Chemical Hazards and Poisons Report

From the Chemical Hazards and Poisons Division
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Contents

Editorial

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In this issue a number of significant incidents are presented, one of which is a concerning case of cyanide poisoning. The value of early alerting to chemical incidents is highlighted in a paper on the role of public health practitioners during non-major incidents. A series of odour-related incidents that occurred at an acute NHS hospital trust are documented as these resulted in the closure of part of the hospital. Two articles on lead are included in this issue: the first is a case series of lead poisonings associated with environmental sources; the second is on the development of a lead 'action card' for public health practitioners.

Readers should note that there is a new telephone number for the Chemical Hazards and Poisons Division Hotline: 0844 892 0555.

A number of articles related to emergency preparedness are included. Of note is the 'Emergency Clinical Situation Algorithm' which provides immediate guidance for the front-line clinician. In addition, papers are given on helping individuals and communities cope in the aftermath of flooding; the West Yorkshire 'Hazmed' service; and 'Exercise Stinkhorn' -a multi-agency 'live-play' exercise involving mass casualty decontamination.

Environmental issues are as always, of significance and in this issue, the focus is on air quality. Our series on air pollution continues with 'Particles as Air Pollutants 4: The Epidemiology'. An article entitled: 'Atmospheric stability: what happened at Buncefield?' provides an overview of the key meteorological factors influencing the behaviour of smoke plumes. Articles are also presented on the history and development of the WHO Air Quality Guidelines and the findings of a recent literature review on the public health impact of asbestos exposures from industrial fires.

A series of conference and workshop reports are included in this issue, covering a wide range of topics: Gold command experience; chemical, biological and radiological clean-up after incidents; environmental epidemiology and waste-related public health issues.

The next issue of the Chemical Hazards and Poisons Report is planned for May 2008. The deadline for submissions for this issue is 1st March 2008. 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

An incident of cyanide poisoning: acute response and public health considerations

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Introduction

On the evening of Monday 12 March 2007, an adult male was arrested by Derbyshire police. It was reported that, whilst in the back of a police car, he had swallowed two mouthfuls of a dark liquid out of a soft drink (cola) bottle and then told the police that he had taken cyanide. He quickly became apnoeic and the police took him to the Emergency Department (ED) at Queens Medical Centre, Nottingham.

An Intensive Care Perspective

On arrival at the ED, an oropharyngeal airway had been inserted, with the patient displaying a laboured respiratory rate of 4 associated with bradycardia and hypotension. His Glasgow Coma Score was 3, with fixed 7mm dilated pupils. Within minutes of being in the department, the patient sustained a cardiac arrest, for which he received advanced life support measures, including 1mg of epinephrine. Spontaneous circulation was returned after 2 minutes cardio pulmonary resuscitation (CPR) but two further arrests occurred, requiring further doses of epinephrine and CPR. In between these events further invasive monitoring was instigated and the man was also put on a ventilator.

In discussion with the police officers the hospital staff discovered the history of sudden collapse after drinking from the cola bottle. The man also had a bottle of amyl nitrate ('poppers') upon his person. On opening the bottle, a strong smell of almonds was noted and the tentative diagnosis of cyanide poisoning was entertained based on the history and subsequent clinical state of the patient.

After consultation with the National Poisons Information Service (NPIS) Birmingham, dicobalt edetate (an intravenous antidote) was administered, along with full supportive measures. The patient was transferred to the adult Intensive Care Unit (ICU). On discussion with his family, it was discovered that, some years previously, he had been employed at a bicycle factory where he had worked with cyanide as part of his job.

By the following morning, his condition had showed no signs of improvement. Toxicology results were being awaited and the possibility of further analysis of the sample was deemed possible by a QMC biochemist. A sample of liquid was decanted from the cola bottle into a universal container and transported to the laboratory for potential analysis, although subsequently this did not take place.

A CT of the brain showed appearances in keeping with severe diffuse hypoxic brain injury. After discussion with the family, brain stem testing was performed and the patient was certified dead at 19:30 on 13 March and referred to the coroner.

During this time, over the course of the day, the police became increasingly interested in the incident, especially as there was a potentially dangerous substance in the custody of two police officers in the hospital on the ICU. Numerous telephone conversations ensued, ultimately ending with the arrival of three representatives from the Fire Service. Under Fire Service supervision, the container was moved through the hospital to a fume cupboard in the biochemistry department, where further analysis was undertaken. Preliminary results confirmed the presence of prussic acid (hydrogen cyanide).

The HPA perspective – 13 March

East Midlands North Health Protection Unit (HPU) was notified at 15:30 on 13 March 2007 that there was a patient on a ventilator at Queens Medical Centre ICU who may have taken cyanide. The HPU liaised with the ICU staff to establish the details of the case. The brother of the patient had informed the police and hospital that several years ago his brother had stored a number of chemicals, including a cyanide salt taken from his then employer, under his floorboards. The police had subsequently cordoned off the house.

The contents of the cola bottle were analysed using a mass spectrometer at the hospital and the results were made available late in the afternoon of 13 March. The 500ml capacity bottle contained 400ml of dark liquid, found to contain 0.1% prusside (cyanide salt).

After taking advice from the Chemical Hazards and Poisons Division (CHaPD), the HPU advised the ICU regarding management of the ventilator (18:30). Although the risk was considered low, the ventilator should not be re-used until flushed through with a non-acidic gas in a fully ventilated room by staff in full chemical Personal Protective Equipment (PPE). Disposal of the body was discussed as chemical body bags were difficult to obtain. It was considered that the body could potentially be 'double-bagged' using normal body bags as the associated risk to those handling the body was deemed to be low.

The HPU then contacted Derbyshire Police Force. They were advised that any search of the house on the following day should be undertaken in liaison with the Fire Service and carried out using chemical PPE. It was recommended that the police officers called to the incident be asked about any spillage in the police car and, that in any investigation of the car, chemical PPE be used when checking for spilt chemicals or bodily fluids.

Box 1. Role of Chemical and Hazards and Poisons Division (CHaPD) on 13 March

The HPU liaised with CHaPD on-call (17:05). Staff at the Newcastle Unit of CHaPD (now the Medical Toxicology Research Centre at Newcastle University) responded to enquiries from the HPU regarding: any remaining chemical(s) at the patient's residence and/or place of work; tracing contacts; and, in the event of death, arrangements for handling the deceased's remains especially the risk of off-gassing post mortem; decontamination of equipment; and the risks to hospital staff carrying out resuscitation - although no symptoms were reported amongst hospital staff).

CHaPD provided the following advice:

- A search of the house should be undertaken, preferably in full PPE (where practicable), as a precaution.
- Tracing of contacts was not necessary, as those exposed to hydrogen cyanide from off gassing are not themselves considered to pose a secondary contamination risk. Furthermore, the effects associated with inhalation of cyanide manifest themselves rapidly, so any health effects in contacts would have been apparent.
- Equipment (such as the ventilator) should be flushed through with an inert liquid or gas in a well-ventilated space. Although off-gassing of hydrogen cyanide following ingestion of cyanide salts (and conversion into hydrogen cyanide following contact with stomach acid) is possible, the evolved cyanide usually binds rapidly to biological material. Hence, the risk to health care workers would be considered to be low and, since no symptoms had been reported, further health effects at this stage would not be predicted. However, CHaPD advised that any body fluids, such as vomitus, in the police car should be treated with caution, as these might have represented a theoretical off-gassing risk.
- Ideally a chemical body bag should be used, though these may be difficult to source. Otherwise, the deceased should be kept in a well-ventilated space until an autopsy (if required) could be performed. However, the risk of off-gassing was considered to be low based on the information given.

HPA perspective – 14 March

On 14 March, CHaPD Nottingham liaised with the Consultant Biochemist at QMC and with the Derbyshire coroner regarding the body. The coroner stated that there would be no post-mortem until the results of the antemortem samples were known, due to concerns over staff safety. The seemingly low concentration of cyanide found in the cola bottle caused some concern, although cyanide poisoning remained the working hypothesis due to consistent symptoms and circumstances. Antemortem samples and a specimen from the bottle were sent to Sheffield for analysis.

Following concern over vomit on the seating, the police were further advised to keep the car out of circulation until the chemical involved was formally identified. Following an initial sample on the morning of 14 March, showing inconclusive results (99.1% water with amyl nitrate and possible traces of cyanide), the police sent the bottle to a police forensic science laboratory.

HPU staff attended a multi-agency meeting at 15:00 on 14 March to discuss how to undertake the search of the house. At this time, blood test results were unavailable and preliminary analysis, although indicating that cyanide was present in trace quantities was inconclusive. After discussion with a former employee at the factory where the patient had worked (who had knowledge of the chemicals used on site), the police were concerned by the potential for a large amount of cyanide, believed to be in crystalline form, and other chemicals to be inside the house. In the event of the use of full PPE, it was felt that there may need to be a limited cordon around neighbouring houses. The options considered at the meeting included that of carrying out an evacuation due to the unknown quantities of chemicals in the house.

The cyanide compound was thought to be potassium cyanide in crystal/solid form. Cyanide in a gaseous form was not expected if the reagent was a solid. However, hydrogen cyanide could be liberated if mixed with acid, which could pose a hazard if released into a non-ventilated enclosed space. After taking toxicological advice from CHaPD, the HPU advised that there was expected to be minimal absorption through skin and that the main route of toxicity is via ingestion. Ventilation of the house was recommended, and sufficient PPE was considered to be gloves to avoid skin contamination when sweeping up any potential solids and masks to prevent inadvertent ingestion of cyanide. It was stressed that it was important to search thoroughly as chemicals may be stored with food, other substances and in unusual places.

The outcome of the meeting was that the police put in a limited cordon overnight rather than carrying out an evacuation. A search and risk assessment was carried out at 19:00 by Fire Service personnel wearing PPE; to determine whether hydrogen cyanide was present. This preliminary search and risk assessment was carried out using cold light sources (due to the risk of inflammable gas). The Fire Service ventilated the property and full clearance was planned for the following day.

Closure – 15 March

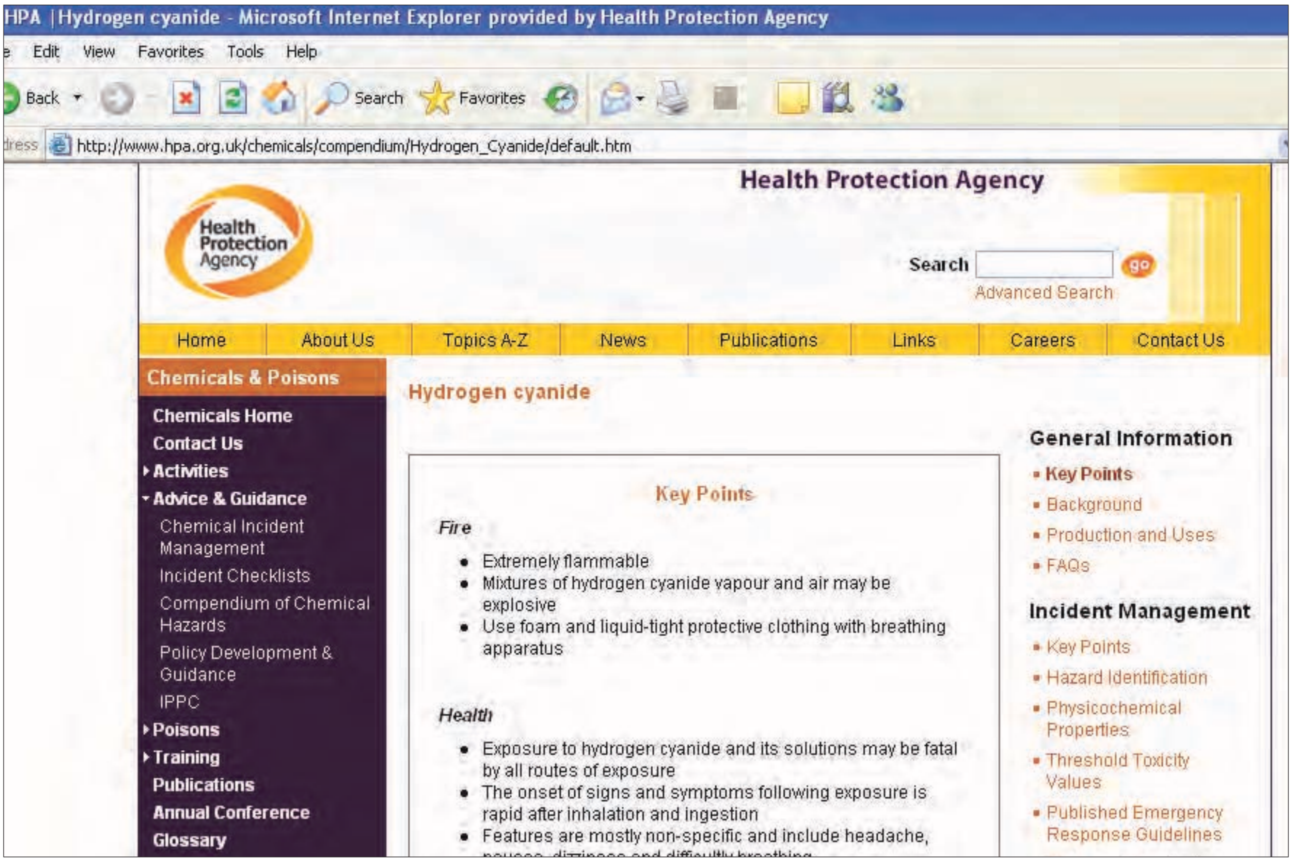
The following day the house was searched and a biscuit tin containing chemicals, presumed to be cyanide, was subsequently found and disposed of by the police. They were advised to contact the Environment Agency regarding safe disposal routes. There was no substantial media interest other than local reporting. It was established that there was no ongoing risk to the public and the HPA stood down.

Postscript

Subsequent analysis showed that the biscuit tin contained sodium cyanide and hydrated sodium carbonate. On further examination, a white powder was found around the cap of the cola bottle. It was estimated that 25ml of the contents could prove fatal without immediate medical assistance. The deceased's blood sample showed cyanide concentrations of 8.4 mg/l – approximately 16 times greater than a level that could be considered fatal.

Learning points

- The HPA became aware of the incident when a QMC staff member queried aspects of the case late on 13 March – neither the Police, Fire Service, nor hospital staff had recognised the need to involve the HPA earlier. Consideration of public health implications should be encouraged at all times and stronger links should be forged with Emergency Departments and ICUs in order to improve alerting in cases which may have public health implications.
- There was a considerable delay before the HPA was notified - hospital staff had opened the cola bottle and although staff used gowns, no further PPE was used in treating the patient. In a similar situation involving different chemicals there could have been significant adverse health consequences.
- There were problems in identification of the transport ventilator (used to transport the patient from the ED to intensive care) for decontamination due to incomplete logging.
- The involvement of a Police CBRN officer caused undue confusion. The officer was involved because of his knowledge of chemical incidents, not because this was considered or suspected to be a CBRN incident.
- The fact that the patient was a death in custody meant that the police involvement and their communication with other organisations had added complications.
- The patient had mental health issues which complicated interpretation of events.
- The patient had taken cyanide in the house and then washed it down with what was though to be cola. This was not immediately apparent at the start of the incident and uncertainty over what other chemicals might have been involved was a complication throughout.
- Detail concerning sampling methodology and timescales was very sketchy. It is important to obtain information concerning the process, timescales, and validity.
- The presence of the HPA at the multi-agency meeting prevented wide-scale evacuation due to fear of chemical release; the final action was that a small cordon was emplaced and the other half of the deceased's semi-detached house was evacuated on the basis that unknown chemicals were present.



The challenges and importance of early public health advice in non-major incidents

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Introduction

Whilst reviewing local incidents in the North East region of England, HPA staff identified that a significant proportion of incidents are not declared as major incidents by any of the emergency services. In fact, anecdotal reports from colleagues working in emergency response across the region, suggest that Strategic Command Group / Gold command response is a rare occurrence and most incidents are managed at a Tactical (Silver) or Operational (Bronze) levels.

The challenge for public health and health protection professionals is to provide early public health advice to those involved in the response to these incidents. This involves raising awareness about the potential public health impact in non-major incidents and developing robust local arrangements to ensure that, when requested, public health advice can be given in a timely fashion to allow effective management of the incident and protection of the public's health.

'Non-major incidents' can be a wide variety of situations; however they are important for a number of reasons:

- There may be risks to the public health – even if it is to a relatively small number of people, and hence a major incident is not declared.
- There may be perceived risk to public health – either from members of the public or through media coverage. Some incidents appear dramatic to members of the public, for instance large fires with exploding canisters. Managing perceived risk is important to reassure the public and maintain the public's trust in the health messages given by the emergency services.
- There may be potential risks to responders.
- There may be impact on local health services – both secondary care and primary care (Emergency Departments for example).
- There may be media interest which may lead to questions being asked about public health risks; if public health professionals are not aware of incidents, responding to these types of enquiries is much more difficult.

In this article, the role of 'health' in non-major emergency incident response is outlined, some illustrative case studies are provided and lessons are identified.

The role of 'health' in emergency response

An important area where public health teams (both from Primary Care Trusts and the HPA) can work with emergency responders is in the understanding of roles and resources available to the different health organisations. In times of constant organisational restructuring, there may be misunderstandings over health organisations' roles.

'Health' can refer to:

- Ambulance Services.
- NHS – both secondary care (usually Emergency Departments) and primary care.
- Health Protection Agency – with confusion amongst some responders about the roles of the different parts of the agency (such as Local and Regional Services, Chemical Hazards and Poisons Division, Radiation Protection Division, Centre for Emergency Preparedness and Response)

Lack of understanding about the roles of these different 'health' organisations can lead to missed opportunities in terms of services and resources that could be accessed in response to an incident.

A further challenge is raising awareness about the range of incidents that may have a public health impact and hence the types and numbers of incidents that public health responders wish to be alerted about. This reflects the different approaches to risk assessment that public health professionals and emergency responders undertake.

The role of the Health Protection Agency during chemical incident response

Traditionally, the role of the Health Protection Unit (HPU) has focussed more on the prevention, investigation and control of communicable diseases (food poisoning, meningitis and tuberculosis for example). However, this role has now expanded to include involvement in the local response to chemical (acute and chronic) and other incidents. It should be noted that the HPA is a 'Category 1' responder under the Civil Contingencies Act (Box 1).

Health Protection teams are skilled in risk assessment, in particular identifying the public health implications of any incident, and are also regularly involved in communication with the public (individuals and groups of the population: schools and community groups for example) and other healthcare professionals.

The regional team includes the Health Emergency Planning Advisors who are involved in the liaison between responders to incidents, and who support the HPUs in the response to incidents.

The parts of the HPA that are perhaps the most familiar to front-line emergency responders are the Chemical Hazards and Poisons Division (CHaPD) and the Radiation Protection Division (RPD – formerly the National Radiological Protection Board). Other parts of the HPA include the Centre for Emergency Preparedness, which includes specialist laboratory services at Porton Down and the Centre for Infections.

Box 1: The Civil Contingencies Act (CCA, 2004)

The Civil Contingencies Act (2004) requires all Category 1 responders to enact a full set of civil protection duties. These duties include:

- Assessing the risk of emergencies occurring and use this to inform contingency planning;
- Putting in place emergency plans;
- Putting in place business continuity management arrangements;
- Putting in place arrangements to make information available to the public about civil protection matters and maintain arrangements to warn, inform and advise the public before, during and after an emergency event;
- Sharing information with other local responders to enhance co-ordination;
- Co-operating with other local responders to enhance co-ordination and efficiency;
- Providing advice and assistance to businesses and voluntary organisations about business continuity management (Local Authorities only).

A successful response to any major incident clearly requires all agencies to act, and to have a clear understanding of the roles and skills of others. The Local Risk Assessment Guidance (CCS, 2006) highlighted the importance of engaging the expertise from across local organisations to feed into the risk assessment process.

In some instances, these services may be contacted directly by the first responders to an incident – through the National Poisons Information Service for advice on chemicals, or through the RPD or the NAIR system for radiological incidents. However, the local and regional teams are also able to act as a point of contact for the whole range of expert services within the HPA, and may be able to make better use of the resources available and provide local interpretation of the advice given.

Early involvement in the response to an incident (major or otherwise) ensures that the most appropriate expert teams are available to support the response to an incident, that those staff with the relevant skills are involved and that key public health concerns are considered early and acted on appropriately.

Staff from the Health Protection Unit and the regional Health Emergency Planning Advisers (HEPA) teams can be contacted 24 hours/day. During office hours, details of the incident will be passed to the relevant HPU office. An on-call system also operates out-of-hours.

Case studies

Using recent incidents from the North East of England as examples, the challenges and importance of early involvement of the health protection and public health teams is highlighted. In each case, when staff from HPA North East reflected on the incident, issues were identified where a more effective response could have been provided. In none of the three incidents were there any serious public health effects, but we believe that they highlight the potential for 'near misses' in respect to the non-infectious aspect of our work.

Case Study 1: Carbon Monoxide leak at a primary school

In November 2006, the HPU was alerted to an incident at a local primary school. Twenty six children and two teachers had been evacuated from a classroom complaining of headache, nausea and dizziness, and taken to two local Emergency Departments. The Fire and Rescue Service had attended the school and a provisional diagnosis of carbon monoxide poisoning was made.
Advice was sought from CHaPD via the National Poisons Information Service (NPIS) and arrangements for clinical assessment and management were led by clinicians at the two hospitals.

At this stage, the HPU alerted the Director of Public Health (DPH) of the local Primary Care Trust (PCT) and followed up with clinicians at the two hospitals to check on clinical status of the children involved. Fortunately, none of the children were unduly unwell, and all but two were discharged following assessment. Two children were kept in overnight for observation and discharged the following day.

The public health response to this incident was through the DPH who attended a meeting on the day of the incident at the local authority. Input from the HPU and local CHaPD teams provided expert advice on the acute and longer-term management of cases, assessing public health risk and risk communication to parents and the wider public.

There was not a multi-agency incident control meeting. Instead, meetings were focussed on investigation of the source of carbon monoxide and were led by the Health & Safety Executive (HSE) and as a result, opportunities for early public health messages to parents and the wider public were missed.

image courtesy of ncjMedia

Case Study 2: Potassium cyanide suicide

In November 2006, the HPU was alerted about a suicide where the victim had taken potassium cyanide. The HPU was alerted via CHaPD/NPIS who had been contacted by the local Emergency Department where household contacts had been taken. Emergency responders had also contacted CHaPD for advice on handling the body and the precautions that the frontline staff needed to take.

The contact with the HPU was late on during the incident, at the point where emergency responders wanted advice about moving the body and precautions that needed to be taken. By this time, household contacts had already been taken to the Emergency Department which had led to considerable disruption to the service at the department as there were concerns over 'off gassing' of cyanide from the victim and the risk it could pose to other people, including members of staff.

An earlier alert to the incident could have led to a quicker and more detailed response regarding concerns over the handling the body and could also have led to prompt risk assessment and provision of information to 'contacts' and advice to any clinicians involved in treating them. Public health messages could also have been quickly prepared and ready for release if required.

Case Study 3: Gas leak leading to evacuation of over 100 people late at night

In February 2007 the HPU was alerted out of hours to a major gas leak which had led to over 100 people being evacuated from their homes late at night.

There was an overall lack of involvement of health services in the early stages of this incident despite more than 100 people being evacuated. This seems to have been due to a lack of understanding of possible services and support that could have been activated to ensure safety and the management of any ongoing health concerns.

Earlier public health involvement could have led to a thorough assessment of wider public health implications and liaison with local NHS services to ensure safe evacuation and ongoing management of any health concerns.

Discussion and lessons identified

Non-major incidents can raise significant public health concerns. The incidents described raised awareness amongst staff at the HPU and HEPA team that work was needed to improve understanding amongst emergency services colleagues about the role of public health teams in emergency response and the possible public health implications of such incidents.

Across the country, HPUs have developed local initiatives to improve working with emergency services in an attempt to ensure early notification of incidents and allow for timely public health advice. These include: working with HAZMAT / HAZMED teams and incident commander arrangements to consider public health risk assessments and early notification; training sessions and joint working with emergency responders; STAC (Scientific and Technical Advice Cell) awareness training sessions with local resilience forums (Box 2); and the London Chemical Incident Early Alerting System (which has been successful in improving early public health notification, Cordery et al., 2007a,b).

The new STAC guidance offers opportunities not only for clarifying arrangements for major incident response, but for agreeing arrangements for notification and public health advice in non-major incidents. Health Protection Teams (local HPU and HEPA teams) will play a key role in developing this awareness and arrangements; however, it is suggested that this is done in conjunction with public health colleagues from PCTs to ensure a joined-up coordinated response to protect the public's health.

Local Resilience Fora have established debrief and lessons identified mechanisms. It is suggested that these are developed to include debriefs of non-major incidents to review incident management including public health risk assessment.

Box 2: Public health response to major incidents

Public health input into the response of major incidents is well described. Latest guidance describes the role of the Scientific and Technical Advisory Cell (STAC) in supporting the Strategic Command Group (Gold Command); these arrangements include advice on public health and health protection, and in many circumstances it is assumed that 'public health' – whether that be the Director of Public Health (DPH) from the affected Primary Care Trust (PCT) or a local consultant in health protection agency from HPA Local and Regional Services (LaRS) – will lead the response in the first instance (for more information see http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081507).

Public health professionals in HPA and PCT roles are trained in major incident response and their potential roles at the STAC and regularly participate in exercises to test local arrangements and response.

The roles of the various divisions of the Health Protection Agency and command and control arrangements for HPA resources are described in the HPA Incident and Emergency Response Plan (IERP) which outlines the levels of local, regional and national involvement in incident response.

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Chemical incidents at an acute hospital trust, April 2007

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Introduction

In April 2007 a number of chemical incidents occurred at a major London hospital, each related to the effects or perception of a strong odour in different areas of the hospital. Despite rigorous investigation into the possible sources of the odour, no definitive cause was found. This report describes the sequence of events that occurred at the hospital and the subsequent investigation by the emergency services, the hospital trust and the Health Protection Agency (HPA).

Incident summary

On 2 April 2007 the on-call Health Emergency Planning Advisor (HEPA) and a local Environmental Health Officer (EHO) were informed of a possible chemical spill in the ground floor laboratory area of the Royal Free Hospital. It later transpired that the incident had been reported as an 'odour' in the medical physics department. This information was conveyed to the North East and North Central London Health Protection Unit (HPU) at 18.30.

Affected staff were taken to the Emergency Department at the hospital with symptoms of dizziness, headache, sore throat and eye irritation. The London Fire Brigade (LFB) made initial investigations but no conclusive source of the odour was found. The incident was stood down that night and a hot debrief was held the following morning.

Two days later a second call to the HPU at 20.25 reported an incident in the intensive treatment unit (ITU) in the same hospital. One staff member had collapsed and four others complained of feeling unwell. Symptoms were similar to those of the previous episode although the reported odour smells were inconsistent with the first incident. At 22.05, the HEPA notified the HPU of a further two cases – these were domestic staff at a third site on the service level. Again the emergency services could not find the source of the odour.

