

Chemical Hazards and Poisons Report

From the Chemical Hazards and Poisons Division
January 2010 Issue 16



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Editorial

Editor: Professor Virginia Murray

**Associate Editors: Catherine Keshishian and Dr Graham Urquhart
Chemical Hazards and Poisons Division**

The International Day for Disaster Reduction (IDDR) was held on 14 October 2009 - a United Nations International Strategy for Disaster Reduction (UNISDR) and World Health Organization (WHO) initiative, supported by the World Bank, which the Health Protection Agency (HPA) had the great honour of hosting with support from NHS London and the Royal Marsden Hospital NHS Foundation Trust. The launch was an accolade for the HPA, raising its profile and voice both nationally and internationally, leading to closer collaboration with the WHO, UNISDR and WHO-Euro in areas such as capacity building for emergency management, emergency medical services and ingraining the need for the UK to act upon the evidence and, where possible, to lead by example. The report on the launch is on page 37.

What happens when a shopping centre is closed because of odour issues and adverse health effects? A report on the Bullring incident in Birmingham in May 2009 shows how difficult these issues can be to respond to and the vital need to identify the source, clean up and then to develop a strategy for recovery and reopening to return to normality. Odours as warning signals for chemical incidents are further examined on page 24.

Mercury toxicity is of concern. Did the 2009 Influenza A H1N1 epidemic result in increased risks from broken mercury thermometers? During the summer months of July and August 2009, an increase in the number of incidents involving broken mercury thermometers was noted both in the press and in queries to the HPA's Chemical Hazards and Poisons Division (CHaPD). Three such incidents are presented, which demonstrate that the HPA step-by-step guide on clean up works if used, but requires further promotion.

Natural hazards and climate change are pertinent topics for the HPA. An editorial in the BMJ by Wilks entitled "Greenwash" at the climate change summit in Copenhagen (30 December 2009)" argues that: "the risks to health from climate change are too obvious to need stating, and when they are, dire predictions of malnutrition, drought, heat waves, and vector borne diseases are simply too big to face".¹ Remaining very aware of these concerns, as I write my editorial on the predicted coldest night of the year in 2010, I am pleased that we have a series of articles on natural hazards, climate change and health impacts. These include the wider health effects of flooding, showing how worryingly difficult these are to measure (page 40); issues we should be considering for

adaptation of housing to reduce the impacts heatwaves, as these are predicted to increase with climate change (page 44); a summary of the health co-benefits of climate change action (page 47); and a report on the International Workshop on Disaster Risk Reduction: Dialogue between Scientists and Stakeholders organised by the UN International Strategy for Disaster Reduction, Europe Office and European Commission, DG Research in 30 October 2009 (page 68).

We have had great feedback about the searchable index for articles from previous issues of the Report plus its predecessor, the Chemical Incident Report, which is available at www.hpa.org.uk/chemicals/reports. In addition to hard copies, we are also launching an email version to enable readers to go direct to articles of interest and share them with colleagues. The next issue of the Chemical Hazards and Poisons Report is planned for May 2010; the deadline for submissions is 1st March 2010 and Guidelines for Authors can be found on the website. Please do not hesitate to contact us about any papers you may wish to submit on chaproport@hpa.org.uk, or call us on 0207 759 2871.

We are very grateful to Dr John Cooper, Mary Morrey, Andrew Tristem and Matthew Pardo for their support in preparing this issue. Thanks also go to Dr Laura Mitchem, Adrienne Dunne, Jamie Bond, Dr Sohel Saikat, Dr Gary Lau and Peter Lamb for their editing assistance.

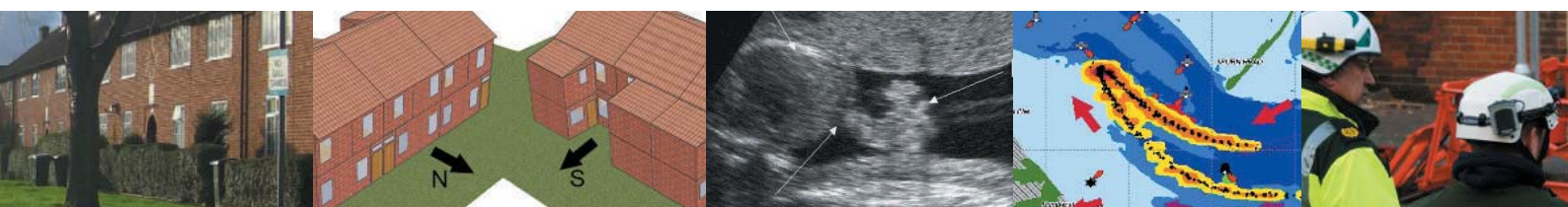
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Front cover image: Justin McCracken speaking to delegates at the global launch of the UN's International Day for Disaster Reduction, 14 October 2009

¹Wilks M. "Greenwash" at the climate change summit in Copenhagen BMJ 2009;339:b5616.

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Incident Response

The Bullring incident

Paul Fisher

Chemical Hazard and Poisons Division, Birmingham

The Bullring

In the centre of Birmingham, built at a cost of over £500 million, the Bullring provides over 110,000 square metres of floor space filled with over 160 shops, boutiques and restaurants and has an estimated 250,000 shoppers every week.

The incident

During the early hours of Thursday 21st May 2009, a number of Bullring staff working within the Operations Centre (situated in the basement of the building) became ill with symptoms of nausea and vomiting. Emergency services were alerted and attended the scene. A number of staff were evacuated from the area and some were transported to City Hospital, Birmingham for further treatment. The Health Protection Agency (HPA) was informed at 4:52 am. Assessments of the area were conducted by the emergency services present, but no cause could be identified. The building was declared safe to re-enter at 7:50 am.

By 8:40 am emergency services started receiving further calls to the Bullring following a number of new cases of persons with unexplained symptoms. There were several thousand people in the Bullring who were evacuated, several hundred people were triaged and the centre was closed. A number of people were treated at a temporary treatment area with some taken to hospital. The HPA was informed of this second incident at 9:35 am and 2 members of the Chemical Hazards and Poisons Division (CHaPD), Birmingham arrived on scene at 10:15 am.

Emergency services were present throughout Thursday, working with Bullring management to try and identify the source of the incident. CHaPD members were able to assist hazardous material (HAZMAT) team of West Midlands Fire Service in their risk assessment process and monitoring tactics/strategy. In addition, being on scene greatly improved CHaPD, Birmingham's efficiency as a conduit for health information. At the afternoon Silver command meeting a decision was made at 6:00 pm that some night staff would work overnight and investigate a possible problem with the Bullring's ventilation system and a further meeting of emergency services and Bullring management would be held at 7:00 am the next morning.

The fire service had utilised all the monitoring equipment they had and even brought in their 'hydrocarbon dog' who was trained to smell hydrocarbons, but no potential source had been identified. The hydrocarbon dog did prove his worth as he started wagging his tail madly at a locker, which was broken open to reveal a store of rotten fruit – a rich source of volatile organic compounds (VOCs)!

At the end of Thursday, West Midlands Ambulance Service reported their official casualty total as 54 patients. Thirty-two were treated on

scene and 22 patients attended an A&E department. Of these 6 were taken by ambulance and the remainder by other transport.

Before the start of the Silver command meeting the following day, it was reported to CHaPD, Birmingham that staff who had been working overnight became ill with nausea and vomiting and emergency services reporting strong smells around the Bullring Operations Centre area (located in the basement of the centre). The area was evacuated and more staff were taken to hospital. The Bullring complex remained completely closed throughout Friday. There was no substance or cause identified by emergency services present and the area was handed over to the Bullring management during Friday.

On Friday afternoon the HPA was able to report back the results of the toxicological testing on blood samples taken from some of the casualties. Although they did not aid the identification of the source as no VOCs were detected, they did provide reassurance.

Bullring management teams worked throughout Friday and Saturday to ensure that the Bullring was safe to reoccupy and the Bullring was reopened to the public at 3:00 pm on Saturday.

The health risk assessment

Although a chemical was not identified, it was likely to be fumes from a petrochemical source. The symptoms reported during the incident were upper respiratory track irritation, nausea, dizziness and vomiting that soon cleared up after casualties were removed from the exposure. The advice given during the incident was that casualties should be monitored for 2 to 3 hours whilst they made a recovery. There were no medium- or long-term consequences of exposure.

Letters were sent to GPs in the area to minimise the risk of a significant number of worried well contacting their health services, but CHaPD, Birmingham received no intelligence that GPs had been contacted over this issue.

The debrief

Birmingham Resilience Group (BRG), a new organisation bringing together the agencies responsible for emergency planning, response and recovery, lead a debrief that was held on Friday 26 June 2009.

The key recommendations following this debrief were:

- Definitions of a major incident in the Birmingham Multi-agency Response Plan to be reviewed and ensure the plan has received widespread distribution amongst all agencies.
- Review the procedures in agencies for identification of key commanders and consider the use of a single form of identification 'tabard' for commanders from each agency.
- Review the arrangements for health representation at Silver command meetings.

- Develop guidance on multi-agency risk assessment at incidents.
- Develop guidance on the use of toxicology in informing the risk assessment process and the circumstances when this could be done.
- Development of a process to ensure consistent communication from incident scenes to receiving hospitals.
- Clarify the arrangements for activating a Science and Technical Advice Cell (STAC).

