain and stinging, initiation of a blinking reflex and lachrimation (secretion of tears). The severity of sensory irritation is largely dependent upon the concentration of the irritant present. An individual exposed to irritant gases in a combustion atmosphere may shut their eyes and hold their breath to alleviate their irritation, hindering their ability to escape from the hazard. An additional characteristic sign of exposure to irritant gases is a burning sensation of the mucous membranes of the upper respiratory tract, including the nose, mouth and throat. Pulmonary (lung) irritation will commonly occur following sensory irritation, due to inhalation of the irritant gas into the lungs. This irritation of the lungs gives rise to bronchoconstriction, coughing and breathing difficulties. Unlike sensory irritation, the severity of pulmonary irritation is dependent upon both the concentration and the duration of exposure to the irritant gas. Exposure to high concentrations of irritant gases can cause inflammation of the lung tissues, pulmonary oedema and could potentially be fatal in a period of between 6 and 48 hours after removal from the exposure.

The combustion of organic materials, particularly if it is incomplete, may also give rise to more complex molecules in the smoke plume, which may typically include longer carbon chains and multiple carbon-rings. The acute toxicity of these compounds is generally low and may not pose a direct health hazard during exposure. However, some of these compounds, in particular those from the polycyclic aromatic hydrocarbon groups, are recognised mutagens and carcinogens, although the risks from single (acute) exposure are very small (and unquantifiable). Other complex molecules such as dioxins give rise to concern because of possible effect in the reproductive system.

Copies of the report 'A Toxicological Review of the Products of Combustion' CHaPD-004 can be obtained from:

http://www.hpa.org.uk/HPA/Publications/ChemicalsPoisons/ChemicalResearchReports/

A review of firework legislation and acute health effects

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Introduction

Fireworks are enjoyed worldwide to celebrate cultural, national and personal events. Essentially, they consist of a combination of explosives and combustibles. Globally, several thousands of injuries, many fatal, occur annually from blasts within factories, stores and consumer use[1]. In the United Kingdom, 991 injuries were reported in 2005, with the majority occurring during the four week period around Guy Fawkes Night (November 5th), when fireworks are most widely used by the general public[2].

Several firework incidents appear in the headlines periodically, and in December 2009, a jury at Lewes Crown Court found the owner and son of Alpha Firework Company guilty of manslaughter. The pair was described by the courts as being 'grossly negligent' for being in possession of an unlicensed metal container packed with fireworks, which exploded during a fire causing the death of two firemen in December 2006[3,4].

From the late 1960s up until 2005, the Department of Trade and Industry (DTI) commissioned and produced the National Firework Injury Report, which included statistics regarding the number of incidents occurring and their type[2]. These data were collected annually over the four-week period between mid-October and mid-November from hospital emergency departments. The last annual report was published in 2005 and from then publication was discontinued as it was not considered to be cost-effective[5]. Currently, the source from which injury data are available is through Hospital Episode Statistics (HES), which are released by the Department of Health[6]. A database called Explosive Incidents Database Advisory Service (EIDAS) contains readily accessible and searchable information about the causes and effects of explosives and firework incidents in the UK, from the 1850s up to 2006, although it has not been updated since[1]. The principle aims of such databases are to provide information regarding firework incidents in order to target measures that help to reduce risks in the manufacture, transport, storage and use of explosives. Although there are several sources in place, there is not one database that collects all accidents arising from fireworks and this is quite a limitation for research.

Legislation

In 2008, the UK spent over £18 million on 11.3 million kg of fireworks, imported mainly from Asia and Oceania[7]. All fireworks supplied to the public require a license to show their design meets the safety standard British Standard 7114[8]. Fireworks are split into four categories[9,10]:

1 Indoor fireworks
- usually party poppers
- labelled “Firework suitable for indoor use”

2 Garden fireworks
- generally stored in a PVC bag with a backing card and header
- have to be viewed at a minimum distance of five metres
- labelled “Garden firework”

3 Display fireworks
- must be viewed at a minimum distance of 25 metres
- rockets of 20g Net Explosive Content (NEC) and those with flash-powder bursting charge fall under this
- labelled: “Display firework”

4 Professional display fireworks
- these are only intended for specialist use
- it is an offence for a member of the public to be in possession of these
- they must not be sold to people who have not received proper training to handle them
- labelled: “Professional firework”.

Section 80 of the Explosives Act 1875 prohibits the public from throwing or setting off fireworks from any highway, street, thoroughfare or public place. It is a further offence under this Act to tamper with, or modify, fireworks. Modifying fireworks or combining two or more fireworks together may be interpreted as meeting the NATO definition of an improvised explosive device, defined as: "*A device fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals and designed to destroy, incapacitate, harass or distract.*"[11]

In order to minimise the number of injuries occurring from firework use, a number of legislative acts are in place. Category 2 and 3 fireworks can only be sold in licensed premises for most times of the year, however permits are not required for the following[12]:

- on the first day of the Chinese New Year and the three days immediately preceding it
- on the day of Diwali and the three days immediately preceding it
- during the period beginning on the 15th October and ending on the 10th November
- during the period beginning on the 26th December and ending on the 31st December.

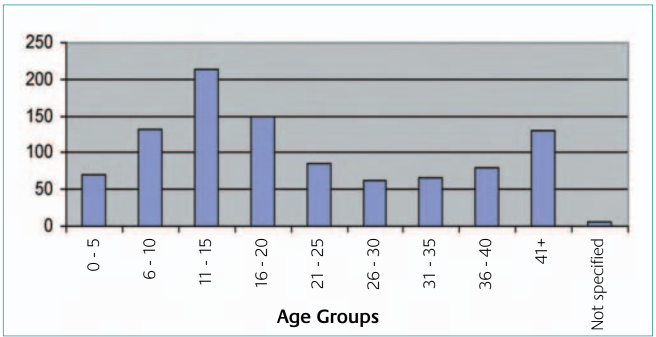


Figure 1: Number of firework injuries by age group from mid October – mid November 2005[2]

Within areas where the public have access to fireworks they should be kept in locked glass showcases, metal containers, wooden boxes, cupboards or drawers and positioned so that no unauthorised person can reach them. Each container must not contain more than 12.5kg net weight of explosive. Legislation also requires records of the personal details of the purchaser to be kept if, in a single transaction, the total amount of explosives held is more than 50kg. This seeks to regulate the number of retailers, selling fireworks to the public in order to minimise the number of storage related incidents[12].

Aim

The main aim of this research was to clarify, summarise and gather information about acute health effects resulting from fireworks use and storage, which in turn would inform the researcher of potential public health issues in relation to current legislation.

Methods

A literature review was conducted using a large number of sources including search engines like 'Medline', 'Pub Med', 'Google', and 'Yahoo'. A collection of peer-reviewed literature, reports, datasets and media articles were identified using the search terms 'firework storage', 'firework incidents', 'firework injuries' and 'firework types'. The inclusion criteria were:

- primary research related directly to the topic
- English language only
- published literature and articles from newspapers
- incidents which occurred from 2000-2010 in the UK.

This exercise gave scope for the research, identified knowledge gaps and allowed formation of relevant research questions. This literature was critically appraised using the 'Quality Framework for Assessing Research Evidence'[13].

Results

In the UK, end user injuries are the most commonly known health effects associated with fireworks, examples of which are in Table 1.

From the data made available by the DTI for 2005, 34% of all injuries occurred to children between the ages of 6-15 years, with around 93% as a consequence of inadequate parental supervision[16]; this finding is consistent from one year to the next. Figure 1 summarises the age distribution of firework injuries in England, Scotland and Wales in 2005[2].

A firework injury is described as an injury from a device intended to produce a striking display by the combustion of explosive or

Table 1: Examples of injuries resulting from firework use reported in the media.

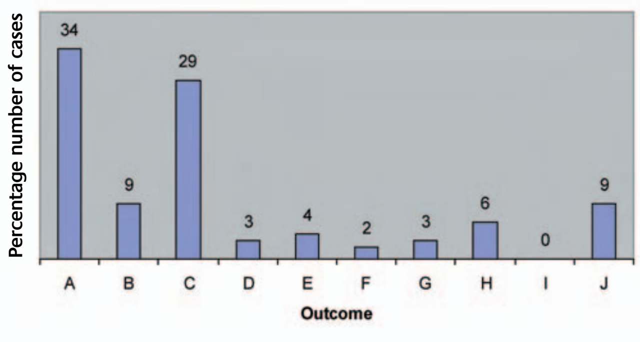
Incident date	Place	Summary of incident
November 2009	Glasgow	A man was treated for smoke inhalation after a firework shot through an open window of a high-rise flat.[14]
November 2009	near Lockerbie	An 18 year old received 18% burns to his upper torso, face and neck during a village bonfire.[15]
November 2008	North Lanarkshire	A 10-month old baby girl suffered burns to her neck after youths threw a lit firework into her pram outside a shop.[16]
October 2003	London	Two teenage boys were injured while playing with fireworks, subsequently they both required surgery.[1]
October 2003	London	An elderly woman was injured when a rocket firework smashed through her double-glazed window and exploded in her front room.[1]
October 2000	London	A youth lost three fingers when a firework blew up in his hand.[1]
October 2000	London	Thirty people were injured during a fireworks display when one firework exploded prematurely and the resulting debris set off other fireworks.[1]

Table 2: The number of firework injuries and body part affected stratified by type of firework between mid October – mid November 2005[2]

Firework Type	Body Part							
	Eye	Head	Hand	Arm	Leg/ Foot	Torso	Face	Not known
Rocket	50	26	85	18	13	23	38	2
Air bomb/ Roman candle	38	16	24	10	18	6	11	0
Sparkler	22	3	71	0	1	3	4	1
Home made/ Extracted Powder	1	2	12	1	1	1	2	0
Other	22	10	48	10	4	12	21	0
Not known	152	56	109	26	48	36	76	8

flammable compositions[17]. Since they are often used around holiday periods, injuries resulting are clustered and in many cases interrupt the festivities. Most commonly encountered are a combination of burns, lacerations, abrasions, soft tissue loss and bony injuries. Several studies highlighted that the most commonly encountered from this list are burn and blast injuries[15].

Generally it is rare for firework related injuries to require hospital admission, and those that do (commonly blast injuries to the hand or significant burn or eye injuries), account for only 0.4 per 100,000 admissions[2]. Figure 2 shows the outcomes of injuries resulting from firework use in 2005[2].



Legend (outcome):
A – No further treatment
B – Referred to GP
C – Referred to out- patient department
D – Detained and no further treatment required
E – Detained and then referred to GP/ out- patient department
F – Detained and then transferred to another unit/ department
G – Transferred to another department
H – Transferred to emergency department/ burns unit/ eye clinic
I – Died
J – Not known

Figure 2: The proportion of cases resulting in the specific outcomes after a firework related injury[2].

Hospital Episode Statistics for the financial year 2008/09 show that 229 patients were admitted to a hospital in England either as a day-case or in-patient with a firework-related injury. Of these, 181 (79%) were males and 48 (21%) were females, and 123 (54%) were in the age group 5-24 years. Interestingly, the other peak in admissions relates to the 35-49 age group with a total of 46 (21%) of cases[6].

Different types of firework injuries

Blast injury
Observations by Al-Qattan et al (2009) show that firework blast injuries to the hand follow a predictable pattern and relate to the pressure wave from the blast[18]. These tend to be injuries to the thenar and hypothenar eminences with central sparing of the hand. The shock wave can cause tissue damage away from the obvious hand wound extending proximally within the carpal tunnel causing contusion of the median nerve and acute carpal tunnel syndrome. Cavitations of muscles within the thenar eminence and of the flexor tendons can also be observed[18]. Blast injuries can result in digital tip amputations as well as fractures (the majority reported in the distal interphalangeal and metacarpal joints) and/or dislocations[19].

Burn injury
Burn injuries related to fireworks occur in three different ways[16]. These are:
- Flame burns, when clothes catch fire. This is often the result of young children playing with sparklers and can result in major full thickness burns.
- Major flame burns which might occur in adult workers due to powder explosions in fireworks factories.
- Finally, heat from fireworks may cause localised burn injuries to the hand and is frequently associated with a blast injury.

Puri *et al* (2008) also reported that of all firework burn injuries, minor burns were the commonest and 80% of all burns were to the hand[15]. Sparklers are often considered by parents as a relatively safe form of firework and therefore parents may not appreciate the need for close supervision[16]. The temperature of a burning sparkler has been compared with that of a welding torch and can easily set clothes alight, causing substantial burn wounds that can be disfiguring, disabling and occasionally fatal[20].

Eye injury
Eye injuries caused by fireworks are often severe and can result in permanently reduced visual acuity or blindness. The literature shows that some of the most common injuries include: corneal abrasion, corneal burns, lid burns/laceration, corneoscleral laceration, hyphema, haemorrhage (retinal or vitreous), traumatic cataract, ruptured globe, iritis and choroidal rupture[21]. A large series of ophthalmic reports exist explaining these injuries. One report found that the majority (78%) of all firework-related eye injuries reported healed without any scarring but that 28% resulted in visual impairment, mainly due to corneal scars or retinal pathologies. Out of the severe injuries (10% of total injuries), 18% resulted in legal blindness due to severe corneal and retinal scars[21].

Inhalation effects
The burning of fireworks releases pollutants such as sulphur dioxide, suspended particles and several metals such as copper (for blue colours) and barium (for green colours), to the air[22]. Firework use is transient in nature therefore these metal emissions only occur at certain times of the year or during special events. Once released, the metals are carried within dense clouds as fine and easily inhaled particles, which can penetrate deep into the

respiratory system[23]. Firework smoke inhalation has been associated in susceptible individuals, with asthmatic attacks, some of which have been fatal. This, along with the increased levels of sulphur dioxide, raises the question as to whether there are any adverse short or long term health consequences to individuals exposed to such pollution plumes[23].

Health effects associated with incidents in firework storage facilities

Firework injuries are not exclusive to end-use. Many injuries and fatalities have resulted from factory and storage blasts, examples of which are listed below.

- Enschede, Netherlands in 2000. A massive explosion at a fireworks storage centre killed 22 people, injured almost 1,000 and destroyed around 400 houses, resulting in the re-location of 1,200 people[24].
- November 2002, Manchester, a fireworks storage site was destroyed in a blaze. Two people were taken to hospital with minor injuries[1].
- Lewes (West Sussex) December 2006, two fire fighters were killed after an explosion in a firework storage depot[25].
- In 2008, at the Xinxin fireworks factory in China a huge explosion destroyed 50 workshops and killed 15 people[1].

In storage plants, explosions in an enclosed space may cause injury from the high temperature and large pressure waves changes, and adverse health effects can also arise from the toxicity of the gunpowder itself[26].

Blast injuries, blast burns and smoke inhalation were seen in a retrospective survey of patients admitted to a centre in China after an explosion in a storage plant[15]. Findings showed 76% of individuals sustained burns greater than 31% of the total body surface area and 58% sustained full thickness burns greater than 21%. Eighty-eight per cent of these burn injuries were to the head and neck. Other associated injuries included fractures, pulmonary explosive injury, perforated tympanic membranes and inhalation injury from hot toxic gas, which left many individuals requiring tracheotomies and mechanical ventilation[26].

Large scale incidents can also lead to chronic health problems. Studies undertaken a year after the disaster in Enschede found that there was a substantial increase in individuals presenting with psychological problems, such as post traumatic stress disorder[24].

Discussion

Evidence from this review indicates that in the UK, past incidents involving fireworks have been relatively small scale involving a few individuals, but there are potential risks of large scale disasters such as those seen in the Netherlands and China. The absence of recent UK datasets about firework injuries makes it difficult to determine whether the 2004 amendments to the Fireworks Safety Regulations[27], which restrict the quantities one may possess and their sales, has had a significant impact on the number or severity of incidents. Surveillance of incidents associated with fireworks would aid the evaluation of legislation and provide an evidence base for recommendations and changes to be made in order to protect the public.

An important aspect of firework use is their impact on air quality, which can have significant public health implications. Although transient in nature, such pollution may have significant health effects and a separate research paper will be published to address this issue. As the NHS is facing financial burdens on a daily basis it would be telling to accurately quantify how much money goes into treating people who suffer from incidents occurring from firework use. Thousands of injuries per year (even though not an accurate figure) result every year from fireworks, but many of these injuries could be prevented.

Tighter controls regarding the quantities stored by retailers, the logistics of where they are stored, the quantities sold and their availability (buying fireworks off the internet) are issues that could cut the number of firework injuries. This is especially pertinent in view of the upcoming Olympics, which will be held in London in 2012, where it is likely that a greater number of fireworks will be supplied, purchased, stored and used, increasing the potential for injury and large scale accidents.

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The effect of cosmetics on health

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Introduction

Cosmetics can be defined by their intended use, as "articles intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance"[1]. Among the products included in this definition are skin moisturisers, perfumes, lipsticks, fingernail polishes, eye and facial makeup preparations, shampoos, permanent waves, hair colours, toothpastes, and deodorants, as well as any material intended for use as a component of a cosmetic product[1].