Strategic command was established at the hospital with ongoing advice from the Hazardous Area Response Team (HART) of the London Ambulance Service and the HPA Chemical Hazards and Poisons Division (CHaPD). Emergency admissions to the Emergency Department and laboratory work were temporarily suspended and responsibility diverted to another hospital. The police were initially involved but did not believe that this was a malicious or criminal incident. A reactive press statement was released by the hospital at 23.00 following liaison with HPA colleagues who were in attendance.

A further incident took place at the hospital on 10 April during which LFB was able to collect air samples and identify the odour as being a polyvinyl alcohol (PVA) based solvent. This event was thought to be a coincidental occurrence and not related to the first two incidents.

Environmental and chemical investigation

Initial investigations by LFB did not reveal any obvious source for any of the odours. Extensive examinations of the ventilation, air conditioning and drainage systems were carried out by the hospital works department in consultation with the HPA and the Health and Safety Laboratory (HSL). There did not appear to be a common physical pathway linking the laboratories and the ITU.

Cleaning products used in the hospital trust were reviewed. A general use detergent was identified as being used in both the medical physics and ITU departments, but could not be further implicated in the incidents. A solution of ammonia (concentration of 13ppm) was located in a bucket in ITU and was noted to be a higher concentration than expected. The health and safety procedures in the labs were reviewed, but there were no concerns raised regarding the management of spillages or storage of chemicals.

Epidemiological investigation

Staff who continued to have symptoms (fatigue, dizziness and eye irritation) following exposure were monitored by the Occupational Health (OH) department. A data collection tool was developed with the HPU and completed for affected individuals. The symptoms experienced by staff at the three different sites are shown in figure 1.

Headache and sore throat were the most commonly reported symptoms overall and in the medical physics department. In ITU, nausea and tiredness were most frequently reported symptoms, while in the service level area, dizziness and headache were more common (figure 2). There were no obvious patterns of similar symptoms.

Conclusions and ongoing investigation

This incident highlights the difficulty in identifying a chemical substance from information given by those exposed, including signs and symptoms experienced and the description of a 'chemical odour'.

Even with the availability of specialist equipment, it is important for the emergency services and others to undertake systematic 'old fashioned' investigation into odour complaints. For example, identifying precise times and areas of complaints and then gathering information on what changes or anomalies were experienced.

There are also lessons to be learned for those involved in a CBRN (Chemical Biological, Radiation, Nuclear) or HAZMAT (hazardous materials) response where multiple casualties may be reporting illness following potential exposure to an unknown substance.

The overall incident was treated by the trust as a serious untoward incident (SUI) and an internal inquiry took place in June 2007. Representatives from CHaPD and the HPU were able to contribute to this meeting and are providing comments on the final report and recommendations.

In order to assist with the investigation of odours during incidents, a draft 'Odour Complaints Checklist' has been developed by CHaPD. This is a useful document in determining potential sources of odours and the checklist can be found in issue 10 of the Chemical Hazards and Poisons Report (http://www.hpa.org.uk/chemicals/reports/hpa_chap_10.pdf).

Helen Smethurst is Research Engineer under the Engineering Doctorate (EngD) programme jointly run by the University of Surrey and Brunel University which is funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Health Protection Agency.

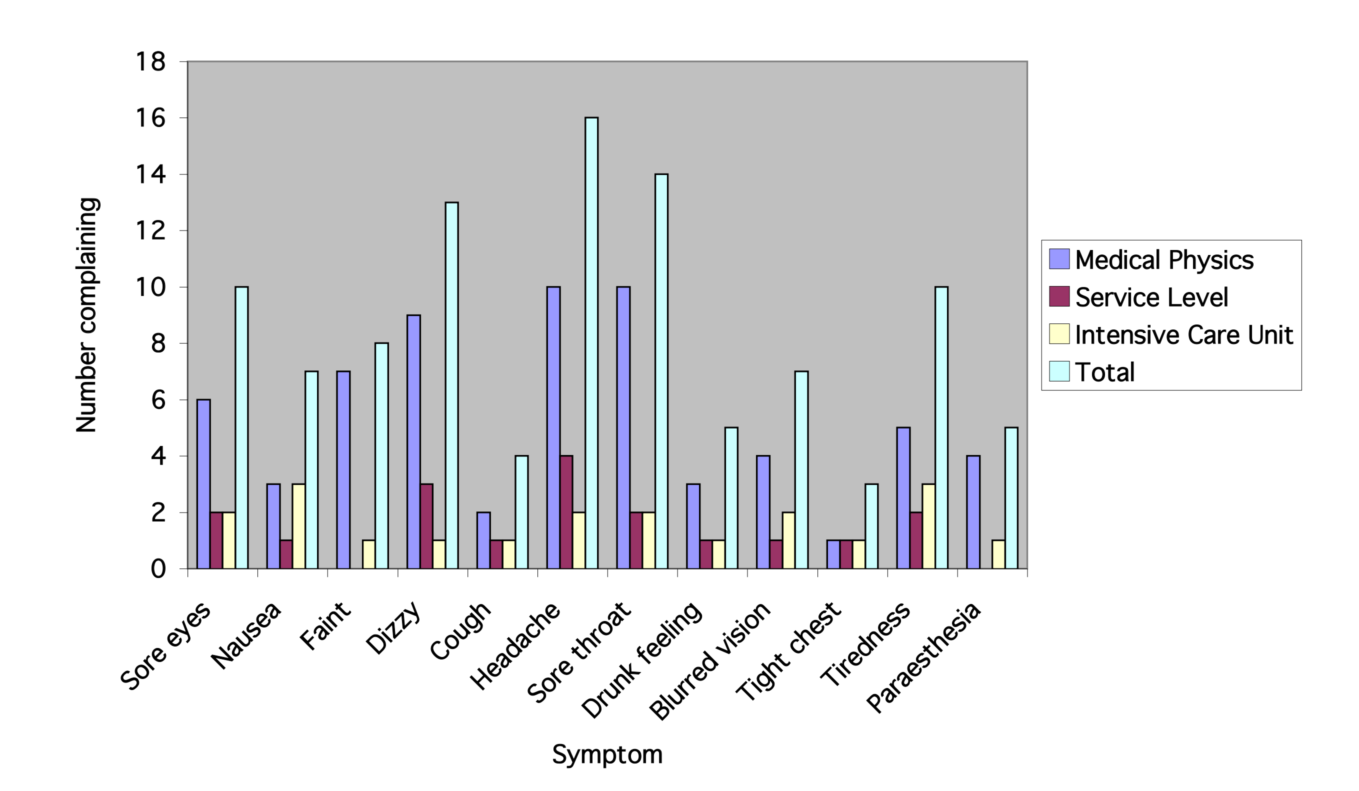

Figure 1: Symptoms experienced by numbers of staff at each of three sites

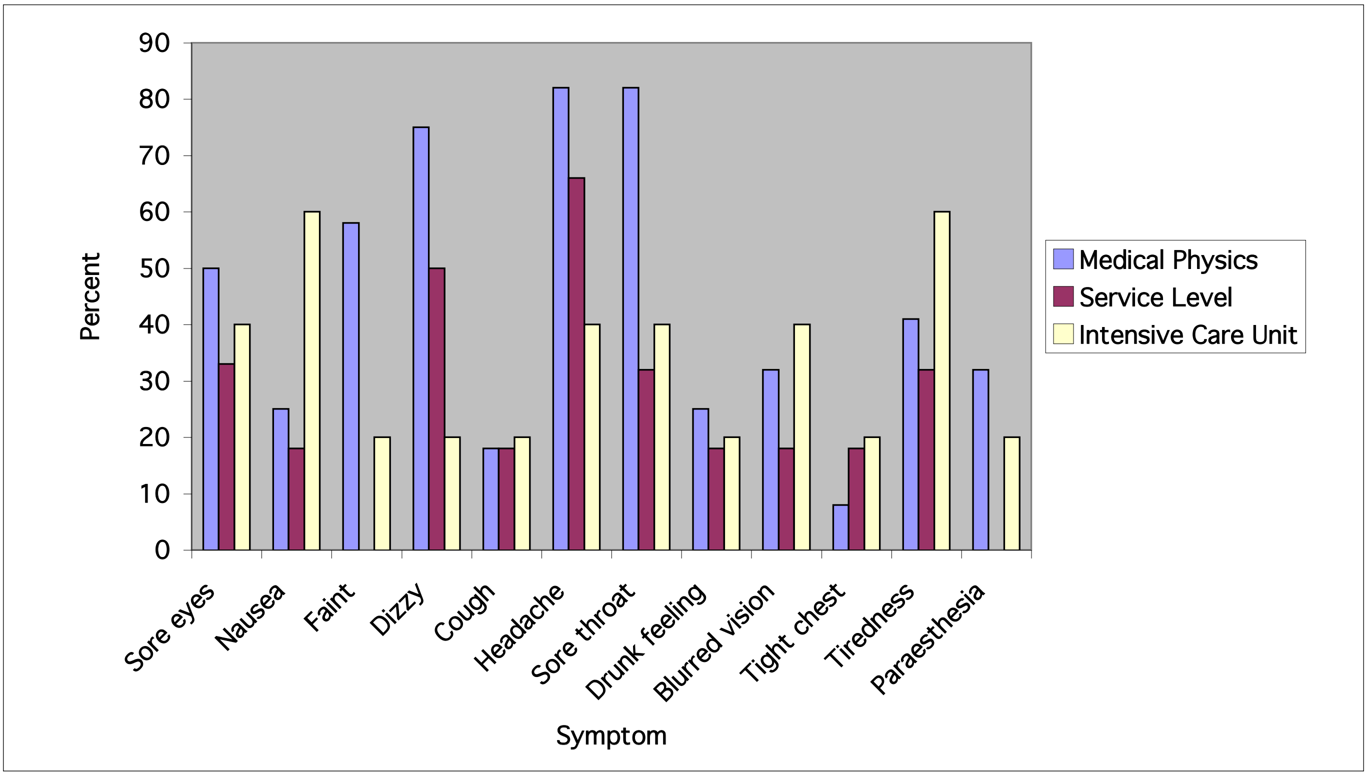

Figure 2: Percentage of staff experiencing symptoms at each site

UK-wide vibration monitoring by the British Geological Survey

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Explosions, mine collapses, aircraft crashes, sonic booms and earthquakes, are routinely detected, analysed and located by the British Geological Survey's seismograph network which stretches from the Shetlands to Jersey and Folkestone to Lands End (some 140 stations). Such events have been recorded and catalogued, using modern instruments, since 1970. In the past 20 years or so, nationwide coverage of instruments has been achieved through the sponsorship of Government Departments and Industry (nuclear, water, oil, mining), and a near real-time, 24-hour, seismic monitoring and information service is supported.

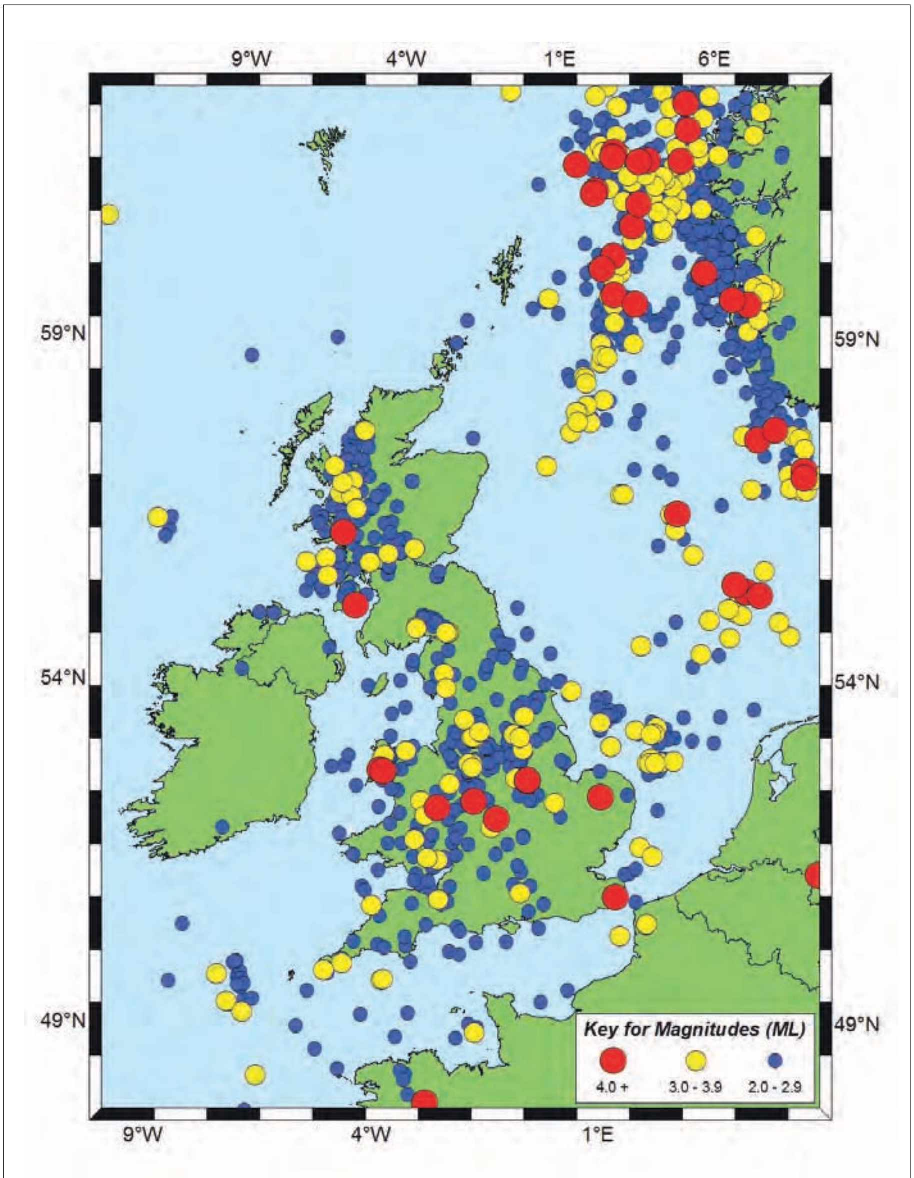

Figure 1: Epicentres of earthquakes with magnitudes of 2.0ML or greater for the period 1980 to October BGS 2007 © NERC.

Almost every week, seismic events are felt somewhere in the UK (Figure 1); most, but not all, are earthquakes of which over 100 are detected each year with about 20% of them felt by people. Before the slowdown in the deep coal-mining industry, a further 50 'earthquakes' occurred annually due to this activity, many of them small in magnitude but felt strongly by communities over localised areas, owing to their shallow depth of a few hundred metres. Our natural earthquakes are usually focused in the range 5 to 25km beneath the surface with their energy attenuating before they are felt, even at the epicentres. Some mining-induced earthquakes continue to occur over deep mines, and others are associated with the collapse of old workings.

Among the many explosions detected each year, both on land and under the sea, the Buncefield fuel depot incident caused considerable concern. On 11 December 2005, the main explosion was observed at 30 seismic stations in the network throughout England and Wales, and in the Scottish Borders, 440km from its Hemel Hempstead 'epicentre'. It was also detected in the Netherlands. Because of the absolute time standard used across the seismic network, it was possible to determine the origin time as 1 minute and 31.45 seconds after 6am with an uncertainty of only 0.5 seconds (Ottemöller, L., 2006). The observing network detected seismic waves which travelled through the ground from the explosion, as well as the slower airwaves.

Acoustic waves travelling in the air are also picked up when generated by aircraft going supersonic. Concorde used to appear daily on our seismic records but now we have only sonic booms from military aircraft and the occasional meteorite. Sometimes they can be strong enough to cause public concern and even break windows. They are also mistaken for earthquake shaking but the seismic records can clearly distinguish the two sources of vibration. Last year, 6 felt sonic booms were distinguished in this way, and were reported by BGS to the authorities and the public to clarify what had happened.

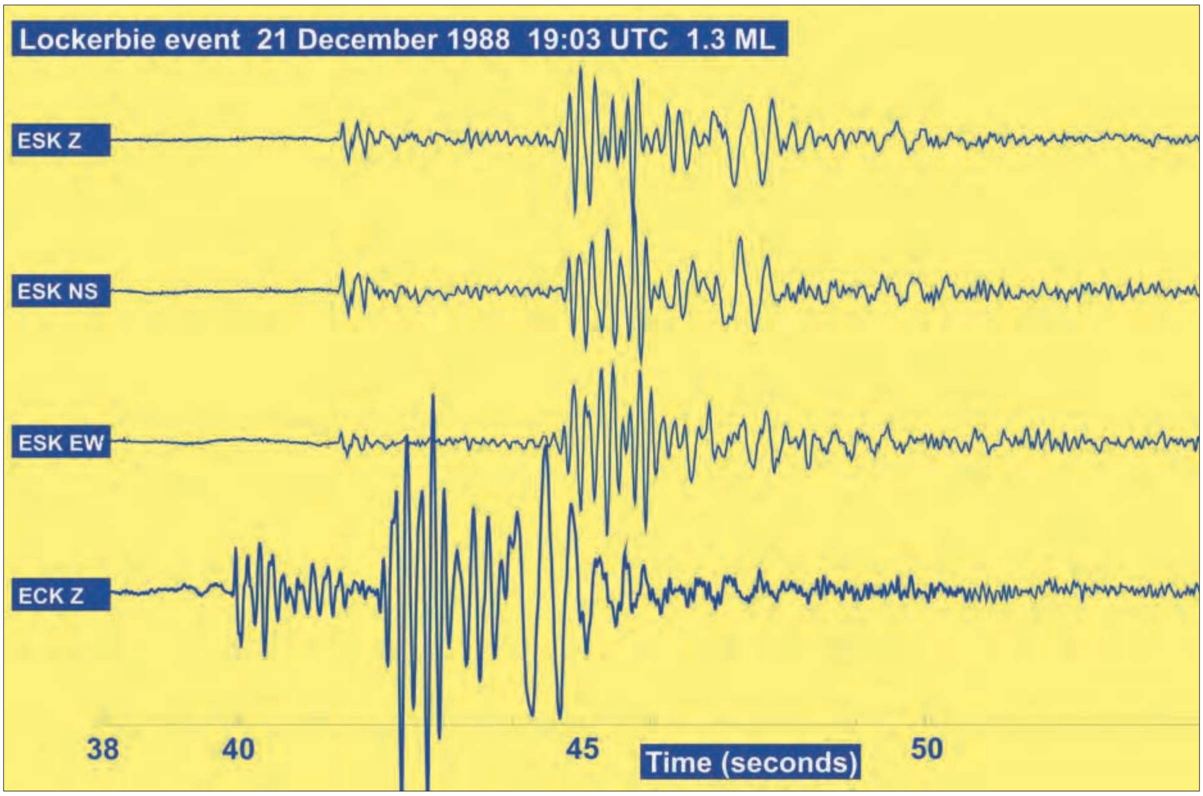

Figure 2: BGS Seismograms recorded from the impact of the PanAm jumbo jet brought down over Lockerbie in December 1988 BGS © NERC.

On occasions, the impacts of crashed aircraft are also detected; most notably the impact and explosion of the Pan Am 747 brought down over Lockerbie in December 1988 (Figure 2). As with Buncefield, our records yielded an accurate time for the impact which proved to be the only absolute time measurement available to the investigation team. In those days, the black boxes did not contain a synchronised clock. This seismographic record was used as evidence at the initial inquiry and in the subsequent trial in the Hague.

One of the most bizarre investigations conducted by BGS using its seismic network, was in connection with an earthquake reported to be felt strongly in North London in August 1992 when three blocks of flats (8-9-storeys) were evacuated following minor damage that included cracked windows and a cracked balcony. Our seismic network showed that there had not been an earthquake or an explosion, and we were able to deduce that the cause was resonance set up by dancers at a Madness rock concert in nearby Finsbury Park. The resonance frequency of such dancing, in harmony, is tuned to the natural frequency of apartment blocks of this height, so that the movement is amplified. Similar events had occurred in the mid-1980s in Brussels, when U2 were playing, for which a seismic trace exists. Around Earl's Court in 1995, another 'earthquake' was felt up to 1km away, when Oasis was playing there. On this occasion we were able to advise the local Police and New Scotland Yard that the concert was the cause and that it would happen again at the same time the following night, provided the band's programme did not change. This prediction proved to be successful.

More recently, the earthquake which caused damage in Folkestone on 28 April 2007 was of modest magnitude (4.2ML) but it occurred at the shallow depth of around 5km and was centred close to the town. The degree of damage, although localised within a few streets, led to the local council implementing emergency procedures, probably the first time for a British earthquake (Figure 3).

Some 2,500 buildings suffered damage, mainly to chimneys and roof tiles (Figure 4) but also some cracks in walls and the fall of plaster. A number of buildings required considerable repairs before they could be reoccupied. Only one person is known to have been injured and it was fortunate that the earthquake took place at 08:16 BST on a Saturday morning, resulting in fewer people being in the streets and exposed to falling masonry.

The area in which the earthquake was felt extended to the outskirts of London (Figure 5).

Kent is a highly-developed area close to London, and a number of potentially high-consequence elements of the local infrastructure were shaken. We have the following details:

- EDF, the electricity company, reported that in the Folkestone area, thousands of homes and businesses lost power for up to 85 minutes owing to automatic tripping of 2 high voltage transformers. The cause was the shaking of Buchholz relays which are designed to trip out when a fault is detected. They are connected to the oil-filled transformers, and contain

Figure 3: Advising the public of disruption caused by the Folkestone earthquake in April 2007 (courtesy of Julian Bommer, Imperial College).

Figure 4: Chimney and roof damage in Folkestone (S. Sargeant ©NERC 2007).

mercury switches which respond to tilting of the relay in response to gas generation (a normal side effect of faults), an oil surge, or oil leakage. In the open position (normal operation), the switches rest at a small angle to the horizontal. During the 1990 Bishop's Castle earthquake, the nearest primary electricity substation to the epicenter (by Minsterley), also tripped out when four Buchholz relays closed. An investigation there concluded that the most likely mechanisms for this were that seismic shaking caused the mercury switches to displace sufficiently to momentarily close the switch, or that small deformations of the walls of the transformers caused oil surges which actuated the relays. In the UK, Buchholz relays normally contain mercury switches but in earthquake-prone countries, these are replaced with magnetically-operated reed switches designed to remain open under intense vibration (David Anderson, Magnox, Pers Comm).

- The power outage caused the Dover Ferry service to suspend operations.
- At the Dungeness nuclear power stations, 25km to the south west of the epicentre, the shaking was reported to be perceptible to some individuals, but there was no damage. The earthquake was also felt at the Eurotunnel offices near Folkestone where objects were displaced from tables.

The Folkestone earthquake was detected on the seismic monitoring network over the whole of the UK (even in the Shetland Islands) but it is the nearer stations which contribute most to the accuracy of its epicentral location, depth of occurrence and magnitude. To achieve accuracy, it is also necessary to have monitoring points all around the epicenter. BGS was able to rapidly gather data from colleagues in Belgium and France and at the coordination agency, the European Mediterranean Seismological Centre (EMSC), to achieve this optimum geometry.

The region around Folkestone has been subjected to larger earthquakes in the past, notably, those centred in, or near, the Dover Straits in 1950, 1776, 1580 and 1382. The two earliest ones had magnitudes estimated at just under 6, and caused damage as far as London, where in 1580, two people were killed by falling masonry. The last earthquake felt by residents in Folkestone was actually a Dutch earthquake (epicentre near Maastricht) in 1992. It should be noted that a magnitude 6 earthquake releases 1000 times the energy of one of magnitude 4 and is potentially much more damaging.

Comparisons can also be made between the Folkestone event and the Colchester earthquake of 1884, magnitude 4.6 ML. At Colchester, there was also much damage in the epicentral region, and it is likely that similarities between Folkestone and Colchester will become increasingly apparent as more analysis is conducted. The shallow depth of both earthquakes beneath a 'soft' geological environment resulted in a concentration (and possibly amplification) of the ground-shaking in their epicentral areas.

Finally, just as we are able to access valuable data from our neighbours when required, we also contribute data to others on a European and global basis in response to direct requests and, on a routine basis, to central agencies. These include the EMSC and the Observatories and Research Facilities for European Seismology (ORFEUS) data centres for Europe, and for the World the International Seismological Centre (ISC – based near Newbury, UK) and the National Earthquake Information Centre (NEIC – based in Golden, Colorado, USA). These exchanges of information are well-established and will be enhanced in the future when tsunami warning systems are implemented for the North Atlantic and the Mediterranean and the BGS will be playing its part in those tsunami warning initiatives on behalf of the UK.

Reference

Ottemöller, L. 2006. Timing of the Explosion at the Buncefield Fuel Depot, 11 December 2005. *British Geological Survey Commissioned Report,* CR/06/038. 19pp

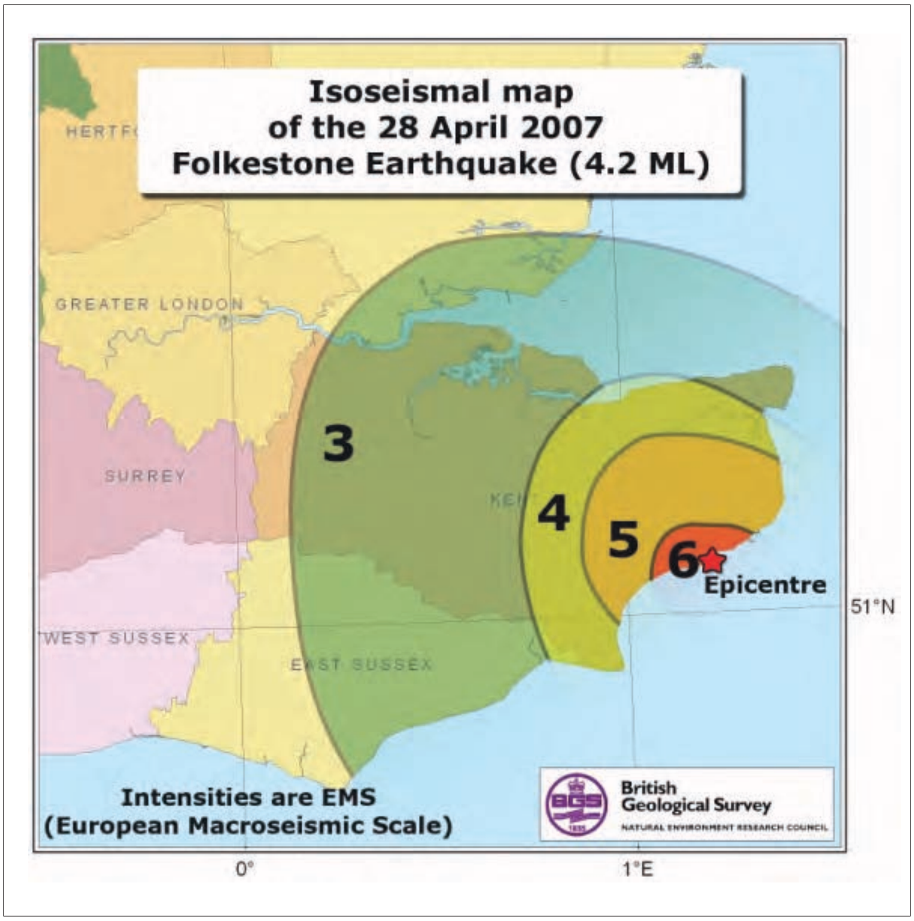

Figure 5: Region in which the Folkestone earthquake was felt readily, with the intensities of ground shaking indicated on a numerical scale.