Discussion

Due to the delay between exposure and the taking of blood and urine samples it was unlikely that VOCs would be picked up given the short period and low concentration of the exposure. Casualties were taken away from sources of potential exposure and into the fresh air to rest and given oxygen exactly because this would reduce the concentration of VOCs in their blood and they would then feel better. Therefore, if samples were taken after this, for example at the hospital, then the likelihood of finding significant levels of VOCs in biological samples would be small. However, the taking of blood samples off casualties who were resting shortly after exposure would be problematic as the emergency services would have other priorities at this point and the casualties would rather be left alone.

There were considerable problems related to the fact that the source and chemical were unknown. None of the environmental monitoring showed any significant concentrations of chemicals, even though towards the end of the incident there was a veritable army walking through the shopping centre with handheld photo-ionization detectors (PIDs) looking for VOCs. Furthermore, the fire service had used a whole van-full of detection, identification and monitoring (DIM) equipment, a hydrocarbon dog and draeger tubes had been placed throughout the centre and water entering and leaving the Bullring had

been sampled. Ideally a source would have been found and neutralised as this would have reassured all the stakeholders, however this was not the case.

There was a tendency to link all reported symptoms to the chemical incident. As there are thousands of staff members and tens of thousands of shoppers, paramedics are called to the Bullring on a regular basis. As staff waited outside for the majority of a sunny bank holiday Saturday, a number of the staff experienced the nausea that could have been due to chemical exposure once they re-entered and the centre was again almost evacuated for a third time. However, thanks to a rapid risk assessment by a paramedic which recognised the symptoms of heatstroke the shoppers of Birmingham were able to continue shopping.

The Bullring prepared a reoccupation plan before opening, which was signed by senior management. This concluded that:

'Based on all actions taken to investigate this situation and the plans developed for re-occupation, having taken advice from competent persons we believe all reasonable steps have been and will continue to be taken and it is considered that the centre is safe to open.'

This placed the reopening of the centre firmly in the hands of the Bullring management, who acted with the safety of their customers of paramount importance.

The frequency of these incidents was demonstrated when the following month another shopping centre owned by the same retail property group was closed on the 23rd June 2009 after retail staff had incorrectly disposed of cleaning products.

For further information (copy of debrief report, monitoring data etc.) please e-mail Paul Fisher at: paul.fisher@hpa.org.uk.



Emergency responders on scene at the Bullring, Birmingham.

Does the Health Protection Agency website prevent harm from breakage of mercury thermometers?

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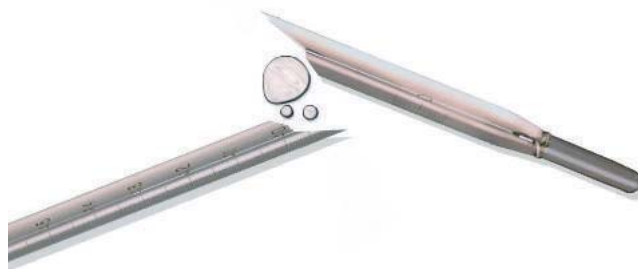
Introduction

Since the EU Directive 2007/51/EC came into force on 3rd April 2009, members of the public have no longer been able to purchase mercury thermometers.¹ The Directive states that mercury thermometers will no longer be placed on the market and requires any shop holding unsold stocks of mercury thermometers to withdraw these goods from sale. Mercury thermometers purchased before 3rd April are not affected and can be used without legal implications. These restrictions are aimed at protecting the environment and public health by decreasing the amount of mercury waste released.

Mercury thermometers contain elemental mercury, a dense, silvery, liquid metallic element. Members of the public can come into contact with mercury globules at room temperature if the thermometer breaks. If swallowed the mercury is unlikely to cause any health impacts as absorption from the gastro-intestinal tract is limited. Inhalation of mercury vapour is much more likely to lead to harmful exposure and is consequently the main health concern.² It has been reported that a spillage of as little as 5 ml (approximately 68 g) of elemental mercury left on a rug can lead to severe toxicity in a child via inhalation in a poorly ventilated environment.³ However if a broken mercury thermometer is efficiently cleaned up and disposed of correctly the mercury risks to health from significant exposure to mercury vapours is unlikely.

The Health Protection Agency (HPA) developed a step-by-step guide to cleaning up minor mercury spills from broken thermometers in August 2007, which is available on the HPA website.⁴ It aims to assist members of the public in dealing with minor mercury spills appropriately and in a way which minimises potential impacts on health as well as minimising the number and impact of calls to emergency services including the fire service.

During the summer months of July and August 2009 an increase in the number of incidents involving broken mercury thermometers was noted both in the press and in incident reports to the HPA's Chemical Hazards and Poisons Division (CHaPD) London.^{5,6} Speculation suggested that there might be an association with the April to July Influenza A H1N1 epidemic. This prompted CHaPD London to evaluate the use of the online step-by-step guide by members of the public when dealing with minor mercury spills. Three incidents involving breakage of mercury thermometers within residential settings reported to CHaPD London are described below. Two of these illustrate appropriate use of the HPA step-by-step guide whilst one describes an incident where the guidance was not consulted until contact was made with the HPA.



Incident 1:

Breakage of a mercury thermometer in a kitchen sink and potential exposure of small children

A member of public was referred to CHaPD London regarding a mercury thermometer which had broken in the kitchen sink whilst it was being washed. The HPA website had been consulted and the step-by-step guide used. The sink's U-bend had been undone as directed by the guide and the mercury collected. Windows had been left open to ventilate the room and four bags of waste which had been generated, including clothing contaminated with mercury, had all been double bagged as directed in the guide. The local authority had been contacted to dispose of the waste. The member of the public wished to know about potential health impacts from using the sink in the future and any likely health effects on their small children.

Incident 2:

Mercury thermometer breakage during pregnancy

A telephone enquiry from a member of public was referred to CHaPD London. They had broken a mercury thermometer in a bathroom at home and the mercury had spilt inside the bathroom cabinet and the toilet bowl. Advice on cleaning up the broken mercury thermometer had been obtained from the HPA website and the step-by-step clean up guide followed. The bathroom had been ventilated, but the caller required advice on disposal of the mercury in the toilet bowl. They were advised to collect the mercury from within the toilet bowl using a spoon or some other suitable disposable implement to scoop the mercury into a sealable container. CHaPD London advised double bagging of all items used for cleaning and recommended contacting the local authority for assistance with waste disposal. The occupier of the property was 31 weeks pregnant and concerned about potential health effects following exposure. CHaPD London recommended contacting NHS Direct or a GP for clinical advice regarding exposure during pregnancy.

Incident 3:

E-mail enquiry regarding spillage of mercury from a thermometer

An e-mail from a member of public was forwarded to CHaPD London outlining the breakage of a mercury thermometer in a bedroom. The mercury had been cleaned up using a handheld vacuum cleaner initially and remaining globules were mopped up and double bagged.

No information on flooring type or the amount of mercury vacuumed was provided. The occupier of the flat was very concerned about potential airborne release of vapourised mercury and was enquiring about the need for air quality monitoring.

CHaPD London directed the member of the public to the online step-by-step guide. Information on the disposal of the vacuum cleaner was provided by the local authority and the member of public was advised to open the bedroom windows to ventilate the room. No information on health symptoms had been reported so CHaPD London advised them to contact their GP or NHS Direct should they feel unwell.

Discussion

The incidents described above show that the HPA online step-by-step guide for cleaning up broken mercury thermometers is used by the public in residential settings. When the guide had not been used initially by the member of public managing the incident, the guide was used by CHaPD London as an advisory tool to inform on the management of minor mercury spills. From contact with CHaPD London it was possible to undertake a risk assessment during each incident and determine, with the use of the guide and its recommendations, that environmental sampling was not required.

In Incident 1 and 2 where the guide had been used at the time of the spill, both spills were managed well with very little potential for the mercury spill to have any impact on health. The callers in these instances were seeking reassurance that all the traces of mercury had been found and removed and confirmation that there would be no adverse impact on the occupant's health. In Incident 3, where the step-by step guide was not used initially, inappropriate handling of the mercury spill was demonstrated with the use of a vacuum cleaner and inadequate waste disposal.

The recent increase in the number of mercury thermometer related calls in London potentially mirrors the Influenza A H1N1 pandemic, where diagnosis guidance recommends members of the public check their temperature. However alongside this clinical advice is the need to highlight the HPA's step-by-step guide making the public more aware of how to clean up a broken mercury thermometer.

The recent EU Directive will hopefully result in a decrease in the number of circulating mercury thermometers used in the future within the UK leading to a consistent decrease in the number of incidents involving them, but it is important to remember that this only applies to the future sale of mercury thermometers and mercury thermometers still in use will continue to break. These case studies demonstrate that the HPA step-by-step guide requires promotion particularly during times when thermometers may be used more frequently.

Finally, the authors would like to advise that a separate step-by-step guide is available on the HPA website for the cleaning up of broken domestic compact fluorescent lamps (CFLs), more commonly known as energy saving light bulbs. This is due to the fact that a typical CFL contains around 4 mg of mercury, which is just enough to cover the tip of a ball point pen⁷⁸, thus breakages of these pose lower risks to exposure, hence a more detailed step-by-step guide is necessary for cleaning up broken mercury thermometers.

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A review of Health Protection Agency involvement in incidents occurring at sites regulated under the Control of Major Accident Hazards (COMAH) Regulations

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Introduction

The Control of Major Accident Hazards (COMAH) Regulations 1999 (amended 2005) brought into force in the UK the requirements of the Seveso II Directive. This European Directive aims to prevent major accidents resulting from certain industrial activities and limit the consequences of accidents for both people and the environment.

