Chemical Hazards and Poisons Report

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Editorial

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In this issue, our incident response section focuses on some recent significant incidents including: the widespread flooding across England; a fire at a fireworks depot; an incident involving WWII grenades; and a land contamination incident which resulted in the use of novel technology for remediation.

Odour issues are discussed in a series of three articles: the first outlines an incident of odour complaints in the vicinity of a landfill site; the second provides an overview of odour-related legislative controls; and the third is on the development of an 'odour incident checklist' for public health practitioners.

As always, emergency preparedness issues are again identified as important. Recent developments in the instigation of Hazardous Area Response and Urban Search and Rescue Teams in London are outlined and the first of a series of papers on human biomonitoring developments is also given. Articles are also presented on the print media's coverage of chemical incidents; the recent development of a carbon monoxide 'action card' for front-line public health practitioners; and the preparedness of front-line public health practitioners to respond to incidents of flooding.

Environmental issues are of note and in this issue we continue our series on air pollution with an article on mechanisms of action of the ambient aerosol. An article clarifying concentration, exposure and dose concepts is also provided. Two articles are given on children's health: the first is on a Children's Environment and Health Strategy for the UK and the second is on the development of a set of children's environmental health indicators.

A series of conference reports are included in this issue covering casualty decontamination, disaster and emergency medicine and the link between the environment and human health.

Training for chemical incident management has long been recognised as a priority area of work with the Health Protection Agency, and as such, a series of reports on recent training days is also presented. These illustrate the ongoing provision and development of training (such as the Level 2 chemical training days).

The next issue of the Chemical Hazards and Poisons Report is planned for January 2008 The deadline for submissions for this issue is 1st November 2007. Please do not hesitate to contact us about any papers you may wish to submit. Please contact us on chap.report@hpa.org.uk, or call us on 0207 759 2871.

We are very grateful to Professor Gary Coleman for his support in preparing this issue.

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Incident Response

Flooding in England 2007

Significant flooding affected many regions of England, during the summer of 2007, including:

- **Yorkshire and Humber:** Hull, Sheffield, Rotherham and Doncaster (photograph 1)
- **East Midlands:** Nottingham, Lincolnshire and Derbyshire
- **West Midlands:** Worcestershire, Herefordshire, Warwickshire and Shropshire
- **South West:** Tewkesbury and Gloucester (Stroud and elsewhere - photograph 2)
- **South East Central:** Buckinghamshire, Oxfordshire and Berkshire
- **London:** South West, including Wimbledon, Putney and Croydon

In Yorkshire and the Humber, for example, 60mm of rain fell in six hours on Monday 25 June 2007. With the ground already saturated from the high rainfall in previous weeks, this resulted in surface flooding which led to local rivers breaking their banks. There were three deaths in the region associated with the flooding. In all the affected areas, there was significant economic damage to properties, businesses and the transport infrastructure.

The HPA has been involved in providing public health advice (http://www.hpa.org.uk/flooding/default.htm) This data includes a summary statement on the HPA's general advice regarding health risks from flooding and what to do minimise the possibility of infections and other problems. The advice covers:

- General advice on protecting against infection
- Hand washing guidance
- How to clean up
- If you are returning to your home
- If you are still in the home
- Food preparation and storage
- Water for infants during disruption to public water supplies
- If your drinking water becomes contaminated
- If your water supply has been interrupted
- Private water supplies during flooding
- How to deal with chemical and environmental hazards
- Precautions during clean-up
- The safe use of emergency generators

Five leaflets were also developed by the HPA for the public, summarising health advice. These are also available on the website and cover:

- Health advice following flooding
- Cleaning up after a flood – health advice
- Top tips for coping with water shortages in the floods
- Public health advice – water consumption
- Health advice following floods – chemical and environmental hazards (Box 1)

Photograph 1: Flooding from the River Don, outside the South Yorkshire Health Protection Unit offices, Sheffield, with a smoke plume from a concurrent fire at the local steel works possibly caused by a short circuit due to flooding on Monday 25th June 2007 (© South Yorkshire Health Protection Unit).

Chemical and Environmental Hazards

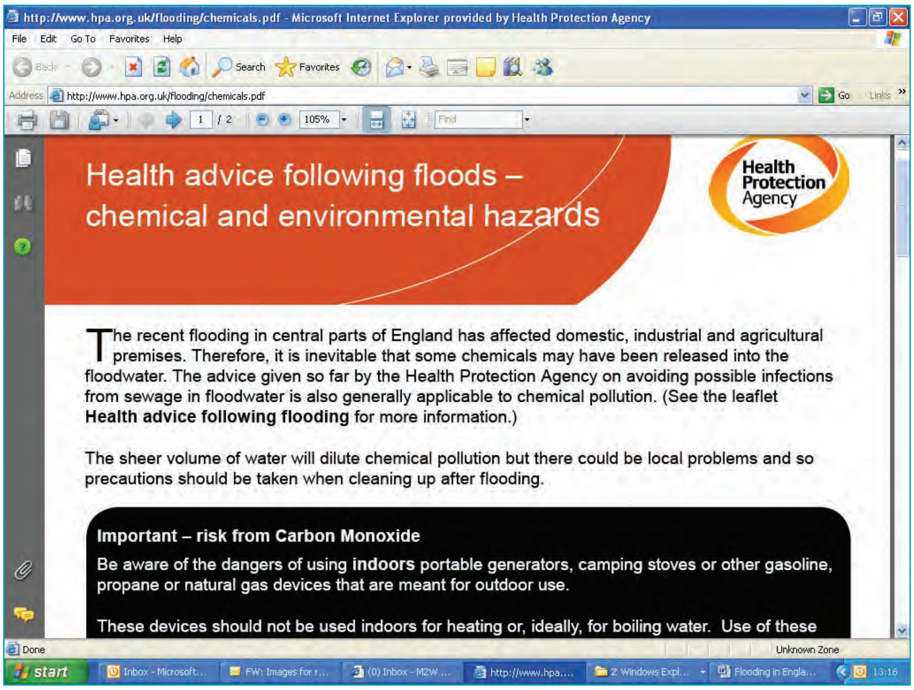
The flooding affected domestic, industrial and agricultural premises. Therefore, it is inevitable that some chemicals may have been released into the floodwater. However, the sheer volume of water will dilute chemical pollution and so, as with possible infections from sewage in floodwater, the risks to the public are generally low. The precautionary advice the Agency has given on avoiding possible infections in floodwater is also applicable to chemical pollution.

Ongoing HPA response

Further work is ongoing to continue to monitor the affected areas. The Agency is carrying out enhanced surveillance in the flooded areas, through routes including calls to NHS Direct and GP consultations, to track any changes in the rates of infectious disease or chemical hazard effects. However, the Agency has stressed that it is not expecting to find any major infections or outbreaks which would give cause for concern. Work is also underway in Yorkshire and the Humber to undertake public health follow-up with affected communities to gather medium to long term information about the wider effects flooding has on people's health.

Photograph 2: River Severn flooding near Gloucester on Wednesday 25th July 2007 (© CHaPD London).

Box 1: HPA webpage on chemical and environmental hazards related to flooding (http://www.hpa.org.uk/flooding/chemicals.pdf)



Fireworks incident near Lewes, December 2006

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Incident Summary

A fire and explosion occurred on a farm in South East England that operated as a retail fireworks outlet and a storage facility for large pyrotechnic displays. A steel fabrication works was also present on the site, adjacent to the retail and storage facilities. The fire started at the site on a Sunday afternoon in December 2006, with a subsequent explosion occurring shortly afterwards in which two emergency services personnel were killed and another eight injured.

Much of the site was destroyed and neighbouring properties were badly damaged and subsequently evacuated. A 500 metre cordon was put in place and nearby roads closed, due to the risk from unexploded fireworks and also gas cylinders in the steel works. The event was declared to be a 'major incident' and a multi-agency 'Bronze' (operational), 'Silver' (tactical) and 'Gold' (strategic) command and control structure was instigated. The Gold command was stood down on the day of the incident but the Silver command was still in place three days later, at the time of the site visit.

Site Visit

Following discussions between the Chemical Hazards and Poisons Division, London (CHaPD-L) and Surrey and Sussex Health Protection Unit (HPU) regarding possible environmental contamination from fireworks, it was agreed that a site visit would be undertaken. The farm was located on top of a low hill, with a small lake and stream nearby. The prevailing wind direction in the area was south-westerly and it was noted that the investigation teams, including Silver command were situated downwind of the site (thereby possibly increasing the risk of front line personnel being exposed to any chemicals released to the air).

Direct access to the site of the fire and explosion was prohibited, as the site was declared to be a crime scene, with police personnel collecting material for forensic investigation from within the cordon. The fire was still smouldering and a smell characteristic of products of combustion was noted during the site visit. Damage to property outside the cordon was apparent (photograph 1). Local Authority, emergency services, and Health and Safety Executive (HSE) personnel provided information and maps, including aerial photographs of the site. It was noted that a larger storage depot was in fact situated off -site at another farm.

HSE personnel outlined issues relating to the storage of fireworks and what chemicals might be on site. Unfortunately, all paperwork and records had been destroyed in the fire. There were still unexploded fireworks present in a lorry on site and in a small warehouse within the cordon. In addition to the risks posed by unexploded fireworks, other issues were raised, including the possibility that asbestos containing materials may have been present in the damaged buildings and could have been released during the explosion and fire.

Photograph 1: Photographs of damaged buildings in the vicinity of the fireworks fire and explosion near Lewes (© Health Protection Agency, 2006).

Actions

A list of possible actions was compiled by health protection and local authority staff, which included sampling from the evacuated properties (window sills and down pipes), air quality monitoring (AQM), and water sampling from the nearby stream. The need for remediation of the site was discussed, and information on prior land use of the site was requested. The local authority agreed to carry out a risk assessment on the other main storage facility where the bulk of the fireworks are stored.

The HPU agreed to check on the status of those individuals evacuated and to provide advice on what items members of the public could take from their homes without being unnecessarily exposed to contamination. The importance of obtaining an update on the health of those injured in the incident was also noted. CHaPD-L agreed to investigate the likely chemical composition of fireworks and their potential for environmental contamination.

Outcomes

Five samples of material that may have contained asbestos were visually identified from the factory site. Subsequent analysis indicated that these samples did not contain asbestos. Further sampling was to be undertaken by local contractors who would continue to move further into the site when it was deemed safe to do so.

Initial AQM data from fixed monitoring points in the local area found no evidence of increased concentrations of air pollutants such as nitrogen dioxide and particulates over the three days following the fire.[1] The possibility of undertaking AQM on the site was discussed, but the risk assessment, based upon extreme weather conditions (rainy and windy) and the distance from site to nearest habitable house, indicated that any local impact on air quality was likely to be limited. The Environment Agency undertook water sampling up and downstream from the site and did not report any significant findings.

The local authority assessed the exteriors of the evacuated properties and noted moderate damage to windows and roof tiles. There was no obvious fire or smoke damage. No material had been deposited on window ledges. There was evidence of shrapnel lying on the surrounding verges and gardens and some firework debris. It was identified that insurers would be responsible for remedial works on the properties, as well as any testing to ensure the buildings were structurally sound.

Remediation of the site will take time and may require input from specialist services, for example in dealing with unexploded material. This waste is currently being kept at the site in piles on the ground and should be managed in a way that does not give rise to significant environmental pollution and is compliant with environmental legislation. Exploded fireworks may also be potentially hazardous; some remains reportedly contain dioxins and furans.[2]

Initial scoping on the possible health effects of fireworks by CHaPD-L suggested that further work was warranted. Studies on air quality during the Diwali festival (India) for example, found elevated levels of sulphur dioxide, nitrogen dioxide, carbon monoxide, carbon dioxide, ozone, and suspended particles (including PM_{10}).[3] Adverse health effects due to air quality following fireworks have also been reported elsewhere.[4,5] Fireworks may contain and emit a variety of compounds, some of which may be potentially hazardous (Table 1). In addition, trace elements have been found in the blood and urine of victims of fireworks disasters,[6] while manganese and chromium have been detected in the scalp hair of fireworks manufacturers who may have been chronically exposed.[7] In the United States, perchlorates have been identified in ground and surface water sources following large fireworks displays.[8] This is a non-volatile and highly soluble substance used as a firework propellant, which may (given significant exposure) effect thyroid hormone synthesis.[9]

With the increased use of fireworks for a variety of major public events throughout the year it is likely that storage and retail outlets such as this one will increase in size and number. Health Protection Agency staff, as category one responders under the Civil Contingencies Act, should be aware of such sites and include them on a risk register, as for COMAH sites. Lessons from this, and other serious incidents such as Enschede in the Netherlands where 22 people were killed, should be learned and an appropriate local emergency response developed. There are both direct and indirect potential risks associated with fireworks and therefore CHaPD-L are considering undertaking further research on the implications their usage has for public health.

Box 1: Six key ingredients in fireworks:[10,11]

1. **Fuel** - Normally, all fuels will contain an organic element such as charcoal or thermite. Non-metallic elements such as sulphur, silicon and boron are used as they produce a large amount of energy when oxidised. Metallic fuels eg. aluminium, magnesium and titanium are used, because when they burn they emit a very bright light.

2. **Oxidising agent** - These can be nitrates, chlorates or perchlorates. Perchlorates are salts derived from perchloric acid ($HClO_4$) and both potassium perchlorate ($KClO_4$) and ammonium perchlorate (NH_4ClO_4) are used extensively in fireworks.

3. **Reducing agent** - These burn the oxygen provided by the oxidising agents to produce hot gases. Common reducing agents are sulphur and charcoal. These react with the oxygen to form sulphur dioxide and carbon dioxide.

4. **Colouring agent** – Different chemicals are used to produce different coloured fireworks (table 1).

5. **Binder** – this is used to hold the mixture of the firework together in a paste like mixture. The most commonly used is dextrin, (a type of starch), although gum arabic and parlon (a chlorinated isoprene rubber) are also used.

6. **Regulator** - Metals can be added to regulate the speed of the reaction.

Table 1: Compounds producing colours in fireworks

Colour	Compounds	Compound Formulae
Red	Strontium salts & lithium salts	Li2CO$_3$ SrCO$_3$
Orange	Calcium salts	$CaCl_2$ CaSO4.2H$_2$O
Gold	Incandescence of iron or charcoal	
Yellow	Sodium compounds	$NaNO_3$ Na_3AlF_6
Electric white	White hot metal	BaO
Green	Barium compounds with chlorine	$BaCl^+$
Blue	Copper compounds and chlorine	$Cu_3As_2O_3Cu(C_2H_3O_2)_2$
Silver	Burning aluminium, titanium or magnesium powder	

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Discovery of World War II Special Incendiary Phosphorous (SIP) grenades in a Wiltshire garden

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Introduction

In October 2006 a resident of Seend village in Wiltshire, whilst working in his garden, disturbed one of several hidden glass bottles containing yellowish liquid which were subsequently identified as World War (WW) II SIP grenades that were destroyed by controlled explosion. This article summarises the response to the event, the input from local health protection personnel and highlights the lessons identified.

Historical Background

Near the beginning of WWII (1940) when Britain was preparing for invasion, Grenade No 76 or 'Special Incendiary Phosphorous' (SIP) grenades were issued for use by Home Guard Units throughout Britain.

Consisting of a glass bottle shaped like a milk bottle, the SIP contained benzene and phosphorous. These grenades were intended to explode on impact leading to fire. The grenade came in two versions, one with a red cap intended to be thrown by hand and a slightly stronger bottle with a green cap, intended to be launched from the Northover projector (a crude 2.5 inch grenade launcher).

The SIP grenade was generally regarded as being a danger to its own operators, and was not issued to troops on the front line. SIP grenades were stored in crates of about 20 and distributed throughout Wiltshire. 141,000 were allocated throughout Wiltshire. Most of these would have been made safe before the end of WWII.

Instructions on each crate of SIP grenades read: 'store bombs (preferably in case) in cool places, under water if possible. Stringent precautions must be taken to avoid cracking the bombs during handling.'

Incident Summary

On 1 October 2006, a resident from Seend, a village in central Wiltshire contacted emergency services saying he had found four bottles containing yellowish liquid whilst digging in his garden with a pickaxe. He had punctured one of the previously hidden bottles which resulted in an immediate flash and flames, which he immediately extinguished.

Special Incendiary Phosphorous (SIP) grenade found in a Seend village garden.

The puncture site in the bottle continued to 'off-gas' and it was reported that he had inhaled the gas. Fire and Rescue Services (including a HAZMAT officer) attended the scene. They were not able to identify the device or its contents. The three remaining intact bottles were picked up and moved to another part of the garden away from the house. The resident was given details of local private hazardous waste removal companies to contact and arrange disposal.

At the time it was considered there was no immediate health hazard, as the resident had not suffered ill effects. However, he was advised to keep his family and pets away from the bottles and contact his General Practitioner should he become unwell.

On 2 October 2006, a senior Environmental Health Officer from the Local District Council (LDC) attended the house and also could not identify the bottles. He took photographs of the bottles, followed by an internet search to try and identify the bottles. The resident believed that pesticides had been used at the property in the past - the senior EHO suggested that the bottles may contain a phosphorous based pest control product commonly used to control rabbits, moles and foxes. Further advice on the possible identity of the bottles and content was sought from Pesticide Advisory Group, Department for Environment, Food, Rural Affairs (Defra) and the Environment Agency.

On the following day the resident reported to the police that more bottles has been found and expressed concern that he had been left to deal with the situation himself. A total of 17 bottles were found. The LDC arranged for a local waste removal company to visit the site to identify and if possible remove the bottles. A waste disposal company visited that the same day but could not identify the contents of the bottles. Wearing full protective clothing, the waste company operator helped the resident (an ex army officer who wore his service issue respirator) to move the remaining bottles away from the house. However, the company refused to remove the bottles from the site without knowing the content and without being able to exclude the possibility that that they may contain explosive material.

On Wednesday 4 October, the resident contacted the police control room expressing concern that the bottles remained in his garden and reporting that he and his wife had suffered headache and nausea following exposure to the gas while moving additional bottles found in the garden. His pet dog had also vomited. The police Emergency Planning Officer (EPO) was not alerted.

The homeowner contacted his GP and was advised to attend an Emergency Department (ED). Before this happened, an ambulance was sent out by the Primary Care Trust (PCT) to assess him at home and following this, the ambulance personnel discussed subsequent actions with the hospital's ED physicians.

It was at this point 3 days after the initial incident, with the report of health ill effects, the PCT Emergency Planning Manager and the Wiltshire Health Protection Team (WHPT) were notified of the incident. The Consultant in Communicable Disease Control (CCDC) contacted police control for more information. Further discussion with the resident revealed he and his wife had suffered nausea and headache 3 days previously (on Sunday), which resolved within 24hrs. WHPT also contacted Chemical Hazards and Poisons Division (CHaPD) and sent photographs of the bottles from the scene, taken by the senior EHO, in order to assist identification. Initial suggestions were that these could be old WWII ordnance.

A further inspection by senior fire and rescue services officers could not exclude an explosive/volatile substance and called for the army Explosive Ordnance Disposal (EOD) assessment. The EOD were able to identify the bottles immediately as No. 76 SIP grenades containing phosphorous, used in WWII by the Home Guard (which is extremely volatile). The Centre for Emergency Preparedness and Response (CEPR), HPA were then alerted. EOD detonated the bottles within a large metal skip provided by the local district council, which was positioned in a clearing next to the house.

During the controlled detonations, the residents in the immediate vicinity of the property were advised to stay indoors and keep windows and doors closed. Local roads were temporarily closed and the police maintained control of entry. The size of the subsequent smoke plume was larger than expected and the following day several personnel present during the detonation reported symptoms of headache and nausea. These symptoms resolved spontaneously within 24-hours post exposure. There were no further reports of adverse health effects from either staff attending the incident or the local residents of Seend.

Early the following week a 'cold' debrief was held attended by key agencies.

Lessons identified

The main issues arising from the incident debrief were identified as:

- Usefulness of photographs for identification of the bottles
- Fire and Rescue Services (HAZMAT officers) should have easy access to photographs of the common hazards identified by EOD and these should be distributed to other agencies.
- Organising waste disposal and site surveys
- Advising staff and residents of possible health effects
- Ensuring patients with possible contamination are not sent directly to Emergency Departments without a risk assessment
- Difficulties in communication between agencies
- Large plume size following detonation of SIP grenades

Early identification of such devices is crucial to enable appropriate response from all agencies. Although photographs were taken of the bottles, there was a delay in circulating them to relevant agencies who could assist with identification early on in the incident. EOD have been requested to give a presentation to the Wiltshire multi-agency group on the types of old munitions that have been found in the past. All agencies involved agreed a database of information and photographic material would be useful in such incidents and should be made widely available. No such manual was available to the emergency blue light services in this incident.

For the resident, the clean up operation after the discovery of the SIP grenades was important. One major concern for the resident was leaving the grenades in his garden and the possible danger this posed to himself, his family and house. If there were another similar incident in which potentially highly volatile substances are found in a public place, residents should not be left to deal solely with the situation and Public Services should co-ordinate their response and keep the residents informed. Local hazardous chemical plans are to be reviewed and updated to reflect this.

During controlled detonation it is important to ensure that all relevant services are aware of the situation. In this case, no one anticipated the size of the smoke plume generated and the subsequent health effects reported by some staff attending the scene. Review of current guidance for personal protective equipment for staff attending similar incidents is to be undertaken.

The Health Protection Team (HPT) was not made aware of the incident until 3 days after the discovery and initial information on the health effects reported by the resident was patchy and at times conflicting. This in turn hampered accurate risk assessment and delayed advice on possible health effects. Multi-agency guidance that serves as both a reminder and possible trigger criteria for public health involvement would help at any incident. The HPT has access to a wide range of expertise on chemical and biological risk and is able to advise when evacuation should be considered.

It was decided that information to local residents about SIPs grenades should be proactively published within the village of Seend through the parish council. It was decided not to disseminate information further as it could generate alarm. The local Wiltshire newspaper had run an article about the incident.

The Health Protection Team is to be contacted as soon as possible in any such future incidents. Local health care providers, NHS direct and ambulance services would be briefed regarding any potential health affects on the local population.

Early recognition of old WWII munitions remains important. Salisbury Plain and the surrounding areas were used extensively during WWII as a bombing/artillery range and general exercise/training areas for the military. The plot of land in this incident was part of the land that had been used as Home Guard HQ during WWII and had had a pill box observation post overlooking the lowlands and nearby Keevil airfield.

The lessons learned are applicable throughout the UK, in particular in areas where WW II ordnance is still being found.

The use of a novel technology in the remediation of a contaminated land site as a public health protection measure

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Introduction

Contaminated land is the unwanted legacy of past industrial activity. If unrecognised or ignored it is a potential risk to health, water resources and the environment. There are many sites across the UK that have become contaminated by previous industrial activities. Existing estimates of the extent of land contamination in England and Wales vary, however, according to the Environment Agency's 'Indicators for Land Contamination Report' (2005), it is estimated that there may be up to 33 500 sites which are to some degree contaminated.

This case study describes how a grossly contaminated site in South Wales was brought back into beneficial use (housing development) with input from public health practitioners. The site of interest is the Castlegate Development, located in Caerphilly, South Wales. The site was formerly occupied by the Penrhos landfill, which was the subject to the disposal of industrial waste, including chemical drums and a range of organic compounds.

Historical records indicate that the site was, amongst other uses, operated as an unregulated disposal site between 1948 and 1968. It was used to dispose of a wide variety of industrial waste products including solid wastes (rubber, glass, quarried shale waste, large quantities of Pulverised Fuel Ash (PFA)) and drummed chemical waste. The drummed chemical waste was deposited into two excavations in the south central area of the site and it is reported that the drums were buried at depths of between 3-6 m with a covering of 2-3 m of clay. After 1968 the site was only used for the landfilling of inert materials such as PFA, colliery spoil and subsoils. During the 1970's a number of developments were undertaken within the area surrounding the site, including the Glenfields housing estate to the east and the northern Caerphilly by-pass to the west. The Castlegate development site is quite extensive and covers an area of approximately 26 hectares. Planning permission was granted in September 2004 for the building of approximately 500 houses in addition to the provision of public open space on the condition that full remediation of the site was undertaken prior to redevelopment.