Lead poisoning cases associated with environmental sources

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Introduction

The removal of lead from petrol has contributed to the decrease in blood lead levels (BLLs) and chronic lead poisoning[1]. However, a number of lead poisoning cases are reported to the Chemical Hazards and Poisons Division (CHaPD) each year with advice on public health actions being requested. This study examines cases of lead poisoning reported to CHaPD London.

Lead paint was removed from sale for general domestic use in the 1970s but many houses and other buildings constructed prior to the 1980s still contain lead paint. In most houses this is not a problem as the old lead-containing paint will be sealed by newer lead-free paint. However, there is potential for the ingestion of lead paint resulting in lead poisoning if paint is flaking or children are chewing the paintwork. A previous article published in the Chemical Hazards and Poisons Report[2] described the common exposure pathways and prevalence of lead poisoning in the UK.

In brief, possible sources of exposure include paint in older housing and the contaminated dust this generates.[3] Other sources include traditional medicines, some types of ceramic pottery, traditional make-up (surma for example) and occupational exposure. More recently, urban renewal and demolition have been identified as a source of environmental lead exposure.[4] Raised BLLs may be due to recent exposure to lead or from remobilisation of lead stored in bony deposits after past exposure(s).[5]

Most of the literature relating to the prevalence of chronic lead poisoning has been collected in the United States. However, two recent studies in the UK, The Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) study and The Health Survey for England (1995), have reported BLLs. ALSPAC investigated BLLs in 585 children in 1995 and found 5 % of the children had a BLL of > 10 µg/dl (0.483 µmol/l)[6] whereas The Health Survey for England sampled 6,868 people and found 3 % of people with a BLL of >10 µg/dl.[7] The ALSPAC study reported a mean blood lead level of 3.44 µg/dl in children aged 2.5 years of age.[6]

Breaking the exposure pathway

The US experience suggests that a case management approach to lead poisoning cases is most effective in treatment and removal from the source of lead.[8] Case management involves a home visit and face-to-face discussion with the patient/carers to explore possible sources of lead exposure. It is recommended good practice in the UK for a home visit to be carried out jointly by a senior member of the local health protection team and the local authority environmental health team to look for the potential source of lead. Further information is given in the lead poisoning action card included in this issue of the Chemical Hazards and Poisons report[9]. This has been developed by the HPA with the aim of facilitating the effective management of cases of lead poisoning associated with environmental sources. It is important that cases are removed from exposure to a lead source(s) once identified; this may involve remediation measures to remove or isolate the lead source. These cases are often complex and due to the multi-agency nature of the response, there may be delays in remediation and treatment.

Aims and objectives

The aim of this work was to examine the factors associated with lead poisoning in cases that have been reported to the Chemical Hazards and Poisons Division, London (CHaPD (L)). This study looked at the source of call; likely cause of lead poisoning; information available and specifically, issues related to the remediation of the property including delay in the removal of the case from continuing exposure to the source.

Methods

Case definition

Cases reported to CHaPD (London) of people living in London or the south east and considered by clinicians to have raised BLLs.

Source of data

The Chemical Hazards and Poisons Division log (including both closed and open cases) and individual case folders were searched for cases related to lead poisoning in individuals or families. Cases reported between January 2003-July 2007 were included. Only cases involving specific patients and enquiries related to lead from the London and South East Region were included. Calls relating to general enquiries or to soil contamination were excluded.

Data Collected

The following data were collated

- Source of report (health protection unit, poisons unit, clinician, other)
- Adult/child
- Any comorbidities
- Initial blood lead levels
- Current blood lead level
- Type of accommodation (age and type of housing) and time in accommodation, condition of internal decoration e.g. flaking paintwork, other sources of lead including water, traditional medicines, contaminated cosmetics and crockery and any occupational exposure
- Clinical follow-up and treatment

Results

Summary of cases

Numbers and location

A total of 25 cases were identified related to London and the South East Region which reported actual or suspected lead poisoning in adults and children (Table 1A-C). Of these, 19 were reported from London, three from Sussex, one from Luton, and two from The Thames Valley. 20 cases (80%) of raised BLLs were reported in children.

Reporting of cases

Twelve cases were reported via Guy's and St Thomas' Poison's Unit (GTPU) nine calls came via the Guy's and St Thomas' Trust clinical toxicology clinic and four from local Health Protection Units (HPUs).

The majority of calls to GTPU were from clinicians requesting information and/or materials for chelation therapy. Information about these calls was passed onto CHaPD for further advice regarding the investigation of environmental factors and possible remediation.

Comorbidities

The majority of children with raised BLLs (15) also had other symptoms or comorbidities which included autistic spectrum disorder, behavioural problems and Asperger's syndrome (n=14), and sickle cell disease (n=1). Five adults were symptomatic, four reported one or more symptoms of nausea and vomiting and abdominal pains and one was admitted to hospital with chronic fatigue. A large number of children (15) were reported to eat non-food objects (pica) or to put them in their mouths. This behaviour was not asked about for two children. Some of the children were reported as having previous pica behaviour and raised lead levels were thought to be due to the release of lead from bony deposits from these earlier exposures.

Blood lead levels (BLLs)

The BLLs of cases reported to CHaPD aged five years and under (n=8) varied from 0.19 µmol/l in a 5 month old baby investigated due to high lead levels in water to 6.60 µmol/l in a child who had ingested lead paint. The mean BLL of children aged five and under was 1.91 µmol/l. Eight children aged 6-10 had BLLs ranging from 0.18 µmol/l to 2.91 µmol/l with a mean and standard of deviation 1.89 ± 0.87 µmol/l. BLLs were reported for two children aged between 11 and 15 years (1.94 and 2.37 µmol/l) and for four patients aged 16 + years (0.69 to 5.95 µmol//l with a mean of 3.13 µmol/l).

Sources of lead

The main source of lead exposure in children was paint (13). However, in many cases this was not considered to be 'true' lead paint (20-50% lead) but rather 'non-lead' (0.1-1%) paint ('lead- free' paint has a concentration of <0.1%.[10]) Three of the cases reported in children appeared to be related to recent decoration in the home, in two of these cases, there was evidence of dust and/or paint flakes being present. Two of the children were also reported to eat soil. Three households reported raised lead levels in their water supply (raised lead levels were confirmed by the local water company for two incidents).

In adults there was a relationship between raised BLLs and traditional/herbal medicines (Box 1). One patient had been using herbal medicines and had a history of previously raised BLLs. A second patient had a number of comorbidites including diabetes and had recently stopped taking Ayurvedic medicines. In two cases no obvious environmental source of lead could be identified, however, it was thought that traditional medicines may have been the cause. Although the cases denied using traditional medicines, empty medicine bottles were seen at the homes. One case was thought to be due to raised lead levels in the domestic water supply. As in children, raised BLLs may be due to previous exposure to lead and later mobilisation from bony deposits.[6]

Box 1. Case Example 1

The case was an adult living in London who had previously been admitted to hospital in 1995 with severe abdominal pain and at the time found to have elevated BLL. Since 1995 the BLL of the patient has been analysed annually. The local health protection unit became involved in the case as the patient's BLL had increased, the case was interviewed and found to be taking three herbal medicines. There were no results of the lead level of these compounds as they were not available for testing.

Remediation- breaking the exposure pathway

In virtually all the cases involving ingestion of lead paint there were delays in the investigation and remediation of properties due to a number of reasons (Box 2):

- Time from diagnosis to investigation of home environment- often due to problems in organising a joint visit between the environmental health department and HPU.
- Variation in practice between environmental health departments in different authorities. It was sometimes difficult to find the appropriate person for liaison.
- Problems of obtaining money to pay for remediation and /or sampling of paint or soil. Variations in methods depended on property ownership and/or local authority.

However water sampling for lead was usually rapid with the local water company providing this service free of charge.

Box 2. Case Example 2

The case of a seven year old boy was notified to CHaPD by the GST Poisons Unit. BLL were recorded as 2.91µmol/l in December 2002 and 2.66 µmol/l in April 2005. The child was reported as showing pica behaviour between 2.5 and 5 years of age. However, in 2005 it was reported that the case was no longer eating unusual objects, was in good health and doing well at school. The family home had been completely redecorated over the previous 5-10 years. The paediatric consultant had contacted the council twice in writing to ask for an environmental assessment of the home. A previous house visit in 2003 recorded lead levels in paint of 1000 mg/kg. A joint visit by the CCDC and EH took place in July 2005, the house had recently been redecorated and was in a good state of repair. The child admitted to eating paint chips when younger. The household visit occurred two years after the initial concerns about BLL were raised.

The patient was seen in the toxicology clinic in mid 2007, currently there is some remobilisation of lead from bony deposits taking place but no need for further chelation therapy. In total the child had seven rounds of chelation therapy with costs in excess of £5000.

Table 1A: Details of lead cases

Case Number	Gender	LA Area	Date reported	Who reported	Chelation Therapy	Toxicology Clinic Visit
1	M	London	03/04/07	Toxicology Clinic	No?	Yes
2	F	London	27/06/07	Toxicology Clinic	Yes	Yes
3	M	London	22/02/06	Toxicology Clinic	No (private?)	Yes
4	M	London	16/06/05	GTPU	Yes	Yes
5	M	London	21/07/06	HPU	No	Yes
6	family	Sussex	08/11/06	GTPU	No	No
7	F	London	19/04/05	Toxicology clinic	No?	Yes
8	M	London	09/05/07	Toxicology Clinic	No	Yes
9	M	London	15/05/07	Toxicology Clinic	No	Yes
10	M	Sussex	23/07/06	GTPU	No	Yes
11	M	London	23/02/05	GTPU	Yes	Yes
12	M	Sussex	27/07/06	GTPU	No	Yes
13	F	Luton	04/07/06	GTPU	Yes	Yes
14	M	London	04/05/06	Toxicology Clinic	Yes	Yes
15	F	London	01/07/03	GTPU	Yes	Yes
16	F	London	01/07/03	GTPU	Previously	Yes
17	M	London	13/05/05	SWL HPU	Yes	Yes
18	M	London	20/05/05	HPU	No?	Yes
19	M	London	07/06/05	GTPU	No	Yes?
20	NK	Thames Valley	18/12/06	GTPU	No	No
21	NK	London	23/02/06	HPU	No	No
22	NK	London	25/01/07	Toxicology clinic	No	Yes
23	F	Thames Valley	25/10/06	GTPU	No	No
24	M	London	01/11/06	Toxicology Clinic	Yes	Yes
25	M	London	17/05/05	HPU	No	No?

NK=not known
GTPU = Guy's and St Thomas' Poisons Unit
HPU=Health Protection Unit
? = unclear from notes

Table 1B: Symptoms and blood lead levels (BLLs)

Case	Age (years)	Symptoms and comorbidities*	Pica (Y/N)	BLL (start) µmol/l	Date	BLL (current) µmol/l	Date
1	13	Behaviour problems	Y	1.94	09/04	0.30	03/07
2	6	Sickle Cell	Y	2.80	06/07	1.26	06/07
3	4	Autism	N	0.69	11/05	0.75	03/06
4	7	NAD	Y	2.91	12/02	2.66	04/05
5	5	Autism	Y	0.72	07/06		
6	8, 2.5, 0.4	NAD	N	0.18, 0.25, 0.19	11/06		
7	38	Nausea/vomiting	N	3.53	04/05		
8	4	Autism	Y	0.62	01/07	0.61	04/07
9	7	Autism	Y	1.50	01/07	0.90	04/07
10	4	Autism	Y	2.50	07/06	1.84	07/06
11	2	NAD	Y	3.68	02/05		
12	10	NAD	Y	1.84	07/06		
13	29	Diabetic + chronic fatigue	N	5.95	03/06	2.12	05/06
14	15	Aspergers	Y	2.37	05/07	2.10	05/07
15	2	Special needs	Y	6.60	05/03		
16	6	Language difficulty	Y	2.40	07/03		
17	Child	Behaviour problems	Y	3.68	05/04	1.01	08/04
18	6	Autism	Y	1.69	05/05		
19	Adult	Previous abdominal pain	N	0.69	04/05	0.30	2003
20	12	Behaviour problems, anorexia	NK	Below level for chelation	12/06		
21	Child	Autism	NK	0.36	02/06		
22	Mother and child	NAD	N	Within expected range	01/07		
23	Adult	Stomach pains and nausea	N	Not done	10/06		
24	73	Type II diabetes, CVA	N	2.34	10/06		
25	7	Autism	Y	1.80	11/04	1.6	05/05

*NAD=nothing abnormal detected
NK=not known

Table 1C: Accomodation and possible lead sources

Case	Accommodation	Decoration	Plumbing work	Medicines
1	Privately owned house	Remediation June 2005, awaiting further remediation	No Pb in water	No
2	1930s house- private	No obvious environmental source	? not tested	No
3	1904 house- private	House in good state of repair	Family told high Pb (?)	No
4	Private	Redecorated over last 5-10 years	? not tested	No
5	Local authority house	Some evidence of raised lead in paint	0.5 µg/l	No
6	Private	N/A	Southern Water 87µg/L	No
7	Modern- private	N/A	Cold water lead free	Possible
8	Victorian, private	Flaking paintwork	Lead pipes	No
9	Rented	Sample lead free, recent decoration	Sample no Pb	No
10	Presumably pre 1960s	very dusty house recent painting	Samples taken ??results	No
11	Private landlord	Chewing of paint	No	No
12	As 10	As 10	Samples taken ??results	No
13	Private, modern	N/A	Pb -free	Possible
14	Private?	Previous exposure in home from paint	Pb -free	No
15	Modern house	Previous dwelling, poor condition ? lead paint	Tested OK?	No
16	NK	Recent painting and paint flakes. No vacuuming	No?	No
17	Owner-occupier 1930s	Paint	No	No
18	NK	Paint? 'Eating everything'	Not likely	No
19	N/A	Herbal medicines likely cause	N/A	Yes
20	NK	Environmental factors investigated	No report	No
21	NK	Water sampled- results unclear, further investigations	No report	No
22	Old house	Redecoration of old house- dust	N/A	No
23	NK	Raised lead levels in water	Raised Pb levels	No
24	NK	Ayurvedic medicines	NK	Yes
25	Local authority housing	'Eats anything'	NK	No

NK= not known

Sources of funding for remediation

The main issues in delays in remediation were related to confusion about the housing legislation and responsibility for funding remediation and additionally lack of funds (Box 3). It was not clear from the majority of case notes which agency paid for remediation. However, it would be expected that private landlords would be responsible for remediation in their properties and local authorities would be responsible for social housing. The cost of remediation for families living in privately owned homes is more difficult particularly if the family have limited resources. In one case, a disabilities grant was used for funding the remediation to a private dwelling, however, the grant took a long time to be awarded whilst the case continued to be potentially exposed to the lead source. There was no record of people using household insurance schemes for remediation.

Treatment and cost

Chelation therapy is usually recommended when the BLL is above 2.17 µmol/l as there is no clinical value in treating below this level.[11] The cost of chelation for a child will partly be dependant on severity and also age but in general the cost will be approximately £800 per course.[12] There are also other direct and indirect costs e.g. consultant clinic reviews both paediatric and toxicology. There are other immediate and long term costs to the family both economic and social including time attending hospital, possible consequences on mental development and possible lower economic attainment in the long-term.

Of the cases, 9/25 had chelation as part of their treatment, one patient had private chelation therapy against NHS advice and in two cases it was unclear whether chelation took place. One patient was given six courses of chelation therapy. Toxicology referrals were requested for 19/25 patients, 4/25 never attended the toxicology clinic and in two cases it was unclear whether a referral was made.

Box 3. Case Example 3

The case was a 13 year old boy from London diagnosed with autism and epilepsy, the case also had pica and raised BLLs were reported in September 2004. The patient had been observed eating plaster and paint. In early 2005 the home of the patient was investigated for lead paint and remediation carried out on parts of the downstairs of the property where there were signs of paint chewing. The BLLs reduced from 1.94 µmol/l in September 2004 to 1.20 µmol/l in Sept. 2005.

The BLLs took a long time to fall and so a repeat visit to the house was carried out and additionally lead paint was identified in doors, sills and the stair banister. One sample had lead levels in excess of 6000 mg/kg (0.6 wt%). It was recommended that further remediation was carried out on the upper floor of the house. The property was privately owned, and the local authority suggested that a 'disabled facilities grant' should be used for remediation of paintwork. Although the child had chronic lead poisoning chelation therapy not used as at this BLL the risks of treatment outweigh the benefits.

In April 2007 the patient was reviewed in the toxicology clinic and the BLL had reduced, however, the house was still awaiting paint remediation.

Conclusions and Recommendations

Lead poisoning from environmental sources continues to be a problem. Cases are reported to CHaPD (London) when there is a need for advice on investigating lead cases thought to be related to environmental sources. Therefore the number reported to CHaPD (London) may not be representative of the total lead cases. Some of the main causes of lead poisoning are reported here, however, there are a number of recommendations to improve reporting, and to improve the speed and efficiency of remedial actions

Reporting and surveillance

- Currently information on lead cases is stored on a variety of filing systems. A specific system for specifically logging lead cases should be developed by CHaPD to allow these to be followed up and retrieved easily in a similar manner to other chronic incidents.

- It is likely that only a small percentage of cases are being reported to CHaPD. A proposal is being developed for submission to the British Paediatric Surveillance Unit to carry out reporting by paediatricians of lead poisoning cases that are seen in children.

- Primary care staff, such as community nurses, particularly health visitors, may play an important role in recognising the symptoms of lead poisoning and organising suitable referral.

Response

- There is a wide variation in practice between different local authorities and HPUs, often this leads to delays if people are uncertain of their roles and responsibilities. An action card for HPUs has been developed for use in following-up lead cases. Additionally, work has begun on an action card with environmental health practitioners and other local authority and PCT colleagues to consider the roles and responsibilities of local authorities in sampling and remediation of homes. Clarity is required around roles and responsibilities relating to different types of housing, i.e. local authority, private rented or owner-occupier.

- Delays often occur in owner-occupier properties due to lack of funds. However chelation and other NHS treatment is expensive and it may be cheaper for the PCT 'to invest to save'. Currently a local pilot is ongoing around identifying a small amount of funds at PCT level to pay for remediation.

Awareness Raising

- Awareness of the potential risks of exposure to lead-paint dust during DIY should be raised. Useful leaflets are available on the Defra website (http://www.defra.gov.uk/environment/chemicals/lead/index.htm). However, it is recommended that these should be made more widely available, for example in DIY stores. Local PCTs may wish to raise issues around DIY in their local household safety campaigns.

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Development of a lead 'action card' for public health practitioners

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Introduction

Lead is a ubiquitous environmental pollutant and there are a diverse number of sources to which humans may be exposed. Historically, a significant source of lead in the environment was the combustion of leaded petrol and although this has been phased out, there are other industrial activities which may result in emissions of lead to the environment. In addition, people may be exposed to lead paint that may still be present in older buildings.

Several factors make it difficult to quantify the current public health impact of lead in the UK and although over recent decades there has been a dramatic reduction in the number of reports of toxicity, some cases with elevated blood lead levels continue to be seen in both children and adults. From a public health point of view, lead toxicity is important as a preventable cause of potentially permanent disability. The potential public health impact of lead was summarised in a previous issue of the Chemical Hazards and Poisons Report.[1]

An effective public health response to lead toxicity involves a number of agencies including the Health Protection Agency, NHS clinicians, and local authority Environmental Health Practitioners (EHPs). In practice, it can be difficult to provide a co-ordinated multi-agency response, as shown in the preceding case series presented in this issue.[2]

Surrey and Sussex Health Protection Unit (HPU) developed an 'action card' outlining the steps to take in the public health management of a case of lead toxicity and the roles and responsibilities of the agencies involved.

The text from the action card is reproduced below. In response to feedback, we are working on a single-page flowchart format. The action card focuses on incidents associated with chronic exposures as these are more likely to impact on public health. The action card is not aimed at the public health aspects of managing incidents involving acute exposures to lead. Expert advice on acute incidents involving lead exposure may be sought directly from the Chemical Hazards and Poisons Division (for enquiries related to public health protection) and a poisons information service (for enquiries related to the clinical management of individual patients).

As the work involved in dealing with such cases is likely to involve several different agencies, it is vital to agree on and be explicit about data sharing and confidentiality issues at all times.

Surrey and Sussex HPU Lead Action Card

1. HPU Roles and Responsibilities

The role of the HPU is to assess the public health issues and ensure that action is taken to limit the public health impact.

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

- Receive a call
- Risk assessment
- Investigation and control of the hazard
- Prevention

2.1 Call to HPU about a lead incident

The HPU may be notified by a health professional to report that an individual has been found to have high blood lead levels (BLL). The call may come from the health professional treating the patient or may be from the Chemical Hazards and Poisons Division (CHaPD) and/or a poisons information service.

The HPU may also be notified where a lead hazard is identified but no diagnosis of lead poisoning has actually been made. Although it is less likely for the HPU to become involved in these scenarios, it is useful to be aware of a scenario where the domestic water supply has been tested (may be due to appearance or taste of water) and found to have high levels of lead. Again, the HPU should advise that all those who may have been exposed to this are tested. Also consider lead toxicity in children with pica, in cases of unexplained anaemia or neuro-psychiatric symptoms particularly in young children or those with behavioural problems.

2.2 Risk assessment: probability of harm

Please refer to the questionnaire (available by request from chemicals.london@hpa.org.uk) which indicates the demographic and social information that will be required and outlines the various sources of potential exposure.

Ask caller for details of the case:

- Name, date of birth and contact details of patient
- Name of clinician and GP
- Has the patient has been referred to the medical toxicologists? If so, request a copy of this clinic letter
- Blood lead levels – may be more than one result –both pre and post treatment
- Has chelation therapy been instigated? (dates and details)
- Date of next out patient appointment (OPA)

Identify others at risk

Consider other individuals, such as children and pregnant women, who are particularly vulnerable in the same family or household as the case. They may not have been diagnosed as having high blood lead levels but may either have already been exposed or may also be at risk of exposure. Infants who are formula-fed are particularly susceptible if drinking water is used to make up the feed. Lead toxicity is a particular risk for young children with excessive mouthing or in those with 'pica' due to behavioural problems such as autism or co-existing iron-deficiency.

Collect data on testing and clinical assessment and liaise with NHS (including poisons information services) and CHaPD.

A joint home visit should be considered at an early stage

This should involve the HPU an EHP and depending on specific circumstances, could also include the GP, health visitor (HV), or community paediatrician.

Identification of source of exposure

If the patient has already been seen in the toxicology clinic, the history taken by the clinicians may have already revealed the likely source of exposure. This will be detailed in the clinic letter; however it may be worth discussing this with the clinician by phone.

- Exposure source can be classified as: 'occupational', 'environmental' or 'miscellaneous'.
- Complete lead exposure questionnaire -this may be done by telephone, by post, or, preferably, during a home visit. A joint home visit is likely to yield additional information that may not be obtained from the completion of the questionnaire.
- Seek advice from CHaPD regarding the need for environmental sampling / assessment to determine/confirm the source of lead.
- It is important to consider all potential routes of exposure (note that these may be different for children and adults) - routes of exposure for lead include ingestion and inhalation (dermal exposure rarely warrants concern).
- Ensure that domestic water sampling is carried out even where another source of exposure has been proposed.

2.3 Investigate and control the hazard

The actions taken to control the hazard with regard to lead will vary depending on the source of exposure that has been identified. Although the HPU are unlikely to be directly responsible for implementing any control measures, they will have an important role in coordinating this response with the relevant health and social care agencies that may be involved (local authority environmental health departments for example).

Typical scenarios resulting in exposure to lead and recommended actions are as follows:

1. Ingestion of flakes of older household paint or exposure to paint or plaster dust resulting in the inhalation of lead containing paint

- If there is a history of ingestion of paint in the affected child, it is essential in these cases that the child has an abdominal x-ray to exclude the presence of paint in the gut; if present this requires urgent discussion with a toxicologist. If flakes of paint are identified in the child's X-ray, sampling of the paintwork should be carried out to confirm that this contains lead.
- Issues to be considered include: whether the property is privately or local authority owned (and if it is owned by the local authority, who manages the property); whether the property is rented; who is liable for costs and whether support is available for private accommodation.
- The EHPs role primarily involves the organisation of environmental sampling and remediation (especially for social housing). This may involve the removal of old paint work from banisters, painting over flaking paintwork or other such measures that result in blocking the source - receptor exposure pathway. It is important that dust is remediated as well as this can provide a continuing source of exposure.
- Remember that it is not just paint on walls/woodwork that is important. For example, antique furniture / toys and imported modern toys may be painted with lead paint.

2. Ingestion of soil with lead contamination

- Children may or may not have a clear history of soil ingestion.
- It may be worth considering soil sampling; although caveats to this include the difficulties in interpreting results and that samples from an urban setting often have lead concentrations close to or exceeding the soil guideline values (SGVs). Obtain advice from CHaPD on a strategy for this before proceeding.
- Remediation may include measures such as supervision to stop the child eating soil and the laying of a barrier of some kind (wooden decking for example) over sections of the garden to prevent the child's access to soil.

3. Use of traditional remedies

Lead toxicity is increasingly recognised as a potential risk from the use of traditional remedies and up to 20% have been found to be contaminated with lead. One study in the US, which looked specifically at Ayurvedic medicines, found that around 20% are contaminated with lead.[3]

- The case may give a history of having obtained a traditional remedy such as Ayurvedic medicine or Chinese herbal medicine. Traditional medicines from many other areas of the world may also contain lead (for example, West Africa, South America, and Australasia).
- The case may not disclose the use of these remedies when questioned. This may either be deliberately concealed or may not be considered as relevant as these remedies are thought of as 'tonics' rather than medicines. Therefore there is the need to be explicit when asking for this information.
- Investigate the source of the medicine, for example, was it obtained in UK or sent from overseas?

- Testing of the medicine could be arranged following discussion with CHaPD.
- If a herbal remedy is found to contain high levels of lead, remediation will involve ensuring that the patient is made aware that use must be discontinued. Advice must also be given to explain that other remedies may also contain high levels of lead as patients may use more than one of these. Also ensure that patient's contacts such as family or friends who may be using this also are aware.
- If a lead contaminated herbal remedy was purchased in UK, liaise with the local trading standards team in order to ensure that there is no further opportunity for the medicine to be consumed by other members of the public.

Other scenarios that may result in toxicity include exposure to lead from dust from old paint during the decorating of older properties. The health protection response to this should include advice on how to limit exposure using protective equipment (see public information leaflet produced by Defra[4])

Lead exposure could result from the ingestion of water that has high lead levels. Even though this is less likely due to the discontinuation of using lead solder for pipes, it is often worth considering whether the domestic water supply should be sampled.

2.4 Prevention

Experience from the management of a number of cases of lead toxicity has demonstrated that a joint home visit consisting of an EHP together with Health Protection professionals and also possibly the patients GP, community paediatrician or HV may be very useful. It has been found that this can yield information that would not have been obtained over the telephone and is likely to enhance joint working between EHPs and health protection practitioners. It may also prevent unnecessary duplication of work.

The questionnaire (available from chemicals.london@hpa.org.uk) can be used to record the information obtained from a joint home visit which may also be helpful in the planning of further investigation, remediation and tasks aimed at minimizing further exposures.