The history of cosmetic use has its roots in Ancient Egypt. The use of cosmetics was also popular with Ancient Greeks and Romans. The Romans and Ancient Egyptians, not realising their dangerous properties, used cosmetics containing mercury and lead. The use of cosmetics is still popular to this day. The cosmetics produced in the western world are free from heavy metals and are produced according to high standards and regulations but there have been incidents where cosmetics produced in developing countries and imported into the developed world have led to cases of chronic poisoning, as described below.

For the purpose of this report we will only be looking at the effect of kohl and skin lightening creams on health. Kohl is a widely used traditional cosmetic. It is mainly worn around the eyes. Kohl is not only used as a cosmetic but also for the protection and treatment of various eye ailments. The use of skin lightening creams is also very popular amongst dark skinned women. The use of both the products is very prevalent in the Middle East, Asia and Africa.

Aims of the study

- To examine if there is a relationship between use of kohl, skin lightening creams and health.
- To use the results of this study to support further research in this topic area.
- To make recommendations to reduce public exposure.

Methodology

A review of the literature was carried out to identify studies specifically looking at the health effects of:
- kohl
- skin lightening creams.

All types of epidemiological studies and case series were included in the review. Only studies on humans were included and any animal studies were excluded from the review. The cosmetics included in the review were kohl (also known as surma) and skin lightening creams. The outcomes of interest were health effects of these products.

Electronic searches were carried out on Pubmed, Medline, Scopus, Embase. Additional studies were identified by scanning the references of included and excluded studies. Only studies published in English were included.

Results

Composition of kohl
The composition of kohl can vary depending on the region it was purchased. A number of studies have been carried out in varying regions; Table 1 summaries kohl and surma analysis from a number of different regions. It is clear that there is a vast range of levels of lead in the samples of commercially sold kohl. Analysis of kohl samples collected from different regions of Saudi Arabia revealed lead levels varied from 53% to up to 88%[2,3]. Up to 86% lead was found in surma products sold in India in comparison to samples from Britain, USA, Morocco and Mauritania which ranged from 0.6% to 50%[4,5]. In another study carried out in the UK, 27 samples of surma analysed showed that 80% of the samples contained lead sulphide levels greater than 50%[7]. In a further study carried out in Israel researchers found lead levels in kohl to range from 17% to 80% [8].

Table 1: Summary of kohl and surma analysis from different regions

Maximum lead level in kohl/surma	Country	Reference
53%	Saudi Arabia	Al-Ashban et al, 2004[2]
88%	Saudi Arabia	Al-Kaff et al, 1993[3]
86%	India	Aslam & Davis, 1997[4]
0.6 – 50%	Britain, USA, Morocco and Mauritania	Parry & Eaton, 19995
>50%	UK	Green et al, 1979[7]
17% to 80%	Israel	Nir et al. 1992[8]

Results of blood analysis
In a case control study in the UK, blood lead concentrations were measured in 62 children, more than half of whom had used surma. The mean concentration in those who had not used surma was 0.98 µmol/L compared with 1.65 µmol/L in those who had[9]. The blood analysis of regular kohl users carried out revealed a high lead concentration and relatively low haemoglobin levels[2]. In a report on the blood analysis carried out on a woman of Moroccan origin, who had a history of prolonged kohl use, revealed blood lead levels prior to chelating treatment of 490 µg/dL and six weeks post treatment lead level of 49 µg/dL[10]. In a study in India that looked at the blood lead

levels of 253 children, it was found that children with no symptoms of pica showed blood levels of 9.6 µg/dL while children with pica had blood lead levels of 23.0 µg/dL [11]. In a similar study in Bradford UK blood level concentrations were measured in 117 Asian children and 49 Caucasian controls. The mean lead concentration of those using kohl/surma was 1.16 µmol/L and of the Caucasian controls was 0.86 µmol/L [7]. Analysis of the blood samples taken from 24 kohl users and 30 non kohl users aged 6-16 months showed that the blood lead levels were significantly higher in the infants to whom kohl was applied (11.2 µg/dL, $p < 0.001$) and in infants who did not have kohl applied to them but their mothers were kohl users (5.2 µg/dL, $p < 0.02$)[8]. Researchers analysing blood lead levels in pregnant women living in the slums of Lucknow, India found mean lead concentration of 14.3 µg/dL. Lead was not associated with reported use of piped water or the presence of paint in homes but increased lead level was associated with increased use of surma and duration of gestation[12].

Health effects

The use of surma/kohl can lead to high blood concentrations, asymptomatic lead poisoning[6] and low haemoglobin levels[2, 9]. Some researchers found preparations to have a mildly anti microbial effect against Streptococcus, Staphylococcus and Proteus species[3]. Lead poisoning can present as abdominal pain, encephalopathy and anaemia[10, 11]. In the study carried out in Israel no significant difference was found in weight and head circumference between children to whom kohl was applied and controls. The only difference was blood lead level[8]. Unlike the other studies the authors of a study conducted in Pakistan concluded that the relationship between kohl use and blood lead toxicity is likely to more of a theoretical risk rather than a practical one[13].

Composition of skin lightening creams

The use of skin lightening creams is very widespread in Asia, Africa and Middle East. The active ingredients in these cosmetics are hydroquinone, mercury and corticosteroids[14]. Mercury is a ubiquitous toxin that can produce a wide range of health effects in humans. Inorganic mercury compounds known as ‘mercuric salts’ are sometimes used in skin-lightening creams[19]. In one study the mercury content of the cream ranged from 660 to 57,000 ppm[15]. In another study conducted in Saudi Arabia 38 skin lightening creams available on the market were analysed for mercury using inductively coupled plasma spectrometry after an acid digestion procedure. Forty five percent of the creams tested contained mercury above the FDA’s acceptable limit of 1 ppm[18].

Results of sample analysis

In a recent study conducted in Hong Kong, blood and urine samples of 286 people who had used beauty creams containing mercury were analysed[15]. The mean mercury concentration in urine was found to be 45.2 µg/L and the mean mercury concentration in blood was found to be 17.1 µg/L. In a cross sectional study in Mexico urine analysis was carried out on 330 cream users. The mean urine concentration was found to be 146.7 µg/L[16]. In a similar study in USA on individuals who had used skin lightening creams containing mercury, 89 urine samples were tested of which 66 were found to contain elevated mercury levels (of >20 µg/L)[17]. In a study carried out in Senegal, hair samples from 20 women with a known history of using mercurial creams revealed a mean value of 15,575 ppm mercury in scalp hair while the normal level is less than 10 ppm[21].

Health effects

Skin lightening creams tend to be used on a large body surface area for a long duration. Percutaneous absorption can be enhanced mostly under hot humid conditions. The complications of these products can be serious with exogenous ochronosis, impaired wound healing, fish odour syndrome and nephropathy and fatalities all being reported[14,20]. Some of the adverse effects can be attributed to the presence of corticosteroids in these products but renal complications are mostly thought to be due to the presence of mercury. Blood mercury concentrations can become elevated within a very short period (48 hrs) and can remain elevated for about 45 days after discontinuing use of creams[15].

Discussion

The use of kohl and skin lightening creams is a socially acceptable phenomenon and is widely practiced by both men and women in Asia, Middle East and Africa. The trend in the use of these products cuts across all socio-economic strata, age and sex. These products are not only used for beautification but also for their perceived medicinal purposes[22]. The health effects of using these products can be quite devastating. Cosmetics produced in UK and other developed countries do not contain lead or mercury but cosmetics produced in developing countries can be purchased through unorthodox sources in developed countries, suggesting that this hazard is not confined to developing counties[5].

This review has highlighted a number of issues:

- Most cosmetic products of concern are produced abroad and imported into the UK. Although there are government restrictions to importing into the UK these are not always adhered to.
- Health promotion messages targeting communities amongst whom these products are widely used would be useful in raising awareness about the risks of using these products[9].
- It is important that the medical profession be made aware of this problem and should consider mercury poisoning, due to the use of cosmetic creams, in the differential diagnosis when assessing patients with unexplained nephrotic syndrome[4,5,23].
- A study looking specifically at the prevalence of these products in the UK consumer market may be of use.
- Research to find out specifically what proportion of cases of lead and mercury poisoning can be attributed to the use of these products will help set a baseline for any health promotion campaigns.

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Increasing carbon monoxide awareness in Camden

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Summary

Camden Council's community safety team introduced an innovative new pilot in July 2009, which aims to increase awareness of carbon monoxide and install audible alarms for vulnerable households in the Borough. Providing fire prevention advice and installing free smoke alarms has always been a key part of Camden's Safe as Houses service, which is now running a carbon monoxide pilot with funding from The CORGI Trust, now called the Gas Safety Trust. The project has received extremely positive feedback from internal and external agencies, including at Health Protection Agency events.

Since its launch, carbon monoxide audible alarms have been installed in 448 Camden homes. At least one carbon monoxide leak, from a faulty gas appliance, has been identified. The publicity campaign, integral to the pilot, has helped to raise awareness in Camden of how to reduce the risks from carbon monoxide.

Background

Camden's Safe as Houses service is a multi-agency partnership that aims to improve all aspects of health, safety and security within the home. Based within the Council's community safety team, it brings together a range of statutory and voluntary sector partners including Metropolitan Police, London Fire Brigade, NHS Camden and Age Concern Camden.

The primary aims of the Safe as Houses partnership are:

- raising awareness of all aspects of domestic health, safety and security
- reducing risks and hazards in the home (including falls prevention, improving fire safety and home security and preventing accidents involving children)
- supporting the development of services that enable older and vulnerable people to live independently and feel safe in their homes.

Safe as Houses works both directly and indirectly to reduce the risks within homes of Camden residents, with a service that installs the following equipment for three potentially vulnerable groups:

- families in receipt of means tested benefits with children under five, who are eligible for child safety equipment
- people aged over 60 who are eligible for additional home security equipment
- people with disabilities, also eligible for additional home security equipment.

In addition to promoting these services, articles in local newsletters and magazines highlight ways all residents can reduce risks within the home and improve safety. Attendance at a range of community festivals and events throughout the year provides further opportunity to raise awareness directly to Camden residents.

During 2009/10 over 1400 Camden residents received crime prevention and home safety advice at 37 community events and festivals. During the same period, more than 500 homes have had additional security measures installed, such as window locks and intercoms, with more than one third being for black or minority ethnic (BME) residents. Approximately two thirds of these installations are for people with disabilities. Safe as Houses' child safety equipment assessments and installations continue to receive positive feedback, with Children's Centres highlighting that many families make first contact with an enquiry for this assessment. Of the 265 child safety equipment installations completed during the current financial year, 80% have been for BME residents.

One of the Safe as Houses partners, Camden Council's Environmental Health team (now renamed Private Sector Housing — Regulatory Services), organised a carbon monoxide training day in 2008. During the training an opportunity for joint working with The CORGI Trust was identified.

Working in partnership is at the centre of The CORGI Trust, established in 2005 as a registered charity and funded by surplus from commercial activities of the CORGI Group. The CORGI Trust aims to reduce incidents of fatalities and serious injuries from carbon monoxide poisoning.

Both The CORGI Trust and Safe as Houses aim to work with underprivileged and low-income communities or those most vulnerable and at greatest risk. These shared aims highlighted the opportunity for a joint scheme that could make a real difference to those most in need.

Why develop a carbon monoxide pilot?

Many people are unaware of the risks from carbon monoxide and the simple steps they can take to reduce these risks. By considering pre-existing services a pilot was designed to reduce risk of carbon monoxide poisoning in key ways:

- educating vulnerable people about the risks from carbon monoxide
- providing and correctly installing carbon monoxide audible alarms free of charge in the homes of vulnerable people
- educating the wider community about the risks from carbon monoxide and how to reduce these risks, such as the need for annual checks on gas appliances
- providing learning that could be used elsewhere to raise awareness of carbon monoxide poisoning.

With funding from The CORGI Trust, the Safe as Houses service was extended to include installation of a free carbon monoxide audible alarm when other equipment was installed. The presentation about the original proposal received extremely positive feedback at the Health Protection Agency's carbon monoxide training day in 2008 in London, an acknowledgement of the potential benefits of the scheme. The CORGI Trust agreed to fund 1,350 audible carbon monoxide alarms to be installed by Safe as Houses, with an aim to reach a further 1,500 people with the publicity of the scheme.

Camden's WISH Plus

Another key factor in the success of the pilot is the WISH Plus scheme. Developed by Camden Council's community safety team and funded by NHS Camden, WISH Plus acts as a referral hub to services provided by 520 frontline staff working across more than 85 partners. As a universal service offering Camden residents an easy way to access services related to warmth, income, safety and health, WISH Plus offered a way to raise awareness of carbon monoxide and the importance of testing appliances, particularly amongst those at greatest risk.

Vulnerable people are often unaware of the help that is available, such as health interventions or services that could make their homes safer. Agencies providing services for vulnerable communities sometimes refer to 'hard to reach people'. Considerable efforts are invested trying to reach these people and link them to the available services. Other people may be living in private rented accommodation and have some contact with some statutory or third sector agencies, yet be unaware of basic legal requirements such as the need for landlords to have an annual gas safety check by a Gas Safe registered engineer. These residents may not consider themselves vulnerable, yet are at risk of carbon monoxide poisoning from unchecked equipment.

The most vulnerable often do not even know about or access services that could help them. Operating from within Camden's community safety team, WISH Plus presents a multi-agency solution to pro-actively link people to a range of services to improve their health and well being. Acting as a referral hub, it enables residents to find out about, and be referred for, packages of support across multiple service providers. Since April 2009, WISH Plus has contacted 869 Camden residents to screen them for services based upon their individual circumstances.

Regardless of the point of access, WISH Plus enables Camden residents to link into a range of services that can help them. For example all residents living in private sector accommodation are asked questions about gas safety checks, with referrals to the private sector housing team made as appropriate.

Camden's Safe as Houses carbon monoxide pilot in practice

Everyone who receives Safe as Houses equipment is encouraged to also have a free carbon monoxide audible alarm installed. Advice and information is given about carbon monoxide and the alarm, which is a sealed unit with a seven-year battery. The expiry date is clearly marked on the alarm. Guidance around testing the detectors and other relevant information, including emphasising the need to regularly test gas appliances, is left with householder in the appropriate format, for example large print.

As previously mentioned, the scheme has been promoted directly to the public and to a range of Camden organisations. Feedback from residents at events has demonstrated an increasing awareness of carbon monoxide, due to both national and local publicity.

Increasing the impact

In addition to directly fitting audible alarms for those most at risk, the pilot aims to reduce the risk of carbon monoxide poisoning by publicising the steps everyone should be taking:

- having an annual gas safety check in all homes with gas appliances
- only using Gas Safe registered engineers
- installing and regularly checking carbon monoxide audible alarms.

Throughout the scheme every opportunity to maximise impact was considered. For example, in addition to providing training for fitters installing the alarms, a range of sessions of varying lengths were offered, including breakfast and lunchtime briefings.

Next steps

By identifying one carbon monoxide leak (from a faulty grill) the audible alarms have already demonstrated a positive outcome within Camden. The next phase of the pilot will include an analysis of the outcomes to date, with a consultation starting in June 2010 to gather a range of information, including:

- how many people have spoken to friends and family members about carbon monoxide since Safe as Houses installed an audible alarm
- how many people are checking their alarms as advised
- whether anyone has not had gas safety checks during the past year.

The feedback from the consultation will inform the further development of the pilot to ensure that the next two years yield the maximum benefits from The CORGI Trust grant.

Further information

Camden Council's Safe as Houses: www.camden.gov.uk
The Corgi Trust: www.trustcorgi.com
Gas Safe Register (find a registered Gas Safe Engineer):
www.gassaferegister.co.uk

High lead soils: a potential risk to animal and public health

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Introduction

A local authority recently requested advice from Veterinary Laboratories Agency (VLA) concerning a village where 39 soil samples averaged 12,000 mg/kg lead in soil and a maximum of 40,000 mg/kg soil. This paper describes animal and human health issues arising from high lead levels in soils.

VLA is a Defra agency and carries out veterinary investigation, disease surveillance, laboratory services, research and advice on animal disease and veterinary public health, including microbiology and chemical food safety. VLA works predominantly for Defra, Food Standards Agency, private veterinary surgeons and farmers, but VLA facilities are available to all government departments and agencies and to local authorities.

The contaminated land regime

The contaminated land regime[1] was introduced in England in 2000 and in Wales in 2001. A similar regime was introduced in Scotland in 2000. The regime is set out in Part 2A of the Environmental Protection Act 1990[2], which was updated to incorporate the regime and later extended to include radioactive contamination. Part 2A prescribes a risk based approach to the identification and remediation of land where contamination presents unacceptable risks to human health or to other vulnerable receptors including livestock, crops, ecosystems and groundwater[2]. The regime is jointly regulated by local authorities and the Environment Agency (EA) in England and Wales and by the Scottish Environmental Protection Agency (SEPA) in Scotland. Local authorities are the main regulators and have a duty of inspection to investigate potentially contaminated land and where appropriate enforce cleanup.

Soil Guideline Values (SGVs) are intended to trigger further investigations rather than provide a strict limit. There was a lead SGV for residential soils and allotments of 450 mg/kg soil[3], which has been revoked and is being reviewed but there was no lead SGV for agricultural land. In the absence of official limit values, this paper defines high lead concentrations in soils as levels exceeding the withdrawn lead SGV for residential soils and allotments.