Site Investigation

The site investigation involved the developer undertaking a desktop study, a review of all previous site investigations and a site reconnaissance using both non-intrusive and intrusive techniques. The review was necessary as there have been a number of intrusive investigations since 1972 and this data attempted to assess the nature, distribution and extent of contaminants present. The developer undertook a geophysical survey of the whole site using a magnetic gradiometry technique with the objective of identifying buried metallic drummed waste in areas of deep made ground and areas where the made ground depth was deeper than the proposed remediation turnover excavation works. On completion of the survey, 204 'anomalies' were investigated using trial pits at each anomaly location. This work identified in excess of 100,000 tonnes contaminated material, whilst approximately 20-25% of the recorded anomalies were found to be benign (e.g. buried reinforced concrete).

The developer undertook further site characterisation with intrusive investigations comprising of machine excavated trial pits, rotary boreholes and shell and auger boreholes around the site. In particular it was necessary to investigate further the buried drum areas in order to fully characterise the extent, depth, hydrology and chemical characteristics of the area. During intrusive site works, excavations were evaluated through visual assessment, on-site monitoring of Volatile Organic Compounds (VOCs) emanating from the waste, sampling of the excavated materials and laboratory analysis using a wide range of analytical techniques targeting a whole range of organic compounds and inorganic contaminants such as heavy metals.

While this work was continuing the developer held liaison meetings with local residents covering all aspects of the proposals with regards to development of the site, including a range of health concerns. The concerns from the residents mainly related to the health effects from odours that migrated off-site during the site excavation and remediation. The local authority anticipated the risk from odours during remediation and the planning consent therefore required the developer to take steps to mitigate such potential nuisance. The developer therefore implemented an environmental monitoring programme as required by planning conditions in conjunction with an occupational monitoring programme for on-site staff. Site works were also scheduled to ensure particularly odorous excavation areas were not excavated during days when the prevailing winds were in the direction of the nearby residential estate. Deodorising sprays were also used as an additional measure during the excavation works.

Risk Assessment

Analysis of soil samples taken from trial pits and boreholes identified a number of potential 'contaminants of concern', the presence and distribution of which varied across the site. The analysis identified volatile and semi-volatile organic compounds and heavy metals. The developer undertook a detailed quantitative risk assessment (DQRA) and constructed a conceptual model for the site based on two scenarios of exposure to contaminated soil and groundwater: (1) during site preparation and construction (risks to construction workers); and (2) post-development (risks to occupiers and maintenance workers). The conceptual model included the following potential pollutant linkages: soil exposure (dermal & ingestion), inhalation exposure to volatile compounds in outdoor and indoor air from both soil and groundwater sources and the inhalation of particulates.

Using the 'Risk Based Corrective Action' (RBCA) risk modelling tool, the developer calculated Site Specific Target Levels (SSTL's) for the contaminants of concern. The model identified that arsenic, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, vinyl chloride, 1,2-dichloroethane, 1,2,4-trimethylbenzene, aniline and acetophenone over various parts of the site required remedial action as they were present in concentrations that exceeded the SSTLs and therefore posed an appreciable risk to human health. With regards to the risk posed by volatilisation of contaminants from groundwater to outdoor or indoor air, elevated levels of benzene were identified as a potential risk to end-users for a small area of the site.

The risk assessment and conceptual model identifying the contaminants of concern and the potential pollutant linkages formed the basis of the remediation strategy.

Remediation Strategy

The objective of the remedial works was to remove contamination presenting a potential risk to human health and the environment. To achieve this all contaminated solid and liquid waste was to be removed from the two principal waste cells identified in the southern part of the site and any other materials deemed as 'contaminated' based upon the SSTLs for the identified contaminants of concern. The site investigation together with the risk assessment allowed the areas requiring remediation to be delineated. Four main areas of the site were designated for remediation: (1) the buried drum area; (2) the land to the north and west of Spine Road; (3) road frontage land and; (4) the 'sump' and public open spaces (figure 1).

Remediation of the area where drums were thought to be buried was required to alleviate public concerns with regards to potential exposure from vapours from the buried drums. The area contained gross organic liquid and solid contamination and the materials were confined to two cells formed in low permeability material. The remedial works for this area required the excavation and off-site disposal of all the contaminated waste material within the two cells (photographs 1 and 2). On completion of the excavation, the resulting void was backfilled to 500 mm below proposed finished ground level with clean imported fill material. The land to the north and west of Spine Road comprised localised areas of shallow contamination. The remedial works for this area included excavation of all significant contamination associated with drummed waste (identified by the geophysical survey) and excavation and removal of contaminated material from the top 2 m of made ground. The 'sump' and public open space areas remedial works involved the excavation and removal of the top 1 m of contaminated materials and backfilling with clean imported material to final-finish level. The remainder of the site was excavated and contaminated materials removed, with the land being backfilled and compacted for geotechnical purposes. The remediation of this site involved the removal of approximately 140 000 tonnes of contaminated solid waste and approximately 6 million litres of contaminated water and liquid waste. The total cost of the whole remediation process was approximately £15 million.

Although the developer undertook thorough site investigation works and subsequent deep excavation, concerns over the accuracy of the geophysical survey remained given that some drummed waste could have been buried to a depth of up to 10 m below ground level. It was accepted that the non-intrusive geophysical survey may not have detected any drums buried at excessive depths. Therefore, it was deemed appropriate that further measures should be adopted to protect future users of the site from exposure to any volatile organic vapours that could potentially leak from buried drums and permeate through the ground to eventually escape to atmosphere. The key question was: could the developer be 100% confident that all the buried drum waste had been identified and removed? This therefore raised the issue of uncertainties (relating to the identification of all buried material and the robustness of the model) that could be applied to risk assessment scenarios using non-invasive site investigation techniques and computational modelling. To satisfy the planning conditions, it was necessary for the developer to include further measures to protect the health of the future site occupiers from exposure to any volatile organic vapours that could potentially leak from buried drums. It was therefore decided in consultation with stakeholders that the developer should further reduce the risk by the installation of a horizontal vapour barrier (in the form of a capillary break) across most of the site and the provision of gas protection measures in all houses.

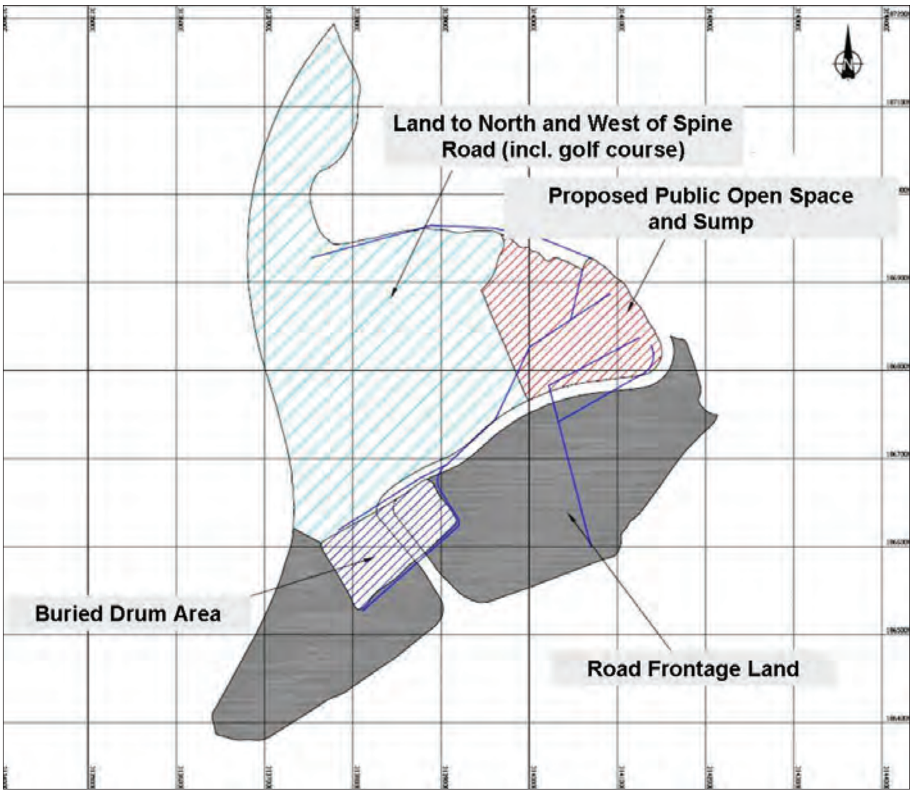


Figure 1: Map showing site layout (©Celtic Walters Land Ltd., 2005)

Horizontal Vapour Barrier

A horizontal vapour barrier was designed by Sladen Associates (2004) for areas of land to the north and west of the site

Photograph 1: Excavation and removal of contaminated soil (©Celtic Walters Land Ltd., 2005).

Photograph 2: Recovered damaged drums (©Celtic Walters Land Ltd., 2005).

with identified contamination and deep made ground, together with all of the area to be used as public open space. The purpose of the vapour barrier was to provide an additional level of protection for future users of the site by removing the exposure pathway for volatile organic compound (VOC) vapours which could theoretically migrate to the surface and to prevent the vertical migration of contaminants dissolved in groundwater into overlying soils. The material that was selected as being 'fit for purpose' was pulverised fuel ash (PFA) sourced from a local power station.

The vapour barrier is comprised of four layers of different grades of material which when saturated with ground water act as a capillary break (photograph 3): i) a 15 mm base layer of 6mm stone which acts as a capillary break by ensuring a low negative water pressure, ii) a 100 mm quarry dust layer that reduces risk of contamination to the vapour barrier layer, iii) a 200 mm PFA layer that acts a barrier to vapour migration and remains close to saturation during periods of little or no rainfall and iv) 100mm quarry dust layer which provides two functions, firstly to reduce the disturbance to the PFA layer and secondly to enable a wide range of backfill materials to be used without impacting on the performance of the vapour barrier. In areas of proposed housing, the depth of the upper surface of the vapour barrier was set at a minimum of 2 m below the proposed development level in order to avoid areas where drainage and service corridors were to be installed. Once the vapour barrier was completed, the whole site was backfilled to restoration level and completed with 500mm of clean imported material.

The vapour barrier was designed to establish a zone of water saturation above the level of the natural water table through the use of an engineered permeability contrast in soil layers. This technique is based on the principle that gas moves through the soil by the processes of advection and diffusion. The rate of advection through the soil is controlled by the gas permeability of the soil and requires a positive pressure difference. The gas permeability of soil reduces rapidly with the degree of saturation and in degrees of saturation exceeding 85%, most soils are effectively impermeable to gas. Once a soil has reached a degree of saturation greater than 85%, the coefficient of diffusion is more than four orders of magnitude lower than that of a dry soil (Sladen Associates, 2004). Therefore the vapour barrier creates a permanent zone of saturation in the soil, thereby mitigating the potential for vertical migration of vapour to the soil surface where receptors (site users) could be exposed.

Discussion

This was the first time that a vapour barrier system using PFA has been employed in the UK on a site undergoing redevelopment as a public health protection measure. The public health practitioners (who were advising the local authority), raised a number of concerns over the robustness of this technique and the models used by the developer for validating the design of the adopted engineering solution. A number of questions were therefore submitted to the developer in order to satisfy the public health team's concerns.

The issue of validation of the computational model used in the design of the vapour barrier for residential development was raised and subsequently addressed by the developer. It was shown by the developer that the vapour barrier model had in fact been validated for residential development by modelling its performance under 'worst-case' scenario conditions, where a theoretical source of VOCs occurs beneath a house. The modelled results indicated that even under extreme climatic conditions VOCs should not pass through the vapour barrier.

Concern was raised over the safety factors built into the model in relation to changes in meteorological and hydrological conditions and the likely effect on the performance of the vapour barrier should soil moisture saturation fall below 100%. However, it was shown that the vapour barrier did not fall below 100% effectiveness during any of the simulated model runs. The model utilised 20 year rainfall and potential evaporation data for the site and four year simulations were run under a number of scenarios including an 'extreme drying case for 2-3 years'. The resulting model runs indicated that the vapour barrier performance remained the same as the 'normal year' model runs. Therefore, it was considered unlikely that any extreme climatic conditions would cause the failure of the vapour barrier and allow any vapour migration to the surface where receptors may be exposed.

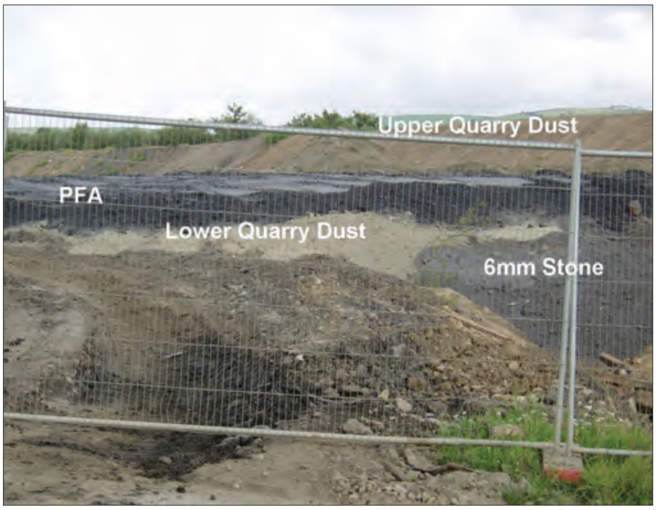
The issue of appropriateness of this technology and its previous uses in other residential developments was also questioned. This was addressed by looking at four other examples where the use of vapour barriers has been successfully used as a remedial technology in housing developments. It was acknowledged that this was the first time that a vapour barrier comprised of PFA has been used in the UK, even though similar capillary break barriers had been used successfully in other countries where vapour/gas protection measures have been required.

Conclusions

Given the pressure to re-develop 'brownfield' sites, all forms of remediation options should be considered. With the rapid increase in land values in recent years, even grossly contaminated sites costing many millions of pounds to remediate, are now economically viable to redevelop. Local Authorities have responsibilities to ensure that the remediated land does not present a significant health risk to existing or future site users. It is highly beneficial for public health practitioners to be consulted during the design of contaminated land development schemes, particularly when untested novel technology is employed, in order to ensure that the potential for adverse public health outcomes is minimised.

In the case of the Castlegate development, there were many uncertainties relating to the site where tipping of waste occurred before legislative controls were in place and therefore no full record of the nature of contamination and depths to which it was present were available. This led to uncertainty with regards to the risks posed to public health. For the site in question, a capillary break was utilized as a safeguard to public health over the lifetime of the development. For other similarly contaminated sites there may be comparable issues around accuracy of records of chemical contamination and the potential for pollutant migration over time.

Where it is not possible to determine with confidence that there is no substantial risk to public health due to soil vapour migration, the protective measure of including an effective vapour barrier system should be considered on a site-specific basis. A consideration of the geological and hydrogeological conditions present at a given site is necessary in order to do this effectively.



Photograph 3: Horizontal vapour barrier profile (© HPA, 2007).

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Odour Issues

Odour complaints in the vicinity of a landfill: should the local Health Protection Unit be involved?

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Incident Location

The village of Stanton Harcourt is located approximately 10 miles east of Oxford City Centre. On the outskirts of the village is Dix Pit Landfill Site. Table 1 shows the locations of residential and commercial properties within 200 metres of the site boundary, with one property sharing it's boundary with the landfill.

The site is an operational landfill that accepts domestic waste from Oxfordshire, plus waste from licensed contractors to dispose of skip waste and inert construction waste. The site is permitted under the Pollution Prevention and Control (England and Wales) Regulations 2000 (PPC Regs), with the Environment Agency (EA) being the Regulator.

Table 1: Proximity of Receptors to Dix Pit Landfill Site

Receptor	Types of receptor	Minimum distance from boundary (m)	Direction from site boundary
Civic Amenity Site	Commercial	Inside installation boundary	SW
Cottage 1	Residential	on boundary	E, S & W
Industrial Estate (East)	Commercial	on boundary	NE
Industrial Estate (West)	Commercial	20m	NW
Offices	Commercial	60m	SSE
Brick Works	Commercial	75m	SW
Farm	Commercial & Residential	150m	SW
Stanton Harcourt Village (East)	Residential & Commercial	180m	NNE
Residential Property (South)	Residential	180m	S
Farm	Commercial & Residential	190m	NNE

Incident Assessment and Investigation

In February 2007 the Operator noticed excess odours on-site and at the site boundary. Following a site inspection the Operator detected a broken leachate[1] pump and suspected this as being the source of the odour (Box 1). The cap of the leachate well was subsequently removed leading to a large release of gas which was suspected as being hydrogen sulphide due to the perception of a distinctive 'rotten egg' smell (no gas monitoring took place at this point). The cap was immediately placed back over the leachate well and a new pump installed without further release of gas. However, odours continued to be detected outside the site boundary and in the village of Stanton Harcourt.

Odour complaints from the local residents were received by the EA and the Local Authority (LA) in late March, although local residents reported that odours had been detected in the village since January. The LA, however, were unable to act upon these complaints as their enforcement powers under 'statutory nuisance' do not apply for sites regulated under PPC, the responsibility for regulation being with the EA.

The first multi-agency site visit took place in mid-April, attended by the LA, EA, HPA and the Operator. During the site visit the Site Manager of Dix Pit used a hand held Jerome meter to measure the hydrogen sulphide (H_2S) concentrations around the boundary of the site. Jerome meters can detect hydrogen sulphide concentrations from one part per billion (ppb) up to 50 parts per million (ppm) and are utilised to identify the source(s) of H_2S. The meters give instantaneous readings to the user but are extremely sensitive to moisture and cannot be used in the rain or damp conditions.

The highest concentration of H_2S detected during this site visit was 0.010 ppm, with a slight odour detected around one leachate well head. Further monitoring on numerous occasions carried out by the Operator and the EA since April has given H_2S concentrations ranging from 0.002 to 0.017 ppm.

Table 2 gives an indication of the potential adverse health effects of exposure to hydrogen sulphide at specific concentrations expressed in ppm. Hydrogen sulphide is an odorous gas that has an irritation threshold which is higher than the odour detection threshold hence the 'odour' precedes health effects with exposure to increasing concentrations.

Table 2: Potential Health Effects of Hydrogen Sulphide (Ellenhorn et al, 1997)

Concentration (ppm)	Clinical Effects
0.02-0.025	Odour threshold
0.3	Distinct odour
3-5	Offensive, moderately intense odour
10	Obvious, unpleasant odour; sore eyes
20-30	Strong, intense odour but not intolerable
50	Conjunctival irritation first noticeable
50-100	Mild irritation to respiratory tract and eyes after 1 h
100	Loss of smell in 3-15 min, may sting eyes and throat
250	Prolonged exposure may cause pulmonary oedema
1000	Rapid collapse, respiratory paralysis, imminent coma, followed by death within minutes

Following the incidence of odour detection in the village, the Primary Care Trust carried out a survey of the local General Practises to ascertain whether any reports of adverse health effects, attributable to the odours from the site could be identified. The PCT requested this data from January 2007. The EA took the responsibility of informing members of the public about the work that was to be carried out on site and to reassure the local residents.

Incident Management

The Operator and the EA together formulated an action plan to address the odour issues in the village. The Action Plan suggested three phases of work with each phase being completed and assessed for its effectiveness prior to the next phase being instigated if the odour was persisting. Phase One included replacing seals on the leachate tank, rearranging leachate pipe work, replacing filters and increasing gas extraction to the waste to energy plant. This was completed in March 2007. The Operator felt that the odour situation was not adequately reduced by the completion of Phase One and realised that the work planned for Phase Two would not be sufficient to rectify the problem either. Therefore Phase Two of the works was not initiated and the operator went straight to implementing Phase Three. This involved the excavation of waste already landfilled in the problematic part of the site to form trenches. Pipe work was then laid within the trenches and recovered with waste. The horizontal pipes would then be connected to the existing gas extraction system therefore aiming to increase the collection of gas and hence reducing odour. It is worth noting that the process of excavating through old previously landfilled waste has the potential to release significant amounts of landfill gas which can be odorous (Box1).

Phase Three work was completed at the beginning of June 2007. Table 3 shows a summary of the complaints received from the start of the works up to the end of this period. Complaints were still being received in July 2007 and as a consequence the Operator is continuing to carry out remedial work on site. It is important to note that at a public meeting in mid-May many residents felt very strongly about the odour and the detrimental effect that it was having upon their quality of lives

Table 3: Complaints received by the Environment Agency from Stanton Harcourt residents following odour complaints at Dix Pit Landfill site (data provided courtesy of the Environment Agency, last updated on 11 July 2007,).

Date reported	Time reported	Time noticed	Location	Intensity out of 10 (1 = no odour, 10 = very strong odour)
21-Mar-07	21:40	Last 8 weeks	Cottage 1	7/10
04-Apr-07	16:19	Last 2 days	Access road to Stanton Harcourt	not available
11-Apr-07	12:05	07:00 that morning and 21:30 last night	Access road to Stanton Harcourt	10/10
25-Apr-07	09:26	Last 2 weeks but especially on 16-Apr, 21-Apr, 22-Apr, 23-Apr	The Village Green	10/10 on 22-Apr pm
14-May-07	22:31	13:00, 18:00	Cottage 1	4/10 and 5/10
22-May-07	23:03	At the time	Main Road, Stanton Harcourt	10/10
25-May-07	11:34	Tues/Wed/Thurs/Fri	Cottage 1	9/10
25-May-07	11:56	Day 5/10, evening 9/10	Cottage 1	5/10 – 9/10
03-Jun-07	08:32	31 May, 2 June, 3 June	The Village Green	'Very strong'
11-Jun-07	22:36	22:30	The Village Green	not available
11-Jun-07	22:41	22:41	Main Road	'Strong'
12-Jun-07	09:39	08:45 - 09:00	The Village Green	7/10
12-Jun-07	09:40	06:15	The Village Green	8/10
12-Jun-07	09:59	Last night, this morning	The Village Green	10/10 last night, 3/10 this morning
15-Jun-07	20:25	At present	The Village Green	Strong/ gassy
26-Jun-07	10:29	Wed 20th at 12:00 Sun 24th at 09:00	The Village Green	'Smell'
28-Jun-07	07:44	07:30	The Village Green	'Very strong'

and their health. However most of the residents admitted that they had not complained to the EA's Hotline, which had been set up to log and collate such complaints, and had not been to their GPs for health advice. The public meeting did however open up communication channels between parties. Explanations that the relatively minimal concentrations of hydrogen sulphide would not be detrimental to their long-term health from a toxicological point of view were accepted, but all the agencies present recognised that the malodours could affect quality of life and in the long-term, may be stressful.

Possible Explanations

A source-pathway-receptor linkage for this 'incident' was partially established. The source of the odour was likely to be emanating from the landfill site, but why this should be occurring was not definitely established. The Operator hypothesised that it was possible that there may had been an inappropriate waste stream accepted at the site and that as a result a quantity of gypsum as plaster board could have been landfilled. The deposit of the gypsum, coupled with an unusual amount of rain in November and December 2006, may have contributed to the generation of hydrogen sulphide and hence the odour. Gypsum (calcium sulphate) undergoes biologically mediated conversion to hydrogen sulphide in anaerobic conditions (such as those present in a landfill). This results in the release of odorous hydrogen sulphide and associated health concerns (Lee et al, 2006).

Should there be Health Protection Unit involvement with this investigation?