The COMAH regulations have two levels, a lower tier and an upper tier. Thresholds at which each tier applies are set for quantities of both specific chemicals and generic chemical classes; these reflect the potential hazard with higher thresholds applying to the upper tier. Upper tier industrial sites must prepare (and test) off-site emergency plans. County Councils or Fire & Rescue Services usually prepare the off-site emergency plan on behalf of the site operator, who reimburses their costs. The plan details the actions to follow to mitigate the potential effects on the environment and people living in the vicinity of a site.

The Health Protection Agency's (HPA's) local Health Protection Units and Chemical Hazards and Poisons Division (CHaPD) supra-regional units participate in multi-agency planning and exercising for specific sites within the geographical areas they cover. The HPA's national COMAH work is led and co-ordinated by the Environmental Public Health Network COMAH working group. This paper presents a review of the HPA's involvement in incidents occurring at sites regulated under the COMAH regulations.

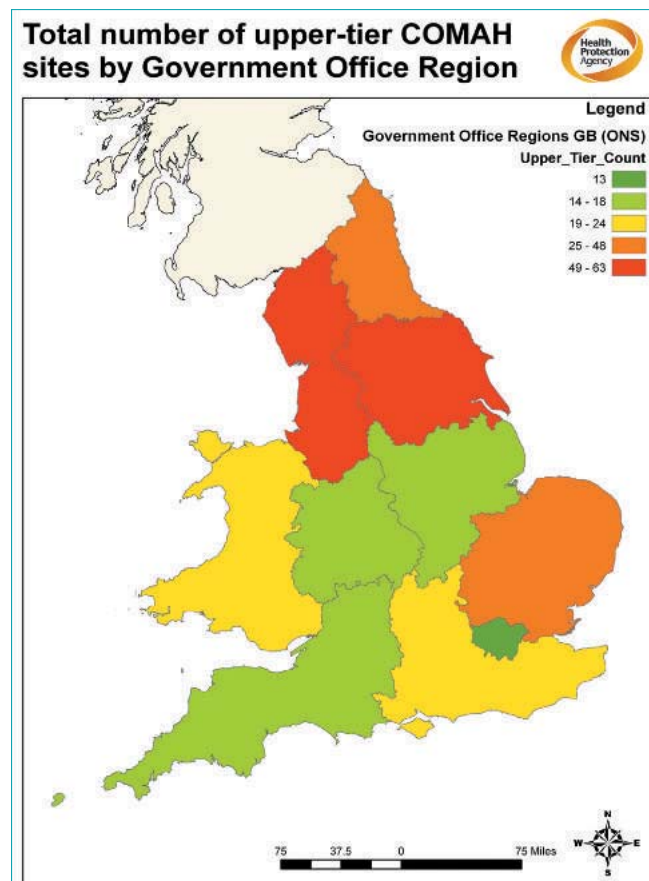
Figure 1 shows the distribution of upper tier COMAH sites in England and Wales, based on information held by the Health and Safety Executive (HSE) that was updated by the HPA throughout 2008-2009 to form a national dataset. Clusters of "domino" sites occur across the country; these are most prevalent in the coastal industrial areas of the northern regions and alongside major communications routes such as motorways.

Methodology

The HPA has a role in responding to acute incidents such as chemical releases and fires; providing public health and specialist chemical advice. Local, regional, and national alerting arrangements exist for the notification of the HPA by emergency services and other responders in the event of such incidents. A central log is held by the HPA of incidents for which CHaPD is notified and/or consulted for specialist advice. Location data for all CHaPD-logged incidents from the calendar years of 2005-2008 were extracted. This was compared to HSE listings of both lower and upper tier COMAH sites as of 2005 and 2008, and listings of upper tier sites held by the HPA, in order to identify incidents which were potentially associated with COMAH sites. This identified 189 (of 3899) incidents potentially related to COMAH sites.

The detailed log associated with each incident was then scrutinised

Figure 1: Upper-tier COMAH sites by Government Office Region © HPA



and summary data were extracted for 84 entries that were unequivocally related to a COMAH installation, excluding entries associated with exercises. A further ten entries were likely to be related to COMAH installations but this could not be definitively corroborated by the log and these were excluded from the final analysis.

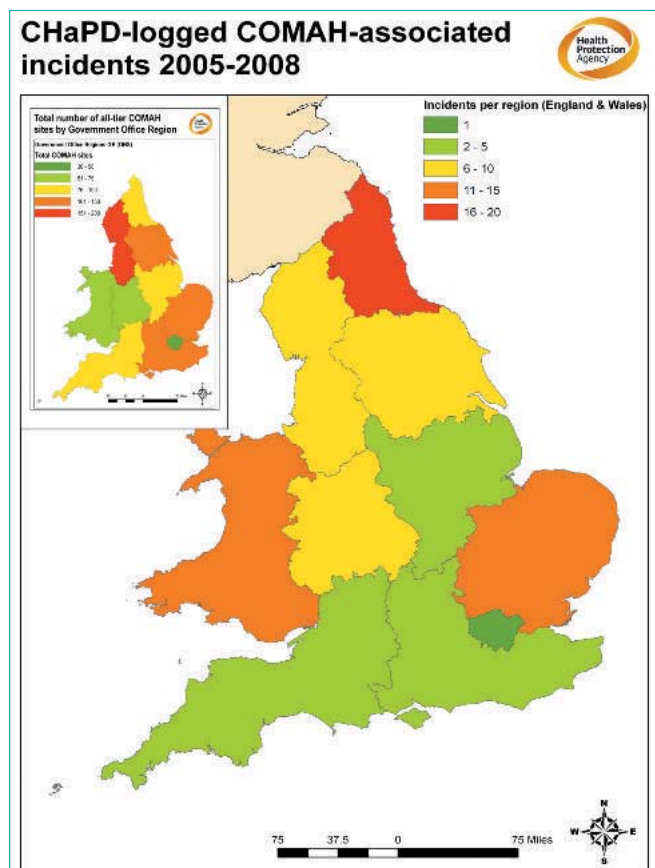
Results

Figure 2 shows the location of the 84 COMAH-associated incidents identified by the review. The inset map shows the total number of all-tier (i.e. both lower and upper tier) COMAH sites by Government Office Region (based on HSE data from 2008).

Of the 84 COMAH-associated incidents 54 (64%) were related to upper tier sites, 29 (35%) lower tier, and one (1%) was unknown. The HPA's first notification came in-hours (0900-1700 weekdays) in 35 (42%) incidents, and out-of-hours in 32 (38%) incidents. The alerting time was not recorded in 17 (20%) incidents.

For 32 (38%) of these entries, the incidents were flagged as being at a COMAH site in the incident log (either under the specific location or within the text of the log). Of these 26 were upper tier, five were lower tier, and one was unknown.

Figure 2: CHaPD-logged COMAH-associated incidents 2005-2008 © HPA



For 52 (62%) entries there was no indication from the logged information that the HPA was aware that the incident was related to a COMAH site. This was not restricted to lower tier sites (i.e. those without off-site multi-agency plans) as 28 entries related to upper tier sites, and 24 to lower tier.

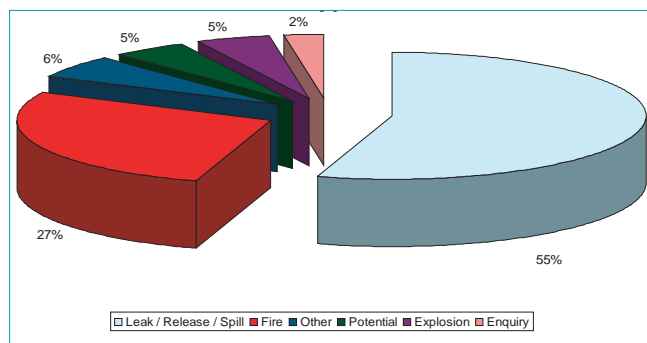
In terms of repeat events there was one site that gave rise to five separate logged entries, two sites with three entries, nine with two entries, and 50 with one entry. Steelworks, ports, terminals and chemicals installations were the industry types most likely to generate repeat entries.

Figures 3 to 5 present information from all log entries related to COMAH installations summarising the: incident type; industry type; and principal chemical involved.

Figure 3 shows that the majority of incidents related to chemical leaks, releases and spills (55%). Fires (27%) and explosions (5%) were also relatively common, whilst 13% of entries were not related to a realised incident (these included non-incident-specific queries; and entries documenting the HPA's alerting to a potential incident that was subsequently not realised).

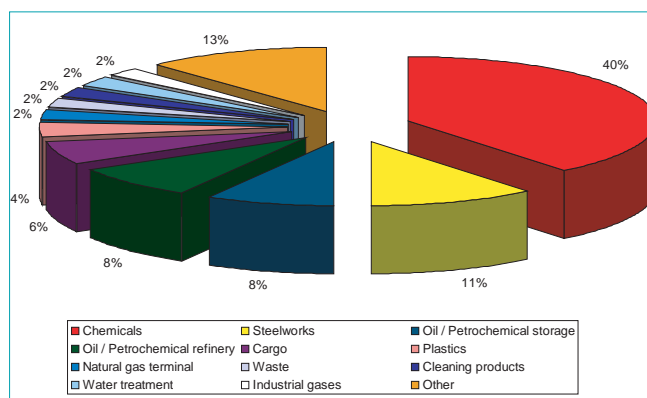
The industry types to which incidents relate, shown by Figure 4, are dominated by the chemical (40%) and oil / petrochemical (combined 16%) categories. This is to be expected given that these sectors represent a large proportion of the total number of sites subject to the COMAH regulations. In any future reviews, where these encompass a sufficiently greater number of entries, the dominant categories could conceivably be broken down into more specific sub-groups (e.g. extraction; wholesale storage and production; etc). Incidents related to premises handling natural gas are perhaps lower than would be expected when it is considered that these make up a high proportion

Figure 3: CHaPD-logged COMAH incidents by incident type © HPA



of the total number of lower-tier installations and are a significant contributor to the total number of upper-tier installations. There are a limited number of steelworks in England and Wales, and the relatively high proportion of incidents related to this sector (11%) reflects the fact that this review found multiple log entries related to individual steelworks sites.