2.4.1 Secondary prevention

Actions should be carried out in conjunction and following discussion with the relevant environmental health department. The key piece of legislation is section 80 of the Environmental Protection Act (EPA)[5], which defines the Local Authority's ability to act for 'statutory nuisance' and, in particular those premises that are in such a condition as to be prejudicial to health. However, the definition of this may be open to interpretation in different situations and by different local authorities. Each case will therefore have to be discussed individually with the EHP involved with the case.

The role of the EHP would be to undertake the necessary environmental sampling for example of paint or dust and to co-ordinate any necessary remediation. A reasonable time-scale for the landlord to carry out any remediation should be agreed.

It is important to balance out the risk of lead exposures against other public health risks such as being made homeless and this needs to be considered when dealing with a family living in private rented accommodation who may have anxieties about this process, in particular that it may jeopardise their relationship with the landlord.

2.4.2 Primary prevention

There is potential for HPUs to be involved in primary prevention efforts to limit the exposure to lead containing products.

Examples could include:

- Community development work with targeted communities to raise awareness of the potential risks of traditional medicines.
- Work with EHPs to publicise the risk from lead related to deterioration of old leaded paint or redecoration and removal of lead paint; this could include distributing leaflets to local DIY stores.
- Work with health professionals to highlight the potential health hazards of traditional medicines. Diabetic patients and those with rheumatological conditions in particular, could be targeted as many traditional remedies are specifically aimed at these groups.

2.5 Communication

The effective management of a case of lead poisoning will always require a multi-faceted approach and there are advantages in holding an incident meeting or teleconference in order to agree a co-ordinated approach across the various agencies. This can help to clarify roles and responsibilities and also give an opportunity to address queries such as, in the situation where a child's lead levels are not decreasing, whether this is as a result of ongoing environmental exposure or due to 'normal' slow clearance of the whole body lead burden.

Depending on the source of exposure and the demographics of the individual(s) concerned, communication may need to include the following:

Health:

Primary care: GPs and health visitors.
Secondary care:
Paediatricians – acute and community
Physicians
Emergency Department staff
Chemical pathologists
Medical Toxicologists
Chemical Hazards and Poisons Division (CHaPD)
National Poisons Information Service (NPIS)

Local authority:

This may include members of the following teams:
EHPs, trading standards, social services and child protection teams.

Other:

May include: Food Standards Agency, Defra, local water company and Environment Agency

3. Overall roles in a chronic lead incident

Task	Generally undertaken/organised by:	Key legislation of note
Diagnosis and treatment of individuals	NHS – may be toxicologists, physicians, paediatricians (including National Poisons Information Service and others)	
Coordination of health protection with environmental interventions	EHPs in conjunction with Health Protection Unit (in liaison with Chemical Hazards and Poisons Division)	Health Protection Agency Act 2004
Public health risk assessment	Health Protection Unit in liaison with Chemical Hazards and Poisons Division	Health Protection Agency Act 2004
Test water supply	Public water supply mains: local water company (generally amenable to excluding water contamination as a source) Private water supplies: responsibility of water supplier, however regulated by local authority	The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007 Water Act 2003 Water Supply (Water Quality) Regulations 2000 in England and 2001 in Wales Private Water Supplies Regulations 1991 Part II Environmental Protection Act 1990
Sampling and remediation paint in domestic households	Social housing: Environmental Health Practitioners Private housing: homeowner/landlord (may arrange in liaison with insurers)	Part II Environmental Protection Act 1990
Soil sampling – garden, playground etc	Local authority	Part IIA of the Environmental Protection Act 1990

Contact details

Contact information for relevant local authority personnel / local arrangements can be added here.

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Emergency Planning and Preparedness

Immediate guidance for the front-line clinician: Emergency Clinical Situation Algorithm

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Summary

In situations of unusual clinical illness, the Emergency Clinical Situation Algorithm provides the front-line clinician with:

- immediate guidance
- key features to aid diagnosis
- consensus-based approach to patient management
- sources of further information
- who to notify

Introduction

An unusual illness may be defined as single or multiple cases of patients presenting with atypical clinical features for known aetiology or cases of unexplained syndrome with atypical signs or symptoms especially if accompanied by high morbidity or mortality. There may be a common geographical or temporal association to these presentations.

An unusual illness may have any one of a number of causes, including: infectious, chemical, or radiological and there is considerable overlap in initial presentation and generic management. By definition, unusual illnesses are uncommon and will present diagnostic challenges for front-line clinicians.

The HPA advice on *Initial Investigation and Management of Outbreaks and Incidents of Unusual Illnesses* is intended to aid decision making for health professionals and other health protection personnel involved in the initial stages of an incident for assessing whether an outbreak or incident is natural, accidental or a result of deliberate release.

From the detailed document the essential information has been distilled into a readily accessible and useable format for immediate front-line guidance as the Emergency Clinical Situations Algorithm (figure 1).

Are Cases Natural, Accidental or due to Deliberate Action?

Clinical awareness, timely surveillance and intelligence are prerequisites for detection and recognition of an event that may require special action. Consideration should always be given to whether the underlying cause is natural, accidental, the result of deliberate action, or indeed a new or emerging condition.

Usually an **OVERT** event will be rapidly apparent, although the precise content of the release may not be clear. However, if a release is **COVERT** the first indication may be the presentation of people with unusual illness to the front-line services. It is essential to have a high level of awareness of the possibility of such incidents.

The outbreak or incident can be classified as **ACUTE** or **DELAYED** for further management.

Clinical Assesment Management

Irrespective of whether the act of release was deliberate or not, the immediate aim is to prevent further exposure amongst staff or patients, using PPE/ decontamination/ containment. Speed of diagnosis may be crucial to save lives and for the protection of others. While a definitive diagnosis usually requires laboratory or technical confirmation, clinical management should be based on the steps shown in the Algorithm.

As usual, a good clinical history is vital. Further questions about any other people that have been seen suffering from the same symptoms or that have described the same unusual events or experiences, may reveal diagnostic pointers. Information which may give clues to the cause if illness include:

Case detection - the way cases are detected gives clues to likely aetiology
Epidemiology (when, where, who)
  Time: have cases presented over minutes, hours, days or weeks?
  Place: geographical location of the cases?
  Person: Any particular section of the population affected?

Many agents could potentially be used in a deliberate release, including those that clinicans may see in the course of routine work, as well as the more exotic. Therefore **the need to seek expert advice is emphasised**. Health professionals involved with cases of unusual illness should notify the local HPU.

Although personal safety and clinical care take priority, forensic issues such as preservation of evidence and chain of evidence must be taken into consideration where possible.

Critical Factors in Responding to Incidents of Unusual Illness

- Prompt and appropriate action is crucial
- High level of awareness
- Patient decontamination/ containment and staff safety/ PPE
- Early expert clinical assessment of patients
- **SEEK EXPERT ADVICE EARLY**
- **URGENT CASE CONFERENCE** including: clinicians, laboratories, public health officials and expert advice centres to facilitate effective investigation and management
- Initiate the relevant emergency plan and convene incident control team

Emergency Clinical Situation Algorithm

IF ANY OF THE FOLLOWING UNUSUAL CLINICAL PRESENTATIONS OCCUR – CONSIDER DELIBERATE RELEASE

- Unusually large numbers of patients present over a time period
- Cases linked by epidemiological features
  - ¬ Similar features/ similar geographical area
  - ¬ STEP 1-2-3 (see Box)
- Signs/ symptoms unusual or unusually severe
- Known cause but unusual in UK or where acquired
- Known cause but not responding to standard therapy
- Unknown aetiology

CBRN INCIDENTS
hpa.org.uk/emergency/CBRN.htm

Consider the risk of transmission or contamination to staff and/ or other patients
***Isolate patient**
***Use standard personal protective equipment (PPE) - wear gloves, gown, and mask (add eye protection if patient coughing or vomiting)**

ACUTE
- over minutes to hours
- occur in circumscribed geographical area
- occur in people who may have shared a known common exposure

Most likely: CHEMICAL
Other possibilities: Biological toxins
Radiological

DELAYED
- over hours to days or days to weeks
- may or may not occur in geographical clusters
- may or may not occur in people who have shared a known common exposure
- detected by surveillance

Most likely: INFECTIOUS AGENT
Other possibilities: Radiological
Chemicals (latent period)
(Psychological)

- **STAFF PROTECTION (PPE), HOSPITAL PROTECTION (air conditioning, isolation)**
- **INITIAL CLINICAL ASSESSMENT, HISTORY AND LIFE SAVING MANAGEMENT**

In a chemical incident prompt decontamination may be life saving. In a radiological incident triage and treat life threatening injury before decontamination; if the patients clinical condition permits, decontaminate first and then treat. Initiate local/ regional contingency plans.

1. Seek expert advice locally*

2. Ensure safety of self, other staff and patients

3. Detailed clinical assessment – use standard PPE
- **Nature and time course of symptoms**
- **Detailed clinical history**
- **Identify possible recent risk factors:**
  - **Where has the patient been?**
  - **What has the patient been doing?**
  - **With whom or what has the patient had contact?**

4. Management as per best available advice
- **Take samples for laboratory investigations**
- **Treatment or Prophylaxis as indicated**

5. Record information and communicate with
- **Senior clinician**
- **Hospital management**
- **Infection control**
- **Local medical microbiologist & chemical pathologist**
- **Laboratories**
- **Local HPU**
- **Chemical Hazards and Poisons Division/ National Poisons Information Service**
- **Local Radiation Protection Advisor**

STEP 1-2-3

The following precautions should be taken before continuing with the assessment.

First Actions
One Casualty
Treat as **normal**

Two Casualties
Have a **low index of suspicion** but otherwise treat as normal

Three Casualties or More
Initial assessment should be outside the department, use **PPE**, ask for **SPECIALIST HELP**

DECONTAMINATION

Rinse-Wipe-Rinse

Step 1
Gently wash affected areas with soapy water (0.9% saline for open wounds and eyes): this dilutes the contaminant and removes particles and water based chemicals

Step 2
Wipe affected areas gently but thoroughly with sponge or soft brush or washcloth: this removes organic chemicals and petrochemicals

Step 3
Gently rinse affected areas

☎

***Inform local HPU IMMEDIATELY**
http://www.hpa.org.uk/lars_hpus.htm

SEEK EXPERT ADVICE
For full list and contact details see Appendix 1

- **EFFECTIVE COORDINATION** by an overall incident management lead, which may be local, regional or national depending on the nature of the incident
- **EFFECTIVE COMMUNICATION**
- Maintenance of comprehensive, contemporaneously written records

Related Documents

Initial Investigation and Management of Outbreaks and Incidents of Unusual illnesses
http://www.hpa.org.uk/infections/topics_az/deliberate_release/unknown/unusual_illnesses.htm

Protocol for the investigation of microbiologically unexplained serious illness and death
http://www.hpa.org.uk/infections/topics_az/deliberate_release/unknown/unusual_illnesses.htm

CBRN Incidents: Clinical Management and Health Protection
http://www.hpa.org.uk/emergency/CBRN.htm

Home Office Guidance (2004) for decontamination is available at
http://www.ukresilience.info/upload/assets/www.ukresilience.info/peoplecbrn.pdf

Specific Guidelines for deliberate release agents:
http://www.hpa.org.uk/infections/topics_az/deliberate_release/defaultDAR.htm

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A ‘puff of smoke’ or ‘a blaze of glory’? An evaluation of the Hazmed service in West Yorkshire

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Introduction

In 2005, over 1000 chemical incidents were reported to the HPA in England and Wales[1] and many more may have gone unreported. Early involvement of appropriately trained frontline staff and expert public health advice is invaluable in reducing the immediate impact and long-term effects of such incidents.[2] This report describes an evaluation of a unique service developed to improve the preparedness, local surveillance and operational management of chemical incidents with the potential of reducing human and environmental harm.

Background

Possibly due to the lack of a formal local mechanism for identifying and reporting chemical incidents, Yorkshire and the Humber appeared to have one of the lowest incidence rates in the country in 2005.[3] Similar reporting discrepancies have been previously reported in other parts of the UK.[4,5] Early alerting criteria for emergency services in West Yorkshire were subsequently developed in 2005 (Box 1).[6] Initially the plan was for Fire Service Hazmat officers to contact local Health Protection Units (HPUs) for advice when an incident fulfilled the alerting criteria.

Box 1: Chemical incident alerting criteria for emergency services in West Yorkshire

- Major fires involving 6 or more pumping appliances
- Chemical incidents involving any of the following:
  - Vulnerable people
  - Casualties
  - Media
  - Water/ food contamination
  - Biological/ environmental sampling required
  - The public evacuated/ sheltered
  - Other agencies (Environment Agency, Local Authority, Food Standards Agency, Water Companies, Police)

Despite the application of these criteria, some system deficits persisted, notably:

1. A lack of immediately available clinical chemical information for responding paramedics at the scene of an incident
2. A lack of a formal mechanism for gathering clinical information about incidents
3. No ‘on-scene’ health contact for Hazmat officers
4. No formal procedure for Yorkshire Ambulance Service (YAS) to pass chemical information to wider health economies e.g. HPA, Primary Care Trusts (PCTs), Emergency Departments (EDs).

To address these deficiencies, a decision was taken to train twelve paramedic officers in chemical incident management to take on the above roles thereby forming the ‘Hazmed’ service. The service went ‘live’ in December 2005 with two Hazmed officers being on-call 24 hours on top of their usual paramedic rotas. The Hazmed officers have access to an emergency vehicle carrying specialist equipment and information. The service is funded from the Department of Health’s resilience budget.

The Hazmed Alerting Mechanism and an Illustrative Case Study

The Hazmed chemical incident alerting system is presented in Figure 1. This is best described through documenting one of the incidents dealt with by the Hazmed service.

On 26 July 2006, West Yorkshire Fire and Rescue Service (WYFRS) were called to a fire at a chemical processing plant in Halifax. Because of the presence of chemicals at the plant and the involvement of thirteen fire engine pumps, the Hazmat officer contacted his Communications Centre and requested the attendance of the Hazmed service before continuing with his operational role. WYFRS Communications Centre contacted YAS Communications Centre who then contacted the Hazmed officer on-call. On arrival at the fire, the Hazmed officer assessed the two casualties, and gathered information on the chemicals present at the plant, the nature and extent of the fire, and the number of staff involved. The Hazmed officer then contacted Leeds HPU via Seacroft Lodge who directed the call to the Consultant in Communicable Disease Control (CCDC) covering Halifax. The Hazmed officer relayed information to the CCDC before going off to manage the casualties, gather further details and provide on-scene advice to the Hazmat officer. The CCDC offered initial advice, requested a CHEMET plume model, contacted the Chemical Hazards and Poisons Division (CHaPD) for advice on the possible interactions and consequences of exposure to the chemicals involved, and liaised with the Local Authority (LA) and Environment Agency (EA). Once the required information had been gathered, the CCDC re-contacted the Hazmed officer and gave further operational advice relevant to the incident.

The alerting system ensured that the local HPU became involved in the response at an early stage. The CCDC was able to access more detailed expert information and liase with other agencies whilst providing support to the Hazmed officer and freeing them to provide assistance and ‘on-scene’ advice. Thus, the Hazmed officer became health’s forward liaison point at this incident. Afterwards, the Hazmed officer completed a reporting form which was logged on a database for audit and local surveillance purposes.

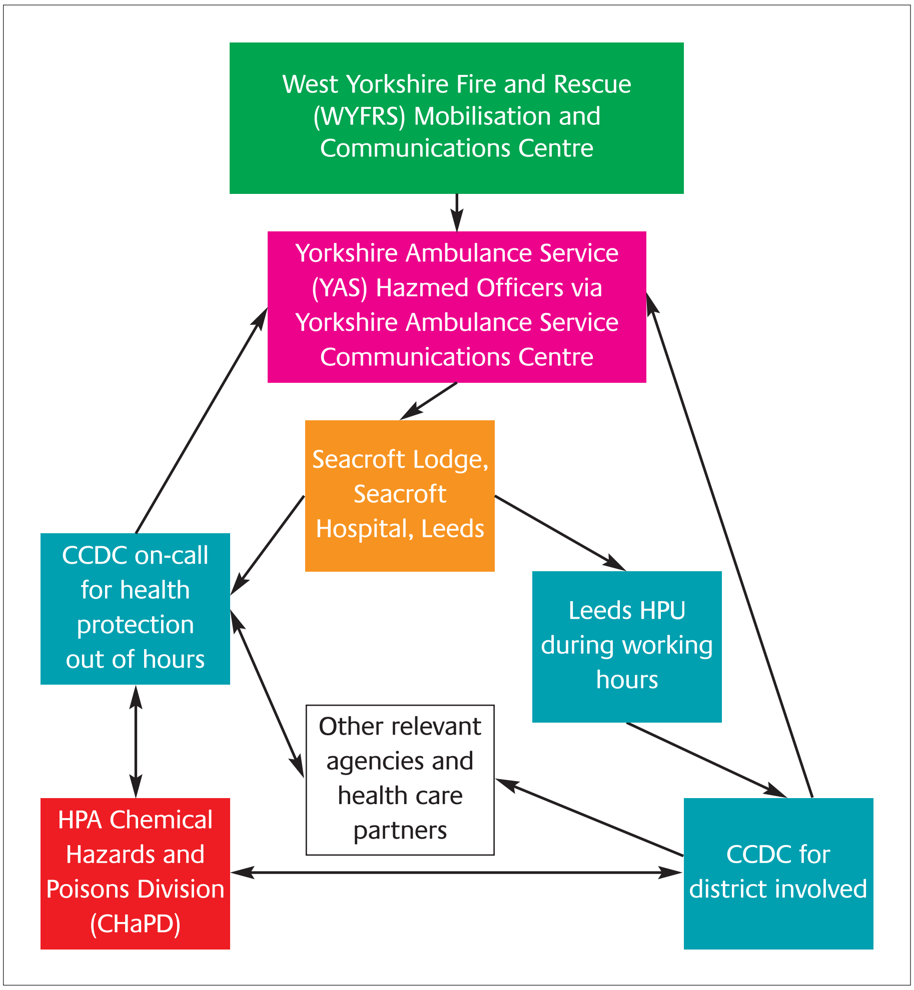

Figure 1: Major Fires and Chemical Incidents West Yorkshire Incident Alerting Flowchart

Hazmed Service Evaluation

Methods

At the service's inception it was agreed to evaluate it mid-2006 for the purposes of clinical governance and to highlight areas for modification and of good practice. The evaluation had two parts:

Part 1 -All Incident Reporting Forms from 21 December 2005 to 31 July 2006 were reviewed with attention to:

1. Incident timing
2. Incident location
3. Incident scenario
4. Chemical and medium involved
5. Scale of response
6. Effect on the public
7. Involvement of other agencies (e.g. HPA, EA, Police, LA).
8. Nature of advice from public health.

Part 2 -All Hazmed officers were sent a questionnaire and interviewed to gather informal views about their role and the service. All thirteen Hazmat officers of WYFRS and members of the West Yorkshire Chemical Incident Group (representatives of fire and ambulance services, local CCDCs, LA, EA, CHaPD were also sent questionnaires).

Results Part 1: Incident Reporting

Between 21 December 2005 and 31 July 2006, Hazmed officers attended 40 incidents that fulfilled the early alerting criteria; 27 incident forms were received at Leeds HPU. The other 13 incidents were compiled by one of the YAS project leads. The missing forms from the Leeds HPU database concerned incidents from the service's first three months and only contained details of the incident's location, type and local HPU involvement. The monthly call distribution is shown in figure 2 (mean number of calls was five per month).

(1) Incident timing: 26 of the 27 incidents recorded on the Leeds HPU database recorded a time, 9 of these incidents (35%) occurred outside 9am-5pm and only 2 (7.7%) occurred after midnight.

(2) Incident location by district: Bradford had the highest number of incidents (figure 3) which may reflect the large number of chemical plants in the area and the proximity of the M62 (a major transport route for chemicals).

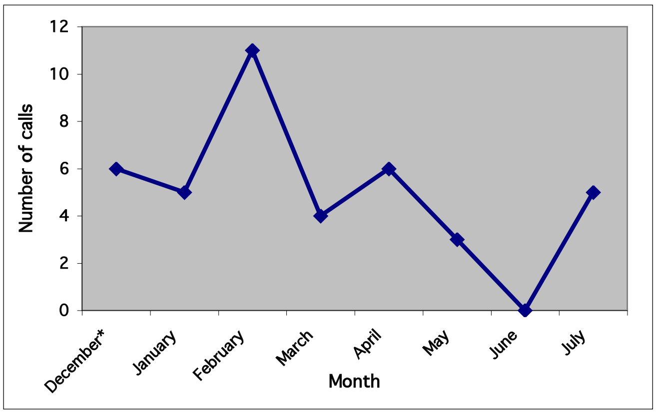

Figure 2: Plot of the number of Hazmed calls to incidents in West Yorkshire by month (21 December 2005-July 2006)

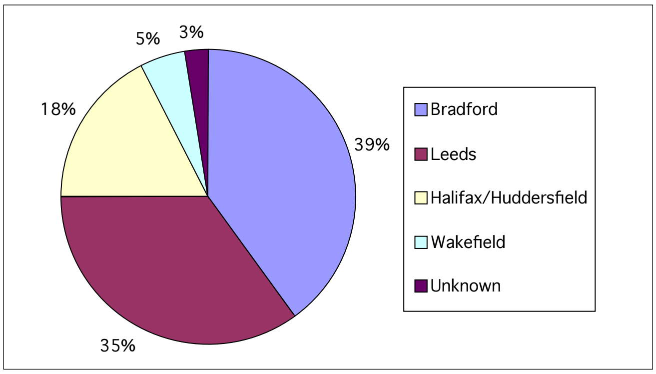

Figure 3: Chart showing distribution of chemical incidents between districts in West Yorkshire.

(3) Incident scenario (by location): 52.5% of incidents occurred at industrial sites (figure 4) which is three times the reported national figures for the same period.[7,8] This may reflect the high number of industrial plants within West Yorkshire. Three incidents (7.5%), occurred at Control Of Major Accident Hazards (COMAH) sites compared to the national rate of 1.5%.[7,8] All three of these separate incidents were at the same COMAH site in Bradford. Incidents involving transport sites were more than twice the national figure (17.5% versus 8%).[7,8] This probably reflects the large number of major highways transecting West Yorkshire (5 transport-related incidents occurred on the M62).

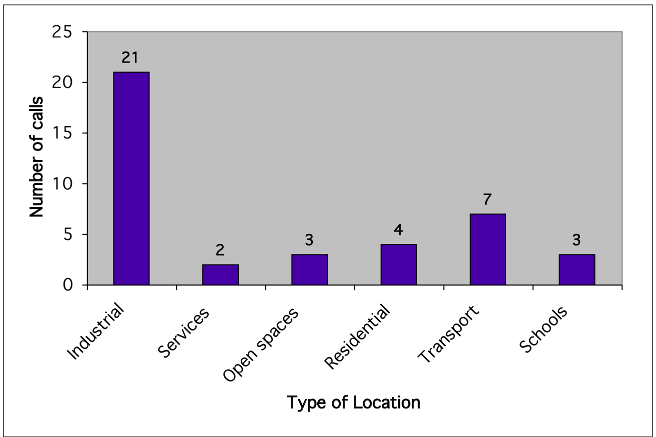

Figure 4: Chart showing proportions of chemical incidents by location type

(4) Chemicals and medium involved: excluding incidents only involving fire (and smoke release), the Hazmed service dealt with 27 incidents involving chemicals (figure 5). In comparison, only 14 chemical incidents had been detected in a similar time period of the previous year by routine reporting methods.[3]

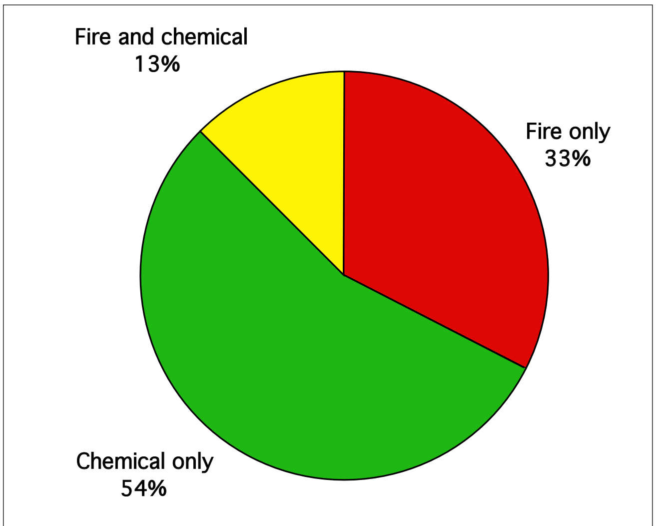

Figure 5: Chart showing proportions of incidents involving fire and chemicals

A chart showing proportions of incidents by chemical group is presented in figure 6. Notably, a fifth of incidents involved unknown chemicals which presented difficulties in trying to discern the possible clinical effects and interactions. In such cases, it was useful for the Hazmed officer to be able to call on the CCDC's support. The most common medium affected was air (figure 7).

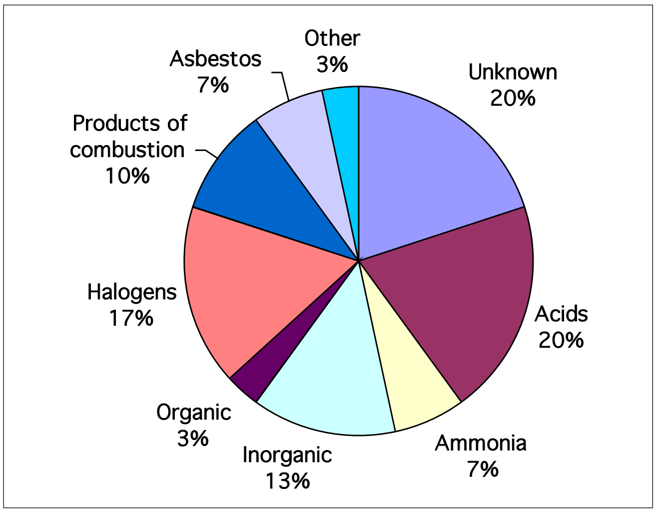

Figure 6: Chart showing proportions of incidents by chemical group

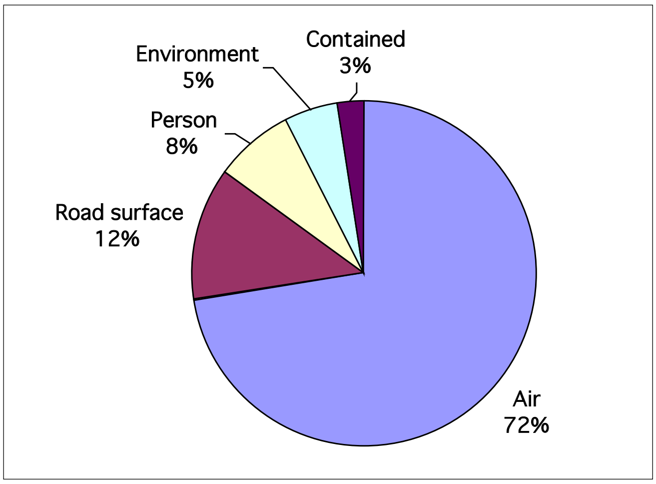

Figure 7: Chart showing proportions of chemical incidents by medium affected

(5) Scale of response: from the Leeds HPU, of the 27 incidents:

- Only two (7%) required the presence of two Hazmed officers.
- Nine (33%) required six or more fire appliances.
- Five (19%) involved establishing a command unit.