The HPU and PCT were not informed of the incident immediately and only became involved as a result of contact from a member of the public. The local GPs were asked to inform the HPU if members of the public reported health effects attributable to the landfill since January 2007 when the odour was first brought to the attention of the EA and LA. No GP reported health effects that they considered likely to have been caused by exposures to the site during this episode. Subsequent to the public meeting two GPs reported that they had each had one consultation with a patient describing mild respiratory symptoms. The patients attributed their symptoms as being related to gas coming from the landfill. This is a similar picture, though on a smaller scale, to the experience in a previous incident in Merseyside where there was no evidence for increased morbidity, but there was concern among residents that reported symptoms were due to, or exacerbated by exposure to gas emitted from an industrial facility (Jarvis et al, 2006).

The actions taken by the HPA and PCT are outlined in Table 4.

Table 4: Actions undertaken by the HPA and PCT

Action
Review of possible health effects from exposure
Joint site visit with EA, LA, Operator
Advice to partner agencies on possible health effects, information distributed to residents.
Local GP reporting system.
Attendance at public meeting.
Leaflets for public distribution summarising the health effects of H_2S at different levels and reassurance regarding the local levels.
Attendance of joint meetings, risk communication to residence via mail drop.
Liaison with and response to queries from the local parish council.

Communications problems at the beginning of this incident led to mistrust on the part of the local community. The HPA's involvement with this incident was to undertake a risk assessment and with this to reassure the public, and provide risk communication. The role of the HPA as an independent body protecting the health and well-being of the population was stressed to the residents. The authors feel that the early involvement of HPUs in similar incidents may benefit the multi-agency management of odour-related incidents involving perceived risks to health.

This report is an interim summary and further investigation and assessment is on-going.

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* A copy of the full report by the Cheshire and Merseyside Health Protection Unit Environmental Incident Report on Sandon Dock Waste Water Treatment Works Odour Investigation is available from Dr Jarvis on request (Richard.Jarvis @centralliverpool.nhs.uk).

Box 1: Leachate and landfill gas

1. Leachate is produced when water percolates through waste and reacts with the products of decomposition, chemicals and other materials in the waste. Leachate can contain organic and inorganic chemical compounds, including heavy metals.

2. Landfill gas (LFG) is produced from the decomposition of waste and can be composed of hundreds of gases. The largest components of LFG, by volume, are methane and carbon dioxide which are odourless. However, LFG also contains trace amounts of other gases including sulphides (such as H_2S), ammonia and non methane organic compounds which are odorous.

Odour and Legislative Control

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Introduction

Odour complaints are common and have been reported in association with regulated activities such as waste disposal and industrial installations. Odours are also often reported as 'complaints' during chemical incidents, being perceived as either a nuisance or as a direct threat to health. The health protection issues relating to odour complaints (whether from regulated industrial installations or during specific incidents) are frequently difficult to respond to, due to the difficulty in explaining symptoms attributed by to odour by those making the complaints. The difference in the two types of odour complaint is that regulatory complaints potentially have a constant source of odour whereas odours from incidents tend to have a short term source, a chemical spill for example. For regulated sites, several legislative regimes exist and the responsibility for managing odour complaints is often shared between several different organisations.

This paper aims to: describe the legislative regimes for odour regulation; suggest which organisations are responsible for control when odour becomes an issue; and briefly discuss when public health advice is required in such situations. However, this paper does not attempt to explain how and why the public respond to odours.

Legislation and Odour Issues

The legislation surrounding the prevention and control of pollution, including the regulation of pollution from odour, is considered under two separate, but complementary systems: the planning system and the pollution control system.

Planning and the Regulation of Odour

The planning system in the UK aims to anticipate the impact of planned developments and to control the use of land in the public interest (i.e. eliminate/minimise pollution). This includes the production of odour from any such developments. The introduction of the European Directive 2001/42/EC, known as the 'Strategic Environmental Assessment' or 'SEA' Directive, also requires a formal assessment for certain plans and programmes including effects on population and human health. Again, this includes controlling odour. The role of health professionals in the planning process is not included in this paper, however it is worth briefly explaining how the process operates.

Town and Country Planning Act 1990
The process of planning gives the Local Authority (LA) the power to impose conditions relating to environmental protection in order that developments are, as far as possible, not affected by, or indeed add to, major existing or potential sources of pollution. Planning authorities should work in the belief that the relevant pollution control regime will be applied and enforced by others, therefore the planning regime should act to complement the pollution control system, not duplicate it. For example, in terms of odour planning, authorities may wish to impose conditions on the height of chimneys for odorous emissions. The remediation of contaminated land may lead to concern over odour. For example, Russell et al. (2007) describe how a particular Local Authority considered the risk of odours arising during a land remediation scheme. Planning consent in these cases may contain conditions requiring the developer to take steps to mitigate odour generation. Wastewater Treatment Works (WWTWs) can generate odours therefore setting boundary limits e.g. an odour concentration at the site boundary on planning permissions has become common practise by Local Authorities prior to their development.

Pollution Control and the Regulation of Odour

The Pollution Control system is concerned with preventing pollution, once a development has been built, through preventing or limiting the release of substances to the environment to the lowest practicable levels. It also ensures that ambient air and water quality meet standards that guard against impacts to the environment and human health. Odour is considered to be a pollutant and as such, is considered under the pollution control regime.

Part I of the Environmental Protection Act 1990
An important piece of legislation which deals with pollution control, including odour, from industrial processes, is the Environmental Protection Act 1990 (EPA). This part of the Act sets out an integrated approach to pollution control, Integrated Pollution Control (IPC), by addressing emissions to air, land and water from certain industrial processes.

By 2007 IPC will be repealed by the Pollution Prevention and Control (England and Wales) Regulations 2000 (the 'PPC Regulations'). These regulations cover a broader range of environmental impacts than those covered by IPC. PPC also covers more types of industry that have the potential to cause pollution, including: intensive farming, food and drink manufacture and waste management facilities. Typically, these industries have the potential to be odourous in nature. PPC also introduces three separate, but linked systems of pollution control.

The Environment Agency regulate what is considered to be the most polluting of the three industrial categories: 'A(1) activities' (which includes landfilling hazardous waste and intensive pig farming for example). These are regulated for multi-media emissions such as air, land, water and other environmental considerations including odour. Therefore for A(1) activities with an associated odour issue, the Environment Agency will be the responsible authority in terms of odour control and if necessary, enforcement action. However, there may be public health involvement, such as the provision of advice on health effects and risk assessment (see Harrison et al 2007, for an example). The Environment Agency has produced guidance for the regulation of odour from sites regulated under the IPPC regime entitled IPPC H4:

Horizontal Guidance for Odour. This document states that the 'Agency will aim to regulate odorous emissions by the imposition of emission limit values (ELVs), where this is feasible or equivalent parameters and technical conditions'.

Local authorities regulate the comparatively less polluting Part A(2) activities (multi-media regulation) and the lesser polluting Part B activities (these are regulated for emissions to air only). Examples of such activities include animal rendering, the cremation of human remains, and dry cleaners. Local Authorities can impose conditions on the permits such as 'no offensive odour outside or beyond boundary' (NOOBB) of the site. In determining whether odour is offensive, LA Inspectors will take into account the nature, persistence, frequency and intensity of the odour.

Part II of the Environmental Protection Act 1990

This part of the Act covers the collection and disposal of waste (not covered under PPC) and sets out a waste licensing system to ensure that activities do not cause pollution of water, danger to public health, or detriment to local amenities. For waste management licence applications under s.36 of the Act, the application should include a risk assessment relating to odour from the site (see the Environment Agency Guidance for regulation of odour at waste management facilities, v.3.0, July 2002).

Part III of the Environmental Protection Act 1990

This part of the Act contains the main legislation on statutory nuisance and allows local authorities and individuals to take action to secure the abatement of the statutory nuisance.

Section 79 (1) of EPA defines statutory nuisances, including:

'c) fumes or gases emitted from premises so as to be prejudicial to health or a nuisance;

d) any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance.'

Action for nuisance defined as above may only be taken against a process regulated under IPPC with the consent of the Secretary of State. It is worth noting that statutory nuisance legislation cannot be used to take action against land which is in a contaminated state.

a) Action by Local Authorities

Under sections 79 to 81 of the Environmental Protection Act, the Local Authority has the duty to deal with odour from industrial, trade and business premises that they consider to be a statutory nuisance. Where the Local Authority considers that a statutory nuisance exists it can serve an abatement notice on the person(s) responsible for the nuisance. Failure to comply with the terms of the abatement order may result in prosecution at Magistrates' Court. Odour from wastewater treatment works tends to be regulated by Local Authority Environmental Health Practitioners under the statutory nuisance provisions of the Act, although some works are regulated under the IPPC regime. An example of an odour issue at a wastewater treatment site is described by Jarvis et al. (2006).

b) Action by Individuals

Individuals may also take action to abate a statutory nuisance under section 82 of the Environmental Protection Act through the Magistrates' Court.

Conclusions

For odour complaints that are associated with regulated activities such as waste disposal and industrial installations, public health advice from professionals may be sought. Control of the odour or enforcement action against the perpetrators of the odour will be undertaken by the organisation that initially permitted the activity.

For odour incidents that do not emanate from regulated processes, it is the Local Authority who is the controlling/enforcing body under 'statutory nuisance'. Health advice may also be sought for these events.

Acknowledgements

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The author would like to take this opportunity to thank Andrew Prynne, QC of Henderson Chambers for casting his expert eye over this paper and for offering many valuable comments.

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*A copy of the full report by the Cheshire and Merseyside Health Protection Unit Environmental Incident Report on Sandon Dock Waste Water Treatment Works Odour Investigation is available from Dr Jarvis on request: (Richard.Jarvis@liverpoolpct.nhs.uk).

Development of an odour complaints checklist for chemical incident response

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Introduction

The Chemical Hazards and Poisons Division are frequently required to assist front-line public health practitioners respond to incidents where odour is an issue. Odour can be generated from many sources including: regulated processes such as incinerators, landfills and mineral refining facilities; accidental chemical spills; and the deliberate release of chemicals. In some instances the actual source of the odour is unknown. Odours are often perceived as either a nuisance or as a direct threat to health. The health protection response to odour complaints, whether from regulated industrial installations or during acute chemical incidents, are frequently difficult to manage, due to the difficulty in explaining symptoms attributed to odour by those making the complaints and the relatively complicated legislation surrounding odour (Smethurst, 2007).

The issue of odour and the implications for public health protection is the subject of a jointly funded 4-year Engineering Doctorate (EngD) project between the Engineering and Physical Sciences Research Council (EPSRC) and the Chemical Hazards and Poisons Division of the Health Protection Agency. Over a four year period this project aims to develop methods for the determination and estimation of population exposure to chemicals involved in, or associated with, odour complaints and to develop tools to aid in assessing adverse health effects. It is intended that the knowledge will lead to new approaches to community level hazard assessment for odour. This work will be developed via the investigation of odour incidents where the HPA has been asked for advice on the health protection impacts of odours. In addition to developing best practice for exposure assessment, the project will target issues related to the management of odour incidents.

In order to assist with the investigation of odours, a draft 'Odour Complaints Checklist' has been developed. Checklists have previously been developed within the Chemical Hazards and Poisons Division and are published on the HPA website:
(http://www.hpa.org.uk/chemicals/checklists.htm).

The draft checklist presented in Annex 1 is designed as an aide-memoire for public health professionals and other emergency responders when dealing with odours. The checklist is still under development and your comments on it would be most welcome by the end of October, 2007. (email Helen.Smethurst@hpa.org.uk).

Acknowledgements

This paper is part of a research project under the Engineering Doctorate (EngD) programme jointly run by the University of Surrey and Brunel University and is funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Chemical Hazards and Poisons Division of the Health Protection Agency.
Simon Cathcart is thanked for his contribution to the development of the checklist.

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Smethurst H. (2007). Odour and Legislative Control, Chemical Hazards and Poisons Report 10, 18-19.

Annex 1: Draft Odour Complaints Checklist (in development)

The purpose of this checklist is to aid the early investigation of an odour complaint. Such complaints may be reported as a nuisance or related to health effects. Odours can often be the first indicator of a potentially serious incident. This checklist is primarily intended for public health practitioners at Health Protection Units and Environmental Health Officers who may be asked to deal with local odour-related complaints.

Checklist Contents

Section 1 - **Source and nature of the odour - hazard identification**
Recommendations for questions to ask the caller
Section 2 - **Pathway - exposure assessment**
Section 3 - **Receptors - risk characterisation**
Section 4 - **Recommendations for the acute phase response**
Suggested actions
Section 5 - **Legislation**
Section 6 - **Recommendations for post incident investigation**

References

Appendix 1: Odour characteristics and detection threshold levels

Appendix 2: Sensory effects of odour

Section 1 – Source and nature of the odour - hazard identification

Recommendations for questions to ask the caller

Source and nature of the odour

- Describe the odour, what does it smell like? Table 1 (odour characterisation)
- What is the strength of the odour (intensity), is it a faint, mild, strong or a very strong odour?
- Does the odour strength/intensity vary?
- Is the odour perceived to be pleasant, mildly pleasant, strongly unpleasant or very strongly unpleasant?
- **When was the odour first noticed?**
- Is the odour persistent or intermittent?
- Is there any temporal variation in the odour?
- Is there any seasonal variation in the odour?
- Has there been a chemical spill, accident?
- Can the source be identified? If so where is it coming from?
- Is the odour inside the building?
- Is the odour outside the building?
- Describe the environmental setting. Is it residential, industrial, commercial, a landfill site?
- Is the source a regulated activity (see section 5 – Legislation)?
  - If so what is the activity e.g. wastewater treatment, landfill, incinerator, dry cleaners, animal renderers and who are the regulators?
  - Is it the Environment Agency?
  - Is it the Local Authority?

Section 2 - Pathway - exposure assessment

Exposure assessment

- Who first noticed the odour?
- Can everyone smell the odour?
- Where do they live in relation to the odour?
- How many people are potentially exposed to the odour?
- What are the age(s) and sex of those exposed?
- Have "at risk" groups been identified including those in schools, hospitals, residential and nursing homes etc.?

Environmental sampling

- Has any environmental sampling taken place?
  - Who is taking the samples?
  - Is there appropriate quality control?
  - Are duplicate samples being taken and analysed by an independent organisation?
  - What are the samples being tested for, which chemicals?
- Are there any sampling results available?
  - What chemicals have been detected?
  - At what levels/concentrations?
- Is there a possibility of biological odours as well as chemical?

Environmental modelling

- Has any environmental modeling taken place?
  - Is there a CHEMET available?
  - Has any dispersion modelling taken place?

Section 3 - Receptors - risk characterisation

Health effects

- Are there any reported health symptoms in relation to the odour?
- What symptoms have been reported?
  - sore throats
  - coughing/sneezing

    - eye irritation/watering
    - nausea/vomiting
    - headaches
    - breathing difficulties
    - if other symptoms, please specify
- Have any health professionals been contacted e.g. NHS Direct, GPs. If so by whom and who has been contacted?
- Has there been any health effects that require medical attention? If so please detail.

Section 4 - Recommendations for the acute phase response

Our sense of smell is a valuable source of information about chemicals in the environment. For some chemicals the fact that we can smell them is a warning to move away from the source hence protecting ourselves from further exposure. For the vast majority of chemicals we can smell them before toxicological effects, including irritation, occurs. However, for a few chemicals the toxic threshold is below the odour threshold and once it is detected, serious toxicity may already have occurred (see Appendix 1).

Suggested actions

If significant health effects are likely due to odour exposure (see Appendix 1) then an immediate response is necessary:

- Removal from source of exposure by eliminating source.
    - Is the source of the odour known?
    - If known can it be removed?
- Interrupting the exposure pathway.
    - Open windows (if the odour is inside)
    - Close windows (if the odour is outside)
- Removing receptor
    - Evacuate at risk individuals to location away from odour source
    - Advise affected individuals to seek medical advice
    - Inform local GP or A&E of possible presentation of those affected

If a gas-like odour is reported, advise immediate ventilation of property and contact National Grid Gas (free): **0800 111 999**

Section 5 - Legislation

Odour 'pollution' is controlled primarily under the *Environmental Protection Act 1990* (EPA).

5a) Regulation of odour

Certain industries are regulated under the EPA and the associated *Pollution Prevention and Control (England and Wales) Regulations* (PPC Regs). The regulatory authorities for PPC are the Environment Agency (EA) and Local Authorities (LA). Permits to operate PPC industries are issued by the EA and LA, depending on the scale of the operation, and will have conditions relating to odour control. A breach of these conditions will be dealt with by the relevant organisation.

Examples of activities regulated by the EA - landfills, intensive farming, refining gas. For more detail see Defra Environment Agency PPC Guide

Examples of activities regulated by the LA - animal rendering, printing and textile treatment, small scale incineration (pet crematoria). For more detail see Defra LAPPC Manual

5b) Odour as a nuisance

Section 79 of EPA defines statutory nuisances including:

*any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being **prejudicial to health or a nuisance**.*

Hence there are two limbs for enforcement action for odours.

- The nuisance limb

There is no definition of nuisance in the Act but to be actionable the nuisance must be 'substantial and unreasonable'. It is the duty of LA's to take action under this legislation.

- The health limb

The definition of the health limb appears in section 79(7) of the EPA as being

'injurious, or likely to cause injury to health'

The test for whether a matter is prejudicial to health must be if it results in ill health in the form of disease. It demands more than mere discomfort or annoyance and requires proof of harmful effects or the risk of such effects. Where an allegation of prejudice to health is made, there must be some expert evidence to substantiate the claim.

Section 6 - Recommendations for post incident investigation

- Agencies potentially involved in odour investigations are:
  - Health Protection Unit, PCT (for possible health effects of exposure)
  - Chemical Hazards and Poisons Division
  - LA Environmental Health (for PPC regulated sites and for nuisance claims)
  - Environment Agency (for PPC regulated sites)
  - Health and Safety Executive (exposure to odours in an occupational setting)
  - Meteorological Office (for air dispersion modelling)
  - Others such as water utilities, industry etc.
- Effects on health will be a matter of concern; the local population should be closely involved in any investigations at an early stage and should be kept as fully informed of developments as possible

References

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The Pollution Prevention and Control (England and Wales) Regulations 2000, The Stationery Office Limited, ISBN 0110996216

Appendix 1: Odour characteristics and detection threshold levels

Odour threshold values

The quality of odour detection threshold data can be poor. 'Odour measurement and control - an update' (Woodfield and Hall 1994) differentiates between chemicals for which threshold values have been determined by a recognised test method and those chemicals where threshold values have not been determined by a recognised test method. The data quality for compounds determined by recognised methods are more likely to approach the 'true value'. The table below contains odour thresholds which are known with sufficient confidence for air pollution modelling purposes (*) and odour thresholds which are less certain (**).

Odour descriptors

Descriptors can help to establish the source of an odour and it is useful, when recording information from an incident, to seek the description of the odour.

Table1: Odour descriptors, threshold ranges, and threshold values of common odorants (consolidated and adapted from Woodfield and Hall 1994 and The Royal Society of Chemistry Chemical Data Sheets 1989 -1992)

Compound	Descriptor where available	Reported Threshold Range mg m^{-3}	Odour threshold mg m^{-3}	Odour threshold ppm
Acetaldehyde **	apple, stimulant	0.00001-0.004		
Acetic acid *	sour vinegar	0.025 - 0.064	0.043	0.016
Acetic anhydride *	pungent, vinegar		0.0013	0.00029
Acetone *	chemical/sweet/solvent	1.4 - 40.2	13.9	4.58
Acrylic acid *	distinctive, acrid		0.0013	0.0004
Acrylonitrile **	onion, pungent, garlic	4.65		
Ammonia **	sharp, pungent	0.1 – 11.6		
Amyl acetate *	banana	0.27 – 0.96	0.95	0.163
iso Amyl acetate *			0.022	0.0038
Benzene *	solvent	1.5 – 108	32.5	8.65
Benzyl benzene **	oranges	0.41		
Benzyl chloride **	solvent	0.045 – 1.5		
Benzyl mercaptan	garlic, leeks	0.000002-0.00003		
Bromine **	bleach, pungent	5E-06		
1,3-Butadiene *	mild, petrol	0.45 – 1.1	1.1	0.455

Butane **	natural gas	2100		
1-Butanol *		0.02 – 0.55	0.09	0.03
2-Butanol *			3.3	1
2-Butanone (MEK) *		0.5 – 1.29	0.87	0.27
Butoxybutane *			0.03	0.005
2-Butoxyethanol *		0.004 – 0.006	0.0051	0.00097
2-Butoxyethyl acetate *			0.045	0.0063
Butoxypropanol *			0.191	0.0324
Butyl acetate *	fruity, mild banana	0.006 – 0.7	0.047	0.0066
2-(2-Butoxyethoxy)ethanol *			0.0092	0.0013
2,2-butoxyethoxyethyl acetate *			0.015	0.0016
Carbon tetrachloride *	sweet, ether	280 – 884	280	40.73
Carbon sulphide *			0.0275	0.0102
Chlorine **	irritating, pungent	0.23 – 3.0		
Chlorobenzene **	Mothballs	5.9		
Chlorocresol **		142.6		
Chloroform **	pleasant sweet	119.4		
Chloropicrin **	intensely irritating	0.000073		
m-Cresol *	sweet, tar		0.0013	0.0003
o-Cresol *	sweet, tar		0.0028	0.0005
p-Cresol *	tar-like, pungent		0.0029	0.0006
Cyclohexane *	sweetish when pure, pungent when contaminated		315	83.8
Cyclohexanone *	acetone-like		0.083	0.019
1,4-Dichlorobenzene **	mothball	0.73		
Dichloromethane *	sweet, penetrating, ether	0.02 – 5.7	3.42	0.912
Diesel *	Distinctive		0.06	
Dimethyl adipate *			7.101	0.913
Dimethyl glutarate *			1.212	0.169
Dimethyl succinate *			0.992	0.152
1,4-Dioxane *		3.0 - 31	30.6	7.78
1,3-Dioxolane *			56.3	17.02
Diphenylmethane *	oranges		0.41	0.55
Ether **	pungent, aromatic	2.4	0.011–1.0	
Ethoxypropanol *			0.161	0.035
Ethoxypropyl acetate *			0.0052	0.0008
Ethyl acetate *	fragrant	1.25 – 3.82	2.41	0.61
Ethyl alcohol *	pleasant, wine	0.17 – 0.39	0.28	0.136
2-Ethyl-1-butanol *			0.07	0.015
2-Ethyl-1-hexanol *			0.5	0.086
2-Ethylhexyl acrylate *			0.6	0.073
Formaldehyde **	disinfectant, pungent, suffocating	0.49		
Formic acid **	pungent, suffocating	2		
2-Furaldehyde *			0.25	0.058
Fluorine **	pungent, choking	0.15		
Glutaldehyde **	pungent	0.08		
1-Hexanol *		0.00004 - 0.006	0.005	0.0011
Hydrogen chloride **	pungent, irritating	0.39 - 7		
Hydrogen sulphide *	rotten eggs		0.00076	0.0005
2-Hydroxyethyl acetate *			0.527	0.114
Light fuel oil *	distinctive		0.053	

3-Methylbutanal *			0.0016	0.0004
2-Methyl-1-butanol *			0.16	0.041
Methyldithiomethane *		0.001 – 0.046	0.0011	0.00026
Methyl methacrylate *	acrid fruity		0.38	0.085
2-Methyl 5-ethyl pyridine *			0.032	0.006
Methyl isobutyl ketone *	sweet	0.24 – 0.81	0.54	0.121
Methyl methacrylate *	pungent, sulphide like		0.38	0.085
3-Methoxybutyl acetate *			0.044	0.007
1-Methoxypropan-2-ol *			0.0122	0.003
1-Methoxy-2-propylacetate *			0.0075	0.0014
2-Methyl-1-pentanol *			0.096	0.021
2-Methyl pentaldehyde *			0.09	0.02
4-Methyl-2-pentanone (MIBK) *		0.24 – 0.81	0.54	0.121
2-Methyl-2-propanol *			71	21.46
α-Methyl styrene *			0.021	0.003
Naphthalene **	mothballs	0.2		
Nitric acid **	sweet, acrid, choking	0.7		
Nitrobenzene **	bitter almonds	0.2		
Nitrogen dioxide **	acrid, pungent	0.02 - 2		
1-Nitropropane *			28.2	7.09
1-Octene *		0.33 - 37	0.33	0.066
2-Octene *			0.5	0.1
2-Octyne *			0.03	0.006
2,4-Pentanedione *			0.045	0.01
1-Pentanol *			0.02	0.0051
Petrol (light) **	distinctive	800 - 3300		
Petroleum naptha *	distinctive		0.2	
Phenol	sweet tarry, carbolic acid	0.046 – 0.8		
Phenyl ether *			0.0021	0.0003
Phosgene **	mouldy hay	4		
Phosphine **	garlic, decaying fish	2.8		
2-Picoline *			0.014	0.0034
Propanal *		0.0036–0.014	0.014	0.0054
2-Propanol *	ethanol and acetone mix	1.18 – 1.19	1.185	0.442
2-Propen-1-ol *			1.2	0.47
iso Propylamine *			0.158	0.06
Propylbenzene *			0.048	0.009
Propylene-n-butylether *			0.206	0.01
Propyl ether *			0.024	0.0053
Pyridine **	nauseating, fish, burnt	0.0037 – 2.4		
Sulphur dioxide **	irritating, suffocating	0.00009		
Styrene *	penetrating, rubbery, plastic		0.16	0.0344
1,1,2,2-Tetrachloroethane *	pungent, chloroform	1.6 – 12.0	1.6	0.21
Toluene *	floral, pungent, moth balls	0.47 – 0.79	0.644	0.16
Trichloroethylene *	solventy	6.5 – 34.9	8	1.36
Trimethylamine *	fishy, pungent		0.0026	0.001
Xylene (mixed) *	aromatic, sweet	0.062 – 0.097	0.078	0.016
2,3 Xylenol *			0.0037	0.0007
2,4 Xylenol *			0.064	0.0117

Reference for odour range and threshold data

Woodfield and Hall, Odour measurement and control - an update. Prepared by AEA Technology on behalf of the Department of the Environment, 1994.