Figure 4: CHaPD-logged COMAH incidents by industry type © HPA

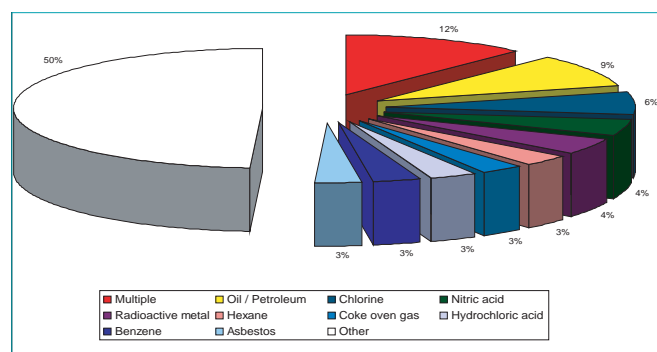


As can be seen in Figure 5, incidents were related to a wide range of different chemicals; reflecting the diversity of chemicals stored at COMAH installations and shown by the 50% of entries within the miscellaneous "Other" category. Multiple chemicals were reported in 12% of incidents and, reflective of their ubiquitous nature, oil / petroleum (9%) and chlorine (6%) were the largest specific groups represented. The entries related to radioactive material are interesting, particularly as it could be argued that this nature of incident would be under-reported by CHaPD. The Radiation Protection Division is the HPA's expert body in radiological matters and separate regulations apply to installations dealing with radioactive material (e.g. the Radiation (Emergency Preparedness and Public Information) Regulations). It is, however, the case that chemical incidents and fires occurring at COMAH installations may also involve limited quantities of radioactive material. The log entries included a query regarding the presence of a gauge containing radioactive cobalt that was involved in a wider on-site fire; a false alarm related to an off-site release; and reporting of a batch of radioactive scrap metal being delivered to a steelworks.

Transport

There were five entries related to transport; three of which were associated with cargo or freight operations. In only one case was this flagged as being associated with a COMAH site (where a lorry leaving a chemicals installation spilt aluminium oxide some distance from the site,

Figure 5: CHaPD-logged COMAH incidents by principal chemical involved
© HPA



leading to an evacuation of customers of a nearby restaurant and restaurant staff being advised to shelter). These incidents were of variable levels of risk: from localised occupational exposures associated with incidents on-board ships or loading/unloading operations (such as exposure to the pesticide aluminium phosphide when emptying shipping containers, an example of which is reported by Goodfellow *et al.*); through to significant leaks of flammable substances with the potential for a much larger area of effect. A number of ports and terminals fall under the COMAH regulations and it is feasible that a significant incident involving one of these site's inventories may be initiated by transport near or on-site. When responding to incidents, it is worth health professionals bearing in mind that what on first impression appears to be an unrelated transport incident may have occurred at, or be from, a COMAH installation. Transport incidents, as opposed to those related to site structures and inventories, may also lead to initial uncertainty regarding the activation of off-site COMAH plans.

Incidents with on-site impacts

There were 35 entries (42%) where the incident resulted primarily in occupational exposure and impacts on-site, with limited off-site impacts. Eight such incidents were associated with smaller scale fires and were dealt with by the operator and emergency services. Chemical releases were involved in 20 of these 35 incidents. The severity varied from on-site containment, to occupational exposure and follow-up, through to more serious events involving the exposure, decontamination, and hospitalisation of workers following exposure. The largest-scale occupational exposure led to 27 individuals being treated at two separate hospitals. Several such incidents resulted in secondary contamination issues associated with the exposure of paramedics or hospital departments. A further seven entries were related to either individuals' accidents on-site or potential incidents notified to public health that were subsequently stood down without having become a public health incident. In one case where the incident was not overt in nature, complaints were received from local residents who were disputing the shelter advice which had been issued.

Incidents with off-site impacts

Exclusion of the on-site incidents described within the previous paragraph and selection of entries related to explosions (3); fires (16); and leaks, releases, and spills (26) returned 45 incidents which resulted in off-site impacts (29 at upper tier sites, 15 at lower tier sites, one unknown). This represents 54% of the total log entries linked to COMAH sites.

The HPA was first notified in-hours for 17 of these entries and out-of-hours for 19 entries (log details were unavailable for 9). The log entry for 18 (40%) of these incidents was flagged as occurring at a COMAH installation. The most common industry types involved were: chemicals

installations (21); oil / petrochemical installations (8); and steelworks (5). Mixtures of chemicals (6); oil / petroleum (4); and nitric acid (3) were the most commonly reported principal chemicals involved.

Evacuation took place during eight of these 45 incidents, but appeared in the majority of cases to be limited to the inner cordon and nearby houses. Complaints were reported by persons located off-site in six incidents. Off-site injuries or symptoms that were attributable to the incident were recorded for five incidents. The most common off-site impact reported in relation to chemical exposure was respiratory and/or ocular irritation; however, the number of people reporting symptoms in any given incident was generally low and restricted to those in close proximity to the site. No entries reported significant numbers of members of the public consulting NHS Direct or presenting at accident and emergency (A&E) departments after a chemical exposure although there was a case where four passers-by to an explosion involving ammonia subsequently presented at A&E suffering from shock. The most notable incident within this review was the explosion and subsequent long-lasting fire at the Buncefield fuel terminal in December 2005 which resulted in: a number of off-site injuries due to the blast and flying debris; damage to surrounding property; and concern associated with long-term contamination of groundwater. Of the five incidents with attributable health impacts off-site, three were also associated with chronic (long-term) impacts off-site including those associated with pollution of groundwater, drinking water, and land. There were no logged incidents that led to reported fatalities off-site.

Although several of these incidents reported that Silver and/or Gold multi-agency co-ordinating groups were set up; the log entries contained insufficient detail to examine the frequency of activation of upper tier sites' off-site plans.

COMAH Major Accidents notified to the European Commission (EC)

Table 1 presents a summary of COMAH Major Accidents notified to the European Commission by the HSE between 1999 and 2005. A reduction in notifiable incidents over the HSE's reporting period is apparent, although it should be noted that these incidents pre-date this review of CHaPD log entries; in which the fire at Buncefield was notifiable. Some of the incident reports reflect the findings of this review, in that a number of incidents resulted primarily in on-site impacts, although personnel may have been hospitalised. However, by their nature the EC-notifiable accidents are serious: the HSE reports a number of incidents involving the extensive damage of nearby buildings and the shelter and evacuation of considerable numbers of people. Despite the reduction in risk that is driven by the COMAH regulations, the scale and impacts of the more serious incidents reported illustrate the high potential hazards posed by COMAH sites, and the importance of emergency preparedness and response and continued good practice in this area.

Improving the HPA's response to incidents at COMAH sites

It is desirable for the staff of any organisation with a role in incident response to have an overview of the location and nature of any high hazard sites within the area that they cover. In practice, this may be difficult when response is across a wide regional or national area. CHaPD log entries indicate that, for a number of incidents (62%), the potential involvement of a COMAH site was not recorded. Some level of under-reporting is to be

Table 1: COMAH Major Accidents notified to the European Commission 1999-2005 Table © HSE