Lead content of soils

Lead is present in all environments but background concentrations in soils are usually low. Distribution of lead in soils is very heterogeneous so representative soil sampling is problematic. Prediction of lead exposure and lead accumulation in animals kept on high lead soils is even more uncertain due to factors such as transfer of lead into crops, direct ingestion of soil and bioavailability of lead in soil and crops. Elevated soil lead concentrations identify the presence of the hazard but direct measurement of lead in exposed animals and animal products such as meat, milk or eggs is usually the best method of assessing risk and monitoring the success of remediation measures.

Lead in soil may be expressed as total lead or extractable lead, such as EDTA extractable lead[4]. Extractable lead represents bioavailable lead better than total lead concentration. The Soil Geochemical Atlas of England and Wales[4] reveals median total and extractable soil lead concentrations of approximately 40 mg/kg soil and 15 mg/kg soil respectively, which is consistent with the UK Soil and Herbage Survey[5]. Approximately 2% of soils surveyed in England and Wales had total lead concentrations higher than 450 mg/kg (currently revoked lead SGV) soil, but a large proportion of this 2% contained much higher lead concentrations as a result of mobilised natural mineral deposits[4].

The lead content of soils formed from mineral deposits can be well in excess of 10,000 mg/kg soil. Natural mineral deposits containing lead occur typically in limestone bedrock[4]. In England and Wales, veins of minerals containing very high concentrations of lead are typically less than one meter wide[6]. Veins may extend considerable distances across fields and fields may contain multiple veins. Lead minerals have been released from naturally occurring mineral deposits by natural erosion, landslips and agriculture but especially by historic mining activities. Lead mining and smelting activities date back more than two millennia in England and Wales and lead contaminated mine spoil has been abandoned in close proximity to livestock and human habitation in some districts. Thornton and Abrahams estimated that 4000 km^2 of land in England and Wales is contaminated as a result of historic mining activities[7].

High lead soils and mineral deposits initially mobilised by natural erosion or mining are further mobilised and transported by natural erosion, especially water. Lead minerals can be moved long distances down streams and rivers contaminating river gravels and sediments and also flood plains and alluvial soils downstream of mineral deposits[8]. There is evidence that lead mining in the Yorkshire Dales in the 9th to 13th centuries caused lead contamination in York[9]. Land adjoining rivers draining areas where lead mining took place, such as the River Swale in Yorkshire, may have high lead soils irrespective of the underlying local geochemistry.

Lead contamination of soil also occurs as a result of industrial activities and waste disposal. Lead smelting, manufacturing of lead utensils, paint, building materials, batteries and the use, until recently, of tetraethyl lead in petrol have released very large amounts of lead into the environment. Lead containing dusts released by industry, weathering, erosion or replacement of lead articles and lead containing paints, caused aerial deposition on vegetation and soil.

The effects of aerial lead deposition on soil lead concentrations are usually very small as the deposited mass of lead is very small compared with the mass of soil it is diluted within. However, soil lead concentrations may be significantly elevated where pollution was poorly controlled and aerial deposition continued for a long period of time. As an extreme example, land close to a large metal smelter in Australia was shown to be sufficiently contaminated to have caused lead poisoning in grazing animals[10].

In their soil survey, McGrath and Loveland reported that many soils with lead concentrations between 50 and 150 mg/kg soil especially in Wales, Lancashire, Derbyshire, Yorkshire, Cumbria and Teeside, are not associated with underlying deposits of lead minerals or alluvially deposited lead and are thought to be associated with industrial pollution[4]. Aerially deposited dusts are also washed into sewers. As a result, sewage and sewage sludge, the product of sewage digestion, became contaminated with lead[11]. Lead contamination of sewage sludge has decreased very significantly following the withdrawal of lead from petrol and reduced use of lead in manufactured products such as paints and water pipes. Heavy use of sewage sludge as fertiliser can increase soil concentrations of lead and other contaminants contained in sewage sludge and application of sewage to land is controlled[12].

Risks of lead poisoning in animals associated with high lead soils

All animal species are susceptible to lead poisoning and lead poisoning has been and remains the commonest cause of chemical poisoning diagnosed in grazing livestock in the UK[13,14]. Exposure pathways for livestock kept on farms with high lead soils are summarised in Figure 1.

Published toxicity data suggest that the susceptibility of ruminants and horses is similar, dogs are relatively susceptible but pigs, goats and poultry are relatively tolerant to ingested lead[15]. Young animals of all species tend to absorb much larger proportions of ingested lead and consequently are more susceptible to lead poisoning than adults. The acute oral toxic dose of lead has been estimated between 200 and 600 mg/kg body weight for calves[15;16], 600-800 mg/kg body weight for adult cattle[15], and 600-800 mg/kg body weight for adult sheep[16]. Chronic poisoning can be caused by much lower exposures. Doses of lead as low as 1 mg/kg body weight have been reported to cause chronic intoxication in ruminants[15], but most evidence suggests rather higher doses are required. Estimates from experimental studies suggested that adult sheep ingesting less than 3 mg of lead daily should not accumulate lead in soft tissues[17], which is a much higher tolerance than humans, mice or rats. Cattle and sheep tolerated up to 5 mg/kg body weight for at least a year without showing any clinical signs[16]. Milk fed calves are much more susceptible and can be killed by daily lead intakes of 2.7 mg/kg body weight within 20 days[18]. Subsequent work showed that in addition to the age related physiological factors and development of the rumen, the milk based diet increased lead absorption[19]. Milk fed young of other species are probably similarly susceptible. Pigs are more tolerant to lead than ruminants. Pigs fed lead acetate at a dose of 66 mg/kg body weight /day developed signs of chronic lead poisoning especially illthrift, tremors and incoordination within a month but survived a further two months[20].

Birds are probably less susceptible to lead poisoning than ruminants but are quite susceptible to poisoning by lead shot[15] or particles of lead minerals in soil. Large shot and grit are retained in their gizzards, where they are subjected to physical and chemical digestive processes. Retention time is likely to increase with increasing particle size.

Exposure to lead in high lead soils is only occasionally sufficiently high enough to cause clinical lead poisoning of domestic animals. However, most livestock kept on high lead soils, including cattle, sheep, goats, horses and free range chickens, are subclinically affected with increased accumulations of lead in bone, soft tissues, especially liver and kidneys and in produce such as meat, milk or eggs. Adult ruminants are less susceptible to oral lead poisoning than milk fed ruminants because the rumen converts a proportion of relatively absorbable species of lead into very poorly absorbed lead sulphide[21]. Milk fed, young lambs and calves do not have a fully functioning rumen and are usually the indicator animals, which identify high risk pastures.

Nutritional factors especially calcium, vitamin D, zinc and iron, affect bioavailability. Calcium balance also affects sequestration of lead in bone and clearance. Maintaining a balanced diet provides significant protection from lead poisoning[15].

There was never a high risk of lead poisoning in farm animals arising from the use of sewage sludge as fertiliser and the risks are now considerably lower as lead content of sewage sludges has decreased since the withdrawal of tetraethyl lead from petrol and the reduced use of lead in paints and plumbing.

Controlling exposure to high lead soils

The major factors that determine the risks to livestock from high lead soils include the lead concentration in the soil, the quantity of soil ingested, levels of lead contamination of feed crops and quantities ingested, the absorbability / bioavailability of ingested lead and the nutritional status of the animal.

Grazing animals ingest a lot of soil. Involuntary soil intakes of up to 18% in cattle and 30% in sheep have been recorded in grazing animals[7]. Soil contamination of pasture is increased by wet weather (mud splash and trampling of the grass into soil and mud), dry weather (dust) and involuntary soil ingestion is increased by overgrazing. Soil ingestion rates are expected to be higher at winter grazing but overgrazing, summer rainfall, flooding and drought can increase soil intakes in summer to levels comparable with winter grazing. Soil ingestion is minimised by grazing livestock on clean, dense swards with grass heights greater than 3cm (sheep) or 5cm (cattle). Close grazers such as sheep are likely to ingest at least 2-3% of soil in their diets even on clean summer swards. Soil intakes may be very high when crops such as roots and kale are directly grazed. Grazing animals may also display pica (intentional soil ingestion) causing very high soil intakes. Mineral deficiencies can cause pica, which can be controlled by providing mineral supplements but pica is sometimes apparently idiopathic.

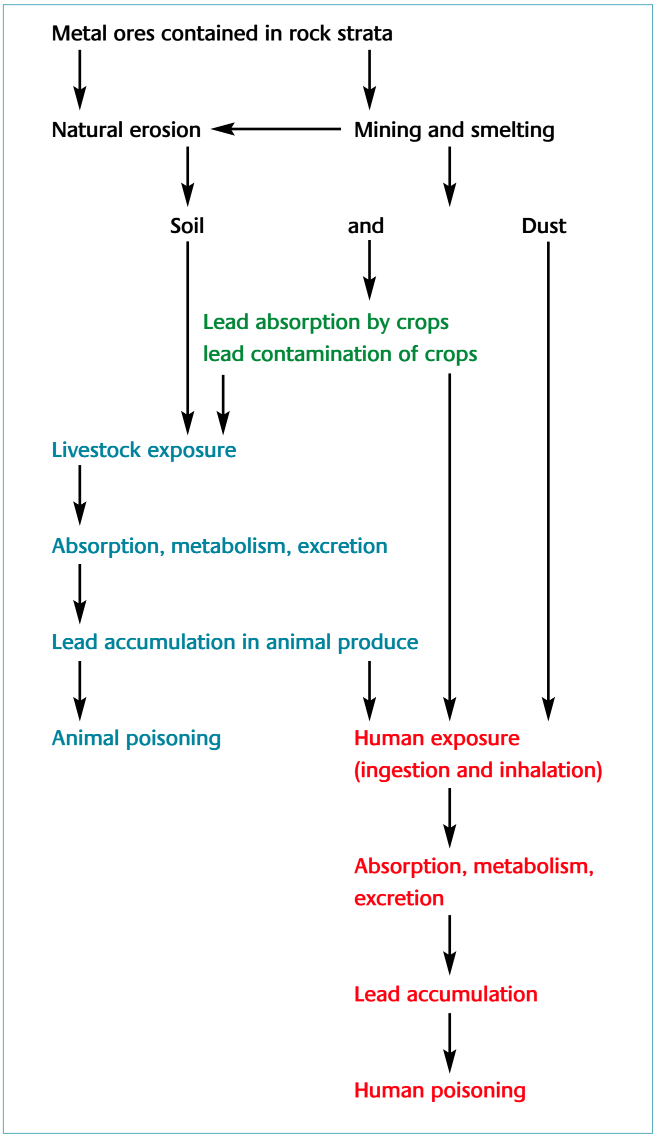
Poultry ingest grit as part of their diet as the grit aids digestion and also provides mineral nutrition. Poultry kept free range on high lead soils are likely to ingest lead minerals and accumulate lead, which will increase the lead content of eggs and of edible tissues, especially liver.

The physico-chemical species of lead affects bioavailability. Oxides and carbonates are more bioavailable than sulphides and lead metal objects[22]. The usual mineral ore in the UK and worldwide is galena (lead sulphide) but other lead minerals also occur, such as anglesite (lead sulphate) and cerussite (lead carbonate), which is also known as white lead ore. The bioavailability and risks may vary with the type of mineral in soil.

Most feed crops translocate very small amounts of lead into the aerial parts of the crop but, significant translocation has been identified in maize[23] and some brassicas[24]. These reports suggest that high lead soils may be unsuitable for growing some feed of food crops, such as maize and brassicas. For most feed crops, lead contamination is mainly a function of soil contamination with lead and crop contamination with soil. Lead adsorbs to roots and is absorbed into roots. Dust may adhere to the aerial parts of feed crops and lead in very small dust particles may adsorb to the crops, such that washing may not effectively remove surface contamination.

The amounts of soil expected to be present in conserved forages depend on the type of crop and the efficiency of harvesting. Grass silage can contain around 10% soil, usually as a result of mole activity or uneven ground increasing soil pickup at harvesting. Hay should contain relatively small proportions of soil. Maize silage should contain less soil than grass silage but maize may translocate lead, increasing the lead content of the silage. In addition, growing maize requires ploughing. Ploughing mobilises dust and ploughing high lead soils can contaminate pastures and other crops in the vicinity with high lead dust. Permanent long term pastures avoid the need for ploughing and usually have a denser sward, which also reduces soil ingestion in grazing animals. Debris from abandoned mines has been used as hardcore for constructing roads, hard-standings or buildings and high lead dusts released can contaminate pasture and feed crops and cause lead poisoning.

Figure 1: Exposure pathway: lead transfer from mineral deposits into soils and subsequently into animals, the food chain and humans.



Suspecting the presence of high lead soils

Geochemical atlases such as the Soil Geochemical Atlas of England and Wales[4] provide an indication of districts at increased risk. The districts of England and Wales with the highest prevalence of high lead soils, a history of lead mining and highest incidence of soil related lead poisoning in livestock are the Pennines, the Mendip Hills, and parts of Wales and the Lake District. Similar soil contamination would be expected to occur in other countries with similar geology and history of lead mining. Local knowledge and names of districts and farms may suggest where mining and smelting took place.

In fields where soils have very high metal concentrations, grass growth may be stunted and uneven with patches of exposed soil. This was previously regarded as a primary toxic effect of the metals but there is good evidence that at least some of the adverse effects are caused by deficiencies of nutrients such as phosphorus and nitrogen in metalliferous soils[25]. Nutrient deficiencies typically restrict photosynthesis and cause yellow discolouration of plant leaves, described as chlorosis. Some plants are relatively tolerant to metalliferous soils, especially if nutrient deficiencies have been overcome through fertiliser applications[25,26]. Poor grass growth exposes the underlying soil and usually increases the amounts of (high lead) soil ingested by animals grazing such pastures. In the past, in some parts of the UK, soils containing high levels of lead were planted with trees, probably to mark the land as unsuitable for grazing livestock, due to the high risk of lead poisoning.

Human exposure to lead

Human exposure to lead arising from high lead soils are summarised in figure 1. High lead soils can cause human exposure to lead via contamination of animal products, food crops and via direct ingestion of soil and dust.

Food safety

Local marketing of food or national marketing as "farm branded" produce from areas with high lead soils increases the risks of increased exposure to lead compared with national marketing and dilution of produce in the food chain. The Food Safety Act[27] requires all food businesses, including farmers, take due diligence to avoid contaminating the food chain; EC regulation 178/2002 lays down general food law and requires food and feed businesses to ensure that foods and feeds satisfy the requirements of food law[28].

Farmers that know they are farming high lead soils must take measures to ensure that animal and vegetable produce entering the food chain are acceptable for human consumption. Food businesses such as dairies should refuse to accept produce from a farm with a suspected chemical poisoning incident until the farmer can provide data to prove that produce does not contain excessive concentrations of the particular chemical.

The maximum permitted concentrations of contaminants in foods are set out in EC Regulation No 1881/2006[29]. The limits for lead are 0.5 mg/kg for offals including liver and kidneys, 0.1 mg/kg for meat and 0.02 mg/kg for milk, all on a fresh weight basis. Maximum levels for other produce such as vegetables and fruit are also prescribed. There is no limit specified in the Regulations for eggs but farmers need to check free range egg lead concentrations and confirm these are acceptable with the Food Standards Agency (FSA) in areas with high lead soils.

The FSA provides advice on the safety of chemicals identified in animal tissues and produce. The VLA can provide diagnostic laboratory services, which will confirm clinical and subclinical lead poisoning and will advise farmers on sampling and control measures. Products from animals with clinical lead poisoning will certainly be unsuitable to enter the food chain but contamination of animal products at levels which exceed statutory limits for foods can occur without evident illness in the animals.

Soil inhalation and ingestion by humans

Humans inhale and ingest dust and soil and children may play with soil and even intentionally ingest it. Similar risk factors of dose and bioavailability apply to humans as to livestock but farm animals such as ruminants are relatively tolerant to exposure to lead compared with tolerable exposures in humans. Clinical poisoning is rare in farm animals on high lead soils and where it occurs it indicates particularly high dose and probably high absorbability of the soil lead. When farm animals develop clinical lead poisoning as a result of high lead soils they may be sentinels of high human exposure in the same environment.

Information sharing

Diagnoses of lead poisoning in farm animals made by the VLA are routinely reported to the FSA, local authorities, Health Protection Agency and to the Environment Agency, enabling these organisations to undertake further investigations of human exposure.

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Natural Hazards and Climate Change

Rapid estimation of excess mortality in England and Wales during the heatwave of June 30th to July 2nd 2009

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Introduction

Heatwaves are well recognised to lead to an increase in excess all-cause mortality, particularly amongst the elderly and frail.[1] Following the European heatwave in summer 2003 many countries in Europe [2,3], including the United Kingdom, developed heatwave plans. [4] Amongst other things, this has involved the development of temperature-specific thresholds which trigger public health interventions to minimise the health impact.

Between June 30th and July 2nd 2009 temperatures in England and Wales exceeded the thresholds set for a heatwave in the heatwave plan.[4] In all regions the minimum night-time temperatures exceeded the region-specific thresholds of 15-18°C and in three regions the maximum day time temperatures also exceeded their respective thresholds of 30-32°C. The hottest day was July 1st when the mean central England temperature was 22.7°C and the maximum recorded in any region was 33°C.