References for the odour descriptors
The Royal Society of Chemistry, "Chemical Safety Data Sheets" Volumes 1 and 5 (1998 – 1992)

Leonardos G. Kendall D, et al. (1969). Odor threshold determinations of 53 odorant chemicals. Journal of the Air Pollution Control Association 19(2):91-95.

For detailed information regarding threshold toxicity values of Acrylonitrile, Ammonia, Benzene, Chlorine, Chloroform, Hydrogen Chloride, Formaldehyde, Hydrogen Cyanide, Kerosene, Methanol, Naphthalene, Nitric Acid, Nitrobenzene, Phenol, Phosgene, Phosphine, Petrol, Sodium hypochlorite, Styrene, Tetrachloroethylene, Toluene, Trichloroethylene and Vinyl Chloride see HPA Compendium of Chemical Hazards http://www.hpa.org.uk/chemicals/compendium/

Appendix 2 – Sensory Effects of Odour

There are relatively few guideline values for odour exposure. The WHO has devised a small number of values for limiting annoyance for single compounds with malodorous properties at concentrations below that at which toxic effects occur (Table 2). In contrast to other air pollutants, odorous substances in ambient air often cannot be determined easily and systematically by analytical methods because the concentrations are usually very low.
Furthermore, odours in the ambient air frequently result from a complex mixture of substances and it is difficult to identify individual ones.

Table 2. Rationale and guideline values based on sensory effects or annoyance reactions, using an averaging time of 30 minutes

Substance	Detection threshold	Recognition threshold	Guideline value
Carbon disulfide(index substance for viscose emissions)	200 µg/m3	-	20 µg/m3
Hydrogen sulphide	0.2–2.0 µg/m3	0.6–6.0 µg/m3	7 µg/m3
Formaldehyde	0.03–0.6 mg/m3	-	0.1 mg/m3
Styrene	70 µg/m3	210–280 µg/m3	70 µg/m3
Tetrachloroethylene	8 mg/m3	24–32 mg/m3	8 mg/m3
Toluene	1 mg/m3	10 mg/m3	1 mg/m3

From World Health Organisation. Air Quality Guidelines for Europe, Second Edition. World Health Organisation Regional Publications, 2002.

Detection Threshold Values
The odour threshold value is the lowest concentration at which an odorous substance is detectable by 50% of a test panel. The concentration is expressed in parts per million (ppm) or parts per billion (ppb) by volume or in milligrams of odorant per cubic metre of air.

Recognition Threshold
The recognition threshold level is defined as the lowest concentration at which the odour quality (description), of the compound can be described (by 50% of a panel).

Guideline Value
Values which are likely to protect the public from odour nuisance.

Emergency Planning and Preparedness

Hazardous Area Response and Urban Search and Rescue Teams: advanced life support in difficult environments

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Introduction

The provision of advanced life support (ALS) is now an essential feature of emergency medical response teams around the world. ALS provides support for airway, ventilation and support of the circulation in life-threatening medical conditions and trauma. Normally such emergency care is provided by medical or paramedical teams who can respond quickly and have easy access to the patient.

However some emergencies are in themselves a danger to emergency responders and can lead to delays in providing emergency care. A chemical agent release is a classic example where persistence of the toxic agent in the release zone and on the victim may contaminate emergency responders. Standard casualty management in this situation involves the delineation of contaminated zones where only suitably protected personnel may enter and from which patients may only leave after decontamination (figure 1).

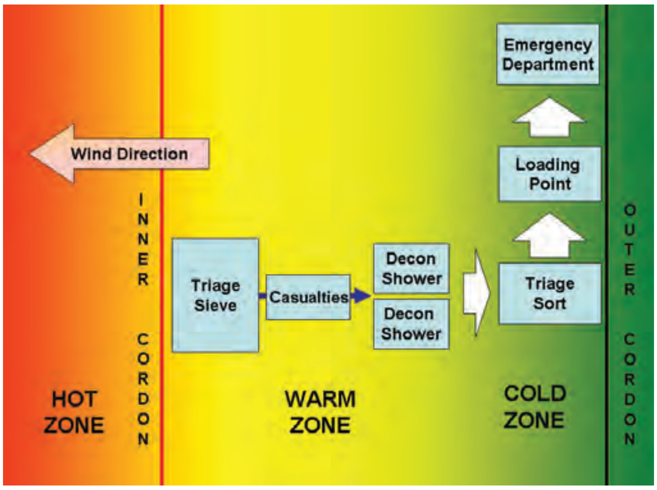

Figure 1: Division of response areas following a hazardous chemical release. The requirement for decontamination in the contaminated warm zone, adjacent to the hot zone point of release may lead to life threatening delays in the provision of emergency medical treatment. Protected HART teams work here and during decontamination to provide essential ventilatory and antidote support as well as early triage of casualties. Once decontaminated patients are re–triaged and evacuated for hospital care (adapted from London Ambulance Service training materials).

Equally, there may be physical entrapment of a patient in non–toxic disasters such as a building collapse, road and rail crashes and explosions due to urban terrorism. In such cases rapid evacuation of the patient may not be possible and essential life support measures and surgery must be provided on site, again, by paramedical and medical personnel who are suitably trained and equipped to operate in such circumstances.

Advanced life support in a contaminated zone (TOXALS) was first suggested over 10 years ago[1] and has been adopted by a number of emergency medical services around the world.[2] Chemical agents have wide–ranging effects on the body systems but are immediately life-threatening as a result of actions on the respiratory system, blocking the upper and lower air passages to the lungs (the airways). Blockage may be physical due to the production of massive secretions and the inhalation of vomitus or due to pharmacological effects causing narrowing or closure (a situation that might be termed 'chemical asthma'). Chemical agents also affect the neural control of the breathing mechanism causing a failure of chest movement and the central brain control of breathing. Organophosphate nerve agents and pesticides are examples of such agents. In addition to this double chemical attack on airway and breathing many chemical agents cause the lung sacs (alveoli) to fill with fluid - a condition called toxic pulmonary oedema which stops the passage of oxygen from the lungs to the blood.

Antidotes such as atropine and oximes have long been considered to be the mainstay of the emergency response to nerve agent chemical attack on the respiratory system but in severely injured patients, antidote therapy alone is not enough. There must be provision of airway clearing and support and of artificial ventilation to ensure survival. For patents trapped in a contaminated zone, the conventional management was to wait until decontamination had been completed before starting advanced life support in the cold zone. However the delays enforced by decontamination in persistent chemical releases may be life-threatening for those with developing toxic respiratory failure. The rationale of TOXALS is to provide such essential care inside a contaminated zone before and during contamination.

Development of Hazardous Area Response Teams (HART) and Urban Search and Rescue

Background

To address the problems associated with managing potentially contaminated casualties, the UK Department of Health (DH) Emergency Preparedness Division has created a special paramedic taskforce trained and equipped to operate in difficult and dangerous surroundings called 'Hazardous Area Response Teams (HART)'. The initial aim of the DH initiative was to be able to provide advanced essential life support in chemically – contaminated zones. However, the HART concept has now been expanded to allow paramedic teams to operate as Urban Search and Rescue (USAR) teams for victims of conventional physical trauma with entrapment.

Planning

The first HART teams became operational in London during December 2006 after a two-year planning stage. A planning committee was convened by the DH Emergency Preparedness Division with the brief of providing essential emergency medical care inside contaminated zones.

The committee brought together expertise from many organisations including the emergency services (ambulance, fire, police); emergency medicine practitioners, medical toxicologists from the Chemical Hazards and Poisons Division (CHaPD) of the HPA; transportation and specialist human resources personnel from the ambulance service association; and trade unions. In addition, support was given from the Defence Scientific and Technical Laboratory (DSTL) and from the Emergency Preparedness and Response Division of HPA. The Ambulance Service Association (ASA) also provided supporting senior officers drawn from ambulance services all over England and Wales.

The committee was divided into subcommittees to discuss a wide range of issues, including: production of standard operating procedures, training, paramedical protocols, personal protective equipment, vehicles, equipment, communications, strategic equipment and drug reserves together with human resource issues. The challenge of the group was compounded by the fact that a whole new sphere of operations for paramedical personnel had to be set up with issues involving special training and equipment and such diverse human resource issues as terms of employment, insurance and equal opportunities.

The group drew much from the experience in London of the earlier Multi–Agency Initial Assessment Team (MAIAT)[3] which essentially provided a toxic reconnaissance capability during 2004 – 2005. As a result, detailed ambulance operating and training procedures were produced by senior ambulance personnel with considerable personal experience of contaminated zone working.

Clinical guidelines were produced by a sub-committee that included representation from medical personnel specialising in emergency response to chemical incidents and anaesthesiology (CHaPD) along with a senior paramedic lecturer from the Department of Allied Health Sciences at the University of Hertfordshire. Protocols were developed for triage, TOXALS and antidote therapy that drew from the recommendations of the Department of Health Expert Group on the Management of Contaminated Chemical Casualties whose reports appeared in 2003 and 2005.[4]

The objectives of the clinical group was to keep clinical responses as simple and straightforward as possible given both the tactile and communications problems associated working in lightweight personal protective equipment (PPE) (figure 2). The overall objective was to provide achievable clinical endpoints in airway, ventilation and circulatory support.

Figure 2: Gas tight chemical protective suits used by HART teams. These suits are ventilated and allow drinking for essential rehydration. Ambient air is filtered through canisters mounted at the waist and a display inside the helmet of the suit tells the wearer when the canisters must be changed (© London Ambulance Service, 2007).

Part of the HART planning included revising the strategic and tactical reserves of drugs and equipment available for use in a chemical disaster with mass casualties (PODS). PODS contain essential equipment (such as small portable ventilators and antidotes) and are now under the direct control of ambulance trusts. This will allow rapid deployment to support HART operations. In addition, immediate first aid in incidents involving large numbers of casualties will also be stocked in stations around London. The packs contain enough dressings, gloves etc., to allow station staff and members of the public to carry out emergency first aid until ambulance services arrive on the scene. They will be essential in the crucial first minutes after an incident, whether it is the result of an accident or deliberate attack.

Training

HART and USAR training began in late 2006 with personnel who were selected from a large number of volunteers. In addition to high levels of paramedic skills in the management of airway, ventilation and circulation personnel were sought who had good physical fitness and commitment to working in difficult and dangerous environments. Trainees received instruction over a six week period in safe operations designed to replicate contaminated environments, the use of personal protective equipment and the provision of advanced life support in contaminated areas. Procurement of multiple outlet oxygen systems, the use of the laryngeal mask instead of the conventional endotracheal tube and provision of small portable ventilators (figure 3) capable of operating in contaminated and collapsed areas allows paramedics to provide ALS under the most difficult of circumstances.

Figure 3: A VR1 portable gas – powered ventilator for use in a contaminated zone. These devices are carried by HART and USAR teams and are also part of the strategic equipment reserve (PODS). Airway control by HART uses the laryngeal mask rather than endotracheal intubation. In addition to ventilation oxygen can be delivered to multiple casualties from a special multi - outlet delivery system capable of operation in the contaminated zone. Photograph courtesy of Smiths Medical International Ltd. (Pneupac).

Operation

HART teams are now operating on a 24 hour basis in London and attend all incidents involving accidental chemical release as well as potential terrorist incidents and suspect packages. Use of the teams in this way means that trained and equipped ambulance response is routinely available and is capable of responding to incidents that may escalate. Deployment is not exclusively to chemical, biological, radiological or nuclear (CBRN)-type incidents but rather a general one that has the capacity to manage incidents on scene so that many of the ambulances that would have been sent can continue to deal with 'core' emergency ('999') work. The deployment of HART to incidents therefore frees up ambulances to treat patients from 'regular' emergencies (i.e. those not involved in the mass-casualty incident) who may be in a serious or immediately life-threatening condition. Typical incidents to which HART is dispatched are building collapses, serious road-traffic collisions, suspect packages, fires and tube trains stuck between underground stations (where there are potentially many dehydrated patients).

Only approximately 20 per cent of the calls on which HART has been dispatched since the beginning of the evaluation have been to hazardous-material (HAZMAT) incidents.

HART and USAR teams operate with a range of specially-designed and equipped vehicles (figure 4) with sophisticated command and communication systems and a full range of tactical equipment required for operations in contaminated and trapped conditions with immediate on-board logistical support to allow treatment of multiple casualties

Figure 4a: HART command and control vehicle. The HART pilot unit is based at a south London ambulance station but operates all across Greater London. There are three large vehicles - a command & control vehicle, a reconnaissance & light equipment vehicle, and an equipment-only vehicle. Two other smaller vehicles are rapid-response cars which, when not being used to support incidents to which HART is deployed, are sent to normal Category A emergency ('999') calls (© London Ambulance Service, 2007).

Figure 4b: HART heavy equipment vehicle (© London Ambulance Service, 2007).

In September 2007, the first USAR team commence operations in Yorkshire. Equipped with special response vehicles (figure 5) and equipment that allows safe entry to dangerous sites such as collapsed buildings and train crashes the USAR paramedics can bring life – saving care to trapped patients while their release is being ensured by the fire services.

Figure 5: USAR response vehicle displayed at the 2007 ASA conference (© David Baker, HPA, 2007).

Ongoing Developments

The clinical skills required by USAR paramedics are still being developed by a special clinical group. In certain situations (such as the need for emergency amputation to achieve release from an entrapment) ad-hoc medical teams have been deployed in the past from nearby hospitals but these are not usually equipped with the necessary protective equipment. Certain teams such as the London Helicopter Emergency Medical Service (HEMS) have been providing such care for many years but there is currently no national policy to support this work. It is hoped that in the future a coordinated response will emerge from DH which will bring USAR and medical teams together to provide a systematic pre-hospital medical response.

Conclusions

The Department of Health HART and USAR initiatives allow specially trained paramedic teams to operate safely in contaminated zones and in sites where patients are trapped. This means that essential life support can be provided before casualties are transported on to hospital care. Following pilot studies in London and Yorkshire which are being carefully evaluated, the HART and USAR programme will be extended to a number of other locations in England and Wales during 2007 – 2008.

HART and USAR operate on a daily basis, freeing other paramedic crews for conventional emergency ('999') calls. In the case of mass casualty incidents arising due to accidents or terrorist activities, these new initiatives allow a rapid deployment of trained and equipped emergency response teams that have extensive experience in operating safely in dangerous surroundings.

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Human Biomonitoring Developments at the HPA Part 1: Chemical Exposure Assessment Kit (C*h*EAK).

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Introduction

The Chemical Hazards and Poisons Division (CHaPD) is in the process of developing its biomonitoring capability both for the provision of advice as well as the practical aspects of collecting biological samples following an acute chemical exposure or as part of the investigation of potential chronic exposures.

A Laboratory Review and Liaison Group (LRLG) which includes leading experts in the field of biological monitoring and chemical analysis has been convened. The overall aim of the LRLG is to develop National Guidance and Protocols for Human Biomonitoring following a chemical incident.

The LRLG is at present addressing a number of projects with the aim of producing: 1) a detailed guidance document for health professionals; which will include practical and theoretical aspects of human biomonitoring (HBM); 2) a criteria document as well as detailed protocols on a database to supplement the guidance; 3) an HBM web site. The HBM web site will be autonomous but will link to key HPA and non-HPA sites, including appropriate HPA web pages (such as the Chemical Compendia, on the Chemical Hazards and Poisons part of the site as well as Centre for Emergency Preparedness and Response pages), European Union and United States sites for human biomonitoring background documents as well as key UK laboratories. These aspects will be discussed in subsequent articles in this series.

It was evident from past experience as well as current discussion, that a sampling kit which complies with UN as well as EU regulations was needed for the collection and subsequent transport of samples for HBM.

Such a sampling kit has been developed following extensive discussion with key end-users of the kit. These include clinical Emergency Department staff as well as National Poisons Information Service (NPIS) and Chemical Hazards and Poisons Division (CHaPD) clinicians who will collect samples and the analysts who will receive the samples. The contents of the C*h*EAK have been agreed to be appropriate for 'most' chemical exposures. The logistics of collection, storage, transport and delivery of the filled C*h*EAKs has to be addressed in order to ensure that valuable samples are delivered in a timely and safe manner to the laboratories.

Figure 1: Chemical Exposure Assessment Kit (ChEAK) with UN3373 compliant packaging (© HPA, 2007)

Chemical Exposure Assessment Kit (C*h*EAK) Contents

The C*h*EAK (figure 1) has been developed from and will replace the currently used TOXIBOX. It provides a robust tool for the collection of samples in an appropriate manner following acute or chronic chemical exposure. The content of the kit will allow for the analysis of the vast majority of potential chemical exposure and has been developed to allow Emergency Department or other clinical staff to collect samples without having to think about which sample tubes should be used, what volume of sample should be collected and with the appropriate protocols and systems in place, the whole kit will be delivered to the laboratory for analysis with the minimum delay and additional stress to staff who have many other duties to fulfil.

The C*h*EAK will include:

- three blood sampling tubes (1x10ml PP EDTA tube, 1x10ml PP heparin tube, and 1x5ml glass EDTA tube) with screw caps fitted with Teflon liners;
- one 25ml capacity universal bottle for the collection of urine;
- medium sized disposable nitrile gloves;
- 1 water-based sterile wipe.
- appropriate needles and syringes (both adult and paediatric).

Each sampling tube when filled will be transported in an adsorbent sheath inside individual plastic *pathoseal liquitite* bags. All the samples can then be placed into the rigid plastic container and then into the cardboard box, sealed and labelled and sent to the laboratory for analysis. These three layers conform to UN standards for the transport of non-pathological ('Category B') biological samples.

Issues Surrounding Data Use and Abuse

A detailed discussion is necessary on the use and possible abuse of the data generated, in relation to the provisions of the data protection and freedom of information acts.

Following a chemical incident where the potential for acute health impact necessitates the collection of biological samples, the data will relate directly to the management of patients or the incident. However, where the data is required for longer term public health follow-up, the need for ethical approval and appropriate data processing and storage is necessary.

Conclusions

The need for a quality standard in sample collection, distribution and processing is an essential part of the service the Health Protection Agency, Department of Health and the NHS should provide in the case of an acute (or chronic) incident involving chemical exposure of the public. The kit provides quality assurance sample collection. However, if the transport and storage of the samples is not appropriate, the quality standards reached in the analysis of the samples is undermined. Thus it is necessary at many levels to have a robust and guaranteed system for sample collection, transport and analysis together with data storage and interpretation.

The C*h*EAK system will fit these requirements and enhance the overall management of chemical incidents.

Quantifying the print media's coverage of chemical incidents

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Introduction

Chemical incidents can attract large amounts of media coverage and in some cases the media response may be disproportionate to the toxicological risk of the chemical involved. The social amplification of risk framework was developed to describe how social and individual factors, including media interest, act together to either amplify or dampen public concern in response to a hazard.[1] The theory suggests that a hazardous incident has the potential to produce a ripple effect, with the initial event leading to secondary and tertiary consequences on health and society far beyond the expected impact. These ripples spread via risk signals such as the messages about an event, metaphors and photographs, with the media playing a key part in producing and communicating these signals to the public. The media can therefore act to either amplify or attenuate the public's perception of the risk associated with a chemical incident.

A joint Institute of Psychiatry and Health Protection Agency (HPA) research project is underway, applying the social amplification of risk framework to investigate the health and social impacts of chemical incidents across England[2]. Over 300 recorded chemical incidents are being considered in the study, which vary from domestic fires and over-chlorination of swimming pools, to flooding and deliberate releases. In order to quantify the media impact associated with a chemical event, we are systematically collecting all printed mass-media publications referring to the incident. By obtaining the full-text articles, we will also be able to qualitatively evaluate the role of the media in the aftermath of a chemical incident. A range of databases and other sources are being exploited to identify published accounts of chemical incidents; their coverage and their limitations will be discussed in this article.

Collecting national and regional newspaper articles

LexisNexis: LexisNexis[3] provides a searchable database that contains comprehensive print news coverage from around the world. The database stores full-text articles from all printed national newspapers published in the UK, as well as most regional newspapers and some online articles. The database can be accessed online with a subscription and searched using keywords. Relevant archived articles can be viewed and downloaded in full.

This service is easy to use and comprehensive; however it does not cover stories by freelance journalists, those under copyright, or letters to editors, which can also provide important insights into a community's reaction to a chemical incident.

HPA press cuttings service: The press office at HPA Chilton provides a daily cuttings service from the UK national press for the Chemical Hazards and Poisons Division (CHaPD) plus a web based incident search. This is a relatively bespoke service that can be adapted for particular incidents.

Collecting local newspaper articles

LexisNexis: There are around 15,000 local and regional newspapers printed in the UK. The LexisNexis database provides coverage of those local newspapers which are owned by large newspaper publishers, which may produce hundreds of local papers each, but does not include papers produced by many smaller publishers.

Local health agencies: Local Health Protection Units, regional Health Protection Agency offices, Primary Care Trusts and Local Authorities will often collate newspaper articles regarding local incidents. This will frequently be limited to incidents which are particularly high-profile or in which the agency had been heavily involved and therefore coverage will not be comprehensive; this will vary from unit to unit.

Libraries: British Library Newspapers in Colindale, north London, collects a wide range of local newspapers from across the country. These are stored on microfilm so are not easily searchable, and there can be substantial delays of 1 to 2 years in processing for some publications. Local libraries in the area of an incident are likely to archive copies of print media, and are therefore excellent sources of information for small scale studies.

Press cutting agencies: There are a number of press cutting agencies who read all types of printed publications from across the country on a daily basis on behalf of their clients. They operate prospectively to a short listing of keywords on which to search. These services are costly and are only really suitable for those who can provide a specific brief in advance.