Date	Operator & location	Accident description & dangerous substances
10 July 99	Union Carbide, Wilton, Cleveland	Fire following flammable gas release. 12 tonnes of isododecane from broken pipework
11 July 99	Associated Octel, Ellesmere Port, Merseyside	Fire following flammable liquid metal spillage. 4 tonnes sodium spilled during road tanker offloading.
14 July 99	Esso Petroleum, Fawley, Hampshire	Flammable liquid spillage. 400 tones of a crude oil (extremely flammable) from a storage tank into bund.
21 July 99	Vopak, Middlesbrough, Cleveland	Toxic liquid spillage. 12 tonnes of sodium cyanide solution from a storage tank into ground and River Tees.
09 Aug 99	Corus, Redcar, Cleveland	Toxic/flammable gas release. 207 tonnes of blast furnace gas (21% carbon monoxide).
02 Nov 99	Fine Organics, Middlesbrough, Cleveland	Toxic gas release. Hydrogen chloride from a chemical reaction in a road tanker of product (CCMZ)
12 Dec 99	BG Transco, Poole, Dorset	Flammable gas release. 40 tonnes natural gas from a gas holder.
20 Dec 99	BASF, Middlesbrough, Cleveland	Toxic gas release. Hydrogen cyanide released during sampling.
20 Jan 00	Hickson & Welch, Castleford, West Yorkshire	Toxic gas release. 70kg of sulphur dichloride from batch reactor system.
08 Mar 00	European Vinyls Corp. (UK), Runcorn, Cheshire	Toxic gas release. 0.5 tonnes of hydrogen chloride from pipework during commissioning
13 May 99 and 05 May 99	European Vinyls Corp. (UK), Runcorn, Cheshire	<i>These 3 accidents were reported solely on the grounds of being a 'near miss of particular technical interest'. Details of all 3 'near miss' accidents are provided in the full report. The current guidance is that a 'near miss' should only be reported when there are new and significant lessons to be learned across the EU and these 3 'near miss' accidents would probably not have been reported had this guidance been available in 1999/2000.</i>
20 Sept 99	BP Chemicals, Wilton, Cleveland.	
10 June 00	BP Amoco, part of BP Grangemouth Petrochemicals Complex, Falkirk	Release and ignition of 13 tonnes of extremely flammable hydrocarbons (Naptha) fluidised catalyst cracking unit
6 Oct 00	Uniqema (ICI Chemicals and Polymers Ltd t/a), Wilton, Middlesbrough	4 tonnes of flammable and toxic material Ethylene Oxide at approx -5°C released to a bund during filling of a road tanker
30 Oct 00	Cleansing Services Group Ltd, Upper Paddington, Works, Sandhurst. Nr Gloucester	Fire in the storage area of a chemical waste transfer station. Approx 180 tonnes of flammable and toxic material consumed in the fire
13 Jan 01	Nipa Laboratories, Ruabon Works, Wrexham	14 tonnes of toxic Phenol released from storage tank into bunded area
16 Apr 01	Conoco Ltd, Humber Refinery, South Killingholme, Immingham	Release & ignition of 179 tonnes of extremely flammable hydrocarbons (a mixture of ethane, propane & butane) from the de-ethaniser column overhead pipe
16-17 Jul 01	Park Environmental Services Ltd, New Port	Release of 186m ³ of hydrogen sulphide gas from a 500m ³ treatment tank during a transfer of waste alkali solution from a road tanker
27-28 Sept 01	Conoco Ltd, Immingham Pipeline Centre, Immingham Dock, Immingham	Release of 16.10 tonnes of liquid propane during sampling from a road tanker
8-9 Nov 01	Corus (UK) Ltd, Port Talbot Works, Port Talbot	Fire & explosion in Blast furnace No 5 allowing an unknown quantity of extremely flammable & toxic gas (mainly carbon monoxide) released
24 July 02	Fehrer (GB) Ltd Smethwick, West Midlands	Ignition of combustible material
25 July 02	Hickson and Welch Ltd, Castleford, West Yorkshire	Release of approximately 30 tonnes of para-toluidine from a heated bulk storage tank
14 Aug 02	QinetiQ PLC, Shoeburyness, Essex	A charge weighing about 10 kg had been made. The employee had decanted this into its container and was about to prime it when the energetic composition spontaneously ignited
29 May 03	Shell Oil UK Oil Products Ltd, Ellesmere Port, Cheshire	Release of approximately 20tonnes of isobutane and between 60 and 160 kgs of Hydrogen Fluoride
Apr 04 – Mar 05	No major accidents reportable to the EC	

expected, given the concise nature of the CHaPD log entries and due to the relatively minor nature of a number of the incidents reported. On the other hand, some entries related to COMAH installations may have been excluded from this analysis due to factors such as installations changing ownership and/or name; and limitations associated with location data.

Recent work within the HPA has established a national listing of COMAH sites and built a portfolio of Initial Reference Sheets (IRSs) for HPA staff. Each IRS contains a description of each upper tier site and its surrounding location; principal chemical inventory; and likely hazard scenarios. This information is currently compiled and held on a regional basis. Bespoke Geographical Information Systems are also being developed which identify the location of COMAH sites.

An opportunity exists to combine future re-development of the CHaPD logging system with these outputs from the recent work of the HPA's COMAH working group. By cross-referencing the location data in each new entry into the logging system with a national listing of COMAH site location data, and by making this available out-of-hours, it would be possible to significantly improve the HPA's awareness of incidents potentially being associated with these high hazard sites.

Summary

The COMAH regulations apply controls to sites which present a high hazard; and consequent potential to impact significantly on public health. This was reflected by incidents notified to the EC by the HSE and

in a proportion of incidents examined by this review. Over half (54%) of the total COMAH-related incidents logged by CHaPD between 2005-2008 resulted in off-site impacts: 10% were associated with some level of off-site evacuation; whilst 6% led to attributable symptoms or injuries reported by persons off-site; most commonly respiratory and/or ocular irritation. There were no CHaPD-logged incidents that led to reported fatalities off-site during the review period.

42% of logged incidents resulted primarily in occupational exposures and impacts on-site, with more limited off-site impacts. It is worth noting that the potential for secondary contamination of ambulance service and acute trust workers remains an important consideration in such cases; emphasising the need to be aware of the chemicals present at COMAH sites and their effects.

The HPA has an important role to play in delivering emergency planning, public health risk assessment, and incident response functions in relation to COMAH sites. Developing best practice in this area will further the HPA's ability to best protect the communities living in the vicinity of these sites. The HPA's national work in this area is led and co-ordinated by the Environmental Public Health Network COMAH working group.

Reference

1. Goodfellow F, Gent M & Harman R. Close Encounters with Aluminium Phosphide in West Yorkshire. *Chemical Hazards and Poisons Report 2009*; 15:7-9. Available at: www.hpa.org.uk/chemicals/reports

Emergency Planning and Preparedness

The HAZMED training course

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Background

The Yorkshire Ambulance Service's "Hazmed" (hazardous medicine) service was established in December 2005 to improve the preparedness, local surveillance and operational management of chemical incidents. Trained ambulance personnel (Hazmed Advisors) are despatched to chemical incidents to act as on scene forward liaison persons for the wider health economy whilst also having a 'direct reach back' capability to the Health Protection Agency (HPA) (both local Health Protection Units (HPU) and the Chemical Hazards and Poisons Division (CHaPD)) for expert advice on the management of chemical incidents.

With the national roll-out of HART (Hazardous Area Response Teams) in Yorkshire and the Humber, a Hazmed Advisor will be embedded in each HART team. This ensures that public health and environmental considerations are considered from the very beginning of any incident response. To train the Hazmed Advisors, a bespoke three day training course was developed by the HART manager, local HPU and staff from the supra-regional CHaPD unit and was held on 7-9 September 2009.

Aims and objectives of training course

- 1 To ensure that for chemical incidents, Hazmed advisors are able to act as:
 - the forward liaison officer for the health economy;
 - the on-scene health advisor; and
 - the liaison officer for the management of the public health aspects of an incident.

To ensure that the Hazmed advisors have an understanding of:

- the types of chemical incidents that may occur (including CBRN, COMAH, transport-related, small commercial, household);
- on-scene procedures and risk assessment;
- sources of information;
- when to contact the HPA for advice;
- what health advice to provide to operational ambulance staff and other organisations;
- the Hazmed requirements at a variety of incidents, from large fires, aircraft incidents and bomb disposal, to smaller incidents which might not initiate a HART response but may still have public health implications.

Overview of the course

There were 11 participants on the first running of this new course. Speakers were drawn from a variety of backgrounds and agencies including the Environment Agency, Hull Port, Leeds Bradford International Airport, West Yorkshire Fire Service and West Yorkshire Police. The training included group exercises based on real incidents and a practical demonstration of the fire service detection, identification and monitoring equipment and its capability.

The roles and responsibilities of the various organisations involved in a response were explained and the variety of tools and information sources that are available during an incident, including CHEMET and FIREMET were demonstrated. Speakers from the Port of Hull and Leeds Bradford International Airport attended to outline the particular chemical and environmental hazards that may be encountered on these sites and their emergency procedures. The basic science behind radiation and the arrangements for radiation incidents were covered by a speaker from the Radiation Protection Division of the HPA.

The course culminated in a formal assessment comprising of a multiple choice questionnaire and a scenario based assessment. This involved the participants rotating through a number of stations and interacting with assessors in a role play to simulate a real incident. During these encounters the trainee advisors gathered information about the incident, interrogated a database to gather chemical and toxicological information and answered assessors' questions about what advice they would give at scene.

Conclusions

The strength of the Hazmed training course is that it involves a wide range of speakers from the various agencies that might be involved in a major incident. The speakers were able to provide a personal perspective on what they could provide to the Hazmed Advisors as well as what they might expect from them. The emphasis is not only on individual casualty management but also encouraging first responders to consider the wider public health implications that need to be considered both initially and in the medium to long-term. A lot of material was delivered through dynamic presentations, participant involvement and practical exercises. The course exam, though undertaken within a relaxed atmosphere, had to be passed before the participants could be signed off as a formal Hazmed Advisor.

Participant feedback was extremely positive, and a review of the speaker's performance has helped to inform and build upon this first course. The plan is to train a second cohort in March 2010 which will mean that the Yorkshire Ambulance Service will have some 20 trained Hazmed Advisors in the region.

Currently there are five HART teams that are operational in England, with another four coming on stream through the course of 2010. By



Figure 1: Yorkshire Ambulance Service Hazmed advisors responding to incident.

2011/12 there will be 12 teams across England, with another three teams across Scotland. The Welsh team will be developed in the near future. If other regions are interested in developing a similar service, or for further information on Hazmed and the course, please contact Mike Gent (Mike.Gent@hpa.org.uk) or Mick Hardaker (Michael.Hardaker@yas.nhs.uk).



Figure 2: Yorkshire Ambulance Service Hazmed advisors responding to incident.

Acknowledgements

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A summary of the NHS Security Management Service Lockdown Guidance

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Introduction

The purpose of this paper is provide a summary of the Lockdown Guidance produced by the NHS Security Management Service in February 2009 (restricted document available from Local Security Management Specialists) to assist national NHS emergency planners in incorporating lockdown requirements in their emergency plans. The paper is produced in the context of the HPA's Chemical Hazards and Poisons Division (CHAPD) draft framework for managing influx into community health facilities following chemical incidents developed by Dr Chee Yung et al 2008¹ and the Guidance Pack for primary care centres on managing an influx of patients from a chemical incident produced by Dr Delphine Grynspan et al 2009².