At the time of the heatwave in 2009, daily data on death registrations in England and Wales were being supplied to the HPA Centre for Infections by the General Registry Office (GRO) using the newly implemented online system for the registration of deaths. This system was in place for detecting excess all cause mortality during the H1N1 2009 influenza pandemic and had been set up following the first reported cases of H1N1 on April 27th 2009. Data on all death registrations received by the GRO on a particular day were reported the following day to the HPA, stratified by age, registry office district and date of death. Initially the data supplied did not cover all districts in England and Wales because roll out of the registration online system was still in progress; however by July 1st 2009 all districts were using the system.

The availability of these daily real-time data provided an opportunity to rapidly estimate excess all-cause mortality during the heatwave.

Methods

To calculate excess deaths the observed number of deaths on a given day is compared to the expected number. For a rapid analysis, the observed number must be estimated based on registered deaths available and the expected number estimated based on historical data.

Estimation of observed deaths

The final total for the number of deaths occurring on a particular day can only be known many months later when all registrations have been received by the General Registry Office. In England and Wales, 80% of deaths are registered within three days and 95% within 7 days, however 4% of deaths have coroners' inquests, and these deaths can take much longer to be registered.[5] In the elderly most deaths are registered quickly but in the younger age groups, the proportion that are registered rapidly is much lower, as many are reported to the Coroner and have an inquest. This is demonstrated in figure 1, which shows the cumulative proportion of deaths registered during the first month after death by age group.

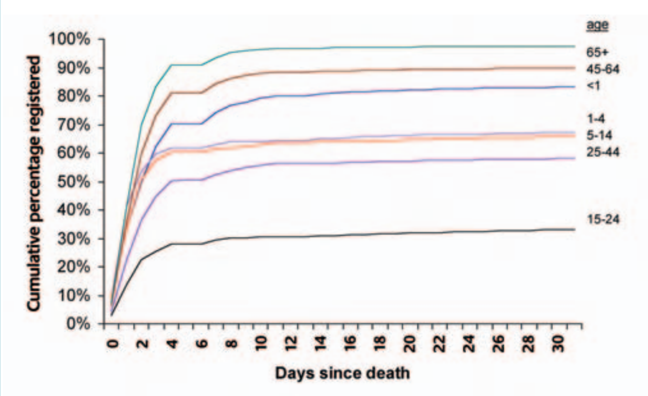

Figure 1: Delay in registration of deaths by age group in England and Wales using 2005-2007 Office for National Statistics data.

To estimate the number of deaths that occurred on a particular day, a correction factor was developed by the HPA based on historical death registration data on the cumulative delay distribution (figure 1). This correction factor also needed to be dependent on the day of the week of death. For example if, amongst those aged >=65 years, 80% of deaths on a Friday are registered by the following Tuesday then an observed total of e.g. 600 would be scaled up to 750 (600/0.8 = 750). Since not all Registration Offices were using the online registration system at the time of the summer 2009 heatwave, an additional correction factor was needed based on the completeness of online registration.

Estimation of expected deaths

Expected death occurrences were estimated using historical mortality data from 1999-2008 provided by ONS. An age-specific regression model was fitted with sinusoidal waves to allow for seasonality and down-weighting of outliers to account for the effects of influenza and extreme temperatures. This is similar to the model used by Serfling.[6] This model was set up for weekly analyses but was adapted for daily estimates by dividing estimates by seven.

Results

Figure 2 shows the central England mean temperature along with the expected number of death occurrences and the delay-corrected observed number of deaths from April 27th to July 10th 2009 in England and Wales.

The mean central England temperature started to increase in the

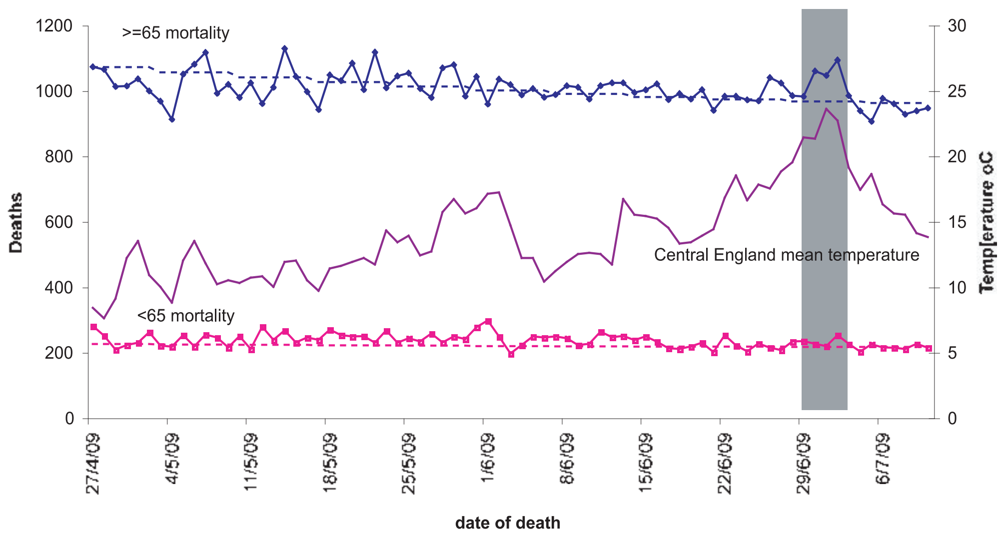

Figure 2: Observed (solid lines) and expected (dashed lines) all cause mortality in England and Wales and mean central England temperature between 27th April and July 10th 2009. The shaded area illustrates the heatwave (June 30th to July 2nd 2009).

week of 22nd June, peaking on 1st July 2009. A corresponding peak in deaths can be seen for the days of June 30th to July 2nd.

Early estimates of the excess mortality during the heatwave were possible by July 5th 2009, but uncertainty over the time at which online registration reached 100% of registry offices meant that reliable estimates were not possible until July 14th, at which time the total excess for the period of June 30th to July 2nd was estimated at 246.

A final estimate of excess of deaths was subsequently made using registrations to the end of January 2010. This gave an excess of 93 on June 30th, 79 on July 1st and 127 on July 2nd, giving a total estimate of 299 excess deaths. When the deaths in those aged over 65 were split into finer age groups it was also apparent that it was those aged over 75 where most of the excess occurred, with a total of 235 more than expected. Regional breakdowns of the excess were also performed using the data as of January 2010, but did not reveal any clear regional patterns.

Discussion

During the heatwave of 2009 a small excess in mortality was observed. Although the excess on any one day was not large, and did not exceed normal variability (i.e. expected value plus two standard deviations), the over 65 daily mortality on July 2nd was the highest for the entire summer period of 2009. With the excess occurring mostly amongst those >75 years who are more vulnerable to heat, it is therefore highly plausible that the observed excess was due to the heatwave. The lack of any measurable regional variation in excess is unsurprising given the relatively small excess.

One possible alternative explanation for excess mortality in the summer of 2009 is the impact of pandemic influenza. This is very unlikely to explain the excess at the time of the heatwave because the pandemic mainly affected those aged less than 65, both in terms of infection and severe disease.[7]

The access to data from GRO allowed a rapid evaluation of excess mortality with the ability to undertake age-group and regional breakdowns. Within a few days of the heatwave an accurate estimate of the excess was available. These timely data can be used to rapidly evaluate the health impact of heatwaves as well as other important public health events, such as cold snaps and influenza pandemics, and to detect unexpected excesses. The importance of such mortality monitoring has been recognised by the European Union, which has funded an EU-wide project, Euromomo that has been running since 2008 to develop and standardise methods to detect and measure excess mortality across Europe.[8]

In the UK, mortality monitoring will be an important part of public health monitoring during the 2012 Olympics in London. This rapid evaluation system was only possible through the daily provision of data from the General Registry Office, which was set up for the 2009 pandemic. It is important that this data flow is available in the future to enable rapid evaluation of heatwaves and other health events.

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Heatwave seminar 2010

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The Fourth Annual Heatwave Seminar was held on Friday 5 February at the Department of Health (DoH). It was organised by the HPA in collaboration with DoH. The seminar was attended by a large variety of organisations; these included the HPA, Department of Health, Local Authorities, NHS, the Met Office, UK Climate Impacts Programme (UKCIP), Charted Institute of Environmental Health (CIEH), academic organisations including London School of Hygiene and Tropical Medicine (LSHTM), University of Warwick and University College London (UCL), and representatives from the Welsh Assembly and the States of Jersey. The other government departments that were represented were: DEFRA, Defence and Civil Contingencies (DCCP), Ministry of Justice, Environment Agency (EA), Department of Energy and Climate Change (DECC), the Greater London Authority (GLA) and a number of Government Offices from throughout the country.

The day began by looking back on progress from 2009 including a review of the heatwave that occurred in early July, and how the National Heatwave Plan had developed following the previous seminar. This was followed by a review of the uses of epidemiological evidence by colleagues from LSHTM and of temperature projections in the short, medium and long term by representatives from the Met Office and UK Climate Impacts Programme. Attendees were then broken into workshops to review key questions that were raised throughout the day.

One particular development in 2009 was a meeting between the Cabinet Office, the Department of Health and the Health Protection Agency about the need to develop a cross government Heatwave Plan with other government departments (OGDs). Further work is planned and there were several representatives from OGDs at the seminar. They were keen to understand the current plan better and the implications of climate projections for future planning.

Looking back on 2009

Jo Nurse (DoH) began the day by giving a review of the history of the Heatwave Plan for England. The recommendations from the 2009 Seminar and subsequent changes to the plan were discussed, to demonstrate how the outcomes of the seminar would be important to the development of the Heatwave Plan.

Wayne Elliot from the Met Office gave an overview of the 2009 summer predictions and temperatures, including a detailed review of the July Heatwave. This described the periods when Level 2 and Level 3 of the Heatwave Plan were activated. Minimum threshold temperatures were reached in the regions where the Plan was activated; however the maximum threshold temperatures were only met in the South East of England. New technology, using satellite imagery, was also described to demonstrate the outputs that may be available in the future. This allows high resolution maps showing temperature distribution; they can be extremely informative when mapping urban environments. The map of London demonstrated that over the heatwave period there was a temperature variation of up to 8°C between different parts of the city.

Rapid Evaluation of 2009 Heatwave

After the 2009 Heatwave the HPA in conjunction with a number of other organisations produced a 'Rapid Evaluation' of the impacts of the Heatwave[2]. Sandra Johnson from the HPA presented the methods used for this report plus the limitations of what was available. A significant part of the rapid output was the addition of daily mortality data which Nick Andrews, a statistician from the HPA, described. The report also included data on temperature, morbidity (NHS Direct and QSurveillance) and London Ambulance Service utilisation.

Overall, the report estimated that during the 2009 Heatwave there were approximately 300 excess deaths between the 30th June and 2nd July. There was also a clear increase in healthcare seeking behaviour, such as GP consultations and NHS Direct sunstroke related calls.

The report concluded that routine reports during heatwaves should be reviewed and other data such as NHS admissions, air quality indicators and wider ambulance service call data should be investigated. Agreeing which data should be included in advance will ensure the outputs would meet what is needed in a timely manner. This was a topic for one of the later workshops.

Uses of epidemiological evidence

Ben Armstrong from LSHTM described the difference between epidemiological and action thresholds for temperature. There is evidence that there are impacts of temperatures below the threshold temperatures of the Heatwave Plan. These were reviewed by region and it was confirmed that for the majority of regions the action thresholds are set at a relative risk of about 1.1 (a 10% higher risk of mortality), except for the North of England where the action threshold is set at a lower risk, and in London and the South East where the action threshold is greater than 1.2.

Shakoor Hajat from LSHTM described differences in how threshold-setting for heat-health warning systems have been developed in different countries. Models used included a basic temperature model (similar to what is used in England), and others including synoptic classifications, humidity or physiologic responses. Research was conducted using ten years of historical temperature data to compare and contrast the days which were activated. Triggering of alert days (and ultimately the initiation of emergency responses) is very dependent on the particular approach adopted to establish thresholds. When looking at excess mortality (though this is very dependent on how the excess is calculated), a temperature based model predicted a high proportion of the days in which excess mortality was high in the more temperate cities, London and Chicago. This research is scheduled for publication shortly.

Temperature projections

Mark McCarthy from the Met Office and Chris West from UKCIP reviewed the most recent temperature projections in order to inform later workshops to determine their implications for Local Authorities, the Health Sector and other government departments. The presentations reviewed how forecasting and temperature projections are developed and the key messages that need to be understood, even after taking their uncertainty into account. Chris West also described the resources available through UKCIP[3].

Feedback from workshops

Template for rapid evaluation of heatwaves

The main feedback from this workshop was that there is a requirement for two types of reports. The first is information for action and the second would be more reflective and should cover retrospective evaluation.

The main recommendations were:

- During a heatwave the HPA should produce a real time report which would include mortality (which can be produced with a three day lag) and morbidity data from NHS Direct and QSurveillance. A specific group should be set up to develop the template and review other possible data sources such as NHS admissions. This should be viewed as information for action, especially in the event of a prolonged event.
- There is also a need for evaluation post-heatwave events. This would include summarising the heatwave in terms of temperature characteristics and impacts of the event in greater detail than what is available during the event. The evaluation should also include a process review of the implementation of the Heatwave Plan.

The implications of the Met Office and UKCIP temperature projections on the public sectors

Local Authorities

- Local Authorities should be made aware of the potential for unintended consequences of the Great British Refurbishment campaign[4] and other mitigation strategies e.g. overheating. This can be influenced by appropriate Planning and Building Regulations. Current government strategies include the Housing Health and Safety Rating System[5] and the National Indicator NI 1886. New building developments need to be linked with affordable heating.
- Local Authorities have a role in raising public awareness of adaptive behaviours e.g. hydration. Provision of information should be via appropriate media in partnership with Primary Care Trusts.
- The Heatwave Plan should be cross government. The scope of the Plan needs to be broadened to include wider societal impacts such as: school, workplace and transport and also to include appropriate advice for Local Authorities. There is a need to ensure messages to the public within the plan do not conflict – particularly "reduce unnecessary travel" (level 3).
- Local Authorities should be provided with the resources to map thermal quality of buildings, vulnerable occupants and the location in urban heat islands.

The Health Sector

- The Heatwave Plan could be integrated into a broader "Heat and Cold" or "adverse weather" plan, combining best practice for minimising the impact of both hot and cold weather events.
- Action cards for evidence-based heatwave response for front-line health care staff could be developed.
- Target/empower patients (including using IT communication) and vulnerable groups throughout the year – not only during heatwaves.
- Training packages could be developed for health practitioners.
- Other ideas covered:
    - Need for joined-up thinking and advice across sectors and government departments.
    - Heatwave protection advice for children as part of standard health advice.
    - Information leaflets for hospital in/out-patients.
    - Hospital advice integrated into discharge planning.
    - Vulnerable groups could be identified and receive phone/text heatwave alerts.
    - Information on heatwaves should be shared between Agencies/ Departments in order for public to receive coherent and consistent advice.

Other government departments

- Key issues discussed for future Heatwave Plan revisions:
    - Broaden the plan away from solely health sector response
    - Lead by good example/practice (Government)
    - Distinguish what is a statutory requirement and what is advised as best practice
    - Plan development to include:
        - initial short term wins - with consideration given to long term investment issues
        - planning assumptions should be shared with all stakeholders
        - public messaging needs to be clear, simple and consistent.
- Areas identified requiring further consideration during heatwaves (similar to those for any major disruptive event, whatever the cause):
    - Impact on air quality
    - Water shortages (drought) – impact on sewage and water quality
    - Animal welfare - transport etc
    - Impacts on crops
    - Electricity maintenance issues due to decreases in electricity output in higher temperatures, alongside increased demand from air conditioning units and cooling of nuclear power stations
    - Failure of IT systems/services from overheating
    - Failure of transport (rail/road) from rails buckling, including distribution of food and water to broken down Underground trains
    - Business continuity at schools, hospitals, prisons etc, with regard to staff and buildings
    - Building adaptation and stock mitigation targets; work is already underway in this area
    - Building subsidence
    - Research into best heat reducing options: air conditioning or others such as keeping shutters closed, bio shading, siesta working conditions
    - Cross government communications – consistent generic and public health messages
    - Cost to economy
    - Increase in violence, social unrest and riots and the impact on justice system, policing, prison indiscipline
    - Increased potential for wildfires, arson and other fires
    - Impact on outdoor events.

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Factors affecting house prices: a comparison of the effects of natural hazards

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Introduction

Property values vary for a whole variety of different reasons: location, size, features, condition, state of the property market, etc. A lot of research has been undertaken on the effect of neighbourhood features on property values, where these include access to services (such as schools, shops, roads or bus routes), nuisance factors (such as noise or odour) and risks (such as floods, forest fires or earthquakes). This paper provides a review of this research and compares the impacts of different nuisance and risk factors on house prices.