Online newspaper sites: For a large-scale project such as ours, the best option for obtaining a comprehensive collection of local print newspaper articles is to manually search online. There are two ways to do this. The first is via a search engine such as Google using keywords. The second option is to identify all the local newspapers that serve the area in which the incident occurred and search their websites. Sites such as the Newspaper Society Database[4] will list many, but not all, local publications associated with a town.

Online searches have a number of limitations. Not all local newspapers have an online presence. Depending on its resources, a publisher may reproduce all of its print articles online, or only some and some articles may be modified, re-written or updated for the online version. Searching should be done as soon after the event as possible, as some sites may not have the capacity to archive old articles for longer than a week. Some sites do not have search engines which also makes retrospective searching more difficult.

It is useful to note that many newspapers from an area will share a website as they are owned by a single company. For example, www.thestar.co.uk is operated by Sheffield Newspapers Ltd, and publishes items from a range of newspapers including The Star, The Sheffield Telegraph, The Sheffield Journal and The Sheffield Weekly Gazette amongst others. The exact same article may therefore be printed in more than one newspaper, but it can be difficult to identify this through online searches.

Web page details may change or be updated, so once found, an article should be copied and the date it was accessed recorded. It is also useful to keep a list of the keywords used.

BBC website: Although not print media, it is worth mentioning that the BBC provides some excellent local news coverage.

Potential areas of bias

When analysing media response, the following areas of bias should be considered:

- The level of media response to a chemical incident will depend on other news stories at the time. For example, a chemical incident that was receiving a lot of attention in July 2007 in Oxfordshire was then surpassed by the widespread flooding in the area.
- Media response will depend on the resources and interests of both the publisher and their journalists – a keen journalist may write many articles on one incident whilst another may find no merit in such a story.
- Some areas of the country may be served by a number of different newspapers whereas others may have only one, and this will be reflected in the number of articles produced.
- The number of published articles may not correspond to the impact on a community. The impact from a single newspaper with a large readership could be the same as the impact of a series of smaller newspapers each with smaller readerships. Categorising publications into national, regional and local goes someway to address this.

A final caveat for searching databases and the internet regards the keywords that are used. Keyword searching can be very sensitive – using specific terms may narrow down a search to the specific incident but could also exclude more general articles discussing the incident. At least one search term should be the location of the incident, and for some incidents month and year or precise details such as road name or the company name where the incident occurred may be useful. For example, the search associated with an incident reported to CHaPD as an oil spill from a metal forgery uncovered no press articles; however, after speaking to the local Health Protection Unit, it became clear that the oil spill was due to a fire, and therefore including 'fire' in the search terms identified dozens of related articles.

Conclusions

The mass media provides an excellent resource for CHaPD and indeed all of public health, often following up and summarising an incident in a way that the HPA cannot due to resource constraints. The media have the capacity to act as extra 'eyes and ears' for CHaPD; through daily searches of local BBC web pages, CHaPD are often made aware of new chemical incidents of which they may not have otherwise been informed. A good example of this followed a seemingly benign fire when the local Health Protection Unit, through gathering local media articles, was alerted to the fact that the local community were holding public meetings to voice their concerns over the fire's perceived health effects.

In this article, we have attempted to provide an overview of our experiences of systematically collating printed press articles relating to chemical incidents and the potential contribution it can make to understanding incident response. It is important to note that although the print media may be relevant today, the world of mass media is changing, with more and more people turning to the internet for their news, with blogs, online discussion forums and community websites becoming important as alternative sources of news information.[5] We have attempted to ensure that our methods for quantifying media response are as comprehensive as possible; however any comments or advice from colleagues with experience in this area would be gratefully received.

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Development of a carbon monoxide 'action card' for public health practitioners

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Introduction

Carbon monoxide (CO) is a colourless odourless gas which kills at least 30 people each year in the UK and causes about 200 cases of recorded non-fatal injury.[1,2] Effective public health response to CO incidents involves several agencies including the emergency services, gas suppliers and engineers, the Health Protection Agency, NHS, Environmental Health and the Health and Safety Executive.

Although the public health response to CO incidents is straightforward, in practice it can be difficult to provide a co-ordinated multi-agency response. Official roles and responsibilities with regard to carbon monoxide incidents are extremely complex, particularly with regard to the division of responsibilities between Environmental Health and the Health and Safety Executive (HSE). There are legal requirements about who does inspection, advice and enforcement.

Following a carbon monoxide incident in which a young girl died, South West London Health Protection Unit (HPU) developed an action card outlining the steps to take in the management of a carbon monoxide incident, and the roles and responsibilities of the agencies involved.

Since introducing the action card in SW London we have improved communication and co-ordination between the HPU, local authorities and other agencies in the acute response to CO incidents. As part of the development of the action card we have strengthened relationships with housing and environmental health personnel in local authorities with responsibility for prevention and response to carbon monoxide incidents.

The action card has been used in the other London Health Protection Units over the last year, and was presented at the CO training day on 25 May 2007.[3] We are now preparing a proposal to pilot the action card nationally, through the HPA's Chemical Hazards and Poisons Division – Local and Regional Services (CHaPD-LaRS) chemical network group.

The text from the action card is reproduced below. In response to feedback from the CO training day participants, we are currently working on a single-page flowchart format.

South West London HPU carbon monoxide action card

1. HPU Role in carbon monoxide incidents

The HPU role is to assess the public health issues and ensure action is taken to prevent recurrence. This is done in partnership with other involved agencies such as the police, fire service, National Grid Transco (NGT), Environmental Health and the Health and Safety Executive. As with other chemical incidents, the principles are to assess the risk, institute control measures and carry out secondary prevention.

There are four main steps for the Health Protection Unit, working with other relevant agencies:

- Receive a call
- Risk assessment
- Control of the hazard
- Prevention

2. Call to HPU about a CO incident.

2.1 Receive a call about a CO incident, known or unknown

- **Known** - Collection of basic data for database – caller name, job and contact number, personal details for any individual diagnosed with carbon monoxide poisoning (name, address, date of birth, other identifiers, hospital and CO level in blood), or details of any known incident.

- **Unknown** – consider in cases of unexplained unconsciousness (e.g. possible meningococcal disease), or description of symptoms consistent with CO poisoning, particularly if more than one resident of a household affected. Note that the half life is short and symptoms are non-specific. Collect data as above and advise testing of person (by NHS) and premises (contact Environmental Health Officers). Negative test does not exclude recent CO poisoning.

- **NB** following extensive flooding when portable generators are sometimes used in a confined space they can generate CO. (Diesel/petrol generators should only be used outdoors).

2.2 Risk assessment: probability of harm

- Ask caller re incident:
    - location of incident (postcode/grid reference if available),
    - nature of incident (i.e. fire, spill etc),
    - time that incident occurred,
    - which emergency responders/organisations are at the incident scene or have been notified (i.e. Ambulance, Fire, Environment Agency, Utilities).

- Obtain details re source if available –
  - what is it,
  - quantity or concentration,
  - have any adverse health effects been reported,
  - describe any effects.
  - Any information on presence or condition of gas appliances, air vents (have residents sealed them?) etc
- Obtain details re those exposed –
  - casualty numbers (where are they now?),
  - numbers of people known to be exposed,
  - any vulnerable groups (which? how many people?),
  - numbers of people potentially exposed,
  - any results of CO levels in blood.
- Find out nature of the premises: workplace or residential. (This information is central to ensuring hazard control and prevention.)
  - if workplace, type of work – office, retail, industrial,
  - if residential whether rented or owner occupied, who is landlord (Local Authority, housing association, private landlord?).
  - Which floor of the property is affected?
- If incident relates to monitoring following a previous carbon monoxide incident, interpret negative results with caution as CO can dissipate or release can be intermittent
  - ask re initial incident,
  - current results
  - questions on exposure as above
- Inform CHaPD. Obtain toxicology advice as needed. Fact sheets are in on-call pack.

2.3 Control the hazard

Roles and responsibilities with regard to CO incidents are complicated. The steps necessary for this are not the direct responsibility of the HPU, but in view of the complexity of the responsibilities involved, the HPU can have a useful coordination role between the relevant agencies to ensure that no steps are missed. Section 3 summarises tasks and capabilities.

Initial contact point should be the Environmental Health Department from the relevant borough whatever the nature of the premises where the incident occurred. They can advise whether it is within their remit or that of the HSE. All local environmental health departments have agreed to be the first point of contact.

Once appropriate contacts have been established, check on these points:

- Affected area has been evacuated if necessary
- Any neighbouring areas at risk. Has someone spoken to neighbours re unusual symptoms/ checked neighbouring premises? (They are unlikely to be affected with CO but possible in buildings with flats- CO is lighter than air and will tend to rise)
- Immediate steps taken to control source of CO (e.g. disconnect boiler) – where gas is involved in domestic premises, boiler can be disabled urgently by National Grid (formerly TRANSCO). Measurement of CO levels may be needed and can be done by TRANSCO, but need to beware of false reassurance as CO may dissipate, or release may be intermittent
- Plans in place to prevent recurrence (see below). This may fall under EHO or HSE- if in any doubt phone relevant EHO to discuss whose statutory responsibility it is. Find out whether area been declared safe to return to (generally this will be done by the same agency i.e. EHO or HSE which initially said it was unsafe).

  - Is the CO level safe?
  - Is the hazard gone? Sometimes CO release may be intermittent. (e.g. check vents have been left open, boiler fixed, residents understand cause where relevant)

- Discuss whether a joint HPU/EHO visit to the premises would be useful (even where not able to serve a notice, it may be possible to provide useful advice)

2.4 Prevention

2.4.1 Secondary Prevention

Actions in conjunction with relevant EH department:
- Ensure specific source of CO has been decommissioned, or been declared safe before being put back into use.
- If there is a risk of recurrence, monitor CO level after normal use of property is resumed. (Discuss with relevant EH department about need for this and technical capacity)
- Remember caution is needed where monitoring is in progress, as CO production may be intermittent.
- Remember the private rented sector is most vulnerable to such incidents and use the opportunity to check compliance with Gas safety regulations, provide information/leaflets for landlords/tenants about rights and responsibilities. Use the opportunity to promote tenant and landlord awareness of these regulations, which exist to reduce numbers of such incidents.
- Consider in HPU team meeting whether other specific preventive action is needed (e.g. following a flood, working with CHaPD to ensure public is aware of risk of portable generators).

2.4.2 Primary Prevention

There is scope for primary prevention also and many EH departments are promoting both tenant and landlord awareness of the gas safety regulations. This work can be in partnership with HPU, who have useful links to GPs, PCT inequalities lead etc. Vulnerable groups are over-represented among tenants in private rented accommodation and joint working can target these.

2.5 Communication

- Ensure appropriate communication as necessary with the following agencies whose roles are summarised in the table in section 3:
  - Chemical Hazards and Poisons Division
  - Local Emergency Department (if repeat likely eg in flooding situation)
  - EHOs
  - Health and Safety Executive
  - National Grid
  - London Fire Brigade
  - London Ambulance Service

- Write report if relevant (e.g. if chemical incident, if incident meetings held, if useful lessons to disseminate).

3. Overall roles and responsibilities in a CO incident

Task	Generally done by
Diagnose and treat exposed people	NHS
Ensure premises made safe and people within are protected	EHO/HSE
Make safe gas appliances	CORGI engineer (Council of Registered Gas Installers)
Say when safe to return	Agency which declared it unsafe, based on credible information from a suitably qualified person (e.g. CORGI engineer)
Preventive action concerning future similar incidents	Primary and secondary prevention – EHO and HPU in partnership
Monitor numbers and types of episodes of CO poisoning	HPA-CHaPD, London and HPU: Early alerting surveillance, weekly & annual reports

Template for Contact details for a Carbon Monoxide Incident

This template can be adapted to your local circumstances.

LOCAL AUTHORITY	LOCAL AUTHORITY CONTACT(S)*	LOCAL AUTHORITY 24HR**
(name)	(names)	(phone/pager number for out-of-hours duty officer)
(name)	(names)	(phone/pager number for out-of-hours duty officer)
NATIONAL GRID		**National Grid Gas Emergencies** 0800 111 999 (24-hour emergency line.)

*** List all contacts. The primary contact may not be an Environmental Health Practitioner, but could be from the housing, trading standards, or other Local Authority departments.**

****Out of Hours duty may be covered by several Local Authority officers on a rota, but they would have access to Environmental Health Practitioners as part of the emergency planning response.**

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Preparedness of front-line public health practitioners to respond to incidents of flooding

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Introduction

Flooding is often associated with physical damage to property and the environment, not to mention injury and loss of life. Significant recent international examples include the flooding in Mozambique in 2000 following excessive rainfall, the tsunami that devastated the countries bordering the Indian Ocean in 2004, and Hurricane Katrina which wreaked havoc in the south of the United States in 2005.

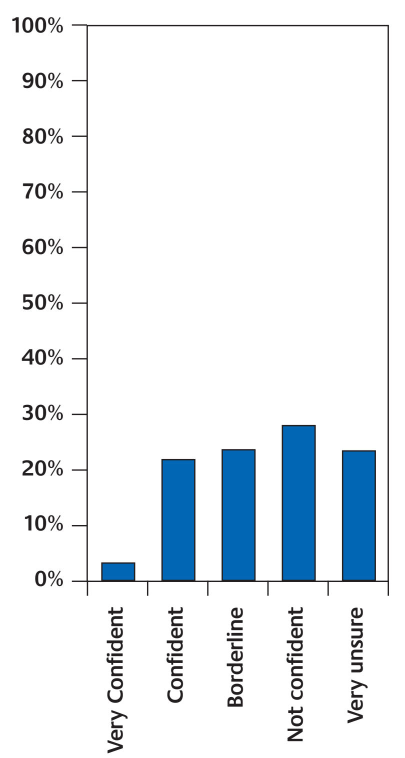
In January 1953, the East Coast of England witnessed one of the worst floods in living memory caused by huge waves along the coastal towns of Lincolnshire, Norfolk, Suffolk and Essex[1]. The coastline of the last three counties forms the coastal boundary of the present Eastern Region. In the autumn of 2006, severe floods were predicted along the East Coast. East Anglia in particular was facing one of the worst threats of flooding in a generation, as exceptional tides were predicted[2]. Concerns over the potential for coastal flooding in the Eastern region of England partly led to the instigation of this study which was aimed at public health practitioners in the Eastern Region. However, it should be noted that across England and Wales around 5 million people in 2 million properties live in flood risk areas.[3] Just prior to publication, the UK experienced widespread flooding and concern over its effects on public health. Further work was undertaken by the HPA (pages 4-5).

The full impact of flooding on the health of the people may not be fully appreciated within the realm of health care provision. Flooding may result in fatalities physical injuries and risks to public health from chemical incidents[4]; infectious diseases, the interruption to supplies of food, and drinking water; the displacement of people needing essential medical care (e.g. dialysis); the disruption of health care services; and adverse psychological effects (including post-traumatic stress disorder)[5]. Therefore, public health practitioners and the agencies they work for, need to have robust plans and strategies for preparedness linking with other partners, both during and out of office hours. In order to assist public health practitioners to respond to incidents of flooding, guidance has been produced by the Health Protection Agency[6] that includes a check-list developed by the Chemical Hazards and Poisons Division.[7]

Table 1: Results of Questionnaire Survey

Element	Very confident	Confident	Borderline	Not confident	Very unsure	Total
Storm water runoffs		4	5	7	8	**24**
Sewage (residential & industrial)		4	5	9	6	**24**
Hazardous landfill sites		3	5	8	8	**24**
Indoor use of fuel operated equipment (e.g. generators) in flood clean up		4	5	9	6	**24**
Use of PPE in flood clean up		7	6	4	7	**24**
Drinking water supply	1	5	7	7	4	**24**
Outdoor environmental hazards for returning residents	1	5	5	8	5	**24**
Indoor environmental hazards for returning residents	1	5	7	5	6	**24**
Food & hygiene	2	9	7	3	3	**24**
Personal and household items	2	7	6	4	5	**24**
Total (%)	**7 (2.9)**	**53 (22.1)**	**58 (24.2)**	**64 (26.7)**	**58 (24.2)**	**240 (100.1)**

Figure 1: Reported confidence of questionnaire responders in being to advice on flooding incidents



Methods

The author prepared a questionnaire with assistance from the Chemical Hazards and Poisons Division (CHaPD), London (Annex 1). Confidence in giving specific toxicological advice was assessed for 10 elements of flood response on a five-point scale ranging from 'very confident' to 'very unsure'. The questionnaire was administered to all Public Health (PH) personnel on the Health Protection (HP) on-call rota across the Eastern Region towards the end of 2006 and replies were received by early 2007. The coastal margin of the Eastern region is formed by the counties of Norfolk, Suffolk and Essex. The responses analysed were been restricted to the Health Protection teams/ unit from Norfolk, Suffolk and Essex. Responses from other parts of Eastern Region have not been considered either because the questionnaires did not reach the staff on the on-call rota, or because the response was poor due to technical communication problems.

Results

The responses to the question relating to confidence in dealing with toxicological aspects of flooding (question 3, Annex 1) are summarised in table 1 and figure 1. Overall, the results of the survey are:

- 24 responses were received out of 25 staff on the rota for HP on-call in Norfolk, Suffolk and Essex, thus giving a response rate of 96%.
- An overwhelming majority of responders (around 85%) has never been called upon to respond to flooding in their HP on-call role, nor have they participated within the last 5 years in a training event to deal with such an incident.
- A quarter of the on-call staff surveyed were confident about giving specific toxicological advice on flooding, half were not confident of doing so and the remaining were borderline.
- Responders were most confident about advice on *food & hygiene, use of personal protection equipment in flood clean-up, and personal and household items.*
- Responders were least confident about advice on *hazardous landfill sites, sewage and storm water runoffs, and indoor use of fuel operated equipment in flood clean up*.
- Responders were most ambivalent about advice on *drinking water supply and indoor environmental hazards for returning residents*.
- The awareness of risk of flooding in their area and the sources of information to be used to provide emergency advice was largely high.
- A high proportion of responders (around 80%) felt they would benefit from a training exercise on 'Public Health response to flooding' and favoured multi-agency participation.
- The Environment Agency, fire service, ambulance, local authority, police, utilities and the Primary Care Trusts (PCTs) were the preferred agencies for participation in the exercise. It was felt that the training exercise, if organised, should be practically oriented for it to be most beneficial.

Conclusion

Overall, the majority of public health pracititioners responding to the questionnaire lack confidence on giving specific advice on flooding. There appears to be a near consensus among the Public Health staff on the Health Protection on-call rota within the coastal counties of the Eastern Region for a need to organise a training session on flooding. Those responding to the questionnaire felt that the training session should be practically oriented and have multi-agency involvement.

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Annex 1: Surveillance questionnaire on preparedness to assess and manage the public health risk associated with flooding

1. Have you ever, in your capacity as HPU on-call person responded to HP related queries on flooding?

☐ Yes ☐ No

If yes, which type of flooding event(s) mentioned below describes the incident most appropriately? (You may tick more than one)

☐ Coastal/ Tidal ☐ Fluvial ☐ Surface water ☐ Conurbation ☐ Rural

2. Have you participated, within the last 5 years, in a training event or exercise dealing with PH management of risks/ consequences of flooding?

☐ Yes ☐ No

If yes, please provide details, including date

3. How confident do you feel about providing specific PH toxicological advice in dealing with the following elements in case of flooding? Please tick once against each of the elements.

Element	Very confident	Confident	Borderline	Not confident	Very unsure	Total
Storm water runoffs						
Sewage (residential & industrial)						
Hazardous landfill sites						
Indoor use of fuel operated equipment (e.g. generators) in flood clean up						
Use of PPE in flood clean up						
Drinking water supply						
Outdoor environmental hazards for returning residents						
Indoor environmental hazards for returning residents						
Food & hygiene						
Personal and household items						

4. Are you aware of areas at risk of flooding (of magnitude to have PH consequences) in your area of on-call duty?

☐ Yes ☐ No ☐ Not sure

5. Are you aware of the sources of information you would use to provide PH emergency advice in the event of flooding?

☐ Yes ☐ No ☐ Not sure

6. Do you feel you will benefit from a training exercise on PH response to flooding?

☐ Yes ☐ No ☐ Not sure

If yes, would you like the training exercise to be a joint event with presence of representatives from partner agencies?

☐ Yes ☐ No ☐ Not sure

If your answer is yes to the above, which of the following partner agencies would you like to be represented in the training exercise? (You may tick more than one box)

☐ Fire service ☐ Ambulance ☐ Police ☐ Resilience forum ☐ Environment Agency

☐ Acute health care ☐ PCT ☐ Voluntary agencies ☐ Local Authority ☐ Utilities (electricity, water)

☐ Maritime & Coastal Agency ☐ Any others, please state:

7. If you would like to comment on training in PH management of flooding, please do so in the space provided below:

Environmental

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

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Introduction

The European Environment and Health Process, led by the World Health Organization (WHO) Regional Office for Europe, aims to support WHO Euro Member States as they plan and implement national and international environment and health policies. This process includes a series of five-yearly ministerial conferences on environment and health. The most recent conference took place in 2004 in Budapest and resulted in Ministers from across the WHO Europe Member States, including the UK, signing up to the Children's Environment and Health Action Plan for Europe (CEHAPE). This plan commits them to the development of national Children's Environment and Health Action Plans (CEHAP) to protect the health of children and young people from environmental hazards.

The Children's Environment and Health Action Plan for Europe (CEHAPE) consists of four Regional Priority Goals, focusing on water sanitation and health; injuries, diet and physical activity; air pollution; and biological, chemical and physical hazards (Box 1).

The four Regional Priority Goals address the main causes of the environment-related burden of disease across the 53 WHO European Region member countries. Rather than being prescriptive, the Regional Priority Goals allow individual countries to focus on the priorities that are most relevant to them. Therefore, in taking this forward the UK should focus on the areas that will bring about the most benefit to health in the UK's child and young adult population.

Why Children and Young People?

In the UK there are around 14.8 million children and young people aged 0-18 years, comprising approximately 25% of the population (ONS, 2006).

Children and young people (Box 2) can be especially vulnerable to infections and environmental exposures during development and growth, and receive relatively greater exposure than adults due to behaviour patterns, lack of awareness of risks, relative size and biological metabolisms.

Box 1: CEHAPE Regional Priority Goals

Regional Priority Goal I: Water, Sanitation and Health

To prevent and significantly reduce the morbidity and mortality arising from gastrointestinal disorders and other health effects, by ensuring that adequate measures are taken to improve access to safe and affordable water and adequate sanitation for all children.

Regional Priority Goal II: Accidents, Injuries, Diet and Physical Activity

To prevent and substantially reduce health consequences from accidents and injuries and pursue a decrease in morbidity from lack of adequate physical activity, by promoting safe, secure and supportive human settlements for all children.

Regional Priority Goal III: Respiratory Health, Indoor and Outdoor Air Pollution

To prevent and reduce respiratory disease due to outdoor and indoor air pollution, thereby contributing to a reduction in the frequency of asthmatic attacks, in order to ensure that children can live in an environment with clean air.

Regional Priority Goal IV: Chemical, Physical and Biological Agents

To reducing the risk of disease and disability arising from exposure to hazardous chemicals (such as heavy metals), physical agents (e.g. excessive noise) and biological agents and to hazardous working environments during pregnancy, childhood and adolescence.

Source: WHO (2004)

Box 2: Definition of children and 'young people'

Children and young people are those under the age of 19 years, including the foetus. The reproductive capacity of adults and the health of the breastfeeding mother are also taken into account where this may affect the health of the child or young person.