The NHS lockdown guidance includes a valuable toolkit for assessing the capability of NHS sites to be locked down and useful advice on the legal rights to barring entry and exit. The guidance also indicates how preparing lockdown plans can significantly reduce costs to the organisation on NHS indemnity insurance cover.

Background

The NHS Security Management Service (SMS) is part of the Counter Fraud and Security Management Service (CFSMS) and has overall responsibility for all policy and operational matters related to management of security within the delivery of NHS services.

Following the lessons identified from the sarin attack in Tokyo of 1995, Exercise Tamino in London in 2006 and Exercise Gerhard in South West London in 2007, CHAPD developed a draft framework for managing influx into community health facilities which covered four key themes, namely: containment, self presenter management, decontamination and treatment.

Lockdown Guidance

The objective of the NHS lockdown guidance is to provide planners with a step by step process to produce a lockdown plan in order to provide a secure and safe environment for patients and staff. Circumstances in which the lockdown guidance can apply range from an incident involving the use of firearms or an armed siege which would trigger a lockdown as required by the police, to the consequences of a terrorist attack such as a CBRN release as described in the HPA draft framework, to a local altercation that threatens staff or patients.

The SMS has defined 'Lockdown' as:

*"The process of controlling the movement and access – both entry and exit – of people around an NHS site or specific NHS building or area in response to an identified risk, threat or hazard that might impact upon the security of patients, staff and assets, or the capacity of that facility to continue to operate. Lockdown is achieved through a combination of physical security measures and the deployment of security personnel."*³

The lockdown guidance enables the emergency planner to develop a lockdown profile for a specific site or facility. The guidance provides a step by step process following a logical planning cycle to produce a lockdown profile. The process includes working with internal and external stakeholders, local threat and hazard assessment, identifying critical assets, a vulnerability assessment and identifying potential weaknesses to being able to lockdown. The planning steps are supported by a 'tool kit' comprising tables and a checklist ensuring factors are considered. The resulting lockdown profile can then be incorporated into emergency plans, or become a specific lockdown security plan as required. As with any planning cycle the process includes regular reviews, testing and exercising.

Reducing the costs of insurance

The National Health Service Litigation Authority (NHSLA) has developed discounts to the NHSLA indemnity schemes covering the Clinical Negligence Scheme and the Risk Pooling Scheme⁴.

Applicable legislation

Having a lockdown plan supports compliance with the Civil Contingencies Act 2004 (CCA)⁵ in that category 1 responders must assess the risks of emergencies occurring and have plans in place to manage the risks.

When a lockdown has been triggered, the guidance indicates that it is lawful to prevent entry to members of the public even though there is an implied right to enter as NHS facilities are usually open to the public. Entry can be also be prevented for casualties or patients on the basis that it is in their best interests to receive treatment at other, safer healthcare premises and therefore their 'right to treatment' under the Human Rights Act 1998⁶ would not be infringed.

The guidance then indicates that the public cannot be prevented from exiting the facility under the Human Rights Act 1998 right to liberty (article 5) and right to a family (article 12) unless emergency powers under the CCA are invoked or the person commits an offence, or can be detained under the Mental Health Act.

Conclusion

Given the rising level of threats and hazards that can trigger the need to quickly and effectively lockdown a facility, emergency planners should incorporate the lockdown guidance and the HPA draft framework for managing influx into community health facilities into emergency plans, and crucially include the wider testing of lockdown in exercises.

References

- 1 Yung C et al. (2008) Draft framework for managing influx into community health facilities following chemical incidents. *Chemical Hazards and Poisons Report 12*; May 2008. Available at: www.hpa.org.uk/chemicals/reports
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- 3 NHS Security Management Service, Lockdown Guidance February 2009 (restricted document available from Local Security Management Specialists)
- 4 The National Health Litigation Authority (NHSLA) Acute, PCT & Independent Sector Standards - 2009/10
- 5 Civil Contingencies Act 2004
- 6 Human Rights Act 1998

Environmental Science and Toxicology

The canary in the coal-mine: Congenital anomalies, environmental chemical exposure and surveillance

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Abstract

Establishing clear causative links between congenital anomalies and environmental risk factors, such as exposure to chemical pollutants, represents a huge challenge to society. Whilst our knowledge of the molecular and genetic mechanisms of development has improved markedly in the past ten years, our understanding of the impact of environmental exposures on embryogenesis is less well understood.

In light of recent advances in IT-based public health surveillance systems and problems identified with congenital anomaly surveillance in the UK, we asked if routinely collected antenatal data could be used to inform an IT-based surveillance and alerting system to help improve upon current practices. A component of this feasibility study is to ascertain which anomalies could be tested in the development of a rapid antenatal surveillance system; here we discuss our rationale for this selection.

Introduction

It is estimated that about 4% of live births in the UK carry a congenital anomaly and for 50-60% of these babies the aetiology is unknown¹. At least 10% of stillborn babies carry an anomaly². This represents a huge burden to our society both in mortality, suffering and healthcare cost. A major goal of research is to identify the causes of congenital anomalies in order to mitigate the effects of any modifiable risk factor³.

Progress has been made in identifying factors that influence birth outcomes such as: ionizing radiation, communicable diseases (rubella, cytomegalovirus and pyrexia inducing illnesses such as influenza), preventative dietary factors (folic acid supplementation), medications (thalidomide, valproic acid and isotretinoin), lifestyle (smoking and alcohol consumption), and maternal conditions (age, obesity and diabetes)^{4,5}.

A plethora of evidence on developmental toxicity of chemical pollutants in animal models exists. However, although well studied, there is little epidemiological evidence that demonstrates a clear causative link between environmental chemical exposure and human birth defects. Whilst there is a handful of notable exceptions for links between acute exposure to chemical pollutants and poor birth outcomes, including Minimata (methyl mercury and stillbirths)⁶ and Bhopal (methyl isocyanate and stillbirths)⁷, on the whole the epidemiological evidence linking specific teratogenic pollutants with congenital anomalies is slim.

There are several reasons why it has proven difficult to produce convincing evidence. Studies typically group anomalies by organ system⁸⁻¹⁰ whilst teratogens may have pleiotropic (multiple) effects upon the embryo depending upon the exposure (time, duration and concentration) and the action of the agent on the developmental pathways that exist during embryogenesis.

Congenital anomaly surveillance is inherently slow and has incomplete geographical coverage in the UK; investigation of a potential cluster may be many months or even years after the exposure or birth of the affected child. There is also a high rate of unreported spontaneous and elective abortions. Whilst there is a comprehensive European congenital anomaly surveillance system (European Surveillance of Congenital Anomalies, EUROCAT) that collects, analyses and reports on birth outcomes (including abortions data), the percentage of UK births covered by EUROCAT is approximately 31%. Under resourcing and the lack of UK regional registries contributes to this low ascertainment rate.

Typically, due to the low numbers involved and the slowness of the reporting process, many studies examining the link between environmental exposures and congenital anomalies are registry-based case-control studies; these can be influenced by recall bias. Confounding factors such as maternal age, socioeconomic status, smoking, alcohol intake and obesity further muddy the water as data on such risk factors are not routinely collected.

Last but not least we must consider that currently there are approximately 104,000 REACH (Registration, Evaluation, Authorisation and Restriction of Chemical substances) registered chemicals that are in use in today's society; developmental toxicity data exist for approximately 1% of these¹¹. Demonstrating that a specific chemical has a clear causative link with a congenital anomaly upon environmental exposure represents a huge challenge to society.

In light of recent developments in IT-based surveillance and reporting systems (see table 1) for public health use, and recommendations from the Children's Environment and Health Strategy¹², we asked if it would be feasible to capture data that is routinely collected during pregnancy to inform an IT-based surveillance and reporting system.

It was envisaged that such a surveillance system would provide timely information about trends and clusters of congenital anomalies by the automated retrieval of routinely collected antenatal health data. Whilst there are several sources of information that could be collected on birth outcomes, we considered that the 18-20 week fetal anomaly scan would be an appropriate starting point. Approximately 98-99% of pregnancies in the UK are subject to an ultrasound scan. In April 2010 England will implement National Standards for antenatal ultrasound screening for the systematic detection of 11 key congenital anomalies. Capturing data automatically from antenatal ultrasound would radically increase the ascertainment rate of anomalies that can be reliably diagnosed by ultrasound. Whilst this would be a crude measure of the incidence of anomalies and would not replace the

need for more detailed registry based data collection of antenatal and birth outcome data, it may provide an early alerting mechanism for public health professionals to investigate aberrant trends further.

Table 1: Examples of European web-based surveillance and reporting systems.

EWRS	Early Warning Response System for Communicable Diseases
RAS-CHEM	Rapid Alerting System for CHEMical health threats
EURO-MOMO	European MONitoring of excess MORTality for public health action
SIDARTHa	Syndromic surveillance using hospital emergency data
RAPEX	EU rapid alert system for all dangerous consumer products (excluding food)
RAS-BICHAT	Rapid Alert System used for exchanging information on health threats due to deliberate release of chemical, biological and radio-nuclear agents

Methodology

To develop and test the system, we decided to select one congenital anomaly that could be used as a sentinel. If successful, further coded anomalies could be included in the study. This section describes our selection process to choose a suitable anomaly.

Discrete anomalies were chosen rather than multiple (syndromic e.g. Down’s) anomalies. In addition, anomalies that have a known genetic (Mendelian and chromosomal) aetiology (e.g. achondroplasia) were excluded. The remaining anomalies were ranked as follows:

- highest detection rate at the 18-20 fetal anomaly week scan
- highest incidence of the anomaly (based on Welsh data from CARIS)
- those most likely to survive to one year.