(6) Effect on the public: no incidents have resulted in fatalities since the Hazmed service began. Only four (15%) of the incidents required evacuation of the public mainly as a precautionary measure. The most commonly reported symptom was breathing difficulties.

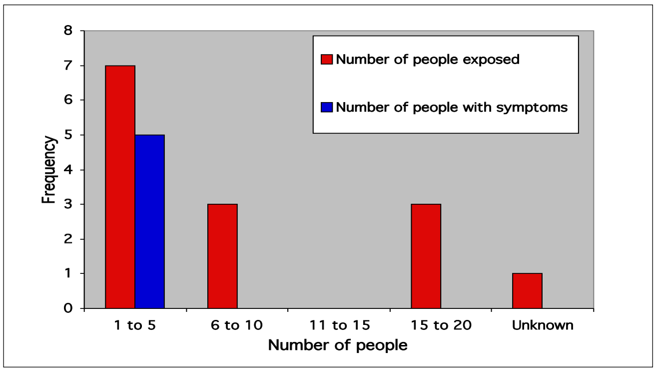

Figure 8: Chart showing numbers of both those exposed during chemical incidents and those symptomatic

(7) Involvement of other agencies: the multi-agency response to many incidents is reflected in figure 9. Notably, the HPU was not contacted during every incident. However, because Reporting Forms are usually completed, they provide a method of recording which can be logged for future reference. Hazmed officers attended only 39 incidents of the 40 reported (in one case they were stood down on their way to the incident scene).

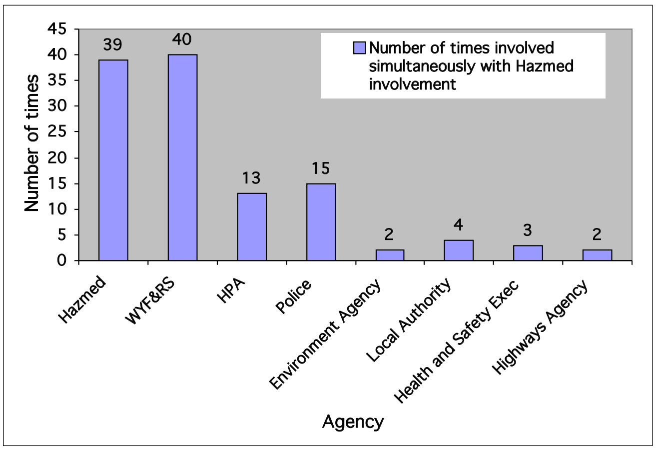

Figure 9: Chart showing number of times different agencies were involved in chemical incident response

(8) Nature of advice from public health: this included:

- Obtaining CHEMETs.
- Contacting CHaPD about the chemicals involved.
- Advising on casualty management.

The HPU only needed to be contacted in 33% of incidents. This could suggest that the initial Hazmed training was of a high enough standard for them to handle the majority of incidents alone. Additionally, the information in the Hazmed vehicles (which consists of in-depth data files) is comprehensive enough to cover most scenarios.

Results Part 2: Key themes identified

1. Hazmed officers' views as Hazmed Service (questionnaire response rate = 83%; N=10)

Training

One respondent felt their initial training had been minimal; the rest were satisfied with the preparation. There was a general feeling of having to learn on the job. Another felt *'in at the deep end'* but through experiencing situations had grown in confidence and ability: *'I'm swimming ok*.'

Future training needs identified included:

- More on patient symptoms and signs in relation to specific chemicals.
- Regular refresher courses.
- Feedback on incidents covered for iterative learning and sharing practice.

On the job

Some highlighted that at the service's start there were problems contacting them. During incident response, none of the officers felt they had done anything beyond their job description. They had mixed views about how they thought they were received at incidents. Some felt their presence was appreciated by attending crews and they took some of the responsibility from the Hazmat officers. Others felt their roles were not well understood or they were dismissed as *'novices'* or *'glory boys'*.

All thought communications with local HPU staff had been helpful, pragmatic and supportive. Knowledge of easily available health protection advice was a *'comfort blanket'* and many were impressed by the support given by CHaPD. Having the CCDC at the end of a phone was seen as being more useful than calling them out. They felt capable of gathering relevant information and thought CCDCs served more use in information interpretation and agency liaison by being removed from the scene.

Several highlighted the problem of inadequate mechanisms for local HPUs to get large amounts of information to them at complex incidents. Laptops with (portable) internet connectivity were suggested as a solution.

Personal opinions

Overall, all were positive about their new role and felt it fulfilled an operational gap in spite of being *'a learning curve'*. Hazmed service leads were pleased with the service and how it fulfilled all initial aspirations. Nevertheless, they acknowledged that the true test would be when a major incident occurred.

2. Hazmat officers' views as Hazmed Service (questionnaire response rate = 100%; N=10)

On the job

Most thought it was easy to contact Hazmed officers except at weekends. This may be because in the week CBRN leads are available to cross-cover duty officers' on-call.

The information which Hazmed officers provided to Hazmat officers was deemed appropriate to their needs; particularly liasing with the wider health economy which one Hazmat said was *'difficult for us* [fire services] *to understand'*. Hazmat officers saw the Hazmed officer's role as being able to *'free them* [the Hazmat] *up'*; *'reducing pressure on them* [the Hazmat]'; and being a helpful link between fire and ambulance services.

Personal opinions

All thought the service was a good idea and had facilitated *'closer inter-agency working'* and *'partnership'* between fire and ambulance services. Again, it was felt that the service's effectiveness would only be truly known when a major incident occurred.

Suggested areas for future work included further joint training, sharing each others' resources and joint debriefs.

3. Other agencies' views (questionnaire response rate = 83%; N=5)

Perceived benefits and weaknesses of the Hazmed service.

All respondents voiced a number of positive benefits of the service, particularly it being:

- A *'logical mobile 24 hour response of expert advice'*.
- An early warning system for incidents that would ensure the early engagement of HPA and the wider health economy, which may prevent an incident escalating.

- A *'real-time surveillance system'*.
- Complementary to the role of the Hazmat officer enabling *'better risk assessment and decision-making'* at incidents.
- A way of improving communication and joint working between emergency services and external partners. In particular, CCDCs thought the role and usefulness of the HPA had been highlighted to other services through the Hazmeds' presence at incidents.

Some concerns included:
- only a relatively small number of incidents had occurred so far
- the EA felt they had little experience of the service
- the HPA had not received much feedback about the usefulness of their advice (until this evaluation)
- communications out-of-hours were sometimes problematic
- Hazmed officers being relied upon too much at incidents
- over-stretching officers if simultaneous incidents occurred.

Roll-out
All respondents supported rolling out the service to the rest of Yorkshire and even beyond. However, funding, local priorities, on-going multi-agency commitment, political support and the logistics of transposing the model onto another area were identified as possible limitations.

Discussion

This evaluation was performed after the Hazmed service had been in operation for nearly eight months. It was felt this would have allowed a sufficient time for the service to have encountered enough incidents from which to learn lessons of good practice and highlight problems before they became entrenched.

Some of the evaluations' strengths include:

- Anonymity of respondents to encourage honest comments.
- A high questionnaire response rate
- The use of qualitative data to capture Hazmed officers' opinions
- That the valuation was undertaken by a trainee who was independent from the development of the service and day-to-day running thereby minimising the potential for bias.
- That many agencies were included, reflecting 'real-life' front-line management of chemical incidents.

Potential shortfalls include:

- Some data was missing from the Incident Reporting Forms.
- The restriction of respondents to the questionnaires for part of the evaluation.
- The views of Police and other ambulance paramedics who are not Hazmed officers were not sought.

However, a number of key issues have come to light:

Communication

All agencies said that sometimes there had been problems with the flow of communication between them, be it Communication Centres contacting Hazmed officers, or Hazmed officers contacting the HPU. In most cases, this was recognised to be due to unfamiliarity with a new system. With reinforcement of communication channels given in figure 1, these communication problems have largely been resolved.

Hazmat officers certainly did not reflect the dismissive attitude that some Hazmed officers felt was expressed towards them. Instead, they saw the service as a valuable resource at incidents.

Notably, the service had enabled better inter-agency communication. This has been further facilitated through on-going multi-agency training.

Surveillance

Surveillance data on the number and type of incidents in West Yorkshire has improved considerably. Twice as many chemical incidents were detected during the evaluation period compared to similar periods in preceding years.[3]

Management

Hazmed officers have brought specialised knowledge to the scene of chemical incidents so ensuring they have been managed better to the benefit of staff and the wider public and environment. Furthermore, the Hazmed service has been crucial in providing ground level input of the HPA at incidents as well as helping co-ordinate the response by the health economy – in effect, fulfilling two functions in one role. The presence of the HPA at Bronze level command is often lacking; the agency usually being confined to Silver or Gold commands partly due to limited staff numbers. Nonetheless, it has been recognised that capacity to gather information relevant to the HPA at the operational level is crucial to incident management[9] and the Hazmed officers fulfil this vital role.

Role of local HPUs

Local CCDCs were more engaged with chemical incident management. CHaPD, being a national service, was more appropriately contacted via local 'front-line' public health practitioners.

Of note, the Hazmed service provides a potential blue-print of a service model working in practice to fulfil a number of the HPA's key strategic goals and corporate objectives (Box 2).[10]

Roll-out

All parties involved in the Hazmed service have worked extremely hard to ensure that officers are adequately prepared, have the right equipment and that the service's sustainability is maintained. Importantly, the Hazmed service has continued during the recent reconfiguration of West Yorkshire Metropolitan Ambulance Service to the new Yorkshire Ambulance Service.

Crucial components to any national service roll-out were identified as being the requirement of local ownership of the service, and locally configured services to fit the variable industrial and transport infrastructures and population densities across the UK.

Box 2: HPA Strategic Goals and Corporate Objectives of relevance to the Hazmed service.

Strategic Goal 2: To anticipate and prevent the adverse health effects of acute and chronic exposure to hazardous chemicals, poisons and other environmental hazards

Corporate Objectives (p.14): To prevent adverse effects of exposures to acute chemical and poisoning incidents by improving preparedness and response of the HPA, NPHS-W and the NHS through the development of national and international alert, response and surveillance systems, as well as 24-hour evidence-based clinical and public health services.

Strategic Goal 6: To improve preparedness of responses to health protection emergencies, including those caused by deliberate release

Corporate Objective (p.22): To create and improve the infrastructure and systems within the HPA for emergency response and provide support and advice to other responding bodies and organisations.

Strategic Goal 7: To strengthen information and communications systems for identifying and tracking diseases and exposures to infection, chemical and radiological hazards

Corporate Objective (p.24): To have in place a high quality system for surveillance and alerting, which is closely related to response, enabling the delivery of our health strategy.

Recommendations

Though there has been a positive evaluation and feedback about the Hazmed service, there is always scope for improvement, particularly:

- On-going re-iteration of the communication protocol.
- Multi-agency training and feedback to continue developing professional relationships and provide reflective learning.
- Continued commitment by local HPUs to ensure their Chemical Incident Management knowledge is up-to-date and how to access further resources.
- Provision of laptops to Hazmed officers so they can access up-to-date chemical data and receive further information from HPUs at incidents.
- Development of the database of logged incidents into a formal surveillance system similar to other regions.[11]
- Using this surveillance data to strengthen and modify existing contingency plans to ensure that risks to the public and environment are further minimised through robust preparedness.
- Formally linking into the HPA's strategic and corporate goals of a coherent surveillance system.[10]
- Disseminating the knowledge and practice of this service to other regions.

Conclusions

Preparedness is the key to any major incident. This is facilitated by having a rapid, cohesive and integrated response to emergencies. The Hazmed service has fulfilled the niche of providing intelligent frontline expertise, surveillance and improved inter-agency partnerships in chemical incident management. Although there has not been a major incident in West Yorkshire on the scale of the London Bombings or the Buncefield Oil Depot Fire, this evaluation suggests that the service has laid sufficient foundations in terms of capabilities and commitment for it to be robust enough to tackle such incidents.

Acknowledgements

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Further details about the Hazmed service can be obtained from Dr. Mike Gent at Leeds HPU: 0113-2840606

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Helping individuals, families and communities cope in the aftermath of flooding

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Summary

The Health Protection Agency (HPA) was involved at several levels in the public health response to the widespread flooding that occurred in England during June and July 2007. In response to a request for advice on what psychosocial interventions may be effective in such situations, and what the evidence base for these interventions is, we prepared preliminary guidance. Here we provide an overview of that guidance, which was based on a selective review of the literature and reflects a first draft of an evidence-based framework to guide the activities of regional and local Health Protection Units in dealing with floods. The recommendations are based on an analysis of activities underway in response to recent flooding incidents (e.g. Hull and Sheffield, July 2007) and case study analyses of previous incidents in the UK (e.g. Carlisle 2005; Boscastle 2004; Lewes 2000). Where relevant, international research literature is also reflected, for example the World Health Organization (WHO) has produced guidelines for strategies to ameliorate the mental and social impact of acute emergencies and disasters (Inter-agency Standing Committee, 2007; WHO, 2003).

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

Introduction

Reactions to traumatic events such as flooding are often described in terms of a number of stages (e.g. Tyndall, 1951; Raphael & Newman, 2000; Alexander, 2005).

- The *Impact Phase* describes the time of the immediate threat of the disaster, where the greatest force and disruption occur. At this stage individuals and communities may be displaced or isolated, and will be dealing with the shock of the immediate situation. In these circumstances, the majority of individuals often show resiliency through acts of bravery and altruism; reports of panic are rare (Durodie & Wessely, 2002). However there are a number of stressors which occur at this time that may have longer-term consequences, such as threats to life and encounters with death, feelings of helplessness and powerlessness, difficulties communicating with and ensuring the safety of loved ones, and dislocation, whether geographically or from normal social networks (e.g. Raphael & Newman, 2000; Rubin et al., 2005, 2007). Support needed at this stage is primarily in the form of rescue and meeting basic needs such as shelter, security, warmth, food and water and facilitating communication, providing information and re-connection with loved ones.

- The *Immediate Post-Disaster Phase* describes the days and weeks following a disaster. At this stage, individuals, communities and emergency responders are able to take stock of the impact and damage caused, and those affected will be attempting to reconnect with families and former social networks, and where possible return home and try to establish a sense of normality, often despite continuing disruption. Authorities and emergency responders are likely to have been able to establish a response infrastructure, providing essential services alongside drop-in centres, help-lines and information leaflets, as well as outreach programmes targeted at those worst affected.

- At the *Recovery phase*, the actions of authorities and continuing efforts to re-build and restore communities in the following months and years can have a significant impact on the ability of individuals to cope with disaster, and the long-term likelihood of positive or negative outcomes (Alexander, 2005). Poorly-managed and implemented response and recovery operations, however well intended, can serve to increase feelings of isolation, loss, anger and distrust. At worst, increased incidence of physical and mental health problems may occur.

A range of factors are known to promote positive outcomes and facilitate coping in the post-disaster and recovery phases. These include providing accurate, timely and practical information; effective practical assistance with employers and financial and legal authorities; provision of emotional and social support; and activities designed to facilitate the re-building of communities, and the maintenance of new social networks created in response to the disaster (Raphael, 1986; Rose et al., 2002; Wessely, 2003; 2005; 2006).

The following section provides an outline of strategies and activities that can facilitate coping and positive outcomes in individuals and communities in response to flooding.

Strategies and activities to facilitate coping and promote resilience

The recommendations set out below outline strategies and activities that can be undertaken in the immediate post-disaster and recovery phases of response.

- **Setting up a database of flood-affected households and individuals;** to include flooded addresses, temporary addresses of affected individuals and families (temporary accommodation or rest centres). Mapping of the contact details of close family members or friends of affected individuals to assist families who may have been separated by evacuation. Estimates from the 2005 Carlisle flooding, suggest 98% of those affected were identified and reached by establishing such a database.

- **Practical and timely information, via a range of channels;** the development of specific practical advice materials, disseminated via door to door leaflet drops, local and national media, websites and face-to-face in community centres. These can include information on:
  - How to deal with the clean up and damage to homes
  - How to protect individual health and the health of family members and neighbours
  - Advice on local services to aid clean up, including grants or other sources of financial assistance
  - Crucially, if the advice is to wait for professional assistance with returning home and clean up, information on the timescale for these services must be communicated. It is also important not to over-promise and under-deliver services, as this fosters distrust and can confound feelings of helplessness and isolation.
  - Practical advice on insurance claims, dealing with loss adjustors, builders, service providers etc.
  - Providing access to advocacy for individuals in need of help to deal with the above service providers, or connecting individuals with organisations who can provide advocacy (e.g. Citizens Advice Bureau).

- **Proactive and frequent communication with affected-populations;** establishing conspicuous points of contact and communications at a local level can help to provide practical support, dispel myths and communicate important milestones in recovery. In several existing flood-affected areas (e.g. Hull & Sheffield), this was achieved via:
  - A well-advertised local 'flood-line' telephone contact
  - Regular drop-in centres and sessions; both in central locations and in affected areas. If relationships can be established, use could be made of supermarkets / local businesses for the dissemination of information and as a point of contact.
  - Visits to affected households from council staff, to establish the extent of damage and initiate the provision of services to assist clean up.
  - Regular newsletters (e.g. bi-monthly) to affected-populations providing ongoing updates on recovery, local activities, work on preparedness and preventative measures, contacts for advice, help and support

- **Provision of welfare and emotional support;** a range of activities and strategies can be adopted, making important contributions to individual coping strategies in the immediate and medium to long-term recovery phases:
  - **Identifying and addressing immediate welfare support needs;** particularly for vulnerable groups and those known to be at risk, such as young children and adolescents, frail elderly, persons with disabilities and/or physical or mental health problems.
  - **Facilitate communication within flood-affected communities;** in the short-term, displaced families or communities should be helped in their efforts to reconnect, even if returning home is not yet possible. In the medium to long-term, providing opportunities (community meetings, drop-in centres, establishing support groups) for communities to come together and share stories and experiences. Such activities facilitate the creation of 'therapeutic communities'; the spontaneous social groups that are often created by the shared experience of a disaster. These groups can provide important social and emotional support. Local branches of national voluntary organisations (e.g. Women's Royal Voluntary Service (WRVS) and the Salvation Army) as well as smaller local voluntary groups should also be supported in this regard, and in their emergency response activities.
  - **Provide resources for emotional support to flood-affected populations;** evidence suggests that short-term mental health interventions (such as counselling or psychological debriefing) in the general affected population are not effective, and may result in individuals being taken away from their own support networks, impeding them from talking to who they want, when they want (Wessely, 2003; 2006). As an alternative, 'Psychological First Aid' (Raphael, 1993; Alexander, 2005; Inter-Agency Standing Committee, 2007) can be adopted by emergency responders and primary health care workers. This approach does not involve probing individuals for their reactions, but instead promotes a calm, caring and supportive environment, protection from further harm, encourages adaptive coping strategies, opportunities to share experiences (but not in a forced way), provides information about sources of support, facilitates a sense of being in control and helps to identify those who may need further help (mental health 'triage'). In this way the normal process of psychological recovery is facilitated, and professional mental health support is made available for those who 'opt-in' to services.
  - **Availability of primary care mental health expertise;** it is likely that 'common mental disorders' will increase in prevalence within affected populations in the months following the floods, from a pre-incident prevalence of around 10% to a post-incident prevalence of nearer 20% (Inter-Agency Standing Committee, 2007; WHO, 2003). Common mental disorders include depression, anxiety disorders, substance misuse and somatisation. These problems are best dealt with by the communities' usual primary care providers (i.e. within general practice), rather than via additional services. It may be helpful to alert local GP's to the possible increase in these presentations.

- **Recognise and support community needs for spiritual support;** help local religious communities to reach out to affected populations; provide support and advice to these organisations so that consistent messages regarding clean up and practical support are disseminated. Utilise the natural leadership and contacts religious organisations have with affected communities.
- **Promote activities to connect and re-build communities;** through the continuation of the practical and social support activities outlined above, the re-building of pre-disaster social communities can be facilitated. Additionally in the long-term, organising celebratory community social activities (e.g. street parties) to recognise and support key milestones in the recovery of affected areas can further facilitate individual and community recovery. Activities of remembrance, such as documenting and archiving individual's stories and conducting religious services can also be helpful.

Conclusions

There was little high quality evidence supporting the use of specific psychological (or psychosocial) interventions in the aftermath of flooding in the UK. Nevertheless, we were able to provide an overview of what strategies have been used in the past in the UK and also what interventions inform consensus guidelines on post-disaster care at international level. A more detailed and systematic review of the grey and published literature on psychological (and psychosocial) interventions following flooding is currently underway.

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'Exercise Stinkhorn': Mass Casualty Decontamination

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Introduction

Emergency Planning is at the heart of the Civil Protection Duty placed on Category 1 Responders by the Civil Contingencies Act (2004). This requires Responders to maintain plans for preventing emergencies, reducing, controlling or mitigating the effects of emergencies and taking other action in the event of an emergency.

Exercise Stinkhorn was a full scale, 'live-play', multi–agency exercise aimed at testing (at operational and tactical levels) the communities Mass Decontamination plan in response to a conventional chemical incident. The exercise was specifically designed to identify any shortcomings in the collaborative working processes that are essential for successfully managing such an incident. As a result, the exercise centred on the practical application of the plan as well as command, control and communication interfaces.

Exercise Scenario

The exercise scenario consisted of an accidental chemical release occurring as a result of a cargo train derailment. The train was travelling east-bound towards Nottingham Station adjacent to the Nottingham Tennis Centre. The train remained upright but containers carrying 'a chemical' fractured which resulted in large amounts of it spilling on to the westbound track. A train passing in a westbound direction shortly after the derailment dispersed the chemical resulting in a white cloud falling over the tennis centre.

The scenario included chemically contaminated patients self–presenting at the Emergency Department of the Queen's Medical Centre Campus of Nottingham University Hospitals, thereby triggering the mass casualty decontamination plan.

Exercise Planning

Representatives from all participating services and organisations were invited to join the 'Exercise Stinkhorn Planning Group'. The services and organisations presented at the planning group are given in Box 1. Establishing the planning group allowed each player to develop their own aims and objectives within the wider exercise framework. It also produced an exercise team with an in-depth knowledge of the roles and responsibilities of each player and the wider implications of their own decisions and actions.

Box 1: Exercise Stinkhorn Participating Organisations

- Nottingham University Hospitals NHS Trust
- Nottinghamshire Police
- Nottinghamshire Fire and Rescue Service
- East Midlands Ambulance Service
- Environmental Agency
- Nottingham City Primary Care Trust
- Nottingham County Council
- Nottingham City Council
- Health Protection Agency
- WRVS (Women's Royal Voluntary Service)

It was recognised that for future exercises, each service / organisation must be represented at every planning group meeting. This will ensure planning continuity and ensure involvement in the exercise planning / decision making process.

Maintaining the planning group's committed list of core members was instrumental in enabling all participating organisation representatives to take ownership for their part of the exercise. This should be encouraged as good practice for future multi-agency exercises.

Resources and Funding

In the majority of cases, participating agencies were able to commit resources at the early stages of the planning process. The planning group accepted that some of the Emergency Services 'participant' numbers were made up of volunteers and although they were committed to the exercise, definite numbers were not known at the initial planning stage.

At the early planning stage it was agreed that participating staff overtime costs would be borne by their parent organisations. The cost of volunteer and exercise staff meals and refreshments was borne by Nottingham University Hospitals and the WRVS costs borne jointly by Nottingham County Council and Nottingham City Council.

It was identified was that representatives on the planning group should have the authority to make operational decisions and have access to resources within their parent organisations.

Running the Exercise

As already described, the exercise was designed with the aims of each participating organisation being considered. As well as specific results and actions therefore, other more generic, lessons were identified and are replicated here.

1. Management of Self – Presenters

This area of activity was acknowledged by the planning group as being difficult to exercise realistically and it was accepted that this part of the exercise would have to be carefully stage–managed. However, the scenario was designed to test the likely response to this type of situation if it were to occur in reality.

Many learning points were identified during this phase of the exercise:

Identification and Management of a Holding Area

- Methods and protocols are needed to effectively manage potentially contaminated self-presenters until the police arrive to take overall control of the scene(s).
- There is a need to identify primary and secondary areas where self – presenters can be held.
- The time lapse between the arrival of the first self – presenter and communication with security was too long.
- That full personal protective equipment (PPE) is required for both security and NHS staff if they are required to leave a building and enter a potentially contaminated zone.
- There is a need to provide toilet facilities particularly if the situation becomes protracted.
- There is a need for a review of the feasibility and management of providing refreshments for exercise participants.
- Protocols are required for managing the care of patients with disabilities.

Communication

- There was nobody directing the self – presenters on what to do.
- There was no explanation as to why self-presenters were being moved to a holding area.
- No provision was made for non–English speaking individuals and for the visually impaired or disabled.
- Engagement with self – presenters was minimal and therefore an opportunity to allay their fears was missed.
- There is a need to communicate clearly and concisely.
- There is a need to eliminate the perception of 'us and them' for self-presenters and emergency responders.
- There is a need to ensure that self – presenters are constantly updated as the incident evolves.
- The use of 'jargon' or terms with which members of the public may be unfamiliar should be eliminated.

A clear lesson identified was that regular communication and reassurance are key factors in the effective management of the self–presenter. A well-informed group of anxious, concerned people should be much easier to manage.

It is therefore recommended that organisations should review their own plans to ensure procedures are in place to reasonably and practicably manage an incident scenario whereby individuals could self-present at any location where the general public would expect assistance or medical treatment to be provided (such as Acute NHS Trusts, GP Surgeries, NHS Walk-in Centres).

2. Dis–Robing

To simulate this phase of the exercise, 50 volunteers were moved to a holding area prior to disrobing taking place. A structure was erected to accommodate the volunteers, Nottinghamshire Police were deployed for crowd control and a Nottingham University Hospital (NUH) Emergency Department medic provided clinical advice. During this phase of the exercise, a number of lessons were identified:

- 'Contaminated' volunteers were kept in the holding area for a prolonged period (it was least an hour before dis–robing packs were issued by the Fire Service).
- There was a lack of instruction / guidance provided before or during the disrobing process.
- There is a need for provision of modesty facilities to undress.
- When requests were made for drinks and toilets advice given by Police and Medical Staff was both changing and conflicting.
- Casualties were told that the chemical they had been 'contaminated' with during the exercise was innocuous; this raised the question 'why can't we go home then?'
- There is a need for continuous communication to update and reassure the casualties.

A key lesson was that as a large amount of contamination (often cited as 80%) could be removed from patients by dis-robing. Therefore, self-presenters should be encouraged to dis-robe immediately once they are in the holding area. It may be beneficial to consider designing a large poster board or pictogram message which gives very clear instructions on how to dis-robe and where to put contaminated clothing. This could be further enhanced with 'airline style' demonstrations, although this may involve placing an additional responder within a potentially contaminated area.