Assessing risks on house prices

Much of the research that has been undertaken on the impacts of risk and nuisance factors on house prices uses hedonic pricing. This is a technique that uses regression analysis to estimate how much property prices vary in relation to different characteristics (of the house itself and its neighbourhood). Other approaches have also been used to investigate the impact of risks on house prices, including:

- repeat sales analysis
- statistical tests (t-tests) to compare matched properties at and not at risk, or before and after specific risk events
- direct discussions with valuers and estate agents.

The impact of coastal erosion

Figure 1 presents a summary of how house prices in the US change due to erosion risks. The figure shows that the impact on house price increases as the residual life of the property (the time before it erodes) decreases. There are also significant differences between the four regions, with the largest reduction (37%) seen in the Great Lakes region when the residual life is 10 years.

The regional differences have been studied and are explained as being due to the availability of insurance and access to recreation opportunities[1]. Home insurance in the US does not cover flood risk. To help those at risk to protect themselves financially, the US Congress created the National Flood Insurance Program (NFIP) in 1968. The NFIP offers flood insurance to property owners (and renters) if their community participates in the program. By participating, communities agree to adopt and enforce ordinances that meet or exceed the Flood and Emergency Management Agency (FEMA) requirements to reduce the risk of flooding[2]. However, since the NFIP is mainly associated with flood risk, it may not be available to properties at risk of erosion. FEMA (which manages the NFIP) states that 'Subsidence of land along a shore or similar body of water which results from erosion or undermining of the shoreline caused by waves or currents of water exceeding cyclical levels that result in a flood is covered [by the Program]. All other land subsidence is excluded'[3]. Most of the properties at risk in the Great Lakes region are located on cliffs, with little or no exposure to flood risk. Therefore, these properties may not be able to insure against the risks, hence the greater reduction in house prices seen in Figure 1. Furthermore, erosion in the Great Lakes region reduces opportunities for mooring of boats close to the properties, decreasing their attractiveness to boat users.

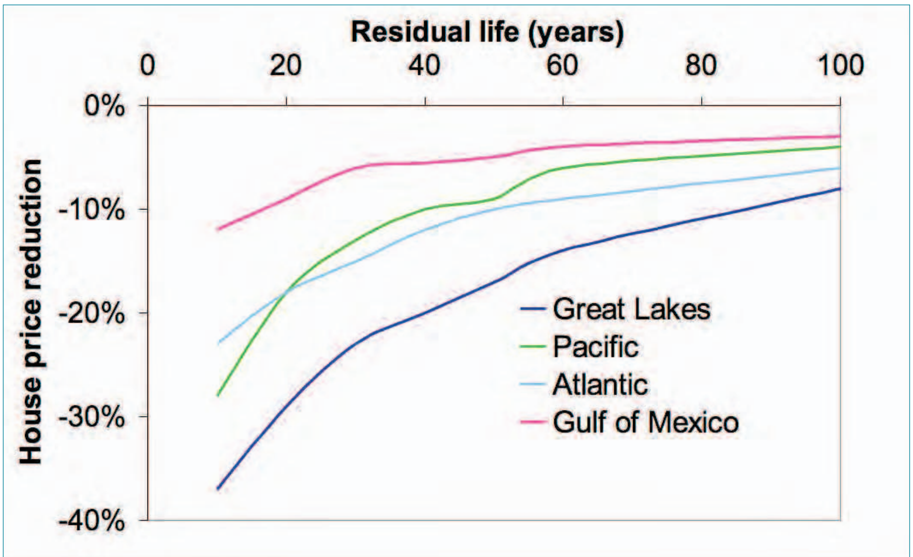

Figure 1: Impact of coastal erosion risk on house prices, shown as house price reduction according to the number of years before house erodes (residual life) (based on Kriesel *et al*, 2000[1])

The importance of risk awareness

Natural events, such as forest fires, earthquakes, volcanic eruptions and floods, can also affect house prices, as shown in Figure 2.

The impact of a second forest fire in the same area of Southern California, US, was found to further reduce house prices. The first forest fire reduced house prices by 10%, but the second increased this to 23%[4]. A different response was seen to the 1989 Loma Prieta earthquake (California, US). Before the earthquake, house prices in the earthquake risk zone were 4% lower than those outside the zone. However, following the earthquake, house prices in the risk zone were only 3.4% lower than those elsewhere[5].

Numerous studies have investigated the impact of flooding on house prices. The three studies shown in Figure 2 relate to:

- flooding in Shrewsbury, England, where valuers identified a median discount of 12% for those properties that had been flooded in the past five years[6].
- flooding from the Meuse, Netherlands, where house prices reduced by 8% to 11% following the flood[7]. Subsequent investigations showed that the recovery of house prices was slow, with reductions of 8% to 10% still seen eight years after the flood[8].
- flooding caused by Hurricane Floyd (North Carolina, US), where house prices in the floodplain were 6% lower than those outside the floodplain[9].

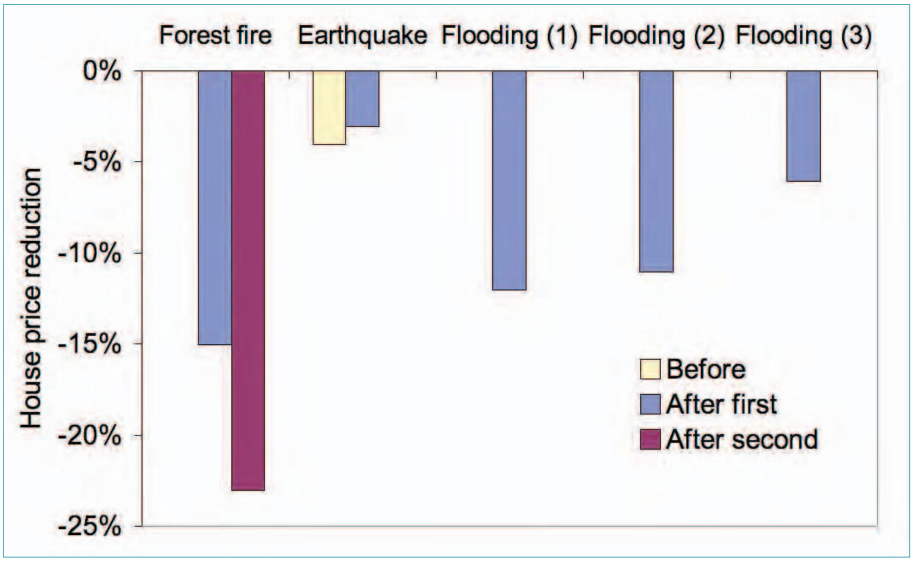

Figure 2: Impact of forest fires, earthquakes and floods on house prices.

Reductions in house prices after an event suggest that property buyers had either under-estimated or were unaware of the risks. Following an event, house prices appear to readjust to reflect the increased awareness. The readjustment following the Loma Prieta earthquake, however, was an increase in house prices. This could show that the risks were well known and understood, probably due to the education and preparedness campaigns that had been undertaken over previous decades[5,9].

Disclosure laws have been implemented in a number of US states to improve information in the housing market. Analysis of the effects of the laws suggests that the increased knowledge and awareness of the risks among house-buyers has increased the extent to which risks are fully reflected in house prices. For example, properties located in the floodplain showed a house price reduction of around 4% in both California and North Carolina after introduction of laws requiring the disclosure of flood hazard information[10].

The importance of memory

Studies investigating how house prices are affected by risks and nuisances suggest that repeated exposure to a risk results in greater reductions in house price. This is also true for man-made nuisances such as noise. For example, houses located within 100m of a flight path in Southern California were 23% lower in value than houses located away from the flight path[11]. Such repeated exposure will increase awareness of the risk such that the house price reductions may better reflect the 'true' impact than for those risks that can be forgotten. People tend to forget where there is a long time between events. This can lead to a bounce-back effect, where house prices fall immediately after an event, but recover over time. Where properties need to be repaired and renovated due to the effects (e.g. of flooding), the house price may recover to the point that it exceeds its pre-event value.

The influence of the media

Media coverage can also be an important factor. Catastrophic events, such as erosion, flooding, fires and earthquakes are attractive to the media as they are dramatic and emotional. As a result, they tend to register more negatively in public perception than risks such as burglary[6]. This can result in properties affected by a catastrophic event being associated with a risk and suffering a reduction in their house price. Such effects are commonly reported in areas prone to coastal erosion, where a village or parish name becomes synonymous with erosion risk. The effect can be that all properties in that village face house price reductions related to coastal erosion risk, even when they are several miles inland.

The influence of other factors

There are many factors that will influence a house price. That in itself can make it difficult to identify any price reductions due to risks. Sea and river views are associated with significant price premiums. There is little agreement in the literature over what these premiums may be, but estimates range from 2% up to 59%. Some of this premium may relate not just to views but also to access to a river or coast for recreation. Views and recreational opportunities may be seen by potential buyers to outweigh the risks which may be associated with a particular location.

Uncertainties within the studies themselves can also significantly affect the results. Pryce *et al* (2009)[10] identify difficulties associated with:

- spillover effects, where non-flooded properties may also suffer reductions in house prices due to their proximity to flooded properties. This can mask apparent differences in house price between flooded and non-flooded properties
- the different reactions of different communities to disasters, this can affect whether the risk is fully or only partly reflected in house prices. This can be important where there is access to insurance or compensation
- demand and availability for risk-free properties, where higher demand can result in quicker recovery periods
- sample selection bias, where studies based on actual property

sales will only take into account those properties that have re-entered the property market. These are likely to be the properties that were least badly affected. Properties that fail to recover will be ignored.

One study that demonstrates how risks may not be captured in house prices is that by Gamble and Downing (1982)[12]. This study found that the price of houses located closest to Three Mile Island following the accident at the nuclear reactor were not statistically different from those at an increased distance. The reasons given included the expectation of compensation and the number of jobs created for the clean-up operation, where this would increase demand for properties.

Conclusions

This paper discusses the potential impact of risks on house prices and highlights how reinforcement and repeated exposure to risks can lead to greater house price reductions. There are, however, many uncertainties associated with awareness and understanding of risk and the response to that risk, which can conceal the 'true' impact. The issue is also clouded by the fact that for many at risk properties, the risks are inextricably linked to certain desired characteristics, for example river views or easy access to a beach.

Acknowledgements

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Environmental health problems from floods: A comparison of flooding in Mumbai, Western India in 2005 and England in 2007

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Introduction

Floods are responsible for considerable, often massive, loss of human and animal life and property globally. Health consequences of floods are often complex, being a combination of immediate mortality and morbidity and long-term damage to health and environmental changes such as contamination of fresh water. Natural disasters show an increasing trend over time, with a steep rise in the past two decades and flooding being the most commonly reported event (Figure 1). International data systems report 2470 flood related incidents between 1990 and 2009 with approximately 1.4 million deaths and 2.3 billion people being affected, resulting in a total financial loss in excess of 300 billion US dollars[1].

Catastrophic floods have occurred in Bangladesh, China, India, Mozambique, Germany, United Kingdom, Poland and the United States[2]; however of the countries affected by natural disasters and flooding, 90% or more are reported from Asia. It is considered that natural hazards cause significant mortality and morbidity in developing countries whereas they predominantly cause economic burdens in developed countries[3]. This paper concentrates on two pluvial flood events. The flooding which occurred in many parts of Mumbai in July 2005 and the flooding which occurred in many parts of England in June and July 2007. The aim was to compare and contrast the resultant environmental health problems in both countries and to obtain more information on effective responses to flood disasters in both countries.

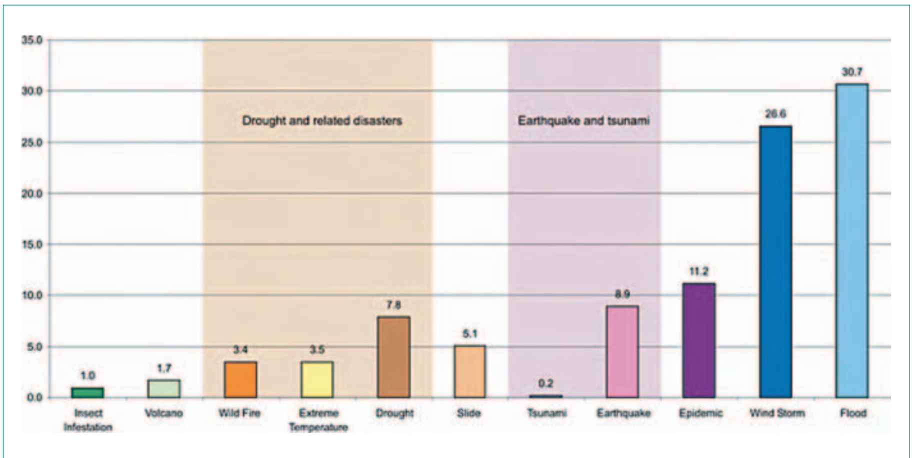

Figure 1: Graph showing the distribution, in percentage, of natural disasters by type (1991-2005) in the world. Image courtesy of UN International Strategy for Disaster Reduction[2].

Methods

A literature search for environmental health effects of flooding was undertaken using bibliographic databases and the internet. The databases searched were Global Health, Web of Science and The International Emergency Disasters Database (EMBASE). Google search engine was used to access other articles in the public domain. Literature published in English were accessed and analysed. The search terms used were "floods*", "natural hazard", "environment* AND health* AND flood*", "Mumbai floods 2005", "Maharashtra floods 2005", "UK floods 2007" and "summer floods in UK".

Summary of the pluvial floods in Mumbai, India, 2005

Introduction

Floods commonly occur in several regions of India every year. Of the 286 natural hazard events documented in India in the past two decades, 186 were major flooding and storm events. These were reported to have been responsible for approximately 44,292 deaths, affecting 554,004,896 people and resulting in a financial loss of approximately US$32 billion[1]. The 2005 monsoon proved to be particularly disastrous for many parts of India, especially western India and Mumbai.

The city of Mumbai is located on the western coast of India on the Arabian Sea in the state of Maharashtra. The metropolis of Mumbai (formerly Bombay) covers a total area of 437.71 square kilometres and is formed by the merger of seven islands in the city and four islands in the suburbs. The city is subdivided into 24 administrative zones called wards. These wards are responsible for providing all public services. The census of 2001 revealed a population of 11.9 million and a population density of about 27,209 people per square kilometre. The city has some of the world's largest slum areas with inadequate health and hygiene facilities[4].

Mumbai July 2005

From 08.30 on the 26th July 2005, the Mumbai suburban area received 944.2mm of heavy rainfall over 24 hours, flooding large areas of the city, submerging roads, railway tracks, airport, houses and low lying areas. It was reported that one third of the surface area of the city was submerged.

Environmental health problems resulting from the flooding in Mumbai

Relatively little information is available detailing the economic damage caused to Mumbai apart from nearly 2000 houses being destroyed and a further 0.2 million houses being partially damaged[5]. From reports it is apparent that the maximum damage from the floods was borne by the poor and underprivileged class, most of whom live in the slums of Mumbai[6].

Physical health effects
Information has been obtained on the number of deaths which occurred within the first week after the floods, and other injuries and infectious disease outbreaks where available. These are summarised below:

- Deaths

The flash floods which occurred in western India during July 2005 were responsible for a large number of deaths, particularly in Mumbai which has a high density of people in the slums and poor localities (Table 1)[7].

Table 1: Immediately occurring reports of deaths from floods in Mumbai up to 31st July 2005

Cause of death	Number of deaths reported
Drowning	233
Landslide	120
Stampede	24
Electrocution	12
Trapped in vehicles	16
House wall collapse	5
Missing	15
Total	**425**

- Injuries

Twenty injuries, mainly physical, requiring hospitalisation were reported[4].

- Illness from infectious disease

A government sponsored epidemiological surveillance report from hospital data in Mumbai during and after the floods provided a brief account of the prevalence of infectious disease (Table 2)[4].

A public sector tertiary hospital (Medical College Hospital) also reported a large number of patients treated in their outdoor and indoor facilities during and after the floods (Table 3)[8].

Epidemiological investigation of the leptospirosis outbreak provided an opportunity to compare the 2004 pre-flood data with the 2005 flood data. This revealed an incidence of 2.1 per 100,000 population with a case fatality rate of 7.3 in 2004, and an incidence of 7.85 per 100,000 population with a case fatality rate of 8.7 in 2005[9]. Another report compared the prevalence of leptospirosis from July to September in the years 2001 to 2005 and the prevalence in July to September 2005. An eight-fold increase in prevalence was recorded in 2005[10]. There was also a sudden increase in the number of dengue fever cases detected, with seven positive serum tests identified in a sample of 111 suspected cases, reported to be high compared to previous years at the same time[11].

The only additional health issue identified was from a non-governmental organisation (NGO) report, which stated anecdotally that a few people had suicidal tendencies due to the stress of coping with post flood loss of lives, homes and properties[5].

Response issues identified
From this review certain issues have been identified from the response to the disaster event and these are summarised below:

- Despite all the preparations in place, it was reported that the Mumbai Disaster Management Cell failed to act and manage the flooding in Mumbai July 2005 effectively[5].
- Details of the response of the various agencies including health, police, transport and the disaster management personnel are not available[6].
- It has been suggested that the meteorology department failed to predict and provide advance warning of heavy rains on the 26th and 27th July 2005[6].
- The local state government declared a national holiday for the two days following the floods on 26th July due to heavy rainfall in the western region. This led to most people staying at home including all the government staff and officials who were responsible for managing the disaster, resulting in very inadequate response to the event[5].
- The fire services were unable to reach an area at risk of landslide early due to the prevailing conditions and were reported to have arrived at the site 15 hours after the landslide. The unexpected collapse of buildings was not preventable in these circumstances[5].
- The Indian Army and Air Force were requested to help in the evacuation and supply of food packets to stranded people. Arrangements were made in temporary camps for displaced people[4].