Developing a Children's Environment and Health Strategy for the UK

Progress to Date

The importance and health benefits of having a clean and healthy environment have long been recognised in the UK. Many initiatives have led to a significant reduction in mortality and morbidity over the past century, including improved water and sanitation provision, air quality, nutrition, vaccination campaigns, housing quality, including reducing overcrowding, and many others. However, although these have been successful there is still more to be done. Also, it is difficult to quantify the environmental related burden of disease, especially as this often has a cumulative effect and long-term impact.

The UK Children's Environment and Health Action Plan will help provide a coherent cross-government approach towards improving children's health from environmental factors. To ensure this is effective it is important to have a good understanding of the current activities and to highlight gaps and priority areas to be taken forward. A multi-stage process has been followed involving an initial scoping study and baseline assessment of children's environment and health in the UK, looking at each of the four Regional Priority Goals and over-arching issues, with the aim of highlighting best practice and areas where further work may be required to completely address the commitments under each of the Regional Priority Goals. During 2006/07 a review of current activities was undertaken, the findings from which will be summarised and made available at the Health Protection Agency's (HPA's) website in September 2007 (HPA, 2007a). This information has been used to inform the development of the UK's Children's Environment and Health Strategy which will be out for consultation in the autumn of 2007 and will also be made available on the HPA's website (HPA, 2007b).

This Strategy will provide an indication of the areas that may need to be considered as high priority in the future, focussing on specific settings such as schools and homes and seeking to build on the many activities already underway. This is particularly important as many activities are taking place in England and the Devolved Administrations at local, regional and national levels that are already contributing to the UK meeting the Regional Priority Goals. However, some actions will be unique to children and to this strategy and will need to be taken forward separately.

Overseeing the Process

Overall responsibility for the Children's Environment and Health Strategy in the UK rests with the Department of Health (DH), and activities are overseen and co-ordinated by an Interdepartmental Steering Group on Environment and Health. This is chaired by DH and comprises representatives from a wide range of Government Departments, Agencies and the Devolved Administrations (Box 3). The Department of Health and the Interdepartmental Steering Group requested that the HPA act as the lead Agency and has been tasked with the development of the Strategy and background documents for the development of the UK's Children's Environment and Health Action Plan.

Box 3: Interdepartmental Steering Group on Environment and Health Membership

- Cabinet Office
- Department for Communities and Local Government (DCLG)
- Department of Health (DH; Chair)
- Department for Children, Schools and Families, formerly the Department for Education and Skills (DfES)
- Department for Environment, Food and Rural Affairs (Defra)
- Department for Business, Enterprises and Regulatory Reform; formerly the Department for Trade and Industry (DTI)
- Department for Transport (DfT)
- Health Protection Agency (HPA)
- Environment Agency
- Food Standards Agency (FSA)
- Northern Ireland Department of Health, Social Service & Public Safety
- Northern Ireland Environment and Heritage Service
- Scottish Executive
- Scottish Environmental Protection Agency (SEPA)
- Welsh Assembly Government (WAG)

Involving Young People

One of the key elements of the Children's Environment and Health Action Plan for Europe is the involvement of young people and within the UK they have been engaged from an early stage. A number of workshops have been run with groups of young people from different backgrounds to identify what is important to them. These findings have been used to help develop the UK's strategy and will be fed into the action plans.

Next Steps

The next step in the development of the Children's Environment and Health Strategy is a public consultation of the Strategy in order to engage and get feedback from interested parties, including young people, to ensure that the areas highlighted are the most appropriate and that these will make a significant contribution towards improving children and young people's health in the UK. The consultation process will take place in the autumn of 2007 and the document will be posted on the HPA website (http://www.hpa.org.uk/); invitations will be sent to a wide range of stakeholders requesting feedback. Comments received through this consultation process will be considered in revising the Strategy, which will be published in its final format in the spring of 2008.

As previously mentioned, it is intended that the outcomes of the strategy will be implemented within the UK primarily at a local and regional level, with coordination being provided centrally (either from UK Government or Devolved Administrations), where appropriate. An important element of the success of this initiative will be the engagement and involvement of those with local and regional responsibility for public health to ensure action is taken at a local level to address environmental hazards that are of relevance to children and young people locally. Relevant public health professionals include Directors of Public Health in Primary Care Trusts, Public Health Observatories, Local and Regional Services of the HPA, Environmental Health Officers, and Local Authorities in general. A process to ensure issues are taken forward consistently will need to be considered.

Implementation, monitoring and evaluation of new and on-going initiatives identified within the strategy is central to enable monitoring of progress towards improving children and young people's health and to ensure positive change takes place. Whilst it is recognised that some initiatives will be regionally or Devolved Administration focused to meet specific needs within particular geographical areas, there still remains a need for the overall coordination and monitoring. The evaluation will be an important element to ensure delivery and means of delivering this will need to be considered when developing the more detailed action plan that may follow from the strategy consultation process.

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Development of a set of Children's Environmental Health Indicators

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Background

Children exhibit behaviours and developmental characteristics which predispose them to exposure to environmental hazards and to increased susceptibility to the effects of those exposures. Although there is considerable evidence that exposures to environmental risks contribute significantly to the burden of disease among children and adolescents[1, 2, 3] the fundamentals of paediatrics – that children are not just 'little adults' – have not traditionally been considered in environmental standard-setting. In addition, there are still gaps in our knowledge about the magnitude and regional distribution of hazards/risks and the environmental burden of disease among the young[4].

WHO considers the development of a set of key children's environmental health indicators as an essential step in the effort to improve children's health through safer environments. Several international policies have called for more effective collaboration on such indicators[5,6] and a global initiative on Children's Environmental Health Indicators (CEHI) was launched in 2002 in response to these concerns.[7] This initiative is also a fundamental part of the UK's commitment to the Children's Environment and Health Action Plan for Europe (CEHAPE).

The West Midlands Pilot

The Health Protection Agency is committed to supporting these initiatives and is developing a pilot project in collaboration with the Government Office of the West Midlands, West Midlands Public Health Observatory and others in the West Midlands region of the U.K. The West Midlands population has a higher proportion of children than the English average and has some regionally distinctive children's health issues including the highest rates of infant mortality, perinatal and neonatal deaths, stillbirths and low birth weight babies in England. The region has a higher percentage of children living in poverty in comparison to the average for England. The region also has some serious environmental health issues and has consequently been working in this field for some years.

This initiative aims to describe the burden and distribution of hazards/risks and of childhood disease and injury attributable to environmental risks within a region, provide intelligence to inform appropriate interventions and monitor the impact of those interventions particularly in terms of reducing inequalities. The project is a pilot for a national system and, in particular, is focused on the local dimension (initially local authority level).

While the emphasis has been on environmental stressors with plausibility, evidence base and relevance for the region, the assessment recognises the importance of 'quality of life' type issues on health.

Methods

Engagement of public health professionals working at a local level is essential to ensure indicators are informed by local intelligence and experience. Accordingly, a working group including staff from Chemical Hazards and Poisons Division (CHaPD), Local and Regional Services Division (LaRS), the Government Office for the West Midlands and the West Midlands Public Health Observatory (WMPHO) was established to oversee the development of locally appropriate indicators. The group built on the HPA's experience of leading the UK's input to the WHO/EU Environment and Health Information System (EHIS) programme[8] and has recruited input from the local authority community.

The working group agreed definitions of environmental health (Box 1) and children and has assessed existing indicator programmes such as EHIS, WHO CHEI programme and Community Health Profiles and established an initial set of indicators following an assessment of the quality, appropriateness and utility of datasets.

Box 1: Definition of 'Environmental Health'

Environmental health for this project includes both the direct pathological effects of chemicals, radon and some biological agents, and the effects (often indirect) on health and wellbeing of some aspects of the physical and social environment which includes sustainable development, housing, urban development, land use, noise and transport

The core set of indicators covers a range of environmental health issues including areas such as housing, noise nuisance, mortality and environmentally linked diseases, accidents and environmental quality (see table 1 for the interim list of indicators).

The most contemporary data are used for the indicators where possible. Although the year(s) data used may differ among indicators, the year(s) for any one indicator will be the same for all the local authorities to facilitate comparisons. Expert advice on the selection of indicators has been sought where necessary and data are being collated and analysed in collaboration with the WMPHO.

Table 1: List of Core Indicators (not definitive).

Core Indicator	
Housing	
1.	Unfit dwellings
2.	Overcrowding
3a.	Homeless households in priority need
3b.	Homeless in temporary accommodation
Health	
4.	Mortality rate due to acute respiratory illness
5.	Hospital admission rate due to acute respiratory illness
6.	Hospital admission rate due to diarrhoeal illness
7.	Infant mortality rate
8.	Hospital admission rate due to asthma
9.	Immunization uptake
Accidents	
10.	Hospital admission rate due to non-traffic related injuries
11.	Hospital admission rate due to traffic related physical injuries
12.	Mortality rate due to traffic accidents
13.	Mortality rate due to non-traffic related accidents
Environment	
14.	Exposure to air pollutants
15.	Exposure to ETS in the home
16.	Proximity to heavily trafficked roads
17.	Noise nuisance
18.	Potential exposure to chemical incidents
19.	Access to sport facilities

The rationale for each indicator, the sources of the data together with an assessment of data quality (including the limitations) has been developed (see table 2). Data are being presented in both tables and maps together with a commentary.

Table 2: Criteria for describing the indicators.

Definition	Denominator definition
Rationale	Source of denominator
Special relevance to children	Geographic coverage
Other sources of indicator set	Dimensions of inequalities available
Primary source	Timeliness
Date last published	Accuracy and completeness
Time period	Disclosure control
Numerator definition	Technical Guidance
Source of numerator	Further Information

Indicators considered important but for which data are not currently available at a local authority level and/or specific to children have been identified as ‘gap indicators’.

While it is not presently possible to use a ‘traffic light’ system describing whether things are moving in the right direction (e.g. sustainable development indicators) given this is a first snap shot, 95% confidence intervals have been used where possible to identify local authorities as red, amber or green in comparison to the West Midlands average.

Discussion

It is anticipated that these indicators will be used to assess the environmental health experience of children in communities at a local authority level and enable a focus on those interventions with the greatest potential for health gain. This is a pilot project and indicator sets developed in other regions will cover different issues dependent on regional priorities although it is expected that there will be a core set of indicators common to all regions.

A final draft of this environmental health toolkit will be circulated for consultation in August/September 2007.

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Ambient concentration, exposure and dose

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Introduction

All toxicologists adhere to the dictum of Paracelsus: *'All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy'* (Doull and Bruce, 1986). In dealing with toxic substances encountered in the environment (air, soil and water) the terms concentration, exposure and dose are often confused or conflated and this can lead to errors in predicting effects. We sometimes need to predict effects from epidemiological studies and in these information on dose may not be available. In some studies information on exposure may be available but, commonly, information on ambient concentrations is all that can be easily obtained. It is important to be quite clear about the sort of data that has been used in studies and about how the results of such studies should be applied in predicting effects. This short paper explores some of the problems encountered in this area. A useful guide or perhaps rule, is that predictions will be most satisfactory when made on the same temporo-spatial scale as that of the studies that provide the basis for the predictions. Thus an epidemiological study that relates the ambient concentration of some air pollutant to an effect, for example daily mortality, should not be used to predict the effects of exposure of an individual to a specified concentration of the pollutant in question. A study in volunteers, for example, a chamber study, would be a much more satisfactory basis for such a prediction. Examples in this paper will be drawn from the air pollution field though they may also apply to questions relating to the contamination of other media, including soil and water.

Concentration

The ambient concentrations of air pollutants tend to be measured at fixed locations: fixed point monitoring sites. These may be sited in areas in which concentrations are likely to be high, for example at roadsides, in comparison with those in 'urban background' areas. The locations of monitoring stations are chosen for a number of reasons: they may be prescribed by EC Directives, they may be intended to provide information on average exposure (see below) or they may be intended for research purposes. Air pollution monitoring on the North West tip of Ireland provides information of Northern Hemisphere background concentrations of pollutants such as ozone.

Concentrations monitored at sites such as those described above are often referred to as ambient concentrations, but it is important to qualify this description, for example ambient urban roadside concentrations or ambient urban background concentrations. Epidemiologists use ambient data as the basis for a range of studies including time-series and cross-sectional cohort studies. Consider the case of time-series studies. These tell us about days in terms of, generally, the concentration of some pollutant monitored at a single site and some count of effects on health, for example, daily deaths. We should note that the location should be specified, for example London or Athens. We assume that day-to-day changes in concentration, as measured, reflect day-to-day changes in exposure of the population and it has been shown that average exposure follows ambient concentration fairly closely (Ozkaynak and Spengler 1996). However, personal exposure is variable and an individual's exposure may not follow the ambient concentration anything like as well as does the population's average exposure. Of course, if we knew that average exposure did not follow ambient concentration we would be justified in suspecting that an association between ambient concentrations and a specified effect was reflecting some confounding factor that was varying with concentration and affecting health.

Concentrations of air pollutants are measured in terms of mass per unit volume, for example µg/m3. For gases such figures may be easily converted to a volume mixing ratio, for example parts per billion.

Exposure

We know far less about exposure to air pollutants than we do about ambient concentrations. Exposure is difficult to measure; ambient concentration is comparatively easy to measure. We do know that exposure, expressed in terms of ambient concentration *x* time varies throughout the day. Consider frying a pan of bacon: exposure to fine particles (and ultrafine particles) will be high during this time. Some particles will be produced from the bacon, others will be produced by the flame playing on surface of the pan. However, the duration of exposure is likely to be fairly short and the contribution of this specific exposure period to the whole day's exposure may be fairly small. We all spend well over 80% of our time indoors and are thus exposed to indoor concentrations of air pollutants rather than to outdoor (ambient) concentrations. Of course, indoor concentrations are affected by outdoor concentrations: $PM_{2.5}$ indoors (produced mainly outdoors) tends to be about 60% of the outdoor concentrations. For some air pollutants (such as ozone), there are no significant indoor sources and because of reactions between ozone and indoor surfaces, concentrations tend to be much lower indoors than outdoors. For other gases (nitrogen dioxide),, indoor concentrations may exceed those outdoors: kitchens are often characterised by high concentrations.

The variation in exposure during the day has led some workers to speak in terms of micro-environments: we all move through a series of micro-environments during the day. Each may be characterised by a concentration of pollutant (or pollutants) and by the time spent in that micro-environment. The exposure in each micro-environment *(i)* is given by $C_i t_i$ where *C* and *t* are the relevant concentrations and time periods. Total exposure is given by $\sum(C_i t_i)$ where $\sum$ indicates summation of all the exposures in the individual micro-environments. Such studies have been valuable in exploring where people receive their major exposure to, for example, fine particles. However, studies of exposure have been by no means as useful in the environmental health field as in that of occupational health where steps to reduce major sources of exposure are more easily taken.

Monitoring individual exposures requires the use of personal-monitoring equipment and thus severely limits the number of subjects that are likely to be studied. This leads to problems: if an effect is so small that it can be only just be detected by a large time-series, then a small study utilising personal monitoring equipment may well not reveal an effect. In part because of this, personal monitoring tends to be used in panel studies with individuals undergoing intensive study. These have produced useful results and, of course, bring us closer to the 'real relationship' between exposure and effect than any study that relies on ambient concentrations as a surrogate for exposure can.

Dose

Toxicologists like to think in terms of dose. In terms of inhaled compounds we think of dose as indicating how much of the compound under consideration is absorbed. Absorbed? Well almost! In the case of inhaled particles perhaps we should think in terms of 'deposited in the airways' rather than 'absorbed'. Toxicologists sometimes refine their definition of dose and speak of 'effective dose' or 'biological dose' as the amount of compound that reaches the target organ or system and appreciate that detoxification processes need to be taken into account in calculating this. In terms of inhaled compounds dose will clearly depend on the minute volume – in ordinary words: how much air containing the compound is taken in each minute. This leads to complications. If we are interested in the amount of the compound reaching the alveoli we will need to take the dead space of the respiratory system into account. In an adult this is about 150 ml. We need to be careful now: a breath (inspiration) of 450 ml delivers only 300 ml of 'fresh air' to the alveoli, 150 ml remains in the dead space. Of course, the alveoli actually receive 450 ml of air but this comprises 300 ml of fresh air and the 150 ml of air that was left in the dead space at the end of the last expiration. This leads respiratory physiologists to define alveolar ventilation as 'the volume of fresh air entering the alveoli' at each breath, i.e. 450-150 = 300 ml. This is important because we could imagine a minute volume of 6.3 l being made up of 14 breaths of 450 ml or 42 breaths of 150 ml. In the latter (unlikely) case no fresh air will reach the alveoli and thus the 'dose' of a compound found in the air will be zero. Exercise, leading to increases in minute volume and large breaths, will increase the rate of absorption of inhaled compounds. We thus need to be careful in specifying the nature of the breathing pattern in speaking about dose: simply using the minute volume is not satisfactory. The problem is further complicated by some compounds being absorbed readily (cleared from the inspired air); some compounds reaching an equilibrium between the blood and the air and others being poorly absorbed. Soluble gases such as sulphur dioxide are largely absorbed in the upper airways whereas more insoluble gases, such as ozone, are absorbed deeper in the lung. Inhaled dose is thus a complicated subject.

In thinking of particles that deposit in the lung we need to recall that only a fraction of the particles inhaled are deposited. With some particles, the fraction may be large, with others it may be very small indeed. Thus 'exposure' is not 'dose'!

Why all this is important

Epidemiological studies of air pollutants tend to relate ambient concentration and effects on health and to calculate coefficients defining the relationship. This coefficient is the concentration-effect coefficient it is not the exposure-effect coefficient and, even more certainly, not the dose-effect or dose-response coefficient often sought by toxicologists. This is important in terms of how the coefficients are used. Let us take an example. The coefficient linking the ambient concentration of particles measured as $PM_{2.5}$ and the likelihood of death from, say all non accidental causes, is expressed as 'an increase in Relative Risk of 0.6% per 10 µg/m^3 $PM_{2.5}$' (24 hour concentration).

Question

If a man is exposed to 10 µg/m^3 $PM_{2.5}$ for 24 hours will his risk of death be increased by 0.6%?

This is by no means an easy question. Of course, we know that predicting an effect in an individual on the basis of a study of a sample of the population will be uncertain and we may ask for the words 'on average' to be inserted with the question: 'will his risk of death, on average, be increased....?' But this does not help very much. The real reason we cannot give a clear answer is that we have not been told the exposure-effect coefficient and without this we cannot predict the effects of exposure. This is not an academic quibble – far from it, it explains why we cannot predict the effects of kerb-side exposure to $PM_{2.5}$ and why we cannot predict the effects of exposure to the high concentrations of fine particles found in kitchens or in other workplaces from the results of common time-series studies. To make satisfactory predictions for any of these micro-environments, we would need to know the exposure entailed and the exposure-effect coefficient. The need for an understanding of the exposure-effect relationship is thus obvious and the need for further studies of this relationship is clear. All the above assumes that fine particles at the kerbside, in the kitchen etc, are the same fine particles as were studied in the work that led us to the ambient concentration-effect coefficient and this, also, may not be true. We need not explore this point further but we should at least note, again, that $PM_{2.5}$ is a measure of the mass concentration of particles within a specified size range and says nothing about how their sizes or chemical compositions are distributed in the < 2.5 µm size range. All this leads us to conclude that the question asked above is, indeed, unanswerable from the information given.

Are things always as bad as this? No, not at all: for some gases we know the exposure-response coefficient. This is obtained from studies of volunteers exposed to known concentrations of gases for specified times. Given such data we can predict the effects of exposure to indoor concentrations and the Committee on the Medical effects of Air Pollutants (COMEAP) made use of such data in recommending indoor air quality guidelines for gases including sulphur dioxide, nitrogen dioxide and carbon monoxide. But no guidelines for particles were recommended.

Conclusion

Concentration, exposure and dose are very different terms and care needs to be taken in using the results of studies involving measurement of these variables. A lack of precision in this area has led to considerable confusion in the air pollution field.

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Particles as Air Pollutants 3: The Ambient Aerosol - Mechanisms of Action

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Introduction

Many publications have set out the epidemiological evidence linking exposure to the ambient aerosol with effects on health. The associations reported in the epidemiological studies are accepted as causal despite an inadequate understanding of the underlying toxicological mechanisms: the reasoning behind this acceptance of causality has been set out in COMEAP reports.[1] Understanding the underlying mechanisms remains an important objective: if one or perhaps a few components of the aerosol could be shown to cause the effects on health associated with the ambient aerosol then these could be targeted by policy makers and more efficient policies would result. However, despite promising hypotheses and expressions of enthusiasm for some potential mechanisms, the problem remains unsolved and thus represents a continuing challenge to inhalation toxicologists. Until this problem is solved policies are likely to be directed to reducing the mass, or perhaps, number concentration of the ambient aerosol with (in the case of mass concentration) special attention being paid to particles likely to be deposited in the gas exchange (deep) part of the respiratory system.

What needs to be explained?

It is accepted that day-to-day variations in mass concentrations of particles (PM_{10} and $PM_{2.5}$) are associated with deaths from cardiovascular disease (heart failure, myocardial infarction and stroke); with deaths from respiratory disease (probably chronic obstructive pulmonary disease); with hospital admissions for the conditions listed above; with symptoms of asthma and with a restriction in activity of those suffering from cardiorespiratory diseases. Long-term exposure is associated with a reduction in life expectancy due to an increased risk of death from cardiovascular disease (the increase in risk expressed as a percentage increase in baseline risk seems to be independent of age) and with an increased risk of death from lung cancer. Thus, there is no shortage of effects requiring explanation! In this article the effects on lung cancer risk will be ignored. It is assumed that these are due to carcinogens associated with particulate material or, perhaps, to gaseous carcinogens that are closely correlated (in terms of concentration) with the mass concentration of the aerosol.

Ideas regarding mechanisms of action

Such a wide range of effects suggests three broad concepts regarding mechanisms:

(a) that the aerosol contains many active components with different effects;
(b) that the aerosol, though containing many components, acts via one mechanism that itself affects different tissues in different ways;
(c) that the aerosol contains some single active component that affects different tissues in different ways.

The last of these is sometimes described as the 'silver bullet hypothesis' and has attracted some attention. If only the key compound could be identified! This has led to confusion, with workers and commentators focusing on a specific size distribution ($PM_{2.5}$ is the answer) or on number concentrations, or on a chemical property such as acidity or perhaps the nickel (or iron or vanadium etc.) content of the aerosol. It will be obvious that these attempts to describe the key compound are inconsistent: $PM_{2.5}$ may well include more of the active components per unit mass than PM_{10} for example because small particles reach the deep lung; number concentrations may well be better linked with effects than PM_{10} because number concentration is dominated by small particles that reach the deep lung, and so on. It is thus important to distinguish between active components *per se* and measuring techniques that may reflect variously well these components. To say that $PM_{2.5}$ or number concentration is the active component is unhelpful and confuses an already difficult issue.

We need to recall that epidemiological studies undertaken in many different locations have yielded remarkably consistent results. This is interesting in that the composition of the ambient aerosol differs from place to place. For example, there is much more sulphate in the East Coast aerosol than on the US West Coast. On the West Coast, nitrate makes a larger contribution that in does on the East Coast. One interpretation of the consistent epidemiological findings is that effects are independent of variations in composition. This creates difficulties for the toxicologist: can it be that composition is really unimportant and that all particles are toxic? Or is there some component that is invariably present – and always makes up the same percentage of the total mass (e.g. a constant fraction of $PM_{2.5}$) that actually causes all the effects? This idea has some attractions though the compound would need to be very active indeed and detailed analysis of different aerosols has not thrown up such a compound as yet. Indeed, chemical analysis has not produced many surprises. Common salts: sulphate and nitrate are found, common metals: iron, aluminium, zinc, nickel etc, are found as is silica and the complex silicates associated with dust from the earth's surface. Carbon is present in both a rather pure form and also combined in organic compounds of varying complexity. More and more detailed analysis reveals more and more elements: this is unsurprising. And yet there has been no 'Eureka moment' with a notably toxic compound being revealed. Most workers have abandoned the search for the 'silver bullet' and have accepted that the effects will need to be explained in terms of the well known components of the aerosol. These components do not, at first glance, look very interesting in toxicological terms. Thus new thinking is needed.