Anomalies were removed from the list using the criteria below:

- those that were detected <60% of the time by ultrasound at 18-20 weeks
- those likely to have greater than 90% fetal loss before birth from termination and spontaneous fetal loss
- those with 0% survival to 1 year of age.

Table 2: Final selection of five anomalies (GA=gestational age, R=rank, aR=average rank)

Anomaly	(UK) Detected by ultrasound ¹⁵		(EU) Discovered <24/40 GA ¹⁶		Live births ¹³		Legal termination ¹³		Spontaneous fetal loss ¹³		Survival to 1 year ¹³		Chromosomal Anomaly ¹⁶		aR
	%	R	%	R	Rate/10K	R	%	R	%	R	%	R	%	R	
Gastroschisis	94-100	1	79	2	5.6	3	5.6	1	1.4	2	93.8	2	3	1	1.7
Exomphalos	87.3-96	2	81	1	4.4	4	49.1	3	14.3	5	69.2	4	27	5	3.4
Spina bifida	70.6-93	3	69	4	8	2	77	5	2.5	3	94.9	1	8	3	3
Hypoplastic L heart	61-88	4	62	5	3.3	5	50.6	4	1.2	1	50	5	11	4	4
Limb reduction	Not available		73	3	10.3	1	28	2	8	4	93	3	7	2	2.5

It was envisaged that these criteria would reduce false positives, improve chances of detecting a cluster and lessen the impact of problems due to unreported fetal loss. Table 2 shows the top five anomalies ranked by the criteria given above. These included limb reduction defects, spina bifida, gastroschisis, exomphalos (also known as omphalocele) and hypoplastic left heart syndrome (described in Table 3).

Table 3: Brief description of anomalies chosen list as per above

Congenital anomaly	Brief description of anomaly
Spina bifida	Bony defect in the vertebral column so that part of the spinal cord is exposed.
Gastroschisis	Separation in the abdominal wall, through which part of the intestines protrude and are not covered by peritoneum.
Exomphalos	Contents of the abdomen herniate into the umbilical cord.
Hypoplastic left heart syndrome	A form of congenital heart disease in which the whole left half of the heart is underdeveloped.
Limb reduction defects	All or part of one or more limbs is not present

Is there evidence for clustering or environmental influence?

A literature review was undertaken to ascertain if environmental chemical insults have been linked to any of the five anomalies. In 2003 Vrijheid *et al.*¹⁷ performed a comprehensive literature review on chemical and environmental exposures associated with congenital anomalies and other adverse pregnancy outcomes. We reviewed the evidence for environmental exposures from this paper and undertook an updated literature review on the anomalies listed in Table 3.

SCOPUS¹⁸ was used as the search engine and a search strategy similar to that used by Vrijheid *et al.*¹⁷ was followed. Combinations of the following words were used in the search: abnormality, pregnant, environment, pollution, organic, inorganic, chemical, teratogen and cluster. These were combined with the following: limb, spina bifida, gastroschisis, exomphalos, omphalocele and hypoplastic left heart syndrome. Titles were trawled for possible articles of interest and abstracts of these then

reviewed to see if the papers met the inclusion criteria. Papers meeting the inclusion criteria were obtained in full text and their references were also reviewed for possible further papers of note.

Inclusion criteria:

- paper published 2003 to June 2009 and not included in Vrijheid paper¹⁷
- English language
- human not animal data presented
- at least one environmental exposure considered in the paper
- at least one of the chosen anomalies mentioned in association with the environmental exposure.

Results

Thirty seven papers were obtained and reviewed in full and 10 met the criteria for inclusion in this literature review. A brief description of the studies identified both from the Vrijheid paper¹⁷ and this updated search are discussed below.

Spina Bifida

From Vrijheid *et al.*¹⁷

High lead concentrations were associated with a higher risk of having a baby with spina bifida ($p=0.015$), however after controlling for the effect of deprivation this wasn't statistically significant ($p=0.11$)¹⁹. Shaw *et al.* 2002²⁰ found an elevated risk of spina bifida in comparison with professional/ managerial occupations if the fathers worked in farming/ forestry/ fishing (OR 1.5, 95%CI 0.7-3.1), precision production/ repair/ craft (OR 1.5, 95%CI 0.9-2.7), operations/fabricators/ labourers (OR 1.7, 95%CI 1.0-2.9), technical/ sales/ administrative (OR 1.8, 95%CI 1.0-3.3) and military (OR 3.0 95%CI 1.0-9.1). Spina bifida was associated with some occupations with potential solvent exposure of the fathers²¹ and fathers working at a sawmill where chlorophenolate wood preservatives had been used²². White *et al.*²³ found an association between risk of spina bifida and pesticide usage exposure index.

A study in communities located near PVC plants showed no association between parental occupation in the plants or residence near them with risk of spina bifida²⁴ and Croen *et al.*²⁵ showed no increased risk between nitrate in ground water and spina bifida.

From 2003-2009

Two case-control studies pooled by Rull *et al.*²⁶ to investigate agricultural pesticides applied within 1000m of maternal residence found an increased association with spina bifida and amides (OR 3.3, 95%CI 1.2-9.3), benzimidazoles (OR 2.7 95%CI 1.1-6.5) and methyl carbamates (OR 1.7 95%CI 1.0-2.9). Groenen *et al.*²⁷ found a relationship between low maternal zinc and spina bifida (OR 2.9 95%CI 1.2-7.0).

A case-control study in China looked at maternal and paternal exposure to pesticides, organic solvents and heavy metals and found these were not associated with neural tube defects²⁸.

Gastroschisis

From Vrijheid *et al.*¹⁷

Gastroschisis was related to occupational solvent exposure, aliphatic hydrocarbons and aromatic hydrocarbons²⁹ in one study (OR 3.8, 95%CI 1.6-9.2). Elliott *et al.*³⁰ found living within 2 km of a landfill site increased the risk of abdominal wall defects (OR 1.08, 95%CI 1.01-1.15) and a further study³¹ also showed a cluster of gastroschisis near a landfill in Wales (OR 4.8, 95%CI 1.6-11.1).

From 2003-2009

Armstrong *et al.*³² investigated localised clustering of congenital anomalies in Great Britain and found a borderline significance of variation over geographical enumeration districts with gastroschisis ($p=0.051$). Clustering of gastroschisis was also noted by Root *et al.* in North Carolina³³. No environmental exposures were linked to the cluster. A study by Nieuwenhuijsen *et al.*³⁴ found a significant excess of cases of gastroschisis in groups with high bromoform concentrations in their water (OR 1.38, 95%CI 1.00-1.92). Mattix *et al.*³⁵ found a positive correlation between the abdominal wall defects gastroschisis and exomphalos with levels of atrazine in the water, $p=0.0392$ and $p=0.125$ respectively, using data from the CDC and Indiana in the USA.

Hypoplastic Left Heart

From Vrijheid *et al.*¹⁷

Hypoplastic left heart syndrome was found to be related to solvent exposure with an odds ratio of more than three³⁶.

From 2003-2009

Kuehl *et al.*³⁷ investigated a cluster of hypoplastic left heart syndrome and found an association with maternal exposure to miscellaneous solvents (OR 3.33, 95%CI 0.96-11.55), and mother's painting (OR 2.73, 95%CI 1.04-7.14).

Gilboa *et al.*³⁸ found no association with hypoplastic left heart and ambient air quality and Strickland *et al.*³⁹ also found no association between hypoplastic left heart syndrome to air pollutants ozone, PM₁₀, nitrogen dioxide, carbon monoxide and sulphur dioxide.

Limb defects

From Vrijheid *et al.*¹⁷

Krickler *et al.*⁴⁰ found increased limb defects with an OR of 3.4 was associated with maternal pesticide exposure. Schwartz *et al.*⁴¹ found an OR of 2.3 for maternal or paternal work in agriculture. Limb defects have also been associated with maternal or paternal pesticide exposure or malathion spraying areas (OR 1.73, 95%CI 0.87-3.46). Maternal occupational exposure to aliphatic hydrocarbons was associated with an increased risk of limb anomalies (OR 1.6, 95%CI 0.7-3.8)⁴².

From 2003-2009

No studies found.

Exomphalos

From Vrijheid *et al.*¹⁷

Exomphalos was not mentioned in the paper.

From 2003-2009

The findings from Mattix *et al.*³⁵ are described in the gastroschisis section above.

Discussion

Although inconclusive and sometimes conflicting, there is some evidence that weakly links four anomalies (spina bifida, hypoplastic left heart, limb reduction defects and gastroschisis) to maternal and paternal environmental chemical exposure.

Considering the evidence from the Vrijheid¹⁷ study along with our literature review, spina bifida and gastroschisis (Figure 1) are the two anomalies that have been most studied with regard to chemical or environmental hazards. Gastroschisis has been reported as clustering

around geographical areas sometimes associated with environmental exposures; spina bifida has not been linked to clusters in these studies. Taken together with the ranking used above and the results of the literature review, we conclude that gastroschisis is the congenital anomaly that should be investigated in the initial phase of the pilot study to develop a Rapid Alerting System for Congenital Anomalies (RASCA).