Table 2: Epidemiological surveillance in Mumbai[4]

Name of disease	Admissions on 29th July 2005 (24 hr period)	Total admissions between 29th July – 31st August	Number of deaths
Gastroenteritis	154	1318	1
Hepatitis	27	194	-
Enteric fever	5	53	-
Malaria	62	406	2
Dengue	5	49	-
Leptospirosis	56	197	10
Fever (Unknown cause)	597	1044	45
Total	**906**	**3,261**	**58**

Table 3: Number of cases treated at a public sector tertiary hospital after the flooding in July 2005

Disease	Out patient department attendance	Indoor admissions
Malaria	5514	746
Leptospirosis	626	282
Dengue fever	157	58
Undifferentiated fever	6325	1157
Community patients treated	200,516	-

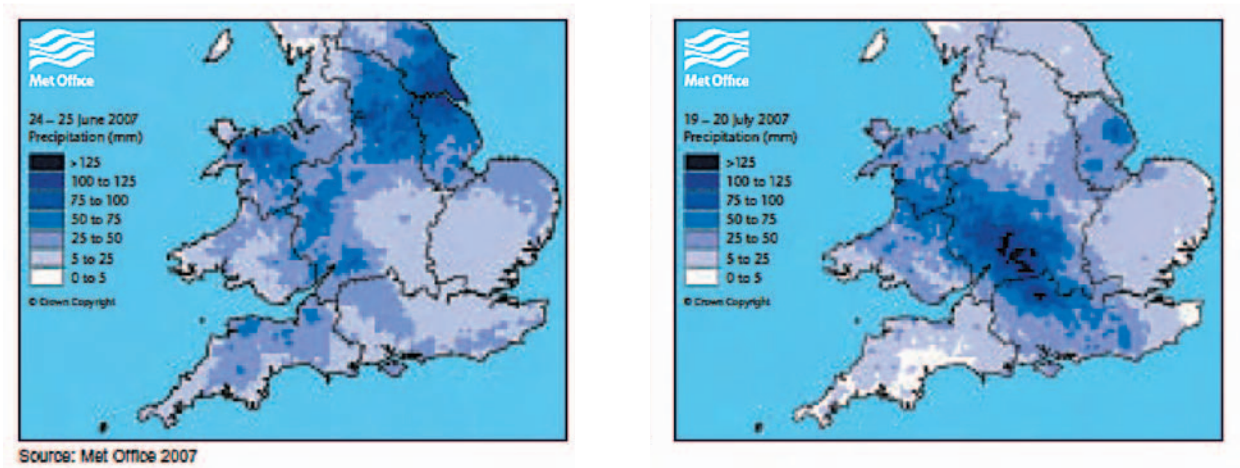

Figure 2: Precipitation levels reported for England and Wales during 24–25 June and 19–20 July 200713 © Crown copyright 2007, the Met Office

- The Mumbai Sanitation Department took measures to clear garbage and dead animals to improve sanitation after the floodwater subsided. An estimated 0.1 million tonnes of garbage was removed within 3 days from the flood areas in Mumbai, using more than 1000 trucks and machinery[4].
- The public health authorities distributed chlorine tablets for the treatment of household drinking water. A large number of equipped medical teams (approximately 133) were deployed to cater for those with ill-health following the flooding and to contain the spread of disease. The government also made special arrangements for admission of seriously ill patients with the support of private health care institutions[4].
- Relief measures were taken to supply food and other commodities free of cost through public distribution systems involving NGOs and self help groups[4].
- The search and rescue was supported by a large number of local groups in the aftermath of the flood. People from other parts of the city reached the flooded area and provided money, provisions and volunteered to help. For example, one person from South Mumbai organised a group of volunteers to collect approximately 50,000 Indian Rupees (INR) and food provisions worth about 150,000 INR for the flood victims and travelled to sites affected by the floods assisting in search and rescue activities. Those who were not affected provided food, clothing, household items and financial support for the people who were most affected and had no resources to overcome the disaster [5].

As a result of these floods and other events the Indian Disaster Management Authority was established in December 2005 and the Mumbai city Disaster Management Cell, which was initially established in 1999, was upgraded in 2005 considering the new National Guidelines[12].

Summary of the pluvial flooding in England and Wales 2007

Introduction

In the last two decades a total of 53 natural hazards are recorded to have occurred in the United Kingdom, 45 of which were flood events responsible for approximately 40 deaths, affecting 866,022 people and leading to a financial loss of about US$27 billion[1].

England and Wales July 2005

Many parts of England and Wales faced severe flooding in the summer of 2007 due to continuous heavy rainfall (Figure 2). Approximately 414mm of rain was recorded between May and July in England and Wales, the highest reported since 1776[13].

South Yorkshire and Hull faced heavy rainfall on the 24th and 25th June 2007. Gloucestershire, Worcestershire and the Thames Valley had similar rain patterns on 19th and 20th July 2007. The floods caused closure of the Mythe water treatment plant in Gloucestershire, which left 140,000 houses without water for several days after the flood. The Castle Meads electricity sub station was submerged, leading to a loss of power supply to 42,000 people for days. The emergency response agencies were stretched to extreme limits requiring extra support from the military[13].

Environmental health problems resulting from the floods in the UK

The Department of Health, as described in the Pitt Review[13], did not reveal an increase in the number of patients reporting to health facilities as a result of the floods. However there were reports of people reporting psychological problems, mainly stress related disorders, but these have not been evaluated on a long-term basis[13]. A questionnaire distributed by Hull City Council, and reported as a case study in the Pitt review, has shown 70% of those who had to move out of their homes floods reported health problems[13].

Physical health effects

- Deaths

The flash floods took people by surprise with many trapped in their houses, offices and vehicles. 13 deaths were reported, and the emergency search and rescue teams rescued approximately 7,000[13].

- Injuries

While no serious injuries were reported during the flooding and post flood recovery phase, some minor injuries including lacerations and puncture wounds were documented[13].

- Illness from infectious disease

Some individuals reported worsening of asthma, arthritis, chest infections and other sub acute diseases. There were also reports of children suffering from cold, asthma, and bronchitis and skin disease[13].

A post flooding insurance and health impact survey of 647 affected households across the country showed that 39% reported having suffered physical health problems, namely exhaustion, due to the flooding, with those who had to move out of their home twice as likely to report problems[13].

Mental health effects

People experienced mental stress from dealing with construction and insurance companies, seeking temporary housing and due to financial problems. "Some individuals have likened their flooding experience to bereavement, going through similar emotions such as shock and disbelief, anger, blame and finally acceptance."[13]

A case study in Hull identified the occurrence of mental stress, difficulties in managing long-term health problems, loss of interest in work, strain in family and personal relationships, increase in alcohol consumption and difficulty in normalising healthy activities to be associated with the recovery from floodingxiv. A survey of the insurance and health impacts of the 2007 floods, commissioned by the Pitt Review and summarised in the Pitt Review final report, reported 67% of the respondents stated the flooding had resulted in emotional health problems with 35% reporting emotional health problems of their children. 31% stayed took time off work, in some cases for more than 10 days and among married couples 22% reported relationship problems with a further 15% reporting problems with other family relationships. The survey also revealed emotional problems were likely to be twice as high in those who had to move out of their homes as those who did not[13,15].

Mental stress and extreme emotions have been reported by people helping flood victims and amongst those considered to be at risk in their homes[16]. A study of the psychosocial impact of the flood disaster in Carlisle, Cumbria showed acute disruption of the social lives of people affected by floods and variable degree of psychological problems[17].

Other hazards and exposure outcomes

Two deaths occurred from carbon monoxide poisoning through the use of generators inside poorly ventilated rooms[13]. One of the long-term health impacts is temporary location to other places. It was estimated and reported that about 5000 householders were still in temporary housings at the end of May 2008[13].

Response issues identified

Certain response issues have been identified by the Pitt review13 and these are summarised below:

- The summer floods in the UK were widespread and especially serious in Gloucestershire, leading to flooding of the water treatment plant and closure of the electricity sub-station.
- There was some lack of clarity about the role of agencies carrying out and coordinating the rescue operations.
- There was little advance warning about the heavy rains and delayed response in disseminating the information to the local agencies to react.
- The local area responders were not prepared for the scale of flooding.
- Evacuation of people stranded on highways and at work places lacked coordination.
- The information about health risks of flooding to people was inadequate and inconsistent.
- Advice to those affected by flooding was inconsistent, with some people advised to stay in their homes while others were advised to evacuate.
- The advice coming from different responders was inconsistent, providing a confusing picture for the community.
- The Army and Air Force were requested to assist in rescue and evacuation work.
- A study in Hull suggested that there was inadequate recognition of those involved in rescue and relief activities associated with the flooding.

Disaster management is activated at different levels of command in the UK - Bronze, Silver, Gold and COBRA - depending on the size of the incident. The Environment Agency in the United Kingdom is responsible for responding to natural disasters such as flooding[18], while the Health Protection Agency provides health information related to flooding[19]. In the event of an extreme emergency a systematic flow of information from the Environment Agency to the local area council and back helps in the management of flood. The local area response team at the community and council level requests support from the higher response teams like Bronze, Silver and Gold. Following the 2007 floods a major enquiry was held by Sir Michael Pitt and work to improve response to flooding continues.

Lessons identified

The environmental health effects related to floods in developing and developed countries vary depending on the socio-economic status of the people affected. The health effects in India, considered a developing country, and the UK, a developed country, are very different. Floods cause widespread loss of life through drowning, injury and illness due to infectious disease in Mumbai in India. For example, there is evidence of death and disease due to spread of leptospirosis. Mortality and illness due to infection following flooding has not been reported to be high in England however many people have been reported to suffer from psychological stress, especially those relocated due to damage to their houses. The health effects were reported to be greatest amongst the financially disadvantaged and this has been observed in both adults and children.

The lessons identified from the floods in India and the UK can be briefly described as follows:

- **Advance warning**: There was a lack of warning of flooding to the general public in Mumbai and it was inadequate in some parts of the UK. Use of scientific knowledge to detect the cause of flooding allowing early warning and preparation is needed.
- **Search and rescue**: The heavy rains and sudden onset delayed the search and rescue operations. Search and rescue preparedness for extreme weathers at all times will help in reducing deaths and burden of disease in the long term.
- **Health provision**: A rapid public health response can reduce the devastating effects of floods on people. Public health response needs to be rapid and prepared before, during and after the flood.
- **Social and community support**: Strong community support can overcome the negative health effects of natural hazards therefore it is desirable that social support systems and assistance of the community should be sought.
- **Safety of vital public utility institutions**: Water supplies, health care facilities, food supplies and electricity supply must be made secure to mitigate the adverse effects of such disasters.
- **Other issues**: Homelessness and displacement cause physical and mental distress to people in addition to the loss of livelihood and property. Processes to facilitate quicker relocation to homes would minimise adverse health effects - particularly the psychological disturbances.

Further work

Flooding is an emergency situation where all efforts need to be taken, as deemed necessary, to minimise immediate and long term health effects. Advance preparatory activities can help in containing the infrastructural losses and mitigate health effects. Proactive action and response is the key requirement for mitigation in a disaster. Demographic studies should be conducted which may be incorporated with the relief and rehabilitation activities during and after the floods. Long term studies of the after effects of floods need to be conducted and a standardised documentation methodology developed and implemented to record the health events. Studies to assess cultural and social determinants of health during flooding hazards and their role in supportive rehabilitation can be very helpful. Multidisciplinary research to identify long term health effects beyond the immediate response to a natural hazard is required.

The research findings need to be translated into actions to achieve strong and healthy socio-economic development. Transfer of scientific and technological knowledge for effective response and containment of negative impacts of natural hazards will help the community.

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HPA Project Updates

Undertaking regional assessments within Europe through the use of environmental health indicators

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Introduction

The Use of Sub-national Indicators to Improve Public Health in Europe (UNIPHE), was developed in response to the Executive Agency for Health and Consumers' call for project proposals. These calls were within the framework of the European Union (EU) 2008 Work Plan to implement the programme for community action in the field of public health (2008-2013) as outlined in Decision No 1350/2007/EC[1]. It seeks to address the priority area "to develop a sustainable health monitoring system with mechanisms for collation of comparable data and information, with appropriate indicators" through the monitoring, consistency and quality assurance of health information by a network of experts. Given this, the Commission awarded a consortium of seven European countries a three year co-financed project which commenced on 1 March 2009 and will continue through to 28 February 2012. The project partners are as listed in Box 1.

Within the framework of Work Plan 2008 for the implementation of the second programme for community action in the field of public health (2008-2013), this project aims to develop a sustainable environmental health monitoring system consisting of a set of sub-national indicators to improve public health across Europe. The creation of a consistent and common framework within Europe will facilitate the comparability of health status data and help to identify those policies and interventions which deliver positive health outcomes and encourage their transfer to other regions. Therefore the project will seek to reduce the burden of disease through control of hazardous environmental exposures and their health effects as demonstrated in Figure 1.

Underpinning the overall objective of the project are six specific objectives as outlined below.

- The development of a core set of sub-national environment and health indicators. This will include the identification and selection of indicators followed by the development of methodological sheets for each (indicator).
- The development of a portal to house the harmonised environmental health information collected from participating countries. This will entail the establishment of a system to

Box 1: Main, Associate and Collaborating Partners for the UNIPHE Project

Main Partner:
- Health Protection Agency (HPA), United Kingdom

Associate Partners:
- Institute of Health and Work NRW (LIGA.NRW), Germany
- National Institute of Environmental Health (NIEH), Hungary
- Centre for Health Education and Disease Prevention (SMLPC, formerly VASC), Lithuania
- National Institute of Public Health (INSP, formerly IPHB), Romania
- National Institute of Public Health (IVZ-RS), Slovenia
- Institute of Health Carlos III (ISCIII), Spain

In addition, three collaboration partners were identified at the onset however, there is the possibility that this number may increase with time. The collaborating partners named in the contract are:

- World Health Organization, European Centre for Environment and Health, Bonn (WHO ECEH-Bonn), Germany
- West Midlands Public Health Observatory (WMPHO), United Kingdom
- National Health Service Scotland (NHS Health Scotland), United Kingdom

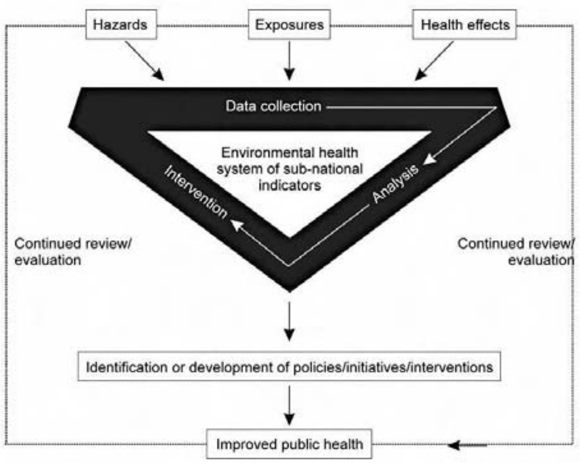


Figure 1: The use of a harmonised system to assess hazardous environmental exposures and their health effects.

improve the quality and consistency of environment and health information collated across the regions in European countries.

- The compilation of a set of extended indicators for which harmonised data collection will be developed. This includes examining the feasibility of harmonised data collection for indicators not fully developed in previous indicator programmes such as the European Environment and Health Information System (ENHIS) Programme if applicable at a regional level. In addition, harmonised data collation will be developed for information collected in partner countries which is considered applicable to the project.
- The active promotion of participation in the project: This will include all partners raising awareness of the project nationally and seeking to publicise the usefulness of the system particularly among the public health fraternity and policy makers. It is also envisaged that the consortium will endeavour to recruit voluntary partners from within the European Community.
- The compilation of a compendium of existing policies, interventions, initiatives etc that have been shown to deliver positive health outcomes within a region. The aim being to make them transferable to other similar regions in other European countries.
- The development of a methodology to facilitate regional comparison within Europe. This will facilitate the transfer of policies and interventions from one region in a European country to a similar region in another country.