The idea that many compounds, having varying effects, are present is difficult to dismiss. Is there a cardio-toxic component and a respiratory-toxic component? This has some appeal to those with a pharmacological background but, again, no compounds with such specific effects have been identified as yet.

The idea that some common mechanism, that may be triggered by a range of components, has become more popular than either of the ideas discussed above. Before discussing this further, it is worth recalling that epidemiological methods are blunt tools for investigating the effects of different components of the aerosol. It may well be that we are being misled by the apparent consistency of results from location to location. If more sensitive methods were available, perhaps we could distinguish the effects of a sulphur-rich aerosol from an aerosol low in sulphate ion. This is important in that toxicologists may be being asked to explain the inexplicable simply because the evidence requiring explanation is far from perfect. This is a challenge to epidemiologists and a reason for caution amongst toxicologists. Developing and testing hypotheses to explain incorrect (or imperfectly correct) observations is unlikely to be rewarding.

The single mechanism theory

Given that a single compound capable of causing all the reported effects of the aerosol has not been identified, effort has been put into developing a single mechanism that could be triggered by various components. At present the free radical hypothesis is the favoured explanation and much has been written about this.[1-3] It is not possible to review all the evidence bearing on this hypothesis in this short article, but several points are worth considering.

- Free radicals are accepted as a common cause of cellular damage and of a wide variety of disease processes ranging from inflammatory responses to the toxic effects of many chemicals, including carcinogenesis. Free radicals such as the hydroxyl free radical ($OH^{\bullet}$) are extremely reactive and can trigger cascades of damage, for example by chain reactions involving lipid peroxidation. Radiation induced injury involves free radical activity.

- Transition metals, such as iron, can take part in free radical generating reactions. The Fenton reaction:

  $$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^{\bullet} + OH^{-}$$

  has been widely discussed.[4]

- Naturally occurring antioxidants including reduced glutathione, uric acid and ascorbic acid react with and neutralise free radicals.

- The effects of free radicals will depend on where they are produced and thus can be linked with a wide range of disease processes. This is helpful in trying to explain the range of effects reported in epidemiological studies.

There are also arguments that count against the free radical hypothesis. Let us accept that active species such as iron or nickel are deposited in the lung. The ions will, if in a soluble state, dissolve in the surface liquid of the airways and alveoli and, let us assume, generate free radicals. These will begin to react with tissue components such as lipid species and cascade reactions will follow. At the same time, defence processes will swing into action and the toxic processes will be halted. At least one hopes so, as free radical generating species are being deposited continuously in everybody. Ozone and oxygen are themselves free radical generators and, again, exposure is ubiquitous. Thus we need to add to the theory the concept of susceptibility: because not everybody is affected (as far as we can tell). Those who are affected are presumably unable to defend successfully against the free radical attacks and thus suffer. But what are the mechanisms underlying susceptibility? Several are possible: inadequate defence mechanisms? Disease processes already underway that are generating free radicals and are thus overloading defence systems? Disease processes underway that need only a small 'push' to trigger some life threatening event? Each is possible. Genetic polymorphisms are sometimes invoked to explain differences in susceptibility. This, too, is possible and certainly there is evidence to show person to person differences in levels of antioxidants in respiratory tract secretions. But we do not yet know that those suffering from cardiovascular disease are especially deficient in defences against free radicals, and if they were, would free radical generation in the lining fluid of the airways lead to destabilisation of atherosclerotic plaques in their coronary arteries? At present the free radical hypothesis may be seen as the best explanation available for the local toxic effects of inhaled ambient particles but other theories are needed to explain all the epidemiological findings.

The penetrant particle theory and the clotting hypothesis

All who breathe ambient air accumulate particles in their lungs. Those who breathe air with a high concentration of particles of a size likely to lead to deposition in the deep lung accumulate more particles. This is clearly shown in coal miners and in those living in dusty deserts. The particles accumulate in sub-epithelial sites and in lymph nodes. Some pass through the lung into the blood and are trapped by the reticulo-endothelial system of the spleen and liver. Until recently it was not generally assumed that these particles reaching the blood stream did significant harm though it may be fairer to say that this had not been thought about in much detail. In 1995, Seaton et al.[5] proposed that ultrafine particles might trigger, perhaps via reactions with the endothelium and secondary messengers to and from the liver, a change in clotting factors that would lead to an increased likelihood of coronary artery occlusion. This was a remarkably bold hypothesis which sought to link epidemiological findings with the growing interest in the special toxicological properties of ultrafine or nanoparticles. It was soon shown in animals that ultrafine particles could reach the blood stream, that ultrafine particles could reach atherosclerotic plaques and that some changes in clotting-associated factors did indeed occur in people exposed to increased concentrations of ambient particles. More significant still, was work that showed that rabbits susceptible to atherosclerosis moved more quickly through the stages of plaque development when exposed to increased particle concentrations. Thus a chain of plausible links between inhalation of small particles and cardiovascular pathology was forged. The details of the evidence supporting this are set out in the COMEAP report on Air Pollution and Cardiovascular Disease. Whether or not this **is** the explanation is difficult to say. It should be noted that though we think that amongst the many people experiencing exacerbations of their cardiovascular disease each day, some instances of, for example, myocardial infarction are related to exposure to air pollutants, we do not know in which patients this is the case. Proving that in an individual patient some episode of disease was due to exposure to particles is currently beyond us. This may sound unsatisfactory – and so it is – but we do not, in general, know why individuals experience exacerbations of cardiovascular disease on specific days. Many factors can affect this, but why a patient with coronary artery disease suffers a heart attack on a Tuesday and not on a Monday tends to be inexplicable. In general, this may not matter much but to those interested in testing and possibly confirming the link with changes in levels of air pollutants it is interesting and important.

The perturbation of control of the heart beat theory

Though the theory described above perhaps holds the field as the current favourite, a second theory has recently been gaining ground. This posits that particles deposited in the respiratory system trigger some autonomic reflex and that this leads to a disturbance in the control of the heart beat. It will be well known that the heart's intrinsic rhythm is modulated by the combined and competing influences of the sympathetic and parasympathetic nervous systems. The former operates via the transmitter noradrenaline; the latter via acetylcholine. It will also be well known that the heart rate rises and falls; for example, during exercise it rises, during sleep or relaxation it falls back to the resting level peculiar to the individual. But much less well known is that the beat-to-beat interval also varies and this phenomenon is, confusingly, described as heart rate variability (HRV). Thus an individual could have a heart rate of 80 beats per minute with low HRV or with high HRV. Is this important? Well, in those with some forms of heart disease HRV is a good predictor of heart failure: low HRV seems to be a bad sign. Recently it has been shown that inhalation of air pollutants, including particles, can affect HRV. This has been shown in volunteers and in experimental animals. The effect seems to be to reduce HRV – i.e. to move it in the disadvantageous direction. Also it has been shown in patients suffering from myocardial infarction that a lowering of HRV is associated with ventricular tachycardia and thus, perhaps, with lethal ventricular fibrillation. Studies in patients with implanted defibrillators have shown an association between how often these devices fire per day and the daily mass concentration of particles. Now this is truly remarkable! Once again a potential chain linking inhalation of particles with effects on the cardiovascular system has been forged. That this potential linkage was entirely unknown just a few years ago is certainly true. Is this, then, the answer: exposure to particles triggers changes in the regulation of the heart rate and these predispose to lethal arrhythmias and death? We don't know. But even if this is a part of the answer the mechanistic chain is very incomplete. Which particles or which compounds trigger these reflex changes? Are some patients more susceptible than others? Does this explain all the linkage between particles and acute cardiovascular disease or perhaps only a small part of that linkage? The latter seems the more likely. The detailed evidence supporting this theory is, again, presented in the COMEAP report on Air Pollution and Cardiovascular Disease.

The acidity theory

For some time the idea that the acidity of inhaled particles played a significant role in inducing toxic effects was popular. This was supported by epidemiological studies linking effects on health and ambient hydrogen ion concentration. Reanalysis of data from London (1965-1972) by Lippmann showed a tight correlation between daily deaths and H^+ ion concentration.[6] The association with H^+ ion was more impressive than that with Black Smoke or with sulphate ion. Much work on the effects of inhaled acid on mucociliary clearance and on lung function[7] supports the idea that inhaled acid could have effects on the respiratory system but a link with effects on the cardiovascular system has been less easy to imagine. But could acidity be the trigger for the reflexes that may influence HRV? This could be the case and some work by Tunnicliffe et al.[8] on the effects of inhaled sulphur dioxide on HRV is suggestive, though the findings in asthmatic and non-asthmatic subjects are not easy to interpret. It is probably fair to say that the acidity hypothesis is less favoured today than it was a few years ago.

Mechanisms of action: discussion and conclusions

Where does all this discussion of possible mechanisms and potentially active components leave us? That particles affect health seems beyond dispute. Though the effects are mainly on the cardiovascular system, the respiratory system may also be affected. Hypotheses to explain effects on the cardiovascular system have been advanced – less emphasis has been placed on explaining the respiratory effects. Fine particles seem to be important and transition metal content seems to play a part. Translocation from lung to blood may be important and free radical generation may be the final and common step in explaining cellular damage. Reflexes may be important and a linkage between the respiratory system and the heart is not implausible. Likewise an effect on clotting – thrombogenesis – and on the progression of atherosclerotic plaques is possible. But none of this is certain. We do not yet know with anything like the necessary level of confidence which components of the ambient aerosol cause the effects reported by epidemiological studies. Given this, the case for targeting the entire aerosol seems strong and this forms the basis of this aspect of the National Air Quality Strategy for England, Scotland, Wales and Northern Ireland.[9] The case for regarding components of the aerosol as non-toxic has often been discussed and the case for regarding sulphate (for example) as inert in toxicological terms has been pressed by distinguished workers[10] but our present state of knowledge makes any such assertions very open to error and, at present, they are best avoided. This is the view taken by COMEAP in their second report on the quantification of the effects of air pollutants on health in the UK.

Looking ahead

Predicting the future in air pollution science is so prone to error that it should be discouraged and yet it may be useful to point to some likely developments and to suggest areas for study. It seems likely that emphasis will be placed on smaller and smaller particles. Pressure for this comes in part from the fast developing field of nanotoxicology and in part from the few epidemiological studies that link number concentration with health effects. Number concentration is dominated by small particles, but in our enthusiasm for this approach, we should not lose sight of the very extensive data base that links PM_{10} and health effects. This need not be a worry to the nano-enthusiasts if PM_{10} is closely correlated with number concentration, but is seems that this may not always be the case.

Enthusiasm for accepting nanoparticles as the explanation for the effects of the ambient aerosol should be tempered by recalling that identifying the fraction of the aerosol that is most closely linked with effects in not the same as identifying either the active components or the mechanisms of effect. This should be especially recalled by those calling for the abandonment of PM_{10} and the introduction of number concentration or surface area concentration as the index for monitoring the ambient aerosol. At present there is little epidemiological evidence to support the former and none to support the latter.

Studies that combine epidemiological and toxicological methods will be needed to unravel the problems discussed above. Such studies will be difficult and expensive: this, at least, is certain.

In conclusion then, great progress has been made in understanding the effects of the ambient aerosol on health in the last twenty years. Much remains to be discovered regarding the active components of the aerosol and of their mechanisms of effects. Policies aimed at reducing the effects of the ambient aerosol on health need to take such developments as have occurred into account but need, also, to be cautious and not to become inextricably linked with unproven hypotheses. Rapid developments in the field seem likely.

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Conference and Workshop Reports

Decontamination of casualties – a European inventory and perspectives, Bad Neuenahr-Ahrweiler, Germany 22-24 February 2007.

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This event was organised by the German Federal Office of Civil Protection and Disaster Assistance and was held in Bad Neuenahr-Ahrweiler at the Academy for Crisis Management, Emergency Planning and Civil Protection.

The event consisted of both seminars and workshops on casualty decontamination and was attended by personnel from the emergency services and the military in addition to medical and scientific professionals and specialists in emergency planning.

A number of presentations were given on the first day of the meeting. The first was entitled: 'Contamination of Casualties: a challenge to be met by the medical and technological communities' by **Dr. Angelika Flieger** (Federal Office of Civil Protection and Disaster Assistance, Centre for Disaster Medicine) who cited recent terrorist events to highlight the need for emergency planning and preparedness (including the need for training and exercising) in casualty decontamination and gave an overview of activities in Germany undertaken to fulfil this need.

Prof. Dr. Bernd Domres (Disaster Research Group, University Clinics Tübingen) circulated a written paper and gave an oral presentation that included the findings of a research project which aimed to develop a feasible concept for timely decontamination of a large number of contaminated casualties. The presentation included an overview of personal protective equipment (PPE) for responders, scene management, triage, disrobing and procedures for decontamination (including 'spot' decontamination) and other interventions.

Åsa Ljungquist (The National Board of Health and Welfare) and **Hans Ekåsen** (Swedish Rescue Services Agency) outlined the approach taken in Sweden to casualty decontamination, including the role of emergency services, on-scene command and control, and procedures for decontamination both at the scene of an incident and within specially designed units in hospital buildings. A presentation was also given on training for casualty decontamination in France.

During the afternoon of day 1, a demonstration of casualty decontamination was given for the benefit of the participants at Cologne Professional Fire Brigade. The demonstration included the decontamination of a non-ambulant volunteer 'casualty' using mass decontamination facilities (photograph 1).

During the morning of day 2, more presentations were given along with the meeting of four workshops groups. The first presentation by **Brigadier Norbert Fürstenhofer** was on civil-military cooperation for casualty decontamination in Austria, which was followed by a presentation by **Dr Frank Martins** (Charité – Universitätsmedizin Berlin) on casualty decontamination in the hospital setting. Dr Martins outlined the risk of secondary contamination of hospital staff due to contaminated self-presenters from the incident scene(s) and outlined the emergency management plan for Berlin and the current infrastructure and equipment available for responding to such an eventuality. In addition to the presentations, an exhibition of commercially available equipment for mass casualty decontamination was provided in the grounds of the Academy (photograph 2).

Photograph 1. Demonstration of casualty decontamination by Cologne Professional Fire Brigade (© CHaPD, 2007).

Workshop participants were asked to place themselves into one of four workshop groups: (1) Medicine; (2) Organisation and Tactics; (3) Equipment; and (4) Training. The four groups each convened for three hours and their findings were presented in the afternoon, in order that a framework paper (including recommendations) could be compiled for group discussion and amendment on day 3.

Photograph 2. Mass decontamination equipment exhibition at the Academy for Crisis Management, Emergency Planning and Civil Protection, Germany (© CHaPD, 2007).

Box 1: Key findings and recommendations presented at the workshop on the decontamination of casualties and requested support from the European Commission.

- The seminar concentrated on chemical incidents but it was agreed that most recommendations apply to all CBRN incidents and there should be one system to cope with all types of incident.
- In most countries the medical sector is the weakest part of the integrated approach.
- Decontamination has two goals: to decontaminate the casualties and to avoid secondary contamination of personnel, equipment and institutions (hospitals).
- The most effective method for decontamination is to undress patients as soon as possible.
- The procedures for undressing, triage, basic life support etc have to be evidenced-based by research.
- Member States (MS) should develop their capabilities in this area at least to a minimum level and dedicate sufficient resources to reach that goal.
- Preparedness has to be improved by defining scenarios in order to limit the consequences of a CBRN threat or incident.
- Best practices and emergency guidelines should be developed, relying on existing MS practices and documents, by exchanges of techniques and common exercises, focusing on decision making processes and Standard Operating Procedures, for example, for mass decontamination as well as decontamination of casualties.
- Cooperation between MS should be developed including trans-border cooperation, designing modules in the framework of the EU Mechanism and considering reinforcement between MS as precautionary measures, for example for major international events.
- Interoperability of equipment is recommended and achievable.
- Need for European inventory of decontamination units. Need for national stockpiles of antidotes and drugs as well as logistics.
- Means of detection need to be developed and laboratory capacity improved.
- Training is paramount for all personnel, especially for first responders.
- Training shall provide for basic as well as special skills.
- Every service involved needs special training in addition to an understanding of joint procedures and interoperability.
- Training has to be subject to quality management principles.

Requested support from the Commission:

- Organise focused experts meetings on the abovementioned subjects.
- Promote common exercises.
- Collect and promote best practices by supporting research for evidence-based results.
- Promote cross-border cooperation and possibly pre-planned reinforcements.

The overall findings and recommendations for decontamination of casualties as presented at the end of the conference (to be conveyed to the European Commission) are outlined in Box 1. Overall, the conference highlighted that many countries in Europe have developed casualty decontamination protocols which in many aspects are similar (such as use of water/weak detergent solution as the decontaminant). These aim to decontaminate at incident scenes using showers inside tents, often under direction of fire services, however there are a number of issues which would benefit from further research. The evidence base available to justify adopted approaches is sparse and there are difficulties in crowd-control on scenes of deliberate releases. At present this means that there is potential for large numbers of contaminated patients to self-present at hospitals near the scene of an incident.

The seminar presentations and workshop discussions allowed participants to gain an understanding of the approaches taken to emergency plans and response protocols used across Europe and promoted very useful discussions.

World Congress on Disaster and Emergency Medicine Amsterdam, 13-16 May 2007

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The 15th Congress of the World Association for Disaster and Emergency Medicine (WADEM) attracted over 900 participants from more than 60 countries. Its members include practitioners in acute specialties and public health who have a desire to collaborate in improving the medical management of disasters and major incidents.

A new development for this biennial congress was the use of internet discussion groups – for each of six 'targeted agenda programmes' - prior to the event itself. The debates continued during presentations and in discussion groups by invitation. Consensus statements were drafted for each of the six topics: pre-hospital resuscitation, psycho-social care, CBRN preparedness, aftercare of vulnerable groups, flooding and climate change. Full reports will be published in a forthcoming issue of Prehospital and Disaster Medicine.

The opening ceremony, with Princess Margriet of the Netherlands as guest of honour, featured a spectacular live re-enactment of Rembrandt's masterpiece *The Night Watch*. WADEM President Marvin Birmbaum's opening address described the numerous current challenges and opportunities facing disaster medicine. These included a welcome increase in disaster-related research, the ongoing vigorous debate about credentials, competencies and standards[1], and the related issue of an influx of 'amateur' responders to recent high-profile catastrophes. He also advocated a renewed focus on psychosocial care and population health. Keynote addresses included Dr Gino Strada's account of his work with victims of conflict and Jennifer Leaning's analysis of the sometimes strained relationship between disaster and humanitarian sectors.

The remainder of the conference consisted of a broad array of presentations and discussion groups. With 130 presentations and 285 posters, anyone involved in this diverse field of healthcare was spoilt for choice. Among the topics were civilian-military cooperation, burns management, disaster education, injury prevention in children and models of pre-hospital service provision. Many sessions addressed the issue of flooding; this is always of concern in the Netherlands and the risk to populations is increasing globally. The discussions were enriched by contributions from many delegates with first-hand experience of the responses to Hurricane Katrina and the Asian tsunami.

Photographs 1 and 2: The major incident demonstration. WADEM 15th Congress, Amsterdam 2007 (© Daniel Campion, 2007).

Also of interest was the programme on CBRN preparedness, where Prof. David Baker from the Chemical Hazards and Poisons Division (London), Health Protection Agency, introduced the international audience to the Department of Health Emergency Preparedness Division's newly-operational Hazardous Area Response Teams (HART). These are now operational in the London Ambulance Service and the project is currently being extended to other major cities in England and Wales. HART paramedics are trained to working in teams with firefighters to provide essential life support interventions in the intermediate or warm zone of a chemical incident. Importantly, for the maintenance of skills, they also attend minor chemical incidents on a routine basis. Clinical protocols are based on the TOXALS system.[2] The conclusions of the group included advocating a common approach for industrial and terrorist chemical incidents, a need for improved CBRN awareness among first responders, and international standardisation of training.

The climax of the congress was a live major incident demonstration in the conference centre car park, using the scenario of an aircraft crash in central Amsterdam (photographs 1 and 2). As well as demonstrating the equipment and skills of Amsterdam's emergency services, it emphasised another core theme of the congress: the previously underestimated self-reliance and altruism of disaster 'victims'.

Overall the congress was very enjoyable and well organised by Dr Joost Bierens and his committee. Much of the administration and a lively social programme were coordinated by an enthusiastic and capable group of local medical students.

Further information about WADEM is available on their website http://wadem.medicine.wisc.edu/ and all abstracts from the congress are published in the association's journal, Prehospital and Disaster Medicine.

References

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2. **Baker DJ. TOXALS: a proposed protocol for medical responders working in a chemically contaminated zone. *Chemical Hazards and Poisons Report* 2005; 3:27-29**

Future Issues in Environment and Human Health (22-23 May 2007), Knowledge Spa, Truro.

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The Peninsula Medical School hosted this international conference, which attracted renowned speakers and delegates with various specialties and interests. The conference aimed to reveal new information about possible relationships between environment and human health, to highlight emerging issues, to consider research in relation to policy formulation and to discuss international efforts to deal with impacts of the changing environment on human health.

The conference was opened by the Chief Executive of Natural England, Dr Phillips, who emphasised the importance of identifying future challenges related to how environmental quality can impact human health and well being.

Following discussions it was concluded that the evidence base demonstrating that the natural environment should be considered as a resource, needs strengthening in order to give proper economic consideration to environmental issues. In addition to directly influencing health, the natural environment can help keep people active and hence reduce the burden of disease associated with inactivity and obesity, as demonstrated by ‘Green gym’ schemes.

Dr Galloway presented results from ecological investigations that might be used as an early indication of potential hazards to human health, for example an estuarine study found unexpected ecological stress indicators up-stream from a suspected source of metal contamination, which upon further investigation, appeared to be due to an unidentified source of polycyclic aromatic hydrocarbons (PAHs). It was speculated that the new Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations might help improve risk assessments to properly consider potential environmental fates of products and likely impacts.

The recent report discussing the predicted health impacts due to climate change was discussed by Professor Maynard (Chemical Hazards and Poisons Division, Health Protection Agency). In the UK, the major threat to health from climate change will most likely be due to heat wave events. However, the evidence currently available suggests that health impacts can be dramatically reduced by behavioural changes such as reducing physical activity at the hottest times of the day.

The Joint Environment and Human Health Programme (funded and supported by the National Environmental Research Council, Environment Agency, Department for Environment, Food and Rural Affairs, Ministry of Defence, Medical Research Council (RC), The Wellcome Trust, Economic and Social RC, Biotechnology and Biological Sciences RC, Engineering and Physical Sciences RC and the Health Protection Agency) was presented by Professor Moore (Plymouth Marine Laboratory), aims to build capacity and create the multidisciplinary relationships needed to identify emerging issues related to the environment and health. The programme also aims to improve understanding of the magnitude of the risks posed by the complicated interactions between environmental, social, behavioural and political factors. The communication between researchers and policy makers needs to be strengthened to ensure research is targeted at answering the questions policy makers pose, rather than drifting into more ‘interesting’ side topics.

Other emerging issues that were discussed over the two days included the relatively new field of environmental epigenetics[1], which may contribute to current knowledge on how genes might interact with environmental factors and what impact on health these interactions might induce. Other research topics included studies into early life, pre-natal and trans-generation effects from exposure to chemicals and the need to develop models that can integrate exposure, health outcomes and socio-economic indicator data to help prioritise health issues. It was noted that there are few examples of where the knowledge base allows an economic health assessment to facilitate a cost benefit analysis, which is the most effective method of influencing policy decisions. Biomonitoring was also discussed as a useful measure of policy efficacy (for example the decrease in blood lead levels measured following the removal of lead from petrol).