Another issue associated with dis-robing is the potential for a large amount of 'contaminated waste' (discarded clothing, other personal effects) to be generated and there is a chance that this could be dispersed into the 'clean zone'. This reinforces the message that there is a need for clear instructions on where items should be placed for disposal and that there is a need to ensure that an appropriate waste disposal facility is provided.

Prior to decontamination, patients may require the use of toilet facilities and consideration should be given to how to provide these. One possible option is the provision of portable toilets on scene.

There are a number of ethical (including religious) issues associated with public dis-robing, and as such, further considerations should be given for the provision of modesty facilities in the dis-robing area.

3. Casualty Decontamination by Nottingham Fire and Rescue Service

Although Nottingham Fire and Rescue are well-practised in decontamination of casualties, this exercise provided the opportunity to work with 'live casualties' including 3 year old children and wheelchair users. In total, 45 casualties passed through the shower unit in 36 minutes.

A number of issues were raised and lessons identified during the decontamination activity:

- There were written instructions provided within the shower unit. Users should be provided with basic, preferable pictorial, instructions on use of the shower unit prior to entry.
- The assumption that 45 minutes would elapse between NFAR arriving on site and having the mass casualty decontamination facilities ready for use is unrealistic. During this exercise, casualty decontamination did not commence until 90 minutes after arrival the first tender arrived on site.
- Family groups were separated when entering the shower unit.
- A number of casualties complained that the soapy water stung their eyes.
- There were not enough re–robe packs available at the ‘clean end’ of the shower structure and therefore a number of casualties had to leave the shower unit area to request re–robe packs.
- There was leakage of contaminated water from the shower unit and Fire Officer decontamination area. In a real incident this could have led to additional requirements for environmental decontamination.

4. Communications

At the exercise planning stage, communications was an activity area that the Planning Group expected to be challenging. Nottingham University Hospital Trust (NUH) issued radios to all multi–agency, non-exercise supervisory staff to both ensure that a reliable communication network was in place which could act as an on-site safety control measure.

It was clear from the onset that the compatibility of the radios used by partner agencies was going to be a problem. As a result, the decision was taken to hold Silver Commander meetings every 15 minutes to allow verbal updates.

In addition to, and as a consequence of the incompatibility of radios used by the exercise players, the following lessons were identified during the exercise:

- The backup plan of holding Silver Command meetings every 15 minutes for verbal updates would not have been sustainable if the incident site was spread over a large area.
- Mobile phones were a good means of communication during the exercise. However this method of communication in a real incident could have proved more difficult as they may not have been available or the network may have become saturated with calls, thereby rendering it unusable.
- In this specific exercise location, the NUH Incident Commanders were forced to place reliance on the hospitals internal radio network. This is known to have significant weaknesses.

Therefore, a vital lesson identified is that participating agencies should review the compatibility of their communication systems.

On a more immediate basis and in a real incident, incident commanders may wish to consider:

- Assessing the feasibility of the Emergency Services providing radios to facilitate inter–agency communication should they be required.
- Providing all agencies operating within hospital boundaries with hospital radios.
- That a list of all mobile phones registered for Access Overload Control (ACCOLC) be compiled and issued to all Category 1 and 2 responders.

5. Emergency Rest Centre Management

The Emergency Rest Centre was jointly organised and set up by the Emergency Planning Teams from Nottingham County Council and Nottingham City Council. Refreshments were provided by the WRVS.

An ultra–violet machine used to detect contamination on hands after washing was put in the rest centre to assess the effectiveness of casualty decontamination. It should be noted that without exception, all volunteers showed traces of ‘contamination’ (fluorescent dye) on their hands and arms.

A number of issues were raised, the majority from the volunteers themselves. These included:

- The need for more signage to direct people to key areas within the rest centre.
- That not enough volunteers were present to simulate the diversity of casualties that would be expected at a real incident scene.

The fact that all volunteers were still contaminated on arrival at the Emergency Rest Centre reinforces the need for contaminated casualties to shower correctly before being moved to a clean area. In addition, further research into the efficacy of mass casualty decontamination procedures would be beneficial.

6. General Exercise Activities

Exercise Stinkhorn was an opportunity for participating organisations to test and review their current capabilities to respond to a mass casualty contamination incident.

East Midlands Ambulance Service provided the following comments as part of a separate evaluation:

- The equipment used by all participating organisations was used as recommended or provided.
- The type and level of Personal Protective Equipment (PPE) varied across participating agencies but again it was functional and appropriate to both the contaminant and activities to be undertaken.
- PPE with identification was observed to be inconsistently worn with identifiers being displayed in a number of ways (on jackets or tabards).
- Appropriate PPE was not available to NUH Security Staff in the initial stages of the incident.

In view of these comments, consideration should be given to having a standardised identification system for responders PPE. For example, the Silver Incident Commander and Bronze Incident Commander could use a similar identification format on their clothing/PPE to clearly identify who is undertaking those roles.

Conclusions

Exercise Stinkhorn successfully tested the multi-agency response to a large scale chemical contamination event of the public at large. Plans were invoked, obstacles were encountered, many lessons were identified which several recommendations to be made (summarised in Box 2).

Acknowledgements

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Box 2: Summary of Key Lessons Identified and Recommendations

Exercise Planning:

Lesson 1: it is imperative that each service / organisation is represented at every planning group meeting.

Recommendation 1: ensure that each service/organisation is represented in the exercise planning / decision making process.

Exercise Resources and Funding:

Lesson 2: some of the Emergency Services 'participant' numbers were made up of volunteers and although they were committed to the exercise, definite numbers were not known at the initial planning stage.

Recommendation 2: representatives on the planning group should have the authority to make operational decisions and have access to sufficient resources within their organisations.

Scene Management and Casualty Decontamination

Lesson 3: regular communication and reassurance are key factors in the management of the self–presenter. A well-informed group of anxious, concerned people should be much easier to manage.

Recommendation 3: organisations should review their own plans to ensure procedures are in place to reasonably and practicably manage an incident scenario whereby individuals could self - present at any location where the general public would expect assistance or medical treatment to be provided (such Acute NHS Trusts, GP Surgeries, NHS Walk-in Centres).

Lesson 4: a large amount of contamination could be removed from patients by dis-robing; therefore self-presenters should be encouraged to dis-robe immediately once they are in the holding area.

Recommendation 4: it may be beneficial to consider designing a large poster board / pictogram message which gives instructions on how to dis-robe and where to put contaminated clothing. This could be further enhanced with 'airline style' demonstrations, although this may involve placing an additional responder within a potentially contaminated area.

Lesson 5: a large amount of 'contaminated waste' (discarded clothing, other personal effects etc.) may result in an incident requiring mass casualty decontamination and there is a chance that this could be dispersed into the 'clean zone'.

Recommendation 5: clear instruction should be given as to where items should be placed for disposal and to ensure that an appropriate facility is provided.

Lesson 6: there are a number of ethical (including religious) issues associated with public dis-robing.

Recommendation 6: further considerations should be given for the provision of modesty facilities in the dis-robing area.
Lesson 7: instructions are provided in shower facilities – however, those who are not able to read English or are visually impaired may not be able to follow them.

Recommendation 7: consideration should be given to having pictograms or other visual instructions at the entrance and throughout the shower unit instructing people on how to shower effectively.

Lesson 8: there were problems during the exercise, due to different organisations using different communication systems.

Recommendation 8: participating agencies should review communication system compatibility. In the long term, this could be with a view to adopting a single communication networking system (such as 'Tetra').

Lesson 9: all volunteers showed traces of contamination on their hands and arms.

Recommendation 9: further research into the efficacy of mass casualty decontamination procedures should be undertaken (and recommendation 7 re-iterated).

Lesson 10: identification on emergency responders' (e.g. Bronze and Silver incident commanders) clothing/PPE was inconsistent.

Recommendation 10: consideration should be given to adopting a standardised identification system on emergency responders' clothing/PPE.

Exercise Stinkhorn volunteers awaiting decontamination

Environmental

Particles as Air Pollutants 4: The Epidemiology

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Introduction

This fourth and final paper of the short series 'Particles as Air Pollutants' aims to summarize the epidemiological evidence linking concentrations of ambient particulate pollution and various indices of health. The papers presented in previous issues of the Chemical Hazards and Poisons Report introduced the principles of aerosol science as applied to air pollution; presented the trends in particulate matter (PM) concentrations in the United Kingdom; and discussed the possible mechanisms of action of particles (Maynard and Myers, 2006; Stedman and Maynard, 2007; Maynard, 2007).

There have been numerous epidemiological studies, of different designs, investigating the health effects of exposure to a wide range of concentrations of particulate pollution. The reported associations are well established in the epidemiological literature and are widely accepted to be true. However, there have been debates amongst those in the air pollution community in arriving at this view. One key item of debate related to the presence of a safe threshold of exposure to ambient particulate pollution at a population level. Prior to the 1990s, it was argued that there was a lack of evidence to support the existence of effects on health at low ambient concentrations (evidence as reviewed by Holland *et al*., 1979). Much of the evidence at that time focused on episodes of pollution (e.g. London smog in the 1950s), where concentrations were far greater than those experienced today. Since then, the literature has developed rapidly and there are numerous studies which have demonstrated the health effects of particles at low concentrations. This remains an important consideration for those in the air pollution community as it implies there is no safe concentration of ambient particulate pollution and it is relevant to the acceptance of results from those 'modern' epidemiological studies which continue to report associations between indices of health and the current (low) levels of particles.

This summary highlights some of the key publications that have led to the acceptance of the reported health effects and briefly discusses their implications for the development of policy regarding particulate matter.

Short-term exposure and mortality

Positive associations have been reported in the time-series literature between PM concentrations and mortality from 'all non-accidental causes' and specific causes such as cardiovascular and respiratory. This evidence has developed particularly in the United States using time-series methodology. Many of the studies used the more common mass metrics, PM_{10} and $PM_{2.5}$, of ambient particulate matter.

One of the earlier studies to report such associations was published by Pope and colleagues in 1992. Their study investigated the association between daily mortality and PM_{10} concentrations in the Utah County (US) from 1985 to 1989 (Pope *et al*., 1992). They reported statistically significant positive associations, with the strongest association occurring using a 5-day moving average of PM_{10} concentrations (maximum, 5-day concentration = 297 µg/m^3; 24-hour concentration = 365 µg/m^3), including the concurrent day. The authors reported an estimated increase in total daily mortality of 16% for each 100 µg/m^3 increase in the 5-day moving average PM_{10} concentration. The largest association was found with deaths from respiratory diseases followed by cardiovascular deaths and those from 'all other causes'.

Using data from a similar time period (1985 to 1988), a study in the southern US (Birmingham, Alabama) attempted to reproduce the existing findings of an effect of particles on mortality (Schwartz, 1993). The study found a relative risk for total mortality of 11% for an increase in each 100 µg/m^3 increase in the PM_{10} concentration (averaged over the previous 3 days). There was no evidence of a threshold down to the lowest observed concentration. Schwartz also reported that the association remained when days with particulate levels exceeding the national standard (150 µg/m^3) were removed. These findings were consistent with those reported earlier by Pope *et al*. (1992) from a different location in the US.

The findings of the early time-series studies, suggesting that effects on mortality were due to particles, were challenged in 1996. Schwartz and colleagues published evidence suggesting that the effects of particles on mortality might be due to fine ($PM_{2.5}$) rather than coarse (PM_{10} - $PM_{2.5}$) particles as they did not find any association with coarse particles. They reported that a 10 µg/m^3 increase in two-day mean $PM_{2.5}$ was associated with a 1.5% (95% confidence limits 1.1% - 1.9%) increase in total daily mortality (Schwartz *et al*., 1996). These results were based on pollution data, collected over an eight year period, for six eastern US cities. They also found greater effects for deaths from cardiovascular and respiratory disease. This was an important development in the epidemiological evidence and this finding of an effect of fine particles has since been repeated in the literature (evidence as reviewed by the US EPA, 2004). The small size of these particles is now regarded as one of the possible factors involved in the mechanisms of action of particulate pollution (Maynard, 2007).

The multi-city studies have been particularly useful in understanding the heterogeneity of PM effects across varying locations. The two studies which have made major contributions to the evidence in this area are, (i) the National Morbidity, Mortality and Air Pollution Study, NMMAPS; and (ii) APHEA (Air Pollution and Health: A European Approach). These two large multi-city time-series studies have been subjected to repeated analyses and have produced largely coherent findings.

NMMAPS, often referred to as the most prominent of the time series studies, is based on the 20 largest cities in the United States. This study sought to reproduce the findings of earlier time-series studies and to address existing methodological issues. One of the first publications from this study came from Samet *et al*. (2000) which found evidence that PM_{10} was associated with total and cardio-respiratory mortality. The relative risk for total mortality was a 0.5% (95% CI 0.07 - 0.93) increase per 10 μg/m^3 increase in PM_{10}. The estimates from the series of publications from NMMAPS were subjected to reanalysis after the identification of statistical issues. The revised estimates remained positive though the size of the estimates were reduced (see review by Anderson *et al*., 2004 – report prepared for the WHO).

APHEA has reported similar findings to NMMAPS, i.e. that daily fluctuation in particles was associated with fluctuation in daily mortality. One of the more interesting results, published by Katsouyanni *et al*. (2001), identified the issue of the modification of the PM-mortality effects by another pollutant – NO_2. They reported an increase in the daily number of deaths for all ages for a 10 μg/m^3 increase in daily PM_{10} of 0.6% (95% CI 0.4 - 0.8%). However, when they examined the PM-effect estimates according to the NO_2 concentrations in the cities, they found a 0.19% (95% CI 0.00 - 0.41%) increase in daily mortality for an increase of 10 μg/m^3 in PM_{10} for cities with a low average NO_2 concentration; while in cities with a high average NO_2 concentration the estimate rose to 0.80% (95% CI 0.67 - 0.93%).

The implications of Katsouyanni *et al*'s results are important as they imply that greater PM-effects on mortality may occur in circumstances where the daily NO_2 concentrations are also above average. However, there is available evidence (as reviewed by IOM, 2004) which suggests that perhaps NO_2 may be responsible for some of the reported PM-effects on mortality, thereby implying confounding of the mortality effects of PM by NO_2. This has emerged from studies which show that PM is not always stable (i.e. is reduced or eliminated) to the inclusion of NO_2 in two or multi-pollutant statistical models used to estimate the effects of day-to-day variations of pollutants on mortality (see WHO, 2006). This issue remains unresolved and warrants further investigation.

There are other epidemiological designs which have demonstrated effects of daily variations in PM on mortality – summaries of their evidence can be found in reviews conducted by the US EPA (2004); WHO (2000, 2006) and Pope & Dockery (2006).

Long-term exposure and mortality

The most important findings on long-term exposure (i.e. exposure for months or years) to particles and its effects on mortality have emerged from two major prospective cohort studies in the United States: the US Six Cities Study and the American Cancer Society cohort. Publications based on these cohorts have been regarded as important as they contained large numbers of participants, had longer follow-up periods and collected information on a range of individual confounding factors, particularly smoking. In addition, these studies were subjected to major reanalysis by the Health Effects Institute in the United States (HEI, 2000). This further established their credibility: their initial results proved to be robust to reanalysis.

The US Six Cities Study examined a cohort of just over 8000 adults followed for 14 – 16 years up to 1991. During that time data was collected on mortality and a range of pollutants, including $PM_{2.5}$. The authors reported statistically significant associations between air pollution and mortality. After accounting for other risk factors, such as smoking, they found a mortality rate ratio of 1.26 (95% CI 1.08 – 1.97) for a 19.6 μg/m^3 difference in $PM_{2.5}$, comparing the most polluted city (Steubenville, OH) with the least polluted city (Portage, WI) – see Figure 1 below (Dockery *et al*., 1993). The strongest associations were found with fine particles and sulphate. Figure 1 shows adjusted mortality rate ratios plotted against long-term average concentrations for various indices of particles. It clearly shows strong linear relationships for fine particles and sulphates.

In addition to the HEI reanalysis (2000) of this study (mentioned earlier), Laden *et al*., (2006) published an extended follow-up of the above cohort. This study also reported positive results with slightly larger effect estimates for mortality.

Pope and colleagues, using the American Cancer Society cohort, also found evidence that fine particulate pollution was a predictor of mortality (Pope *et al*., 1995). Their study involved over 500, 000 adults from 151 US cities, followed for about 8 years since enrollment in 1982. Adjusted relative risk ratios of all-cause mortality for the most polluted area compared with the least polluted area was 1.17 (95% CI 1.09 – 1.26) for a 24.5 μg/m^3 difference in $PM_{2.5}$. The study also found associations with cardiopulmonary and lung cancer mortality, but not with mortality from other causes.

This study by Pope *et al*. (1995) was also subjected to reanalysis by the HEI (2000). One of the more interesting findings to emerge from the reanalysis related to the modification of the PM-mortality effects by educational level (i.e. the effect of particles on mortality decreased with increasing educational level). A further interesting finding was that deaths from cardiovascular disease were affected more than deaths from respiratory causes. This came as a great surprise to many in the air pollution field (Department of Health, 2001). Further evidence from these two prospective cohort studies, as reviewed by Pope & Dockery (2006), has shown positive and consistent associations between particles and cardiovascular deaths.

Recent evidence (2007) published by Miller and colleagues have found considerably larger estimates for cardiovascular mortality than previously reported - each increase of 10 μg/m^3 in $PM_{2.5}$ was associated with a 24% increase in the risk of a cardiovascular event (hazard ratio, 1.24; 95% CI 1.09 - 1.41) and a 76% increase in the risk of death from cardiovascular disease (hazard ratio, 1.76; 95% CI, 1.25 - 2.47). The study was based on over 65, 000 postmenopausal women without previous cardiovascular disease in 36 U.S. metropolitan areas from 1994 to 1998 (Miller *et al*, 2007). These results are startling; if true, they suggest that the effects of long-term exposure to particles on cardiovascular endpoints (i.e. deaths and events) could be much larger than previously thought, at least amongst women.

The ACS study of 1995 (Pope *et al*.) was extended and a further publication of the findings was made in 2002 (Pope *et al*., 2002). This extension benefited from increased statistical power as more deaths were recorded throughout the follow-up period. The authors reported that each 10 μg/m^3 elevation in fine particulate air pollution was associated with approximately a 4%, 6%, and 8% increased risk of all-cause, cardiopulmonary, and lung cancer mortality, respectively.

Further investigations, using this cohort, have been conducted over a smaller spatial scale and have reported effects on all-cause mortality much greater than those previously reported (for example - Jerrett *et* *al*., 2005). These larger estimates may be due to the better characterization of exposure to particulate pollution.

Together, these results on long-term particulate exposure have provided important findings: those living in less polluted areas are likely to live longer than those living in more polluted areas: long-term exposure to particles can reduce life expectancy. As the literature has developed since 2000, the size of the estimate of effects on mortality has increased, raising the possibility that the effect of particles on mortality could be larger than previously thought.

Morbidity

In this section the effects of both short and long-term exposure on morbidity related endpoints will be discussed.

The evidence suggests that, after accounting for other factors, day-to-day variations in concentrations of particles are associated with daily changes in the risk of admission to hospitals and visits to emergency departments for respiratory diseases and cardiovascular events (Atkinson et al., 1999; Lippmann *et al*., 2000; Anderson *et al*., 2001; Le Tertre *et al*., 2002; Schwartz, 1997), as well as other indices of disease status such as the frequency or severity of symptoms and medication use (e.g. Bayer-Oglesby *et al*., 2006).

The literature regarding PM-effects on children is also growing. Associations with PM have been found with deficits in lung function, impacts on lung growth, and exacerbation of symptoms (evidence as reviewed by WHO, 2005). The prospective cohort of Southern Californian children has produced particularly interesting evidence suggesting that long-term exposure in early life may have implications for lung growth and lung function in later life.

In adults, there have also been studies of cohorts which have generated evidence to suggest the possibility of long-term exposure to particles initiating disease – chronic bronchitis – in the absence of important risk factors, such as smoking (e.g. Abbey *et al*., 1995).

Generally, the evidence relating to PM-effects on indices of morbidity indicates that exposure to particles may serve to both exacerbate and worsen the progression of disease.

Discussion

Overall, the reported associations between concentrations of particles and indices of health are quite convincing; however, convincing associations do not necessarily imply causality. Evidence on the mechanisms of action of particles is needed in order to arrive at firm view regarding causality (see Maynard, 2007). Though this is the case, many in the air pollution community believe that the likelihood that the reported associations are causal is high.

The epidemiological evidence has certainly shed light on some important points regarding the effects of particles in the population:

1. Those living in less polluted areas may live longer than those living in more polluted areas. This is a clear inference from the prospective cohort studies which show a reduction in life expectancy from long-term exposure to particles.
2. Long-term exposure to particles affects deaths from cardiovascular disease more than those from respiratory disease.
3. Those studies which examine the day-to-day variations in concentrations of particles have facilitated an understanding of how increases in the levels of particles over days, rather than years, can impact on indices of disease status such as the frequency or severity of symptoms. These studies have also shown that there are susceptible groups in the population for whom such increases might pose a greater risk. These groups include the young, the elderly, the infirm, pregnant women, and those with pre-existing cardiac and respiratory disease. It is thought that these studies suggested that death is brought forward for susceptible individuals in the population.
4. The progression of cardiovascular or respiratory disease in an individual may be related to exposure to particles.
5. After accounting for other risk factors, some cohort studies have suggested the potential for particulate pollution to cause an individual to develop a disease (chronic bronchitis, for example).

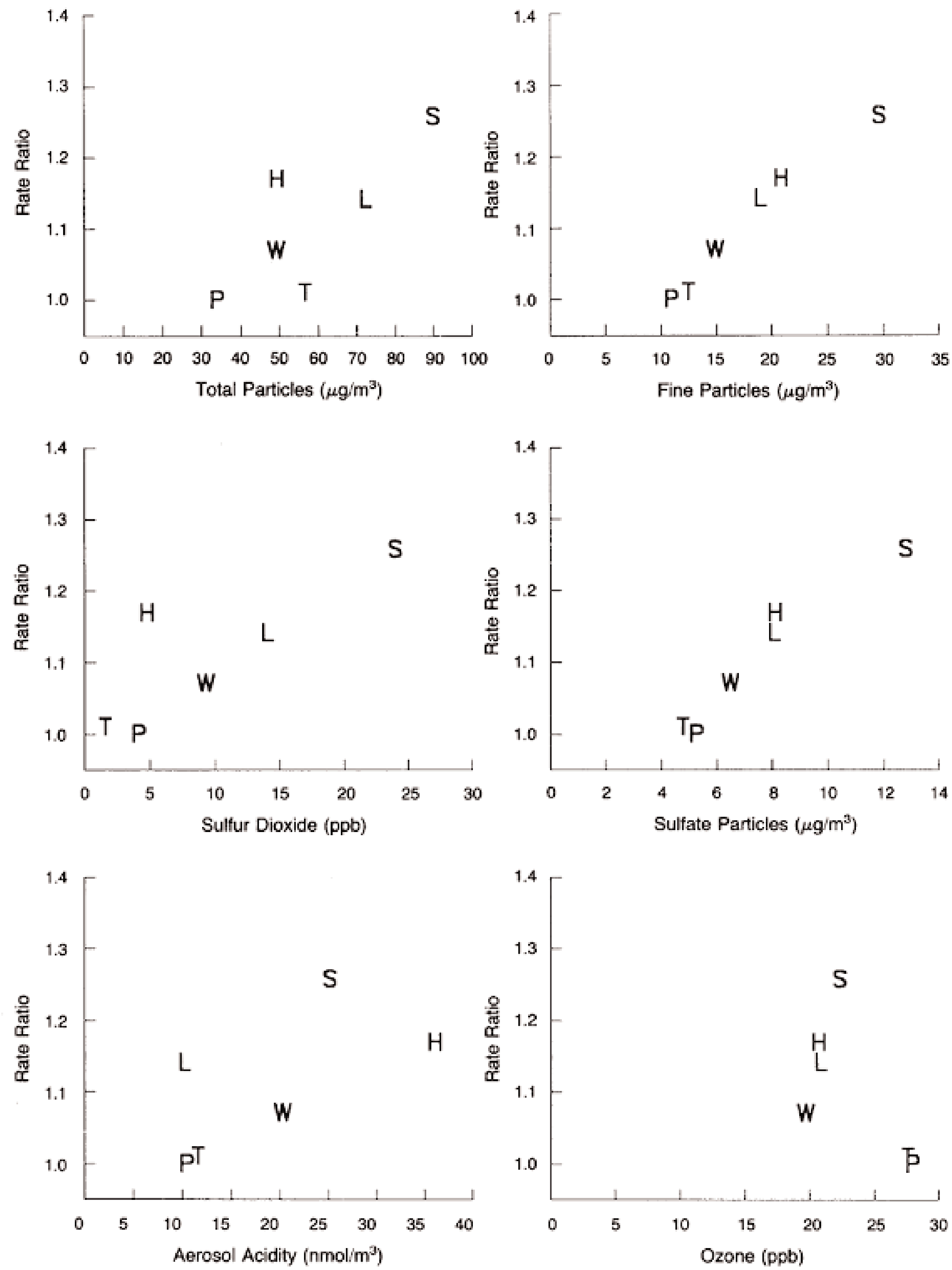
The expansion of the epidemiological evidence since the 1990s has influenced the development of policy regarding ambient particulate pollution. This is reflected in the tightening of air quality guidelines regarding particles and in the development of innovative policies (see the UK Air Quality Strategy - Defra, 2007; Walton, 2007). The availability of numerous effect estimates has also facilitated work on health impact assessment in calculating the total impact of particulate pollution on health in the UK (Department of Health 2001, 2007).

As the epidemiological evidence continues to develop there are still a number of areas which warrant further investigation:

1. A key question pertains to understanding the relative toxicities of the various components of particulate matter. It is currently understood that there may be 'variations in the toxicity, per μg/m^3 pollutant, between various components of $PM_{2.5}$' (Department of Health, 2007). However, using the available evidence policy-makers are unable to develop policies targeted at those components of particles which are largely responsible for the toxicity of this pollutant. To date, policies in the UK have treated the components of $PM_{2.5}$, such as sulphate, as being equally toxic (Department of Health, 2007).
2. Developing a greater understanding of the distribution of risk across the population. Evidence (epidemiological and from other sources, such as chamber studies) indicates that some individuals are more susceptible to pollutant-effects than others. However, it is not currently possible to determine the range of risk posed to the various susceptible groups in the population. An understanding of this issue will aid health impact assessors in applying concentration-response functions across the population when calculating impacts on health.
3. The issue of co-pollutants and the potential for confounding or effect modification of the PM-effects requires further study.

Conclusion

There is a wealth of evidence available that suggests that concentrations of ambient particles have an effect on death rates (for cardiac and respiratory diseases and all-causes), admissions to hospitals and visits to emergency departments, and indices of disease status. Of all environmental factors that affect health, air pollution is perhaps the most important. Research in this area is proceeding rapidly and further, perhaps surprising, advances may be expected in the coming decade.



Mean values are shown for the measures of air pollution.