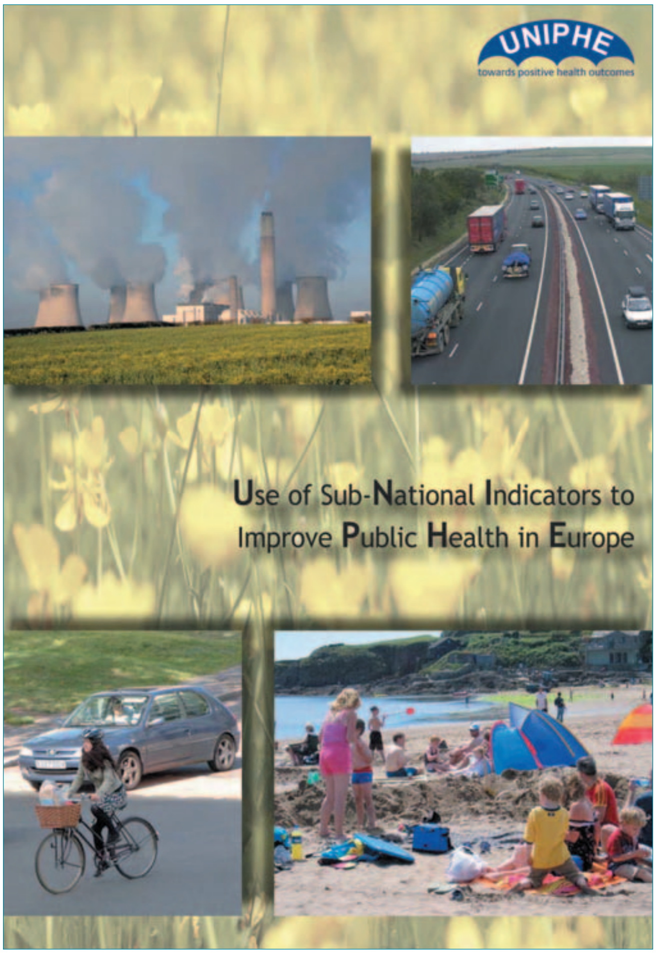
All the activities within this programme of work are aimed at enabling regional assessments of the health status of sub-populations to be undertaken. Hence the project will complement those systems which have been previously developed and enable national assessments. To ensure European added value for public health improvement, activities of this project will focus on:

- developing a harmonised system of environmental health indicators
- collation of data
- development of a method to compare regions
- collation of policies which deliver positive outcomes to ensure transferability within Europe.

Rationale of the project

This project aims to build on previous work which used sets of indicators to carry out national assessments of the health status of populations in Europe. Such existing indicator sets include Environment and Health Information System (ENHIS)[2], European Community Health Indicators Monitoring (ECHIM) and European Community Health Indicators (ECHI)[3]. These systems enable policy makers to quickly compare the performance of their country to another with very little effort. However, it is known that while some policies and interventions may have a positive outcome nationally, it is often necessary to have policies and interventions targeted at sub-population level, where a number of similarities may exist such as access to hospitals, living in close proximity to industrial processes etc. Given this, UNIPHE partners felt there was a need to develop a harmonised environmental health information system of sub-national indicators to complement the national indicators set. The project will also aim to develop methods of collecting data for indicators which are considered relevant but for which comparable data do not exist or are *ad hoc* throughout Europe.

The ECHI project was carried out in the framework of the Community Public Health Programme 2003-2008. In this project indicators were selected based on comprehensiveness, meeting user needs, being innovative, using earlier work and in particular those of the Health Monitoring and the Public Health Programmes. This resulted in the production of a list of indicators for the public health field arranged according to a conceptual view on health and health determinants.



ECHIM was also carried out within the framework of the Programme of Community Action in the Field of Public Health 2003-2008 and continued the work of ECHI. The project sought to develop health indicators and health monitoring in the European Union and all EU Member States.

ENHIS was developed due to the realisation that there was the need for good quality and reliable information on the environment and population health and their linkages. This information could be used to identify and prioritise issues, develop and evaluate policies and actions in order to reduce the burden of disease via control of hazardous environmental exposures and their effects. Accordingly, WHO ECEH-Bonn designed a programme on Environment and Health Information Systems, to establish a harmonised and evidence-based information system to support public health and environmental policies in Europe. As a result of this programme, ENHIS developed a methodology for a core set of twenty-six indicators to monitor and report the health status of a country in relation to environmental risk factors. This set of indicators aims to reflect and communicate the status of environment and health issues at a national level throughout Europe.

ENHIS was based on the DPSEEA (Drivers, Pressures, State, Exposure, Effect and Actions) model which allows for the mapping of a wide spectrum of environmental health issues. Given the usefulness of ENHIS, it seems logical to evaluate and develop the use of a similar system at a sub-national (regional and/or local) level in Europe.

Therefore this project is seeking to use the core set of ENHIS indicators to assess public health linked to environmental exposures at a regional level. Furthermore social, cultural and political issues will also be considered by the use of a modified DPSEEA model which was developed in Scotland by one of the collaborating partners[4]. This modified model recognises that whether a particular aspect of the environment (a State) results in an Exposure for the individual and whether that exposure results in a health Effect (positive or negative) is influenced by Context. The context may be demographic, social, behavioural, cultural, genetic etc. and aspects of Context may also be targets for policy and action to improve the health outcome.

New indicators will be developed where appropriate, using information which is collected locally/regionally within participating countries. The main reasons for extending from countries to regions is that the regions of most countries, for larger countries in particular, are quite heterogeneous in terms of environmental health indicators, and that regional/local assessments would allow focussing on specific urban areas. Comparisons between regions within different countries in the European Union could be based on socio-economic status, geography, rural/urban classification etc. Assessments undertaken using regional indicators are a useful way of identifying health inequalities and as well as sharing policies, initiatives, programmes and interventions which have delivered positive measured outcomes.

Methodology

First sub-objective: To establish a set of sub-national indicators

This was achieved by the assessment of the 26 ENHIS indicators to ascertain whether they are applicable at a sub-national level. Other indicator sets such as those of ECHI were also assessed. This enabled a preliminary set of indicators to be assembled, which was included in a feasibility study and assessed on the following criteria:

- Data availability
- Quality assurance/control of data
- Spatial coverage
- Last year of data availability
- Usefulness/interpretability
- Data source
- Level of spatial disaggregation
- Year of start
- Periodicity/regularity of reporting

The indicators which satisfied all or most of these criteria were included in the core set of indicators shown in Table 1. Methodological sheets were developed for all indicators included in the core set which described the relevance and supporting evidence base for each indicator. Technical guidance on the calculation of indicators is also provided in the methodological sheets. The development of the methodological sheets enables all partners to undertake data collection in a standardised manner.

Second sub-objective: To develop a sustainable system for harmonised health information monitoring and assessment

Negotiations with WHO ECEH-Bonn were undertaken to share the ENHIS portal. Having both systems on the same host would have been beneficial to those wishing to undertake quick national and regional assessments. However, due to a few technical issues it has now been decided that a system for this project will be developed independently while ensuring that it is compatible with the ENHIS system. The system will undergo testing and there will be a workshop in February 2011 to ensure that the system meets the requirements of the relevant stakeholders.

Third sub-objective: Standardised methods for the collation of data for undeveloped ENHIS indicators will be developed using tools such as surveys

Should it be feasible, the required data could be collated by the national statistics offices within European countries or as a part of Health Surveys which are routinely undertaken. It may be necessary to negotiate with the relevant organisation to collect the information during the survey.

Table 1: Core set of indicators

Categories	Indicators
Air quality and noise	Annual mortality rate due to respiratory diseases in children older than one month and under one year of age
	Mortality due to respiratory diseases
	Mortality due to diseases of the circulatory system
	Exposure to ambient air pollutants (urban)
	Population-weighted annual mean particulate matter (PM_{10}) concentration
	Proportion of population living in dwellings that are exposed to the noise ranges of values from different sources of environmental noise in urban areas and along major transport infrastructures
Water and food safety	Number of outbreaks of waterborne diseases attributable to drinking water and bathing water each year; number of cases in the outbreaks
	Number of outbreaks of communicable diseases attributable to food per year; number of cases in the outbreaks
	Incidence rate of acute intestinal communicable diseases and bacterial food toxic infections
	Proportion of identified bathing waters falling under the Bathing Water Directive definition complying with the EC mandatory microbiological standards
	Drinking water quality: microbiological non-compliance
	Drinking water quality: chemical non-compliance
Accident, mobility and transport	Mortality from road traffic injuries in children and young people (0-19 years)
	Mortality in children and adolescents from unintentional injuries not related to traffic accidents (0-19 years)
	Mortality due to external causes in children under 5 years of age
	Injury rate due to traffic accidents per 100,000 population
Chemicals, UV and ionising radiation	Standardised incidence rate of leukaemia as defined by ICD-10 codes C90-C95 in children aged 0 to 19 years
	Incidence of melanoma as defined by ICD-10 codes C43, D03 in the population aged under 55 years
Socio-economic	Life expectancy at birth
	Total unemployment
	Infant mortality rate: infant deaths (age less than one year) per 1,000 live births (crude rate)
	Living floor area per person

Fourth sub-objective: To raise awareness and promote participation
This is critical to the overall success of the project and therefore a conference will be organised for environment and health personnel from across Europe. Through partners networking with relevant government officials, the profile of the project will be raised and attendance should be high. This will also provide a platform to encourage voluntary participation of other European countries to increase the power of the system.

Fifth sub-objective: Delivery of a compendium of policies and interventions
A compendium of those policies and interventions which facilitate the delivery of positive health outcomes will be produced.

Sixth sub-objective: Development of a standardised method for comparing regions in different European countries
A literature review will be undertaken to inform the development of a standardised method for comparing regions in different European countries, which will enable appropriate successful policies and interventions in a region in one country to be transposed into another country.

There are a number of work packages which have been identified in order to help with the timely delivery of the project to high standards as demonstrated in Figure 2.

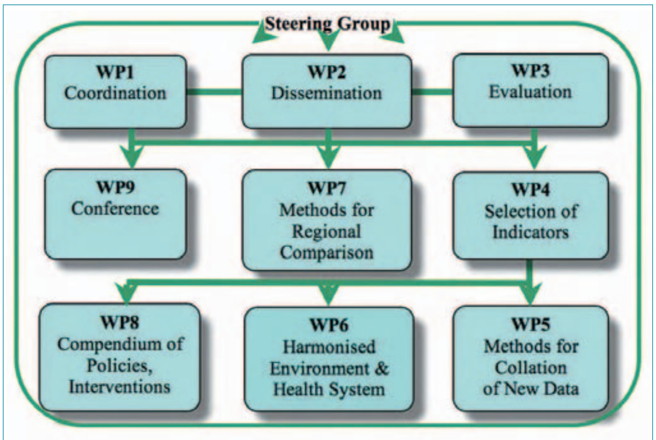


Figure 2: Organisational structure of work packages within the project.

Expected outcomes

The primary outcome of this project will be a sustainable standardised system for the collation and reporting of environment and health information at a regional level across Europe. Through this system it will be possible to monitor and review both the quality and consistency of health information across Europe, thereby generating and disseminating health information and knowledge. The benefits to the creation of this consistent and common framework within Europe are:

- it enables the identification of health inequalities among regions within European countries;
- it facilitates the comparability of health status data; and
- it enables the identification of policies/interventions which deliver positive health outcomes and facilitate their transfer to other European countries.

Further information is available at http://www.uniphe.eu

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Conferences & Workshops

Building Health: Planning and Designing for Health and Happiness conference

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The Building Heath: planning and designing for health and happiness conference represented a timely call to action for planners and health professionals to influence the build and natural environment. The conference on 22 January 2010 was hosted by the Institute for Sustainability, Health and Environment at the University of the West of England and was a collaboration between the Architecture Centre in Bristol, the Department of Health South West, the South West Strategic Health Authority, Government Office of the South West and UWE's WHO Collaborating Centre for Healthy Cities and Urban Policy.

The political and socio-economic landscape is changing at an increasing rate. Recently there has been controversial news such as the climate change negotiations in Copenhagen that ended without the production of a fair, ambitious or legally binding treaty to reduce greenhouse gas emissions. There also seems to be increasing impacts on our population from the obesogenic environment as evidenced by increasing obesity rates in the UK population.

Hopefully the worst of the recession is behind us and this will create significant opportunities for planners and developers to improve our environment as the building rate picks up. The Marmot Review[1], published in 2010, highlights the importance of planning and the need to reduce environmental inequalities. Furthermore, the Faculty of Public Health and Royal Society for Public Health have produced a Manifesto[2], which illustrates the growing linkage between public health and the environment with recommendations for the government such as:

- a 25% increase in cycle lanes and cycle racks by 2015
- Olympic legacy to include commitment to expand and upgrade school sports facilities and playing fields across the UK
- 20 miles per hour limit in built up areas.

The conference provided information and tools for delegates to tackle the challenges faced by professionals and to ensure the most is made of future opportunities to influence the built and natural environment through the planning system. Leading experts in this field shared their techniques and tips for success and the opportunity to discuss these issues was provided in a series of masterclasses held in the afternoon.

The highlight of the day was the showcasing of one of the greenest and healthiest cities in Europe, Freiburg, from which the UK has much to learn. Freiburg has been a green role model for the rest of Europe since the 1970s and has won numerous environmental awards such as 'Ecological capital' in 1992 and 'Sustainable city' in 2004. A lively discussion about the city was led by the inspiring Wulf Dasking, the Director of City Planning for Freiburg. The impact of the lessons learnt from Freiburg was magnified greatly by the fact NHS South West organised a field trip to the city in the summers of 2008 and 2009 which was attended by regional stakeholders and led by the WHO Collaborating Centre for Healthy Cities.

There were also numerous examples of home-grown good practice presented by high-profile speakers such as Irena Bauman, author of *How to be a Happy Architect*, Mike Kelly, Director of the Centre for Public Health Excellence at the National Institute for Health and Clinical Excellence and Sarah Gaventa, Director of the Commission for Architecture and the Built Environment (CABE) Space.

Unfortunately Gabriel Scally, Regional Director of Public Health for the South West, could not attend the event but in an Oscar-esque moment he joined the delegates via video link to give his full support to the event.

While the conference was stimulating and informative in itself, resources will be made available online and future events organised to ensure the momentum created on the day is not lost. For example, the following are available via the conference website, www.architecturecentre.co.uk/events/buildinghealth.htm:

- videos of keynote speakers
- selected PowerPoint presentations from the day
- photographs of the conference
- a PDF of Freiburg study tour report
- useful links including CABE Future Health report.

Personally, I learnt a great deal from the conference and through my attendance have been provided with free access to two modules of the University of the West of England's online planning MSc. I have just completed the 'Healthy Sustainable Communities' and 'The Spatial Planning Approach' modules that provided an interactive overview of these two areas. Provision of short modules is an excellent idea that ensures attendees can continue their learning well beyond the day itself.

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Maritime and Coastguards Agency Hazardous and Noxious Substances Response Team Exercise – Heysham Port

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Background

The exercise was organised by the Maritime and Coastguards Agency (MCA) Hazardous and Noxious Substances (HNS) Response Team in January 2010. The MCA is the competent UK authority that responds to pollution from shipping and offshore installations and is a Category 1 Responder as designated within the Civil Contingencies Act 2004. The MCA operates a robust exercise programme that includes major multi-agency national exercises with emergency response partners, and local internal exercises, which test its resilience and business continuity plans. In addition the MCA is involved in inter-government departmental exercises as part of the Department for Transport's exercise programme[1].

The MCA is regularly called upon to react to a wide range of maritime incidents and has developed comprehensive response procedures to deal with any emergency at sea that causes pollution, or threatens to cause pollution[1]. For this exercise, the MCA worked in conjunction with its HNS subcontractors Braemar Howells and Svitzer Salvage that also have extensive expertise in dealing with maritime incidents. Braemar Howells provides highly trained response and decontamination teams, which are located around the UK, enabling them to respond to chemical incidents nationally within a maximum of three hours. Svitzer Salvage provides interrelated services in the fields of harbour, coastal, terminal/liquefied natural gas, offshore and ocean towage as well as salvage operations, crew boat and standby rescue services.

The HPA is in the process of producing the UK Recovery Handbook for Chemical Incidents, due for completion in May 2012[2]. The end product will be an online handbook in PDF format, which is intended to aid the decision making process for the recovery from chemical incidents, particularly major incidents. The handbook will be split into three parts, with one dedicated to the water environment, therefore exercises such as the Maritime exercise discussed in this report and the input of the MCA as an expert stakeholder for marine environments will be invaluable to the project.

Exercise

The exercise was held over two days. The first day was held aboard the MV Clipper Panorama seatruck ferry and involved a live chemical incident response. The second day was run on the dockside and considered the MCA's alerting and business continuity plans. The first day was split into two separate exercises, both involving the accidental release of chemicals aboard a ship. It was devised to raise a wide number of issues that may be relevant to an actual maritime chemical incident based on experience of the MCA in dealing with previous chemical incidents such as the MSC Napoli incident. The Napoli incident was featured in an earlier article of the Chemical Hazards and Poisons Report 'Operation MSC Napoli'[3].

The exercise was designed to investigate a number of response mechanisms:

- securing and controlling the site (cold, warm and hot zones)
- use of risk assessments / Control of Substances Hazardous to Health (COSHH) assessments
- use of appropriate personal protective equipment (PPE) and the complexities this presents
- decontamination of chemicals from a marine vessel
- rescue and decontamination of casualties
- appropriate decontamination of workers leaving the hot zone.

Day 1: Incident 1

The first exercise comprised of a leak of hydrochloric acid from a 5000 litre International Standards Organisation (ISO) container on board the MV Clipper Panorama seatruck ferry. The HNS response team were required to determine the position of the 'On Scene Command', determine the necessity for breathing apparatus control (BA Control) and to establish appropriate decontamination entry and exits points. As the incident progressed and information regarding the hazard became available, risk assessments and COSHH assessments were carried out taking into account the properties and toxicity of hydrochloric acid.