The ethos of a multi-disciplinary approach was finally captured by plans to develop an international centre for research on human health and the environment. Such plans will require input from experts with different backgrounds including medics, environmental scientists, toxicologists and policy makers. Overall, this conference provided a useful platform to share ideas between groups with such diverse backgrounds in order to advance current knowledge related to the environment and its impact on human health. For further details the presentations can be downloaded and viewed at http://www.pms.ac.uk/ahcc/conferenceInfo.php.

References

1. http://www.epigenome-noe.net/aboutus/epigenetics.php , accessed 31/05/07.

Environment & Human Health: Joining the Dots - The 25th European Conference of the Environmental Geochemistry and Health Society, Liverpool, June 2007.

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Making multidisciplinary dialogue work can be very hard: vocabularies, experiences, expectations and attitudes can all be radically different. Perceptions of the 'opposition' can be stereotypical and stultifying. Opportunities to work together for a common goal can be either threatening or even, sometimes, energising. The Society for Environmental Geochemistry and Health (http://www.segh.net/journal.htm) has a well established track record for inter-disciplinary work in issues affecting the environment and human health, but has recently been dominated by geochemists, with insufficient input from the medical and public health side of the equation.

The 25th European Conference of the Society, held in Liverpool in June 2007 and hosted by the Cheshire & Merseyside Health Protection Unit, offered an opportunity to reverse this. The conference was followed by a Natural Environment Research Council (NERC) - sponsored $2^1/_2$ day interactive workshop. A field trip to local sites linked the two meetings, intertwining environmental and human issues in the real world and preventing the days becoming focused solely on theory.

Delegates came from the health sector (including the HPA), local authorities, academia and industry, and ranged from postgraduate students through practitioners and researchers to the Vice-Chancellor of Winchester University, a geochemist by training and experience.

One of the unusual features of the plenary sessions in the conference was the pairing of speakers and topics. For example, a talk on the Contaminated Land Exposure Assessment (CLEA) model from Ian Martin of the Environment Agency was followed by David Russell of the Chemical Hazards and Poisons Division of the HPA on the evidence for health effects from contaminated land. Such pairing was much appreciated by the delegates, particularly as speakers were able to present technical information in terms understandable by non-specialists. The oral and poster presentations further contributed to a useful interchange of ideas and the making of friendships and interdisciplinary links.

In the workshop, entitled MULTITUDE (Multiple Links Towards Integrating Teams for Understanding of Disease and Environment), there were five separate streams, with delegates able to attend and contribute to three. The themes covered the whole range of environmental issues from basic geo- and bio-chemistry through measurement problems and uncertainty in risk assessment and epidemiology, social, economic and behavioural factors, to the effects of multiple toxins and strategies for improving health in contaminated situations. Delegates and workshop leaders were encouraged to cross fertilise each new discussion with input from other workshops and from previous iterations of the same workshop.

The evaluation of the four days was very encouraging for the organising committee, with average scores for all the speakers of over 80% and for the MULTITUDE workshop of over 90%. This, plus verbal feedback, encourages us that we achieved the objectives of the meetings of

- providing authoritative and accessible reviews of key issues from both perspectives,
- identifying and addressing gaps in our current understanding and
- initiating interdisciplinary collaboration.

The proceedings of the meeting will be published in *Environmental Geochemistry and Health*, acting as a focused review and starting point for further development of this integrated approach.

The next meeting of the society is in Athens, 31st March to 3rd April 2008 (http://conferences.geol.uoa.gr/segh2008/), where we hope to hold another, shorter, workshop as well as the usual scientific conference.

Sponsors

Health Protection Agency; Centre for Public Health, Liverpool John Moores University; Natural Environment Research Council; Department for Environment Food & Rural Affairs; Economic and Social Research Council; Ministry of Defence; Environment Agency; ThermoFisher Scientific; United Utilities.

Training Reports

Level 2 Chemicals Training

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Dr Naima Bradley, CHaPD (East Midlands)
Dr Kirsty Foster, Northumberland, Tyne & Wear Health Protection Unit
Robie Kamanyire, CHaPD (London)
Mike Saunders, Eastern Region
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Introduction

A key goal of the Health Protection Agency is *'to protect against the adverse health risks of acute exposure to chemicals, poisons and other environmental hazards'.* Local and Regional Services (LaRS) undertook a self-assessment exercise in November 2006 to describe the preparedness of Health Protection Units (HPUs) to deal with a major chemical incident and to meet the requirements of the Health Care Commission.

Three areas for LaRS chemical incident response training were identified following this exercise (Appendix, page 58):

1. Specific training for chemical incidents (acute and chronic)

2. Generic incident and major incident response

3. Multi-agency partnership exercising

A chemicals training programme was agreed by the Chemical Hazards and Poisons Division (CHaPD)-LaRS network in January 2007. The first training day was piloted in the East Midlands at the end of June, and will be rolled out in the other regions in the autumn.

The chemicals training programme aims to train HPU and LaRS-regional HPA staff to achieve 'Level 2' competence for the management of chemical incidents and to meet the requirements of the Health Care Commission relevant to preparedness and response to chemical incidents (core standard 24). It is based on the core Environmental Public Health competencies developed by Dr Jackie Spiby and published in a previous issue of the Chemical Hazards and Poisons Report (*February 2006, page 57*, http://www.hpa.org.uk/chemicals/reports/chapr6_feb2006.pdf), and the training needs identified in the LaRS self-assessment exercise. It builds on existing chemicals training within CHaPD and LaRS, and will be integrated with emergency/incident training and exercises.

Aims

The chemicals training is aimed at 'Level 2' as defined by the HPA Workforce Development Group (Table 1). Further work is needed to define in more detail the specific competencies for HPU response to chemical incidents. This will form part the programme development for 2007/8.

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/Toxicology Scientist	Specialist chemical/environmental scientists, engineers, epidemiologists or public health practitioners
4	Super specialist	Named individuals in specialist divisions and teams	Expert advisors in chemical incident response

At present, Level 2 competence for HPUs in the management of chemical incidents has been more generally described by the CHaPD-LaRS network as the knowledge and skills required by HPUs to:

1. Meet their responsibilities as second and/or third on-call for health protection.
2. Use specialist advice and support appropriately in the management of chemical incidents (acute and chronic), including CHaPD supra-regional teams, and other agencies as appropriate.

Learning objectives

The learning objectives are:

1. To demonstrate an understanding of the roles and responsibilities of Health Protection in the management of chemical incidents;
2. To demonstrate an understanding of the roles and responsibilities of other agencies involved in chemical incident management, and how they interact with Health Protection;
3. To understand the principles of risk assessment, biomonitoring, environmental sampling and modelling, and their application in the investigation and management of a chemical incident;
4. To understand the principles of communication and management where there are unresolved public concerns in environmental incidents.

Topics covered on the training day are shown in Box 1.

Target audience

This course is targeted at CsCDC/Health Protection Specialists and other HPU/LaRS staff with on-call responsibilities, but is also open to CHaPD toxicologists, environmental scientists and other specialist staff with daytime duty-desk responsibilities.

Training programme development and evaluation

The Level 2 chemicals training is now in its first phase. It was piloted in the East Midlands Region at the end of June, and was well evaluated by the participants. The working group will continue to monitor and modify the training as it is delivered and evaluated in other regions over the next few months.

Further work is needed to develop the Level 2 chemicals/environmental training, assessment and accreditation in line with the development of the HPA's environmental programme, but also in line with developing scientific and clinical knowledge, and the evolving needs, skills, knowledge and experience of HPA regional and HPU staff.

Box 1: Programme for Level 2 Chemicals Training Day

Morning

Pre-course assessment exercise

Roles and responsibilities

- Health Protection Agency
- Emergency services
- Local Authorities
- Environment Agency

Risk assessment

Environmental and biological monitoring

Communication and management where unresolved public concerns

Afternoon

Interactive exercise including:

- Site visits, safety & Personal Protective Equipment (PPE)
- Data handling
- Environmental and biological monitoring
- Communications

Post-training assessment exercise

Regional Delivery

The dates of the regional training sessions are listed in Table 2.

Table 2: Provisional dates for Level 2 Chemicals Training

Date	Region	Venue
2nd October	West Midlands	Birmingham
4th October	South East	Holborn Gate
9th October	Eastern	Cambridge
9th October	South West	Taunton
1st November	North East	Durham
13th November	North West	Warrington
15th November	Yorkshire & Humber	Leeds
22nd November	London	Holborn Gate

APPENDIX: Key elements of HPU chemical incident training

Chemical incident training		**Proposed delivery**
Specific chemical incident training	a. Roles and responsibilities for management of chemical incidents (Generic HPU staff, Specialist CHaPD staff, such as toxicologists, environmental scientists) b. Risk assessment c. Risk communication (to professionals, public and media) d. COMAH sites e. Toxicology and biomonitoring f. Environmental epidemiology g. Environmental sampling and modelling	CHaPD and CHaPD/LaRS supra-regional teams
Generic incident & emergency response	a. HPA incident and emergency plan b. Strategic, tactical and operational roles including Public Health Adviser, Scientific and Technical Advice Cell (STAC) and Strategic Co-ordinating Group (SCG) roles and responsibilities c. Record keeping, logging (evidence for public enquiries) d. Emergency Operations Centre (EOC) operations e. Debriefing and reports	Health Emergency Planning Advisers (HEPAs) and CHaPD/LaRS supra-regional teams
Regional multi-agency incident/emergency response exercises	Chemical incident scenario by end 2007/8 and at least once every three years after that	HEPAs and CHaPD/LaRS supra-regional teams, together with partner agencies +/- support from the Centre for Emergency Preparedness and Response (CEPR)

Public Health meets Environment Training Days

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Introduction

To exercise and improve the multi-agency response to environmental incidents across the West Yorkshire region, two joint training events were organised on the management of environmental incidents. The training days were organised and facilitated by representatives from the Leeds Health Protection Team, The Environment Agency and Leeds City Council. The training days were designed for any organisations across the region that would have a role in managing the acute and chronic effects of environmental incidents.

Part 1: 'Public Health Meets Environment': Management of Acute Environmental Incidents

The overall objectives for the event were:

- To improve understanding of the interactions between local agencies involved in acute environmental incidents affecting health in West Yorkshire.
- To provide an opportunity to meet local colleagues from other agencies involved in managing incidents.
- Identify training needs and how these can be met in the future.

Summary

The event took place on the 18.9.06 at the Environment Agency in Leeds. Fifty delegates attended from across West Yorkshire with representatives attending from the Health Protection Agency (HPA), Environment Agency (EA), Local Authority (LA) and the emergency services. The day opened with short presentations from the participating organisations outlining their roles and responsibilities when dealing with an acute environmental incident. Following the presentations, delegates were split into groups based on local authority geographical boundaries with delegates from all the main organisations being represented in the groups. Each group, consisting of about 10 people, worked through a facilitated table top exercise based on the management of a major fire at a factory containing unknown chemicals. Various experts were on hand throughout the exercise to assist including HAZMED Officers (Yorkshire Ambulance Service staff trained in the management of acute environmental incidents) and fire service HAZMAT Officers. The exercise was followed by a presentation from Robie Kamanyire, from CHaPD London, on the Buncefield incident. The day was concluded with a session looking at 'what's next?', with the aim of identifying future training events and consolidating the learning. The session identified a need for an event to explore roles and responsibilities of the participating organisations when dealing with the chronic effects of an environmental incident, hence the planning and delivery of part 2.

The event was evaluated using a pre and post event questionnaire; very positive feedback was received from participants. After the event, 89% of delegates reported that they felt fairly confident in dealing with an environmental incident. Delegates particularly valued working in their own local authority based groups, which allowed them to interact with the people they would manage a real incident with.

Part 2: 'Public Health Meets Environment': After the Blue Lights Have Gone

Summary

This second event took place at the Environment Agency in Leeds on the 10.5.07. Approximately fifty delegates attended with a mix of those who had attended the first event and new delegates. The agencies represented were the HPA, LA, EA and Primary Care Trusts from across West Yorkshire. The day followed a similar format to the previous event with a short presentation of the participating organisations roles and responsibilities, which was followed by a facilitated table top exercise building on the scenario used in the first event but focussing on the longer-term impacts. The scenario also included issues surrounding public perception and media coverage of a chronic incident.

The day concluded with three presentations aimed at consolidating the learning from the exercise and relating to real life events. The first was from Professor John Maule, from Leeds University, exploring the perception and communication of risks. The second was from Viv Brealey, Communications Manager Yorkshire and Humber HPA, on how the media cover events with examples of the reporting of recent incidents. The day ended with a presentation by Dr. Rosy McNaught (an HPA CCDC) entitled 'The Big Stink", which reviewed the learning points from an ongoing incident in South Yorkshire that she had been involved in for a number of years. As with the previous event, the day, received positive reviews with many delegates stating that the key benefits of the approach used were the networking opportunities and improved awareness of who to contact in each responding agency in the event of either an acute or chronic environmental incident.

Conclusion

Both events can easily be replicated within any region and we now have two training packs that are planned and ready to be delivered again in the future. If anyone would like to use the prepared training materials and implement the training in their region please contact Mike Gent (Mike.Gent@hpa.org.uk). Following the success of the events the organisers are now planning 'Public Health Meets Environment 3' which is being designed to explore the multi-agency response to an air quality incident. Initial plans are that the event will take place in November 2007.

Acknowledgements
The authors would like to thank: Bridget Butler (Principal Scientist, Human Health Science; Environment Agency); Roger Harman (Principal Officer - Incidents and Emergencies Environment Agency); Susan Porritt (Emergency Planning Officer, Leeds City Council); Phil Gamble (Service Manager, Environmental Health Services); Vince Jenner (Emergency Planning Officer, Leeds City Council).

Carbon monoxide - a communications perspective

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The Chemical Hazards and Poisons Division (CHaPD) hosted a carbon monoxide (CO) training day on the 25 May at Holborn Gate. The audience included HPA LaRS (Local and Regional Services), HPA CHaPD, local authority (LA), and Environmental Health and Toxicology specialists. Learning objectives for the day included gaining knowledge on the clinical features of CO poisoning; the public health implications of CO toxicity in the UK; the potential and limitations of methods used for biological and environmental monitoring; emergency and local responses to CO incidents; and current programmes in place to prevent CO exposure and toxicity in the UK. The main aims of the meeting were to increase awareness amongst the participants of the issues surrounding CO poisoning and to identify local-level priorities for CO research and intervention projects. A range of presentations were given by representatives from health, academia, government and non-governmental organisations to achieve these aims. This was then followed by an open discussion which asked the questions 'what do we need?' and 'what can we do together?'. The outcomes of this discussion were recorded and then presented at the Indoor Air Seminar on the 29 June 2007, an academic seminar organised by the Air Pollution Unit of the Health Protection Agency, and the Royal Society of Medicine Epidemiology and Public Health Unit. Issues identified during the training day included:

- research and development
- building on, and combining current government initiatives
- development of guidance for health protection professionals
- reporting and surveillance
- raising awareness

In this article, communications issues surrounding raising awareness are discussed. When considering awareness about the health effects of CO, there are two main stakeholders: healthcare professionals and the general public. These two groups have different requirements but raising awareness amongst them is equally important. It should therefore be addressed separately in different ways.

Health protection and healthcare professionals

Increasing awareness about both acute and chronic CO poisoning amongst healthcare professionals is important as the accurate reporting of CO poisoning incidents is essential in order to reduce risks from further exposure. Although reporting from the local authorities (LAs) and the primary care trust (PCT) has increased, there is a gap in reporting of incidents from hospital Emergency Departments (EDs). This indicates the need for awareness raising amongst staff within EDs, although others who might encounter CO poisoning, such as GPs, nurses and paramedics, should also be targeted. This training would help staff to spot the signs of CO poisoning and alert them to the dangers of sending patients home, possibly to an environment which may continue to be hazardous to health. The training could also be used to provide them with public facing material explaining the dangers of CO and how to prevent exposure and make their home safe, that they could give to patients. This could be in the form of a leaflet or information sheet. When paramedics attend the homes of patients with CO poisoning, they may be putting themselves at risk, so specialist training should be given to this group in recognising and responding safely to situations where exposure to CO may be a problem.

The general public

The public perception of health risks can be shaped by the communication processes used to distribute information about hazards. Although information is already widely available in the public domain, there still appears to be a level of naivety surrounding the dangers of CO. When designing a comprehensive communications strategy, the general public should not be thought of as one unit. By considering specific groups of people individually, the information can be tailored in the most accessible way to them and presented accordingly. There should be increased targeting of the information to the most vulnerable groups of people (e.g. the elderly, low-income families, people with disabilities). Organisations concerned with the well being of these groups can be used to help relay this information, as they already have expertise and established communicatio channels in this area. Collaboration with these organisations could therefore aid in the dissemination of information about the issue.

Collaboration with Environmental Health Practitioners would be beneficial. They are in a prime position to raise awareness amongst the general public and to be able to recognise and prevent incidents involving CO in the home. LAs are keen to develop health promotion in conjunction with the enforcement duties held by Environmental Health Practitioners and work with them to help do this role which could form part of a wider communications strategy.

In addition to information about the prevention and recognition of CO poisoning, there is a need for clear accessible information about what to do when CO poisoning is suspected. It is important for industry to be involved in this process, and a possible way of distributing this information could be through its inclusion in fuel bills. This could be done via a leaflet included in the envelope with the bill, or information printed on the back of the bill itself.

The Health and Safety Executive (HSE) are responsible for investigating and determining responsibility in cases of CO poisoning, and are keen to publicise this. It is important for the health aspects to be included when publicising cases following prosecution warning of the risks associated with CO and advice on prevention. These cases are mainly of interest to the local press and the development of a standard HPA CO press release template which HPUs could use in these situations would be useful in these cases.

Conclusion

In conclusion, raising awareness about issues relating to CO needs to be a co-ordinated, multi-organisational project in order for it to be effective. Healthcare professionals and the general public require seperate information which needs to be targeted specifically with them in mind.

London Ambulance Service Training Day 12 July 2007

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The aim of the training day was to test the new London Ambulance Service major incident plan for London and to ensure it was compatible with the newly revised London Emergency Services Liaison Panel (LESLP guidance). The participants were the LAS gold and silver cadre and external agencies invited to give expert advice as required. Additionally the London Hazardous Area Response Team (HART) demonstrated the equipment available in one of their response vehicles.

The event commenced on the Wednesday evening with a review of recent major incidents in London and a briefing on the new Major Incident plan. The main tabletop exercise began early on Thursday morning with the LAS attendees being split into four 'Silver' groups and a fifth 'Gold' group. The tabletop scenario was very challenging with each of the four silver commands working on a different scenario set in different areas of London during the same time frame. They were made aware of the other incidents as the exercise progressed; whilst Gold command had an overview of all parts of the unfolding incident.

The external agencies giving expert advice included: the LAS business continuity service, the emergency bed service, Chemical Hazards and Poisons Division London, Metropolitan Police Service (including a representative from the anti-terrorism branch), the London Fire Brigade, The London Borough of Croydon, the Patient Transport Service, the East of England Ambulance Service and the St John's Ambulance Service representing the voluntary ambulance services

All external agencies were briefed before the exercise began. Experts could be requested by any group as required and were able to observe the exercise as the day progressed. LAS were using their radios for communication and also mobile telephones where necessary as the exercise included numerous communications failures for added realism. Some groups were fortunate enough to hear what was going on at all sites but only gold command had a true overall of the whole scenario.

The day gave an opportunity to strengthen links between LAS officers and CHaPD and to gain a better understanding of the roles of the wider HPA including local units, HEPAs and also the local PCTs. Some of the station commanders requested further training for their officers around awareness of the roles and responsibilities of the HPA.

International Conference

Health Protection Agency

Joint working, problem sharing: Protecting the health of communities in the 21st century

20 & 21 May 2008
Hilton Manchester Deansgate

This international conference will focus on the modern environment – the health implications for its communities and the opportunities for sustainable development. It will examine the association between social deprivation and the local environment, highlighting the risks for vulnerable groups, in particular children and the workforce. It will focus on issues of historical waste, in particular contaminated land as well as contemporary waste generation and its management. The conference will lead on to debate contemporary threats – climate change and its challenges and disasters and chemical emergencies.

The conference, convened by the Health Protection Agency Chemical Hazards and Poisons Division, will appeal to all with a role to play in the environment and health, including health and occupational healthcare professionals, first line responders, environmental scientists, policy makers, environmental health officers and emergency planners.

For details please visit:
www.hpa-events.org.uk/chemicalconference

Training Days for 2007

The Chemical Hazards and Poisons Division (CHaPD) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2007 programme is being developed to offer basic and more detailed training, along with the flexibility to support Local and Regional Services initiatives as requested.

Contaminated Land

25th September 2007, Holborn Gate, London

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars/Trainees in Public Health and Local Authority environmental health practitioners

The Training Day will provide delegates with the tools and information to provide an appropriate and timely Public Health response to contaminated land investigations.

General aims:

- To understand the role of public health in the management of contaminated land investigations
- Awareness of the appropriate and timely response to contaminated land investigations
- To understand the interaction with other agencies involved in the investigation and management of contaminated land
- To review current issues relating to the management of contaminated land incidents and investigations including:
    - The Toxicology of Soil Guideline Values
    - Bioaccessibility in Risk Assessment
    - Case Studies on Managing Incidents of Land Contamination

Specific objectives:

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

A maximum of 40 places are available

How to Respond to Chemical Incidents

30th October, Holborn Gate, London

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

The general aims of these basic training days are to provide:

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

These training days also have specific educational objectives. These are, to be aware of:

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

A maximum of 40 places are available

Training Days for 2007

The Chemical Hazards and Poisons Division (CHaPD) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2007 programme is being developed to offer basic and more detailed training, along with the flexibility to support Local and Regional Services initiatives as requested.

Provisional Level 2 Chemical Training Days

Date	Region	Venue
2nd October	West Midlands	Birmingham
4th October	South East	Holborn Gate
9th October	Eastern	Cambridge
9th October	South West	Taunton
1st November	North East	Durham
13th November	North West	Warrington
15th November	Yorkshire & Humber	Leeds
22nd November	London	Holborn Gate

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars/Trainees in Public Health (see page 56 for detailed article on level 2 training).

The chemicals training programme aims to train HPU and LaRS-regional HPA staff to achieve 'Level 2' competence for the management of chemical incidents and to meet the requirements of the Health Care Commission relevant to preparedness and response to chemical incidents (core standard 24). There is no charge for level 2 training.

The learning objectives are:

1. To demonstrate an understanding of the roles and responsibilities of Health Protection in the management of chemical incidents;

2. To demonstrate an understanding of the roles and responsibilities of other agencies involved in chemical incident management, and how they interact with Health Protection;

3. To understand the principles of risk assessment, biomonitoring, environmental sampling and modelling, and their application in the investigation and management of a chemical incident;

4. To understand the principles of communication and management where there are unresolved public concerns in environmental incidents.

Booking Information

Those attending CHAPD (L) courses will receive a Certificate of Attendance and CPD/CME accreditation points.

The cost of the training days (level 2 days excluded) are £25 for those working within the Health Protection Agency and £100 for those working in organisations outside the Health Protection Agency. Places will be confirmed as reserved upon receipt of the fees. These charges are to cover lunch, training packs and administration costs.

For booking information on these courses and further details, please contact Karen Hogan, our training administrator on 0207 759 2872 or chemicals.training@hpa.org.uk

CHAPD (L) staff are happy participate in local training programmes or if you would like training on other topics, please call Virginia Murray or Karen Hogan to discuss on 0207 759 2872.

Events organised by other HPA centres

If you would like to advertise any other training events, please contact Karen Hogan (chemicals.training@hpa.org.uk).

Please see the CHaPD Training Events web page for regular updates: http://www.hpa.org.uk/chemicals/training.htm

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Available to Government Departments, allied Agencies and Organisations, First Line Responders, the NHS and other HPA Divisions