P = Portage, Wisconsin
T = Topeka, Kansas
W = Watertown, Massachusetts
L = St Louis
H = Harriman, Tennessee
S = Steubenville, Ohio

Figure 1: Adjusted mortality rate ratios plotted against long-term average concentrations for various indices of particles for six US cities (reproduced from Dockery *et al* (1993) with permission from the Massachusetts Medical Society)

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The World Health Organization (WHO) Air Quality Guidelines

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All those who work in the air pollution field are familiar with the WHO Air Quality Guidelines for Europe – and recently for the World. The series of books with sky blue covers decorated with a rainbow are to be found in offices around the world and provide a unique and reliable source of advice on the effects of air pollutants on health (World Health Organization, 1987; World Health Organization, 2000; World Health Organization, 2006). Less, perhaps, is known of the history of this series and of the methods used to set the guidelines that are recommended. It is also fair to say that the guidelines are not always used wisely: they are sometimes interpreted as air quality standards. This was never their purpose, though the guidelines can play an important part in setting standards. This article explores the history of the guidelines, the methods used in setting them and some of the changes that have occurred since 1987.

History

The World Health Organization (Geneva) published a report *'Air Pollution'* in 1961 (Barker *et al*, 1961). The report followed on from a meeting of the WHO Expert Committee on Environmental Sanitation held in 1957. This report bears reading today: the historical perspective is invaluable. The Meuse Valley (1930), Donora (1948) and London (1952) air pollution episodes are described in detail as are the conditions in Los Angeles during the 1950s. References to work done in the UK at the MRC Air Pollution Unit are prominent. No attempt to establish guidelines was made. However, in 1972 a short report *'Air Quality Criteria and Guides for Urban Air Pollutants'* was published by WHO Geneva (World Health Organization, 1972). This is a remarkably interesting publication and touches on problems still with us 35 years later. Long-term goals were set out: for oxidants (measured using a potassium iodide technique) the long term goal (8 hour average) was set at 60 μg/m^3 and the 1 hour maximum as 120 μg/m^3. These figures are not to dissimilar to those recommended today. The report considered costs and benefits of air pollution policies: this has been lacking in most recent WHO reports.

The foreword to the 1987 edition of the WHO Air Quality Guidelines for Europe (the first of the 'rainbow books') states that the Government of the Netherlands approached WHO in 1983 after the publication of the WHO Guidelines for Drinking Water Quality, and suggested that a set of air quality guidelines should be developed 'using the same general philosophy and approach'. This was a timely suggestion. Many European countries had, by the 1980s, moved away from burning soft coal as the main method of providing domestic heating and the coal smoke smogs of the 1950s and 1960s were becoming a thing of the past. Air quality was improving and the need to provide guidance on how far such improvements should be taken was widely felt.

Action had already been taken by the European Commission to improve air quality: in 1970, the first EC Directive (70/220/EC) relating to carbon monoxide and hydrocarbon emissions from motor cars, had been enacted. This, and other early Directives, focused on sources and on the establishment of air pollution monitoring networks – albeit limited networks by today's standards. The first Directive to set standards for air pollutants (80/779/EC: Air Quality Limit Values and Guide Values for Sulphur Dioxide and Suspended Particles) was enacted in 1980 and followed in 1985 by one bearing on nitrogen dioxide (EC Directive 85/203/EC). So, WHO Air Quality Guidelines were being mooted at the same time as the need for air quality standards was being perceived in Europe.

Producing the 1987 WHO Air Quality Guidelines was a large task – indeed more effort was devoted to it than has been available for subsequent WHO (Europe) activities in the air pollution area. Three essential inputs that aided the process can be identified:

(i) special funding provided by the Netherlands;

(ii) a major contribution by the US Environmental Protection Agency (US EPA) though the Guidelines were aimed at Europe and the US has its own Air Quality Standards. Dr Lester Grant led the US work in support of the Air Quality Guidelines;

(iii) the appointment of a distinguished project coordinator, who saw the project through to publication: Dr R Türck.

A planning meeting was held in 1984 and Working Groups dealing with groups of pollutants and special issues such as ecological effects of air pollutants were active in 1985. An 'Informal Consultation' on the proposed guidelines was organised during March 1986 and a final meeting was held in November that year. Publication followed in 1987. The UK made an important contribution throughout: Mr Robert Waller (a founder member of the MRC Air Pollution Unit, and later of the Department of Health Air Pollution Unit) acted as rapporteur to a number of working groups and drafted the chapter dealing with sulphur dioxide and suspended particles. Robert Waller was seen by many as a senior member of the groups working on the guidelines and his contribution cannot be overestimated.

Two lessons are clear:

(i) solid funding; and

(ii) the unpaid commitment of thousands of hours of effort by experts

are needed to produce a major monograph. And it was a major monograph: 426 pages with detailed analyses of the evidence upon which the Air Quality Guidelines were based, clear presentations of the arguments leading to the actual guidelines and an introductory chapter which is a model for all working in this field. Twenty pollutants were considered: details of the Air Quality Guidelines recommended can be found in the original publication.

The Guidelines were widely used – generally sensibly but misinterpretations would have been avoided had two paragraphs from the introductory chapter been carefully read. These bore on:

(a) the relationship between the guidelines and standards:

'It should be emphasized that when air quality guideline values are given, these values are not standards in themselves. Before standards are adopted, the guideline values must be considered in the context of prevailing exposure levels and environmental, social, economic and cultural conditions. In certain circumstances there may be valid reason to pursue policies which will result in pollutant concentrations above or below the guideline values.'

and

(b) as regards the risk estimates for carcinogenic air pollutants:

'The risk estimates presented in this book should not be regarded as being equivalent to the true cancer risk. Quantitative risk estimates can provide policy-makers with rough estimates of risk which may serve well as a basis for setting priorities, balancing risks and benefits, and establishing the degree of urgency of public health problems among subpopulations inadvertently exposed to carcinogens.'

These paragraphs sum up the intentions of the authors: they sought not to dictate standards or risk estimates but to assist those setting standards. That other factors would need to be taken into account in developing national air pollution policies was accepted from the outset. Also implicit in the derivation of guidelines for compounds regarded as having thresholds of effect was the view that as long as concentrations of air pollutants did not exceed the guidelines, significant effects even amongst sensitive subgroups were unlikely to occur. Protection of 'the most sensitive individual' was not promised. Additionally, the uses of safety factors made it unlikely that modest exceedences of the guidelines would be associated with widespread severe effects on health. This is forgotten even today and headlines trumpeting 'Guidelines Exceeded!' seldom convey any information on the likelihood of effects on health. It is often said that: 'the devil is in the detail' and so it is with the WHO Air Quality Guidelines.

Revision in the 1990s

Rapid developments in air pollution research, especially the expansion of epidemiological studies, led to calls for revision of the Guidelines. The process began in 1993 and a second edition of the WHO Air Quality Guidelines was published in 2000. Thirty five pollutants were considered and, importantly, sulphur dioxide was separated from particulate matter. This was advocated by the author and Mr Robert Waller and represented a significant step away from using data collected in the days of coal-smoke smogs as a basis for guidelines for these pollutants.

More important still was the recognition that for a number of so called classical pollutants the epidemiological evidence did not suggest a threshold of effect. This led to heart searching and to a modification of the concept of a guideline. It was accepted that a guideline could be a coefficient! A coefficient, that is, linking ambient concentrations with effects on health. Many examples of such coefficients were provided. Careful reading of the text will, however, suggest that not all were agreed on the absence of thresholds of effect and for ozone, the 1987 guideline was recommended in a strongly qualified format.

The second edition differed from the first in one important regard: it was a summary report and did not provide the full accounts of the evidence upon which the guidelines were based. This evidence was provided on the WHO website (see reference for details of WHO website addresses). The revision had been an ambitious task and suffered from inadequate funding. No full-time project coordinator was appointed and despite the splendid work done by Dr Maged Younes and Dr Michal Krzyzanowski, the project dragged.

During the production of the second edition an attempt had been made to broaden the applicability of the guidelines – from European Guidelines to World Guidelines but no very detailed work had been done on this.

The Global Update

In the period 2002-2004 the WHO Regional Office for Europe undertook an important project: '*Systematic Review of Health Aspects of Air Pollution in Europe*'. This was in support of the European Union's Clean Air for Europe (CAFE) programme. The work suggested that despite publication of the second edition of the Air Quality Guidelines in 2000, review was needed in the sections dealing with particulate matter, ozone and nitrogen dioxide. It was also appreciated that guidelines for major air pollutants were needed outside as well as within the WHO European Area. A Steering Group was established to define the scope of the task and draft chapters were commissioned from experts. A meeting, chaired by the author, was held in Bonn (18-20 October 2005) to finalise the updated guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide. The guidelines for the remaining 31 pollutants considered in the second edition were not reconsidered. Editing and, in some areas, redrafting followed and the Update was published in 2006 – commendably soon after the Bonn meeting.

The Update volume runs to 484 pages but a half of this comprises detailed background chapters providing advice on '*Applications of Air Quality Guidelines for Policy Development and Risk Reduction*'. These were included, especially, for use in developing countries and provide a unique source of reference on sources of air pollutants and trends in air pollutant levels, on exposure to air pollutants and susceptibility to air pollutants, and on the concept of environmental equity. In some ways these chapters provide an expansion of the background chapters of the first edition and are important for anyone entering the field.

Annexes providing detailed assessments and tabulations of evidence of effects on health of ozone were provided.

The Bonn Meeting, October 2005

This was a difficult meeting. It was immediately apparent that the approach taken in parts of the second edition, defining some guidelines as coefficients linking ambient concentrations with effects on health, had led to confusion and demands for 'proper guidelines' (defined as a concentration and averaging time as in the first edition) were made. Experts from developing countries pressed this point and argued that such guidance was necessary if governments in such

Table 1: Air Quality Guideline and interim targets for PM: annual mean

Annual Mean Level	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	Basis for the selected level
WHO interim target 1 (IT-1)	70	35	These levels are estimated to be associated with about 15% higher long-term mortality than at AQG levels
WHO interim target 2 (IT-2)	50	25	In addition to other health benefits, these levels lower risk of premature mortality by approximately 6% (2-11%) compared to IT-1
WHO interim target 3 (IT-3)	30	15	In addition to other health benefits, these levels reduce mortality risk by approximately another 6% (2-11%) compared to IT-2 levels
WHO air quality guidelines (AQG)	20	10	These are the lowest levels at which total cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to $PM_{2.5}$ in the ACS study. The use of the $PM_{2.5}$ guideline is preferred.

countries were to take action to reduce levels of air pollutants. Others, including the author, argued that any guidelines defined in this way in the absence of evidence of a threshold of effect should be regarded as arbitrary and thus unsatisfactory. It was pointed out that policies in the UK and in the EC were moving towards cost-benefit tested progressive reduction and away from policies designed to 'reduce to a standard'. A compromise was agreed and guidelines were recommended with the caveat that effects could occur at concentrations below the guideline values. In addition, interim target values were defined as a guide to effects likely to occur at levels of pollutants exceeding the guidelines. An example is provided in Table 1.

Evidence presented in the update was set out in detail and in this respect the update returned to the form of presentation found in the first edition. In the chapter dealing with particulate matter 363 references are quoted and listed. All the guidelines can, of course, be found on the WHO website (See reference list for publication details and website links).

Discussion

The WHO Air Quality Guidelines continue to provide authoritative advice on the effects of air pollutants on health and guidance for policy makers in the air pollution area. The rapid development of the field has placed heavy demands on WHO staff and, unless external sources of funding are found, production of a third edition providing a systematic examination of a vast literature, definition of coefficients linking ambient concentrations with effects on health, interim targets and numerical guidelines will be very difficult or, more likely, impossible. This is to be regretted, especially as far as developing countries are concerned. In developed countries levels of air pollutants are generally low and sophisticated policies for further reductions are in place or coming into place. But in many developing countries levels of air pollutants are high and, in some cases, rising. In these countries, the need for guidance provided by WHO has never been greater.

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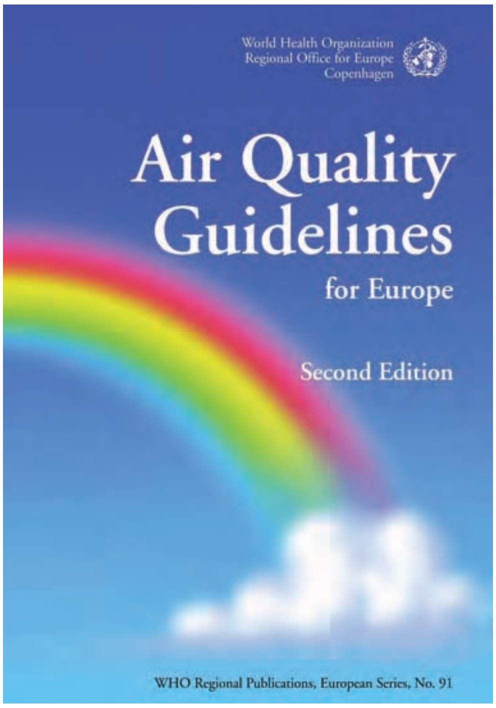

Atmospheric Stability: what happened at Buncefield?

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Introduction

The Buncefield fire, December 11-15, 2005, generated a large plume of hot smoke which rose rapidly and spread out at between a few hundred metres and 3000m above the ground. Dramatic satellite pictures showed the plume dispersing over south-east England (Figure 1). Despite the extraordinary appearance of the plume, very small increases in ground level concentrations of pollutants were recorded and thus effects on health are likely to have been minor. Why did the plume behave as it did? Why did the smoke not spread out near the ground and why did the plume not remix with air closer to the ground? What would have happened if the atmospheric conditions had been different? These are questions that were asked and which can be answered on the basis of meteorological principles. The incident provided a dramatic illustration of the need to understand such principles. This paper sets out some of the key points in a simplified format.

Two key factors need to be considered: wind and the ambient temperature profile above the ground.

Wind

Wind disperses smoke. Smoke is dispersed more rapidly the faster the wind blows. Dispersion will occur predominantly in the direction of the wind though his may be very different at different heights above the ground. For example on Sunday 11 December 2005, the wind at ground level was north-westerly but at higher levels it was north-easterly. This variation in direction of the wind is described as 'wind shear'. What makes the wind blow? Two factors are important: differences in atmospheric pressure and the rotation of the earth. At heights above that which the atmosphere is directly influenced by the ground, the wind tends to blow at a steady speed in a direction parallel to the isobars on a weather map. Below this the wind is slowed by friction with the ground and variations in surface roughness features cause fluctuations in wind speed and direction which we refer to as turbulence. This type of turbulence is referred to as mechanical turbulence – other sources of turbulence, such as convection, do exist. Obstructions to wind flow caused by, for example, buildings contribute to the turbulence and increase mixing of the air. More mixing thus occurs over cities than over open country or over oceans.

Temperature profiles

This is more complicated. We all know that as height above the ground increases the atmospheric pressure decreases. This is because the density of air, determined by the depth of the atmosphere above any point, decreases as we ascend. If the pressure on a mass of gas falls, its volume must increase. As a gas expands it is considered to do work (think of an expanding gas in the cylinder of an engine). If there is no transfer of heat from outside, the principle of conservation of energy tells us that the internal energy of the gas must fall, which manifests itself as a reduction in temperature. Why should we assume that no external energy has been gained or lost and that the process can therefore be described as adiabatic? McGregor (1999) gives the following reasons: air is a poor conductor of heat, mixing of air with its surroundings is very slow and radiative processes produce only small changes during short periods.

Now think of a mass of gas, often described as a parcel of air, rising slowly. Why should it rise? Let us assume that it has been slightly warmed to start it on its way. As it rises it is exposed to a lower pressure, it expands and its temperature falls. Its temperature will continue to fall as it rises: the rate of fall of temperature will be dependent on its expansion and thus on the decline of atmospheric pressure with height above the ground. The atmospheric pressure gradient can be assumed constant over small heights and thus so is the rate of fall of temperature of the gas. The rate of fall of temperature is described as the lapse rate, or more precisely as the adiabatic lapse rate. If we are considering dry air we should define the lapse rate as the Dry Adiabatic Lapse Rate (DALR). This is approximately 1°C for every 100m increase in height above the ground. If the gas contains water vapour the picture becomes more complicated. As temperature falls the saturated vapour pressure of water will eventually be reached and, assuming particles are present, water will condense out as droplets. This process liberates heat: the latent heat of condensation. This will cause the temperature of the gas to rise. The lapse rate will thus be less than that of dry air and we should speak of the Saturated Adiabatic Lapse Rate (SALR).

In actual fact the real picture is yet a little more complicated than this. If the mass of gas we are considering is saturated with water vapour at, say, 20°C it will contain more water than if it were saturated at, say, 5°C. Thus the warm air contains more water available to condense out and thus more latent heat to be released. Thus a series of Saturated Adiabatic Lapse Rates can be defined: depending on the water vapour content of the air as it begins its ascent.

Consider air saturated with water at 20°C

1 mole of any gas occupies 22.4L at 0°C and 1 atmosphere (STP)

Thus at 20°C and 1 atmosphere (1.013×10^5 Pa) 1 mole of gas occupies

$293/273 \times 22.4 = 24.04$ L

the GMW of water is 18g.

Consequently, if water were sufficiently volatile, 18g of vapour would exert a pressure of 1 atmosphere (1.013 x 10^5 Pa) and occupy 24.04 litres at 20°C.

In practice, water is not that volatile and at 20°C and 5°C respectively, the saturation vapour pressure of water over liquid water is 2337 and 872 Pa respectively.

Consequently at 20°C, 1 litre of air contains:

$$18 \times \frac{2337}{1.013 \times 10^5} \times \frac{1}{24.04} = 0.0173 gL^{-1} \text{ water vapour}$$

At 5°C, the molar volume is:

$$22.4 \times \frac{278}{273} = 22.8L$$

and 1 litre of air contains:

$$18 \times \frac{872}{1.013 \times 10^5} \times \frac{1}{22.8} = 0.007 gL^{-1} \text{ water vapour}$$

Consequently, air which is saturated at 20°C will cool less overall as it rises, than air saturated at 5°C as the latent heat release will be greater.

Interesting? Yes, but what does all this mean?

The temperature of the air usually falls with height above the ground. We must be careful not to confuse this decline in temperature with either the Dry or Saturated Adiabatic Lapse Rates. For simplicity we will consider only the DALR from now on.

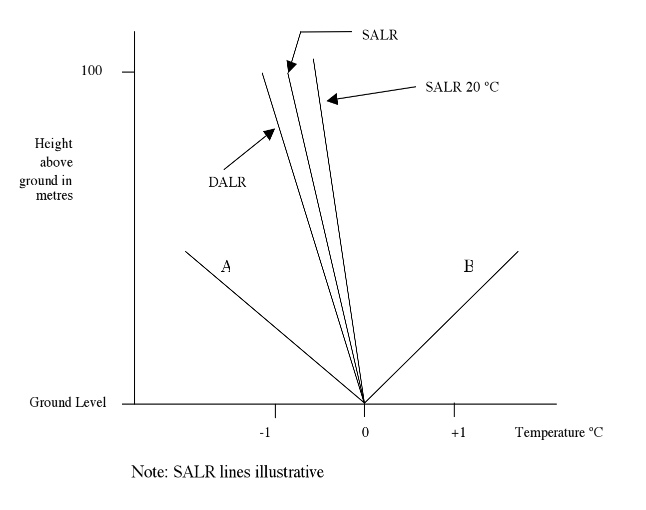
Figure 2 shows the DALR and two possible conditions regarding the change in temperature with height above the ground. Line A shows the actual decline in temperature being more rapid than the DALR, Line B shows temperature increasing with height above the ground. Line A is, a little confusingly, described as a Positive lapse rate and Line B is described as a negative lapse rate. Let us focus on Line A as an actual atmospheric lapse rate.

Think again of our mass of gas rising from the ground. Its temperature will fall in accordance with the DALR line. Now for the tricky part! As the mass of gas cools its temperature will NOT fall as rapidly as that of the surrounding air. Our mass of gas is cooling along the DALR but the surrounding air is cooling along Line A. Thus our mass of gas remains always warmer than the surrounding air. So what? Well, if it is warmer than the surrounding air, it is also less dense and it will continue to rise.

If a parcel of air on line A started to fall it would continue to fall! Why is this? Look again at the DALR and Line A. As the mass of gas falls (let us assume it has been slightly cooled to start it on its way down) it becomes warmer but NOT as rapidly warmer as the surrounding air. Thus our mass of gas remains cooler and more dense than the surrounding air and it continues to fall. Understanding this is critical.

Line A represents what is described as UNSTABLE conditions. Masses of air that are rising go on rising; masses of gas that are falling go on falling under unstable conditions.

Figure 2: Dry and Saturated Adiabatic Lapse Rates (DALR/SALR).



A moment's reflection, perhaps more than a moment's, will show that if we consider Line B our mass of gas will neither continue to rise nor fall. If it begins to rise it will cool along DALR but the surrounding air is actually warming along Line B. Thus our mass of gas will always be cooler and more dense than the surrounding air and it will fall back to its starting position. Similarly, if our mass of gas began to fall, it would begin to warm along DALR whilst the surrounding air was cooling along Line B. Our mass of gas would thus always be warmer than the surrounding air and it would float back upwards to its starting point. Such conditions are described as STABLE.

To recap: UNSTABLE conditions accelerate movements up and down
STABLE conditions prevent movements up and down.

Unsurprisingly there is a NEUTRAL condition where the actual fall of temperature with height exactly follows the DALR. Under neutral conditions our mass of gas that sets off either upwards or downwards will soon come to a halt due to drag forces and float with neutral buoyancy.

Neutral, stable and unstable: these are descriptions of the boundary layer in terms of how its vertical temperature gradient compares with the adiabatic lapse rate. 'Boundary layer' is an important term in this context. It defines the lowest layer of the atmosphere which is directly influenced by the ground. The thickness or depth of the boundary layer can vary from tens of metres during surface-based inversions (discussed below) to a few kilometres. Perhaps surprisingly, neutral conditions are associated with moderate to strong winds and overcast skies. Unstable conditions are produced by periods of sunshine: convection currents are set up in the boundary layer. The ground is warmed and air close to the ground is warmer than that higher above. Thus the lapse rate is positive. The combination of sunshine, wind and cloud cover controls the stability of the boundary layer. McGregor (1999) produced a useful table that describes stability in terms of six classes: A, extremely unstable; B, moderately unstable; C, slightly unstable; D, neutral; E, slightly stable; F, extremely stable (Table 1). These categories were originally defined by Pasquill from observations of smoke dispersal.

Table 1: Atmospheric stability classes

Surface Wind Speed m/s	**Daytime Insolation (sunshine)**			**Night-time Cloudiness (also described in eighths)**	
	Strong	Moderate	Slight	Thin, overcast or low cloud (>4/8)	Cloudiness (<3/8)
<2	A	A-B	B	-	-
2-3	A-B	B	C	E	F
3-4	B	B-C	C	D	E
4-6	C	C-D	D	D	D
>6	C	D	D	D	D

(Modified from McGregor 1999 – Basic Meteorology, in Air Pollution and Health, Academic Press).

Stability and inversions

Line B in Figure 2 showed temperature increasing with height above the ground. This negative lapse rate is described as a temperature inversion: the usual pattern is 'inverted'. Such conditions occur frequently in clear winter mornings before the sun has fully risen. Heat is lost from the ground during the night and the clear sky allows this heat to escape, clouds would have allowed some absorption and re-radiation back towards the surface. The ground thus becomes cold. We have all seen mist lying close to the ground on winter mornings. As the sun begins to climb the temperature inversion begins to break up and the mist disperses. If the ground is cold and temperature rises as one ascends from ground level the inversion of course begins at ground level. Under such circumstances the boundary layer is tens, or at most hundreds of metres deep and pollutants, unless having their own buoyancy, cannot mix and hence stay close to the ground. If a fog forms, this reflects back the sunshine which would otherwise warm the ground, and the inversion conditions can persist for days, or even weeks. This happened in the great smog of 1952 and the more recent serious pollution event in London in December 1991. In the latter event, the top of the inversion was clearly visible, below the clock on Big Ben, in photographs taken at the time. But not all inversions do so. Capping inversions occur higher in the atmosphere and may be formed by a mass of warm air being pushed down on top of a cooler layer. This occurs in anti-cyclonic conditions. Los Angeles is subject to such conditions. As one ascends, the lapse rate changes from positive to negative: the point at which it does so defines the thickness of the boundary layer. Pollutants released at the ground will mix in the unstable layer characterized by the positive lapse rate, but will not be able to rise into the layer above the inversion: the capping inversion is well named.

Plumes and chimneys

Much can be learnt from observing plumes of smoke and water vapour emitted by chimneys and cooling towers: Didcot power station situated near HPA Chilton provides an excellent example for study. Smoke is a mixture of particles and air. When emitted from a chimney or fire it will be warm, perhaps hot, and therefore buoyant. Temperature controls density and density controls buoyancy. The smoke will also possess momentum by virtue of its mass and velocity. Buoyancy and momentum carry smoke upwards. Wind will deflect the plume and soon the stability or otherwise of the boundary layer will take control of its behavior. This occurs as the smoke cools and loses buoyancy and also as it slows down having moved away from the force pushing it out of the chimney. Atmospheric turbulence spreads the plume by mixing it outward, the spread increasing with time and hence downwind distance. What happens next depends on the stability of the boundary layer and on the height of the release point above the ground with reference to the boundary layer.

Imagine a ground level inversion. Non buoyant smoke emitted from a chimney will neither rise far nor fall in the stable conditions and the plume will fan out at about the height of its release point. This can be seen in winter when smoke tends to lie at about chimney level, neither rising nor falling. If the inversion began above the release point we might expect good mixing near the ground, in the unstable conditions under the inversion, but no penetration through the inversion: the capping inversion. Release into an unstable boundary layer can lead to the so called looping plume: this is often seen. The plume waves up and down as thermal eddies pull it about. Remember that under unstable conditions movement upwards and downwards is accelerated. Release above an inversion, above therefore the boundary layer, produces a 'lofting plume'. This occurs either when material is released from a tall factory or power station chimney at a height above the boundary layer or when hot gas or smoke is released with sufficient buoyancy and / or momentum to enable the smoke to rise rapidly and penetrate the capping inversion at the top of the boundary layer. When this happens the smoke cannot get back into the layer beneath the inversion.

What happened at Buncefield?

The Met Office report (Webster *et al* 2006) provides an invaluable description of atmospheric conditions on the first and following days ofduring the Buncefield fire. The exact words of the report are worth quoting:

'(on December 11th) a shallow strongly stable layer with temperature increasing with height (a temperature inversion) existed at the ground up to a height of about 100m. Above this layer up to a height of about 400m above the ground, the atmosphere was approximately neutral in stability. Above the neutral layer the atmosphere was stable throughout with a strongly stable layer up to about 1200m.'

We can interpret this description on the basis of what we have discussed above. The key point is that the lower part of the atmosphere was stable. The fire generated a hot plume with a high buoyancy. This rose rapidly and 'punched through' to the air above the inversion layer. Once above the inversion no mixing back into the stable layer below was possible and the smoke dispersed downwind in the stable layer above the inversion. Stable to neutral conditions were maintained essentially until the fire had been extinguished.

What might have happened at Buncefield?

Two further circumstances can be imagined:

A Had the stable conditions been converted to unstable then the plume may have mixed downwards into the unstable boundary layer. This occurs when an inversion is breaking up and fumigation can occur as large masses of smoke are carried down to the ground. Once unstable conditions had been established the plume might have been expected to loop and ground level pollution levels might have increased at some locations.