Hydrochloric acid is toxic and corrosive by inhalation, eye contact and skin contact. Exposure to any quantity can be dangerous. When hydrochloric acid is released into the environment, it becomes widely distributed into air and water. Vapours released from a spill of hydrochloric acid will likely be in the form of hydrogen chloride and the degradation products chlorine and hydrogen[4].

These factors were taken into consideration, prior to the entry of responders into the 'hot' zone, when identifying appropriate PPE and equipment. The HNS response team then entered the 'hot' zone utilising photo-ionisation detector (PID) to detect chlorine and locate the leak. BA Control used highly specialised equipment such as the 'Draeger control board' which is used to communicate with the responders operating in the hot zone. Information recorded included the pressure within responders' suits (and hence air remaining), temperature and time of entry/exit. The control board was also linked to alarm mechanisms within the responders' suits in case they were required to exit at short notice or if they fell unconscious. The chemical leak was cleaned up by implementing the ship's water deluge system within the cargo hold to rinse the hydrochloric acid into the sea, where dilution effects would ensure there was a negligible risk to public health or the local environment. Following the cleanup operation, the responders underwent appropriate decontamination procedures before exiting the hot zone. All waste water produced from these procedures was contained in a temporary waste water holding tank prior to being disposed of accordingly.

Day 1: Incident 2

The second exercise involved the spill of a 10-30% ammonia solution, which the responders were again required to locate and dispose of accordingly. The exercise scenario was designed to test the responder's ability to negotiate the complexities that marine environments present in responding to a chemical incident. Wearing gas tight suits, four responders were challenged with transporting the necessary clean-up equipment to mitigate the spill and to 'over-barrel' (seal the leaking container in a larger barrel) the leaking container. This required manoeuvring through small doorways and avoiding numerous objects on the ground and at height. This exercise was further complicated by the deliberate positioning of an unconscious worker who required recovery from the hot zone and appropriate decontamination.

The specialist response contractors use these exercises as an opportunity to train new personnel and test the resilience and capability of their equipment under different scenarios.

Day 2

The second day of the exercise, a continuance of incident 1, was undertaken on the dockside due to the unavailability of the seatruck ferry. For exercise purposes it was deemed that temporary repairs had been carried out to the ISO container allowing it to be removed from the ferry. However, before it could be moved from the dockside, a tank to tank transfer of the chemical had to take place. For exercise purposes the product was changed from hydrochloric acid to epichlorohydrin, which is a highly reactive liquid solvent used in resins, paints and varnishes. Epichlorohydrin is toxic by ingestion, inhalation and skin contact and is highly irritant to the eyes and respiratory tract[5]. Epichlorohydrin is removed from water by the natural processes of evaporation, hydrolysis, and biodegradation. In seawater it is also removed by its reaction with chloride ions, which increases the rate of removal[6]. In the second phase of the exercise, the chemical was successfully transferred between tanks without a release to sea water.

Conclusions

The consequences of a chemical release into the marine environment may pose significant challenges to the agencies responsible for their clean up. Lessons learnt from such exercises can improve the planning and response to future incidents.

The MCA is a partner in a new cross-government initiative, Pollution Response in Emergencies: Marine Impact Assessment and Monitoring (PREMIAM), a Defra funded programme running for three years (2009-12) aimed at improving the response and effectiveness of environmental impact assessment following chemical spills and marine oil releases. A major deliverable of the PREMIAM programme will be a set of guidelines to ensure best practice is followed for post spill monitoring and impact assessment. The guidelines will cover necessary at sea and shoreline sampling of waters, sediments and biota, and specify the necessary chemical and biological effects options[7].

Figure 1: MV Clipper Panorama seatruck ferry.

Figure 2: Rescue and decontamination of a casualty.

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Hazmat Event 2010, Birmingham: Conference overview

Peter Lamb[1], Caroline Raine[2]

1. Centre for Radiation, Chemical and Environmental Hazards, London
2. National Chemical Emergency Centre, Harwell

Hazmat Event, the third annual conference for hazmat professionals was held over two days in March 2010. The event was a great opportunity for a large range of experts to connect, share experiences and learn about the latest developments relating to the hazmat (hazardous materials) sector and how it relates to environmental public health.

Vij Randeniya OBE, Chief Fire Officer, West Midlands Fire and Rescue Service, opened the proceedings by expressing that the conference was a great opportunity for all hazmat responders from across agencies to communicate with each other effectively and how we can continue learning from each other's experiences.

The conference began with an interesting presentation from Professor Allister Vale, Head of the National Poisons Information Service (Birmingham Unit), highlighting the differences in the hazards presented during the management of exposures to hydrofluoric acid (HF) in comparison to other mineral acids. For those with a particular interest in toxicology it was fascinating to hear about the debate surrounding the HF decontamination techniques that are currently used, and the potential for using alternative techniques to achieve better clinical outcomes.

Duncan White of Devon and Somerset Fire and Rescue gave a presentation on the fire service's involvement in a large scrapyard fire that occurred close to the site of the Glastonbury Festival, where thousands of revellers were gathered in 2008. The presentation highlighted the issues that an incident affecting air quality could have on a 'mass gathering' and highlighted how an Air Quality Cell would be able to advise on the risk to the public health. One of the lessons learnt from this incident was that although the smoke plume was not directed toward the festival site it still had an impact on the event as the smoke blew across the main evacuation route from the site effectively blocking the revellers' main route of escape in an incident!

The National Chemical Emergencies Centre's (NCEC) Hugh Roberts presented an introduction to the developing technology of nanoparticles and the relatively unknown potential impacts of their use on public health. Changes in the physical and toxicological properties of materials once in 'nano' proportions were discussed and how nanoparticles have the potential to enter into the human body and cross the boundary of its cells.

The Health and Safety Laboratory's (HSL) Chris Keen moved the focus of the presentations into the field of occupational exposure assessment. His discussion on occupational exposure monitoring and the use of biomonitoring was of particular relevance to the attending HMEP (hazardous materials and environmental protection) officers who, as front line responders, are at risk of exposure to chemicals during incidents. The presentation highlighted the intricacies of the various methods available for exposure monitoring.

Mark Gibbs followed this presentation with an outline of the role of the Met Office in the response to chemical incidents and the outputs they may provide for use by responding agencies including CHEMET, FireMet and Hazard Manager, familiar tools to those in public health responding to chemical incidents.

Damien Thompson from the Environment Agency concluded the first day of the conference with an introduction to the new multiagency air quality cells (AQC) for major incidents. The presentation highlighted the aim of the AQC as being able to provide better and quicker air quality information to Tactical and Strategic Co-ordination Groups to inform key operational decisions during incidents threatening public health.

Day two was opened by Ali Karim of the Hazchem Network transport scheme. Ali shared his experience of chemical incidents involving the transportation of palletised chemicals and their causes.

This was followed by an overview of the New National Operations Guidance by Bob Hark from the Office of the Chief Fire and Rescue Advisor. The guidance is due to be launched to all Fire and Rescue Services (FRS) during September 2010 at the Fire Service College. The guidance will contain information on operational, tactical and technical advice for all FRS who handle hazmat incidents, as well as CBRN and decontamination information. The manual is to include advice on informing and interaction with multi-agency partners to help ensure the best outcomes from incidents.

The conference was concluded with two presentations about gas cylinder safety. The first, from Lester Bradley, BOC Group, focused on the practice experience of safely handling and recovering compressed gas cylinders involved in incidents. Two sensible guidelines for anyone dealing with cylinders were provided:

- "You have been designed/evolved to breathe clean air at or about 1 atmosphere of pressure. Any other set of conditions will pose some level of threat to your well being."
- "You should only work with facts that you understand and competencies that you possess. If you only think that you know what is going on and what might happen when you do something – then do not do anything."

Overall the presentation highlighted the threat to responders and to the public of incidents involving cylinders of all types.

The second presentation by Doug Thornton – Chief Executive of the British Compressed Gases Association, discussed the hazard and risk of incidents involving acetylene cylinders. The detailed presentation reviewed the evidence base for the recommended actions following fires involving acetylene cylinders. The presentation concluded that UK procedures have been over-cautious and that "mechanical shock alone to a cold acetylene cylinder, which remains intact and has not been exposed to fire, cannot initiate decomposition." Further work is being carried out to build upon the current evidence base to better inform the risk assessments undertaken during incidents and if there is the potential to reduce the cooling period required, resulting in a timelier conclusion to an incident.

For more information, visit http://the-ncec.com/hazmat-event/

Upcoming conferences and meetings of interest

Flood and Coastal Risk Management Conference – June/July 2010

The joint Defra and Environment Agency Flood and Coastal Risk Management Conference is in its 45th year. With a chance to explore latest thinking and best practice within the field, this year there will also be the opportunity to see more practical demonstrations and technology solutions.

The conference runs over three days, with sessions organised under key themes allowing delegates unable to attend the whole event to pick a day that best suits their interests. These themes are new directions in policy and investment, preparing for and responding to flooding and managing our assets, and assessing risk and where to invest in defences.

The Flood and Coastal Risk Management Conference takes place from 29 June to 1 July 2010 at the International Centre, Telford.

For more information, see http://www.environment-agency.gov.uk/research/114636.aspx

Technology, Environmental Sustainability and Health – ISES-ISEE, August 2010

The 2010 joint conference of the International Society of Exposure Science and the International Society for Environmental Epidemiology will have the theme Technology, Environmental Sustainability and Health. The theme reflects the diversity of environmental health issues, development of exposure techniques and new epidemiological approach. There will be a number of plenary sessions with leading international speakers and several hundred presentations organised into oral presentations, posters and thematic symposia, plus excellent opportunities for networking with professionals from around the world.

Technology, Environmental Sustainability and Health takes place from 28 August to 1 September 2010 at the COEX Convention Center, Seoul, Korea.

For more information, see http://www.isesisee2010.org/

Environmental Quality and Human Health – SEGH, June 2010

The 2010 International Conference and Workshops of the Society for Environmental Geochemistry and Health will provide an internationally leading forum for interaction between scientists, consultants, and public servants engaged in the multi-disciplinary areas of environment and health. Participants of the conference represent expertise in a diverse range of scientific fields (such as biology, engineering, geology, hydrology, epidemiology, chemistry, medicine, nutrition, and toxicology), as well as regulatory and industrial communities. Conference themes include biogeochemistry of trace elements, organic pollutants and radio-nuclides; medical geology, environmental pollution and public health; interpretation using GIS; urban geochemistry, contaminated land and waste management; environmental impacts of climate change and human activities; chemicals fate; perception and communication of environmental health risks and social inequality.
The SEGH 2010 conference takes place from June 27-July 2, 2010 in Galway, Ireland.

For more information, see www.nuigalway.ie/segh2010

Best of the Best – Chartered Institute of Environmental Health, September 2010

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. Delegates will be offered numerous sessions, workshops and project case studies in an informal and interactive atmosphere.

Best of the Best takes place from 21-23 September 2010 at International Centre, Telford.

For more information, see http://www.cieh.org/events.html

Training Days

The Centre for Radiation, Chemical and Environmental Hazards (CRCE) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2010 programme has been 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.

One day training events

How to respond to chemical incidents

Autumn 2010 dates to be announced, London

These courses are designed for all those on the public health on-call rota, including Health Protection Unit staff, Directors of Public Health and Primary Care Trust staff; hospital emergency department professionals; 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 role of public health in the management of chemical incidents
- to provide an awareness of the appropriate and timely response to incidents.

Topics covered:

- processes for health response to chemical incidents
- types of information available from the HPA Centre for Radiation, Chemical and Environmental Hazards to help the health response
- resources available for understanding the principles of public health response
- liaison with other agencies involved in incident management
- training needs for all staff required to respond to chemical incidents.

There will be a charge for these events; please see page 72 for booking details. A maximum of 40 places are available.

Carbon monoxide workshop

November 2010, London
16 November 2010, Leeds

These courses are designed for health and other professionals with responsibility in carbon monoxide incident response or prevention, including: Health Protection Agency staff (local and chemicals specialists), environmental health practitioners (including pollution, housing, health and safety), paramedics, fire and police, hospital staff, Health and Safety Executive, policy makers and industry.

Aims:

- to raise awareness of carbon monoxide (CO) and reduce the number of CO incidents
- to improve multi-agency response to CO incidents.

Topics covered:

- toxicology and health effects of CO
- CO surveillance, reporting and mortality in England
- methods for biological and environmental monitoring of CO, their potential utility and limitations
- emergency and local response to CO incidents
- roles and responsibilities of different agencies in investigating and managing CO incidents
- tools available to responders for CO incident management
- government, regulatory, health service and other programmes preventing CO exposure
- examples of local-level programmes to raise awareness of, minimise, or eliminate CO poisoning
- information about research initiatives in CO poisoning.

There will be a charge for these events; please see page 72 for booking details.

Training Days

Operational lead workshop

3 June 2010, Holborn Gate, London
July 2010, Birmingham
Autumn 2010, Yorkshire
Other dates TBC around the UK

These courses are designed for public health and environmental health practitioners with responsibility for the management or prevention of lead poisoning incidents including: Health Protection Agency staff (local and chemical specialists), environmental health practitioners (including pollution, housing, health and safety), hospital staff, Health and Safety Executive, policy makers and industry.

Aims:

- to raise awareness of lead poisoning and reduce exposure to lead
- to improve multi-agency response to lead poisoning incidents.

Learning objectives:

- the role of environmental and public health practitioners in managing cases of lead poisoning
- the toxicology and health effects of lead
- methods of biological sampling
- environmental inspection, sampling and remediation
- legislation for the investigation and management
- current research initiatives for lead poisoning surveillance.

There will be a charge for these events; please see page 72 for booking details.

Odour workshop

TBC, Holborn Gate, London

This is 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).

Aims:

- to understand the management of odour-related incidents
- to explain how odour can affect public health.

Topics covered:

- odour regulation
- 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 72 for booking details. A maximum of 40 places are available.

Training Days

Understanding public health risks from contaminated land

Spring 2011, Holborn Gate, London

This course is designed for those working in public health from the Health Protection Agency and environmental health practitioners who have to respond to incidents involving land contamination.

Aims:
- to explain the legislative and organisational frameworks that underpin contaminated land risk assessment
- to understand the role of public health in the management of contaminated land investigations.

Topics covered:
- 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
- process for public health response to contaminated land issues
- types of information available and potential limitations of risk assessment models used by different agencies investigating contaminated land
- roles and responsibilities of different agencies involved in investigating and managing contaminated land.

There will be a charge for these events; please see page 72 for booking details. A maximum of 40 places are available.

Incidents during transport of hazardous materials

Spring 2011, Holborn Gate, London

This course is designed for those working in public health from the Health Protection Agency and Primary Care Trusts, paramedics, fire and police and environmental health practitioners who may have to respond to incidents arising from the transport of chemicals.

Aim:
- to provide an awareness of the public health outcomes from incidents during the transport of hazardous materials.

Topics covered:
- transport of hazardous materials in the UK
- information available from the 'Hazchem' labelling of transported chemicals
- processes for response to transport incidents
- liaison with other agencies involved in transport incident management.

There will be a charge for these events; please see page 72 for booking details. A maximum of 40 places are available.

Training Days

One week training courses

Essentials of environmental science

November 2010, King's College London

This five-day 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 for HPA staff and £1000 for non-HPA staff. 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 72 for booking details about this event.

Essentials of toxicology for health protection

May/June 2011, King's College, London

This five-day 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 for HPA staff and £1000 for non-HPA staff. 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 72 for booking details about this event.

Training Days

Introduction to environmental epidemiology

Spring 2011, London School of Hygiene and Tropical Medicine

This five-day 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 £700. A maximum of 20 places are available.

Please see page 72 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	

2010 calendar of chemical training courses

Date	Title	Length of event	Level of event*	Venue
3 June 2010	Operational lead workshop	One day	2/3	Holborn Gate, London
July 2011	Operational lead workshop	One day	2/3	Birmingham
Autumn 2010	Operational lead workshop	One day	2/3	Leeds
Autumn 2010	How to respond to chemical incidents	One day	1	Holborn Gate, London
November 2010	Carbon monoxide workshop	One day	2/3	London
16 November 2010	Carbon monoxide workshop	One day	2/3	Leeds
November 2010	Essentials of environmental science	Five days	3	King's College, London
Spring 2011	Introduction to Environmental Epidemiology	Five days	3	London School of Hygiene & Tropical Medicine
Spring 2011	Understanding public health risks from contaminated land	One day	2/3	Holborn Gate, London
Spring 2011	Incidents during transport of hazardous materials	One day	2/3	Holborn Gate, London
May/June 2011	Essentials of Toxicology for Health Protection	Five days	3	King's College, London
Spring 2011	Carbon monoxide workshop	One day	2/3	Birmingham
TBC	Odours Workshop	One day	2/3	Holborn Gate, London

*Please see Table 1 for details of competency levels

Booking Information

Regular updates to all courses run by CRCE can be found on the Training Events web page: www.hpa.org.uk/chemicals/training

Those attending CRCE 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

Other training events

CRCE staff are happy participate in local training programmes across the country 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

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

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