B The plume was hot, what would have happened had it been cold? Well, this is impossible: large fires generate hot smoke! But to complete the picture we will think of an imaginary cold plume being released into a stable atmosphere. The plume would neither rise nor fall much from its release point at ground level. In the absence of wind diffusion outwards would produce a dense pool of smoke. A little wind would lead to a ground level dense plume: rather like a warship laying a smoke screen. But of course this is fantasy given the great heat generated by the Buncefield fire.

Conclusion

Atmospheric conditions control the dispersion of smoke whether produced by fires, domestic chimney or the great stacks of power stations. The atmosphere near the ground may be described as stable, unstable or neutral in terms of the effects of its temperature gradient on dispersion of parcels of air or smoke. During the Buncefield fire stable conditions existed in a deep layer over the south east of England. The hot plume of smoke rose rapidly and spread out above the inversion layer. Once above the inversion the smoke was unable to mix back into the stable conditions closer to the ground. Thus the smoke stayed aloft and dispersed along the direction of the wind: towards France. This pattern of events led to very low concentrations of smoke at ground level.

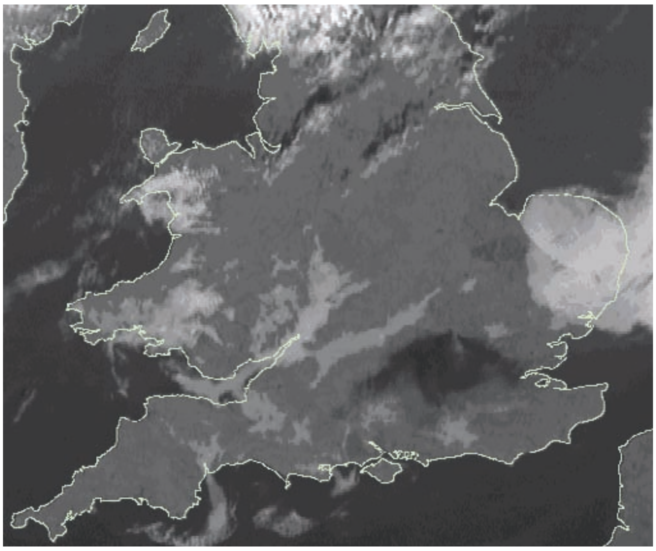


Figure 1: Visible satellite image at 12 noon on Sunday 11 December, 2005 (© EUMETSAT/Met Office).

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New HPA study on the public health impact of asbestos exposures from industrial fires

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Introduction

Asbestos is the name given to a small group of naturally occurring silicate minerals that can be readily separated into thin, strong fibres. Asbestos is defined in UK legislation as one, or a mixture of, any of the following: chrysotile (white), crocidolite (blue), amosite (brown), fibrous anthrophylite, fibrous tremolite and fibrous actinolite. Asbestos fibres are flexible, very strong and resistant to heat and chemicals. These properties have been recognised for thousands of years and asbestos was used by the ancient Egyptians, Greeks and Romans. It is only, however, in the relatively recent past that asbestos use, and therefore potential exposure, became widespread. About six million tonnes of asbestos have been imported to the UK since the late 19th Century with a peak of around 195,000 tonnes in 1973 (DoE, 1991).

The importation, supply and use of asbestos was banned in 1999. However, due to its extensive use in the building industry it is still found in many products including: sprayed coatings/lagging, insulating boards, ropes, cloth, millboard, asbestos-cement sheets, coated metal, textured paints and reinforced plastics.

Because of its extensive use large scale fires involving asbestos containing materials (ACM) are a relatively common occurrence in the UK and can cause significant public concern. In addition, the HPA is responsible for ensuring that public health responses to such incidents are appropriate and consistent. It was therefore considered important to investigate the potential public health consequences of such incidents and explore actions that can be taken to minimise their impact.

To this end, a systematic literature review was undertaken to identify available information on both the level of asbestos exposures that might result from fires and the potential health impact of such exposures. The key elements of plans for and responses to such incidents that can minimise their impact were also briefly explored. In this article the results of this review are presented along with it's conclusions and recommendations.

Results, conclusions and recommendations of the systematic review

The results of the study have recently been published (Smith and Saunders, 2007). The conclusions and recommendations of the study are summarised below:

- Large scale fires involving asbestos containing materials (ACM) are a relatively common occurrence in the UK and can cause significant public concern.
- A number of factors mitigate against significant exposures of members of the public following a fire involving ACM. These include the following :

Fire at a commercial property involving asbestos

- not all the ACM present may be involved in the fire;
- fibres may be entrapped, in larger pieces of material etc.;
- respirable fibres will be a fraction of the total released;
- some fibres may be 'denatured' at the temperatures involved (although in a given incident, this is dependant on many factors);
- atmospheric dispersion and deposition (particularly as a result of rain) will reduce concentrations; and
- the duration of exposure will be short.

- The available evidence indicates that asbestos exposures of members of the public following fires involving ACM will be very small if appropriate clean-up operations are undertaken.
- There is no direct evidence of long-term health risks from fires involving ACM, although the literature in this area is limited. Considering the available evidence on asbestos exposures from fires involving ACM in the context of the results of epidemiological studies of occupational and environmental asbestos exposures it is concluded that the risks of long-term health risks (mesothelioma and lung cancer) are minimal if appropriate clean-up occurs. It is recognised that this analysis involves the extrapolation of exposure response models developed from occupational studies of populations exposed for longer periods at significantly higher asbestos concentration levels. However, it is considered that this approach is reasonable and unlikely to underestimate the risks. This conclusion is in agreement with other similar studies in this area.
- The majority of asbestos encountered in such incidents will be chrysotile. The type of asbestos is a major consideration as the exposure specific risk of mesothelioma is broadly in the ratio 1:100:500 for chrysotile, amosite and crocidolite respectively. Identification of the asbestos type is, therefore, of great importance.
- It is recommended that all Local Authorities have a written policy for dealing with large scale fires involving asbestos. This might be a full and detailed asbestos fire specific plan or simply further guidance in addition to a generic incident plan covering only those issues pertinent to asbestos.
- Some members of the public perceive a greater risk from large scale fires involving asbestos than is actually the case and this needs to be taken into consideration when devising and issuing public warnings.

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Conference and Workshop Reports

Gold Command Experience Workshop, Health Protection 2007

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The Gold Command Experience Workshop took place at the Health Protection Conference on the 18th of September, 2007. The workshop consisted of a series of presentations, followed by discussion and was attended by personnel from the emergency services, health services, medical and scientific professionals and emergency planning specialists. The aim of the workshop was to develop participants' understanding of 'Gold' in a 'dynamic fashion' from Bronze, Silver, and Gold through to the Cabinet Office Briefing Rooms (COBR).

'You have been brave and joined us' was the opening line from **Professor Virginia Murray** (Chemical Hazards and Poisons Division) who explained that Gold command can be an intimidating place. Professor Murray presented an overview of the three command bands: Bronze (operational), Silver (tactical) and Gold (strategic). Professor Murray used several events to illustrate the various levels, including the Buncefield Oil Depot fire.

Deputy Chief Constable Simon Parr (Herts Constabulary) presentation was entitled 'Gold Command in Multi-Agency Incidents'. Simon's interesting (and amusing) presentation focused on responding to an incident at Gold. Lessons included: 'don't panic' and within the first hour find out: what it is?; Who is involved?; What should be achieved?; Who is doing what and who can help? Simon explained the priorities for the first hour were public health; public safety; public confidence; public reassurance and public information! The key message at the end of the presentation was to remember: 'you cannot do everything' and 'you are managing the incident for a short while .... then you are managing the consequences'.

Dr Brian McCloskey (Chief Executive's Office, HPA) presented 'Gold Command – Scientific and Technical Advisory Cells (STAC)' and explained they are the single point for scientific advice to Gold Command. STAC have to be evidence based but pragmatic. Their initial response would be public health issues but these may evolve with the incident. Key lessons were: establish them quickly; ensure they are multi-agency not just driven by health; respond to local circumstances and Gold command; make decisions and document everything!

Dr Rob Carr (Deputy Regional Director, HPA West Midlands) presented the role of the HPA at a local and regional level which includes: local units being a conduit to further specialist advice (on chemicals, biological agents and radiation) from other HPA Divisions; being the health lead on behalf of NHS for operational response to health protection incidents; and being the health advice to other responders such as STAC. Dr Carr used practical examples of the 2007 flooding to demonstrate the types of advice required by the local HPA including infection control; safe use of bottled and boiled water; risks from contamination and safe clean up and return to normality.

Roger Cook (HPA Head of Emergency Operations, Centre for Emergency Preparedness and Response, HPA) presented 'Gold from a National Emergency Co-ordination Centre Perspective' which included legal and government requirements. Participants were shown the continual cycle of planning, response, lessons identified, governance and audit. The presentation also focused on HPA organisational arrangements for information, communication and priorities. It was also stated that SITREPS (situation reports) were essential to ensure that information was updated daily and 'sent up the line'.

Finally, **Professor Nigel Lightfoot** (Chief Advisor to the CEO of the HPA) presented 'The HPA at COBR' and outlined what happens when the Cabinet Office Briefing Rooms (COBR) sit during a major incident. At the outset, the priorities under consideration at COBR meetings will include:

- establishing communication with Gold;
- setting strategic aims and objectives;
- ensuring a public information strategy;
- establishing the 'battle rhythm';

whilst at the same time giving due consideration to any potential conflict in securing the site versus protecting the public.

The HPA delegate at COBR must be fully briefed; keep the Department of Health (DH) fully briefed; and present precise new information for the SITREP (as once it is on government record there is no going back).

The conference presentations and discussions allowed participants to gain a better understanding of Gold Command and the approaches taken in response to a major incident.

The workshop highlighted the importance for senior staff in the HPA being 'STAC trained' and the importance of exercising at 'Gold' level once trained. Discussion's amongst participants after the workshop suggested that similar sessions for 'Bronze' and 'Silver' command and control levels are also likely to be of value.

Beyond Mrs Mop: Chemical, Biological and Radiological Clean-up. Royal Society of Chemistry 13 July 2007

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This one-day meeting was set up to bring together scientists, engineers and government officials concerned with chemical, biological and radiological (CBRN) decontamination in both civilian and military contexts. The conference was jointly organised by the Royal Society of Chemistry (RSC), the Home Office Scientific Development Branch, the Government Decontamination Service (GDS), the Centre for the Protection of National Infrastructure (CPNI) and the Defence Scientific and Technology Laboratory (DSTL). The meeting had a particular emphasis on current research on decontamination in different settings.

The opening address was given by **Dr Andrew Bell** (Chief CBRN Scientist, Home Office). The Home Office has lead responsibility for the cross-governmental Civilian CBRN Science and Technology Research Programme, which includes research on decontamination. Later this year the government will be sending out a call for research proposals on decontamination issues, and would be particularly interested in any proposals that address the following issues:

- The effectiveness, practicability and costs of decontamination in specific settings.
- The hazards created by remediated materials.
- The environmental impact of decontamination.
- The social acceptability of different approaches to decontamination.

Dr Dudley Hewlett (Head of Science) gave an overview of the Government Decontamination Service (GDS). The GDS is an executive agency of Defra which provides advice and guidance to support local authorities during CBRN and significant Hazardous Materials Management (HAZMAT) incidents, and in their contingency planning for such incidents. The GDS assesses the ability of specialist companies to carry out decontamination operations, facilitates access to these services and, if necessary, helps co-ordinate decontamination operations following a CBRN or HAZMAT incident. As an example of their work, Dr Hewlett described the role of the GDS in the decontamination of areas contaminated with Polonium-210 following the poisoning of Alexander Litvinenko in November 2006. Numerous locations around London were deemed to be contaminated with Po-210, and initial forensic examination of these sites by the police and the Atomics Weapons Establishment (AWE) was followed by a risk assessment carried out by the Health Protection Agency (HPA). Dr Hewlett described the difficulty of disposing of waste contaminated with Po-210 and some of the strategies used for reducing the quantities of contaminated waste requiring disposal. These included removing only the surface of an enamel bath rather than disposing of the whole bath, sealing over fixed contamination so that it did not pose a risk to health (possible because Po-210 is an alpha-emitter) and placing contaminated furniture in storage bins until the radioactivity has decayed to a safe level (possible because Po-210 has a half-life of just 138 days). Dr Hewlett discussed some of the issues raised by the incident, such as the need to establish early on who is responsible for paying for decontamination, possible conflicts between the need to collect forensic evidence and the need to establish and reduce risks to health and the logistics of working at a number of different sites over a short period of time.

Professor Ian Thompson (University of Oxford) gave a presentation entitled 'Stimulation of microbiological remediation of the environment'. Prof Thompson presented an overview of his recent research into exploiting the ability of indigenous microbial communities to degrade organic pollutants in soil. Many microbes are naturally able to degrade toxic materials, the technical challenge is how to engineer ways for microbes to degrade materials en mass. This involves identifying whether the relevant genes are present in the indigenous microbial community and developing mechanisms for ensuring that they are switched on. He presented a number of approaches, including soil electro-kinetics, the addition of worms to contaminated soil to improve mixing of microbial communities and adding plants (whose secondary metabolites can also stimulate biodegradation). Prof Thompson also discussed future research possibilities in this area, including the use of microbes as biosensors of contamination and exploiting nanoparticle-microbe interactions.

Dr Norman Govan from the Defence Scientific and Technical Laboratory (DSTL) gave a military perspective on decontamination research. After an overview of the Chemical and Biological Weapon threat spectrum and the main technology options and approaches to decontamination, Dr Govan explained the main research aims around decontamination for DSTL. These are to develop decontaminants, decontamination equipment and processes that: clean to the required level, reduce the burden on the user (in the military setting tank crews have to be able to decontaminate their own equipment), can be used on sensitive and personal equipment towards a broader range of contaminants and that disclose the presence of contamination and verify that the required level of clean has been achieved. Dr Govan presented some recent research on absorbent strippable coatings that can be applied to tanks and other military equipment prior to exposure and are designed to readily absorb liquid chemical weapon (CW) agents, prevent contamination ingress into treated surfaces and result in thorough decontamination when removed. New research is being carried out on developing self-decontaminating and self-disclosing coatings which soak up CW agents and neutralise or disclose contamination in contact with the coating.

Professor Lynne Macaskie (School of Biosciences, University of Birmingham) gave a presentation entitled 'Microbes and microbiological products for decontamination processes'. Prof Macaskie gave a brief overview of her research undertaken during the past two decades on the bioremediation of heavy metals, nuclear waste and other waste products. She then presented some of her recent projects in more detail, including the use of bacteria to recover precious metals from car catalysts and car waste and stimulating bacteria to remove uranium and plutonium wastes. Prof Macaskie has a number of active partnerships with industry, and her work with uranium and plutonium wastes has been used in a nuclear reactor in South Korea with real nuclear waste.

Dr Jim Darwenth (Unilever) spoke on the recent development and challenges in laundry cleaning technology. Dr Darwenth gave an overview of the key characteristics of commercial laundry cleaning products (removing dirt and killing bacteria) and the key ingredients in washing powders before discussing current directions in cleaning technology research. These included using antibody-linked enzymes and polysaccharide-binding domains to improve targeted delivery of key cleaning ingredients and experiments on developing microbiological cultures to produce cleaning chemicals in situ.

The day provided a useful overview of a broad range of issues being investigated in decontamination research, from the rapid acute decontamination required in a military setting to long-term enhancement of natural degradation processes to deal with chronic environmental contamination. As all the research areas discussed are still at the experimental stage, it is unlikely that we will see their use in public health applications in the near future. However, the meeting did provide a tantalising glimpse of what may be over the horizon.

The Nineteenth International Society for Environmental Epidemiology Conference, 5-9 September 2007

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The 19th International Society for Environmental Epidemiology's conference was held at the Sheraton Hotel in Mexico City, 5-9 September 2007. The conference was spread over 4 days, each day beginning with a plenary session followed by 8 parallel streams of seminars, lectures, attended poster viewings and ethical discussions.

On Wednesday evening, the conference was opened by **Dr Mario Molina** of the University of San Diego, who discussed *The Impact of Human Activities on the Atmosphere*. Dr Molina took delegates through key landmark points in climate change research and presented an up to date assessment of the extent to which human actions are impacting on the atmosphere.

In the second plenary, presenters gave a stimulating overview of *Urban Design and Public Health.* Speakers set out the challenges that will be faced by environmental epidemiologists as the world's population increases by an estimated 3 billion by 2050, concentrated mostly in urban centres in developing countries. Public health issues include increased car use leading to rising air pollution and obesity, and increased pressure on agricultural resources and sanitation systems. The importance of good town planning and community design in influencing the health of a population was emphasised (see the World Health Organization Healthy Cities Program for more information: http://www.euro.who.int/healthy-cities).

An overview of the CDC's Agency for Toxic Substances and Disease Registry was given in a seminar. The ATSDR work in public health assessment of environmental hazards, surveillance, emergency response and research and education, and community involvement is integral to every investigation. More information and the ATSDR chemical compendia can be found at: http://www.atsdr.cdc.gov/.

The third plenary explored *Global Environmental Change and Human Health*. Presenters spoke from differing perspectives about the impact of environmental change on human health. The World Health Organization has recently published a report entitled 'Preventing Disease through Healthy Environments'. The report estimates that over 20% of deaths worldwide could be prevented if known environmental interventions were implemented (the report can be found at: http://www.who.int/quantifying_ehimpacts/publications/preventingdisease/en/index.html). The role that cities could potentially play in providing solutions to climate change was discussed, as was the interaction between land use changes and climate change. There was a call for a multi-disciplinary approach to solving climate change, with an urge for health scientists to play a more prominent role in the future.

Translating Environmental Epidemiology into Policy was the subject of the final plenary, which included a presentation describing the development of the UK Air Quality Strategy by **Dr Robert Maynard** (Chemical Hazards and Poisons Division, HQ Chilton). Barriers in getting environmental health knowledge into policy-making arenas were discussed and delegates voiced concerns that this area needed to be considered in far greater depth.

The conference provided a comprehensive overview of recent developments and issues associated with environmental epidemiology from across the world. It provided a useful forum for discussion and provoked much thought on ideas for future research.

Waste: A Public Health Issue. A Conference at the Royal Society of Medicine, 16 November 2007

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Waste and its direct and indirect health impacts was the theme of a conference at The Royal Society of Medicine (RSM) held at their new Max Rayne lecture theatre in London on 16 November 2007. The Section of Epidemiology and Public Health of the RSM organized the event, which was attended by over 40 delegates from a range of organizations including government, academia and public health.

Indirect health impacts of the prevalent attitude to waste were described in the first two talks. **Dr Jenny Griffiths OBE**, a former NHS Chief Executive who now works as an independent public health consultant, gave an overview of 'Sustainability, Health and Waste', and how waste is a consequence of unsustainable consumption of natural resources. She identified patterns of interaction between waste and four current trends: population growth, rampant materialism in the 'developed' world, a declining natural resource base with collapsing ecosystems, and accelerating climate change. Dr Griffiths suggested that work to implement 'Securing our Future', the UK's Sustainable Development Strategy', may lead to a large contribution to public health through 'policy syndemics' (interactions) e.g. walking instead of driving giving health benefits as well as reducing emissions. **Simon Miller** of Best Foot Forward, a company that has prepared carbon and ecological footprint estimates for many private and public customers including the NHS, gave a talk on 'Accounting for sustainability'. He gave an introduction and overview to footprinting methodologies and how these could be used to reduce humanity's impacts on the environment. He presented examples of footprint analyses of aspects of the food sector and the health service, and the relative impacts of different products and activities and demonstrated how the greatest scope for reducing energy and resource use were not always in areas expected pre-analysis.

Direct toxic effects from exposure to waste were the topic of the next two talks. **Dr Richard Mohan** of the Chemical Hazards and Poisons Division of the HPA spoke on 'Models of human exposure to chemicals and other hazards in the vicinity of landfills'; based on his work supported by EPSRC in collaboration with HPA. His main emphasis was on developing methods for the estimation of human exposure and its pathways, based on atmospheric dispersion and population linkage, rather than distance alone. **Dr Lars Jarup**, Reader in Environmental Medicine and Public Health and the Assistant Director of the UK Small Area Health Statistic Unit (SAHSU) of Imperial College, provided a review of 'Epidemiological evidence of adverse health effects for populations near landfills', including details about his experience in conducting such studies in the UK. Use of epidemiology to estimate health effects of waste is difficult because of uncertainties about relevant exposures and exposure pathways. Several population-level (ecological) studies have now suggested possible increased risk of congenital anomalies associated with exposure to landfills but this requires confirmation by individual level epidemiological studies such as a case-control study.

Health agencies may be baffled by the complexity inherent in producing an assessment of health effects of a waste installation, especially when odours have triggered the concerns. **Helen Smethurst**, of the Chemical Hazards and Poisons Division of the HPA gave an overview of the toxicology of substances known to trigger odour complaints, and the context in which it is more likely that such complaints will originate. Her talk on 'Odours from waste sites and the implications for Public Health' also gave a vivid illustration of the range of substances responsible for irritation and nuisance emitted from landfills.

What can be done to address and reduce the size of the health burden attributable to waste or practices leading to waste production? The two final talks at the conference addressed this question. **Dr Zaid Chalabi**, a Lecturer in Health Impact Analysis and Modelling at the London School of Hygiene and Tropical Medicine, spoke about 'A decision analysis framework for minimising health hazards of urban pollution: the example of waste'. Drawing from a study funded by EPSRC: Pollutants in the Urban Environment (PUrE), he introduced the audience to an integrated decision-analytical framework to conduct assessments of environmental policies (or options) for a more sustainable management of urban pollution. The framework was illustrated using the management and treatment of municipal solid waste as an example. Dr Paul Durrands gave the final talk on 'The NHS, the patient, procurement and sustainability'. After work in the private sector and the Commercial Directorate in the Department of Health, Dr Durrands joined South Central Strategic Health Authority to produce a commercial strategy to identify key issues facing providers and commissioners and to improve their effectiveness and identify efficiencies. He argued that by consolidation of supply chains providing the NHS 500,000 product lines, of patient pathways of care, and of outbound chain (waste), much energy can be saved and a reduction of waste can be achieved.

Lively discussions followed most of the presentations, and it was particularly encouraging to see the interaction of health professionals with engineers and other specialists. The day highlighted the direct and indirect ways in which waste can impact on public health and was a reminder to public health practitioners that changing to more sustainable policies in both the NHS and society at large will result in beneficial outcomes on areas as diverse as NHS resources, climate change and the health of individuals.

Training Programme for 2008

The Chemical Hazards and Poisons Division (CHaPD) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2008 programme is being developed to offer basic and more detailed training, along with the flexibility to support Local and Regional Services initiatives as requested.

Planned one day training events for 2008 include:

How to Respond to Chemical Incidents

27th March 2008

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

Contaminated Land

(date to be confirmed)*

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars in Public Health Medicine and Local Authority Environmental Health Officers

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
  - The Local Authority Perspective on Implementing Part II A
  - Bioaccessibility in Risk Assessment
  - The Food Standards Agency (Allotments)

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

**Please see CHaPD Training Events Web Page for regular updates.*

Training Programme for 2008

Level 2 Chemical Incident Training

(dates to be confirmed)

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars/Trainees in Public Health

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).

The learning objectives are:

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

Beyond the Blue Lights

(date to be confirmed)

The Health Protection Agency (HPA), Chartered Institute of Environmental Health (CIEH) and London Fire and Emergency Planning Authority (LFEPA) are pleased to host this interactive workshop and table-top scenario providing an opportunity to cement local joint working by those involved in managing the aftermath of chemical and radiological incidents in London.

Who should attend?

London HPA, Local Authority and NHS professionals with responsibility for the management of chemical, environmental and radiological incidents and emergencies including:

- **HPA** - Health Protection Unit and Chemical Hazards Division Staff, Health Emergency Planning Advisers, Regional Epidemiologists
- **LA** - Emergency Planning Officers, Environmental Health and Pollution teams
- **NHS** - PCT Public Health Directors and Consultants, Emergency Planning Liaison Officers

Topics will include

- Incident notification systems for HPA and local authorities in London
- Joint HPA-NHS-LA response to non-infectious environmental incidents after the blue lights have gone
  - Roles and responsibilities
  - Current response arrangements and assumptions
  - Understanding of 'real-world' response by LAs, HPA, NHS
- Recovery
- Identify gaps for further action by individual organisations and Local Resilience Forums

Environmental and Occupational Epidemiology Spring Meeting

(For the HPA Environmental Network, Consultants in Health Protection with a special interest in environmental contamination and academics working in environmental epidemiology)

This will be the 4th Environmental & Occupational Epidemiology meeting with between 75 and 100 delegates attending. The meetings were judged a great success and enabled cross fertilization between those with an interest in environmental and occupational epidemiology. To further develop these disciplines in the UK and promote collaborative working, the next meeting will take place in the Spring of 2008, (venue to be confirmed). The target audience is those with an interest in environmental and occupational epidemiology. The recent and rapid expansion of occupational and environmental epidemiology and health risk assessment looks set to continue in line with growing public, government and media concern about occupational and environmental health issues, and a scientific need to understand better and explain the effects of occupational and environmental pollutants on human health. The aim of the meeting is to examine various topics in a more informal environment to encourage discussion and collaborative networking.

UK trainees and PhD students have the opportunity to come to a meeting showcasing current work, and offering a forum where they can present posters of ongoing work. Members of UK Government scientific committee members charged with appraising environmental and occupational epidemiology, for risk management and standard setting, can benefit from updates on the most recent developments.

While it is primarily a forum for presenting and exchanging between UK/Irish participants, and posters are invited from research groups in the UK and Ireland, it is an open meeting and colleagues from overseas are welcome to attend.

Training Programme for 2008

One week courses for 2008 include:

Essentials of Toxicology for Health Protection

2nd - 6th June 2008, King's College, London

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

The aims of this short course are to summarise the key concepts in toxicology and of toxicological risk assessment, exposure assessment and to examine the scope and uses of toxicology and the tools of toxicology in local agency response to public health and health protection issues. Sessions on toxicology will be based upon examples of incidents associated with health protection which may lead to adverse health effects. This course would provide an understanding of the limitations resulting from the lack of data on many chemicals, chemical cocktails and interactions. The course would provide an overview of all these aspects to provide an understanding of the advantages and difficulties of multi-disciplinary and multi-agency working in toxicology and the use of strategies for communicating risks associated with the investigation of toxicological hazards. The fee for this course will be around £600.

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

A maximum of 30 places are available.

Introduction to Environmental Epidemiology Short Course

16th - 20th June 2008, London School of Hygiene and Tropical Medicine

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

The aims of this short course is to summarise the key concepts in environmental epidemiology, to explore the key concepts in exposure assessment and cluster investigation, to examine the scope and uses of environmental epidemiology in local agency response to public health and health protection issues. Also it will show how to explore study design and the practical consequences of choices made when planning and undertaking an environmental epidemiological study. This will include an appreciation of the influence of finance, politics and time constraints on the choice of study, to review the advantages and difficulties of multi-disciplinary and multi agency working in environmental epidemiology and to use strategies for communicating risks concerning investigation of environmental hazards. The fee for this course will be around £600.

A maximum of 20 places are available.

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

Booking Information

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

The cost of the training days 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).

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