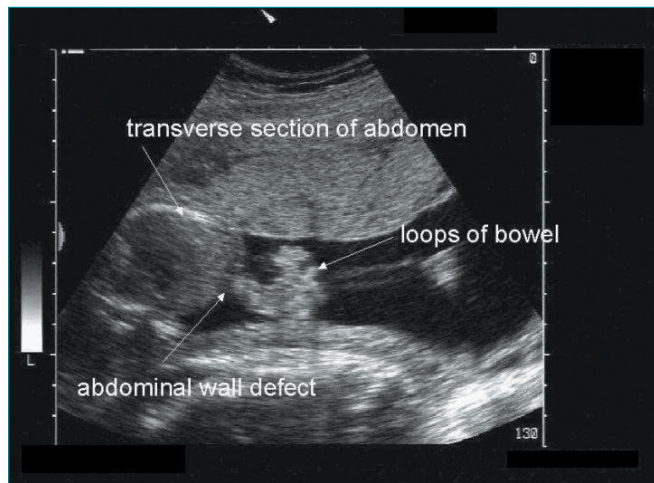


Figure 1: Ultrasound image of unborn baby with gastroschisis (image courtesy of Radiography Department, Singleton Hospital and CARIS).

It should be noted that although gastroschisis fulfils our selection criteria, the anomaly may have several risk factors such as young maternal age, smoking, alcohol consumption and recreational drug use⁴³. A large case-control study is currently underway to analyse the influence of risk factors associated with gastroschisis that will report in early 2010 (Palmer & Paranjothy personal communication). Once published, the outputs from this should provide a measurable index of maternal risk factors and data about antenatal diagnosis.

Unlike certain areas of the UK, Wales has a robust principality-wide Congenital Anomaly Reporting System (CARIS)¹³ that records birth data for all pregnancies. Recently, Wales began implementing a nationwide IT-system Radiography Data Information System (RADIS2)¹⁴ that captures electronic radiography information, with roll-out to be completed in late 2009. RADIS2 contains an obstetric component that records ultrasound information electronically. We propose to utilise the RADIS system in collaboration with CARIS to test the idea of developing a Rapid Alerting System for Congenital Anomalies (RASCA). Data retrieved by RASCA will be subject to CUMulative SUM techniques (CUSUM) and systematic Geographic Information Systems (GIS) analysis to identify aberrant trends in data.

There are several caveats to the success of developing such an approach including the fact that there are only 11-22 cases of gastroschisis in Wales each year (mean 303 cases in UK). Interestingly, several studies have shown that the incidence of gastroschisis across Europe has shown a 10 to 20 fold (1 in 50,000 to 2-5 in 10,000) increase in incidence over the past forty years⁴⁴. Gastroschisis represents a growing public health concern.

If successful, this approach will provide an opportunity to utilise recent advances in healthcare information technology to develop a surveillance and alerting tool for public health professionals. It will provide us with a crude but rapid indicator of perturbations to human development that may be indicative of concomitant environmental

exposures. Further components of this feasibility study will include a retrospective analysis of well described examples of clusters of poor birth outcomes, and asking: (a) if our proposed system would have detected these incidents, and (b) the estimated benefit of earlier detection and reporting. Currently we are examining the utilisation of digital technology in the development of international congenital anomaly and public health surveillance and alerting systems (Hobbs, Manuscript in Preparation 2010).

Aside from the timeliness of the identification and alerting process, a robust and systematic approach is required to identify potential environmental exposures that may cause clusters of congenital anomalies. Whilst this proposed system is not an answer to all the ills of the epidemiology of congenital anomalies, it is a first step towards looking at the feasibility of developing a system to alert health professionals to the potential clusters of anomalies in a timely manner.

Finally, gastroschisis is the tip of the iceberg, there are approximately 3,000 described birth defects which are present in one out of thirty three pregnancies or approximately 30,000 babies in the UK each year; for the majority, the cause remains unknown.

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Fly-tipping of hazardous wastes

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Introduction

UK waste disposal has long relied on managed co-disposal of hazardous and non-hazardous waste to landfill. However the transposition of the EU's Landfill Directive into UK domestic law stopped co-disposal as of 16th July 2004. From that time on, landfill sites had to be designated as taking either inert, non-hazardous or hazardous waste streams (although stable non-reactive hazardous waste, e.g. asbestos, could be consigned to a designated cell at a non-hazardous site). Additional controls imposed restrictions on some wastes going to landfill for final disposal and outright bans for others. Such a fundamental shift in UK landfill use policy led to fears of negative consequences. Fears included hazardous wastes being unlawfully consigned as non-hazardous and an increase of hazardous waste fly-tipping. This paper discusses the latter.

The potential threat to public health from fly-tipping was discussed in Fly-tipping and health protection¹. This article discusses a number of specific groups of wastes likely to be considered to be hazardous waste which, of all waste categories, may pose the most significant threat to public health.

Background

A summary of UK legislation concerning fly-tipping was given in Fly-tipping and health protection. However, a definition of 'hazardous waste' and its use with regard to the available datasets is necessary.

What is hazardous waste?

The EU requires a list of wastes and a list of hazardous wastes be produced for EU member states to use in the classification of wastes. These two lists were combined into the European Waste Catalogue (EWC)² and was introduced into the UK through the List of Wastes (England) Regulations 2005 (SI 2005/895) which came into force on 16th July 2005.

SEPA (Scottish Environmental Protection Agency) gives a clear definition regarding the EWC: the EWC List of Wastes is a

17 Construction and Demolition Wastes (including excavated soil from contaminated sites)		
17 01	concrete, bricks, tiles and ceramics	
17 01 01	concrete	
17 01 02	bricks	
17 01 03	tiles and ceramics	
17 01 06*	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substances	M
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	
17 02	wood, glass and plastic	
17 02 01	wood	
17 02 02	glass	
17 02 03	plastic	
17 02 04*	glass, plastic and wood containing or contaminated with dangerous substances	M
17 03	bituminous mixtures, coal tar and tarred products	
17 03 01*	bituminous mixtures containing coal tar	M
17 03 02	bituminous mixtures other than those mentioned in 17 03 01	
17 03 03*	coal tar and tarred products	A

Figure 1: Extract of chapter 17 of the European Waste Catalogue⁵

harmonised, non-exhaustive list of waste types established by European Commission Decision 2000/ 532/EC, and is subject to periodic review³. It categorises wastes based on a combination of the process or activity that produces them and their characteristics. The full list can be found at www.europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000D0532_do_001.pdf

The EWC is divided into 20 chapters, most of which are based on the industry producing the waste, although some are based on a description of the waste. Each chapter divides further, to reflect a more specific source identification until a relatively specific waste is identified with a 6-figure code. For example, chapter 17 of the EWC lists wastes arising from 'Construction and demolition wastes (including excavated soil from contaminated sites)'; the chapter is further divided into nine sub-chapters such as 17 01 'concrete, bricks, tiles and ceramics' and 17 03 'bituminous mixtures, coal tar

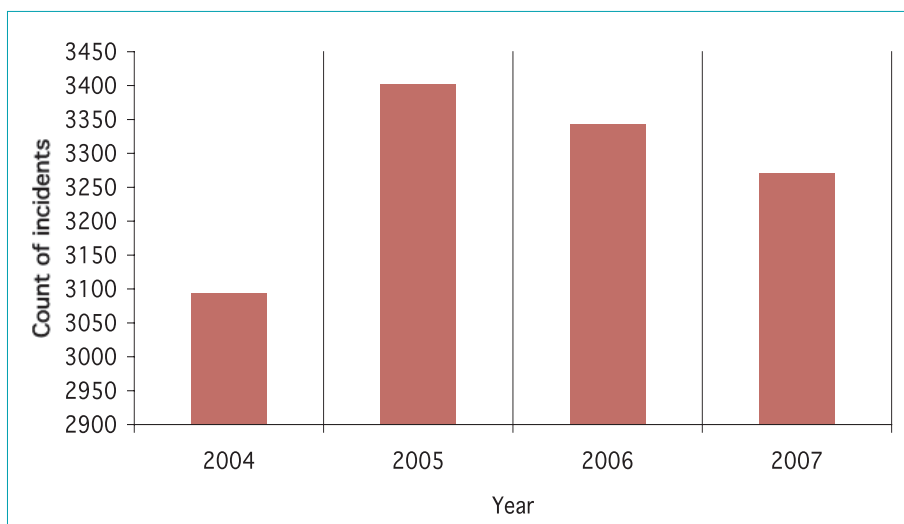


Figure 2: Count of incidents of reported asbestos fly-tipping

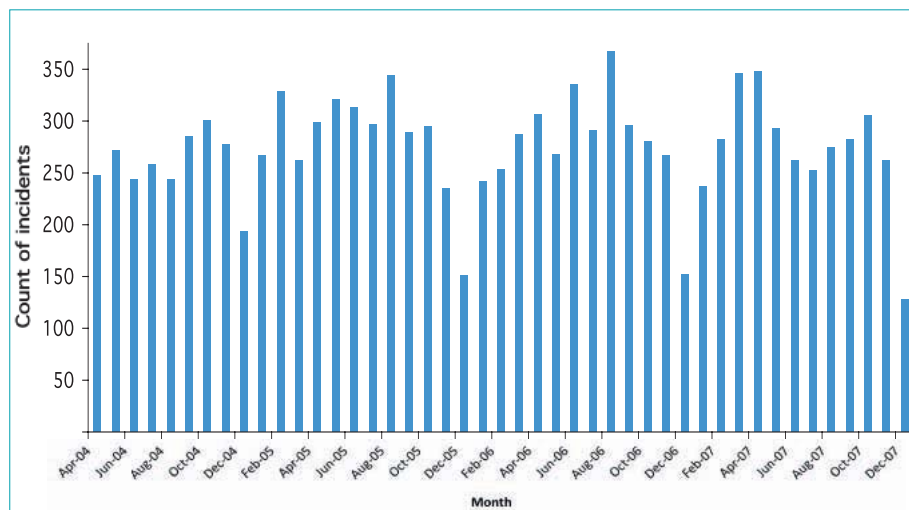


Figure 3: Monthly count of asbestos incidents reported

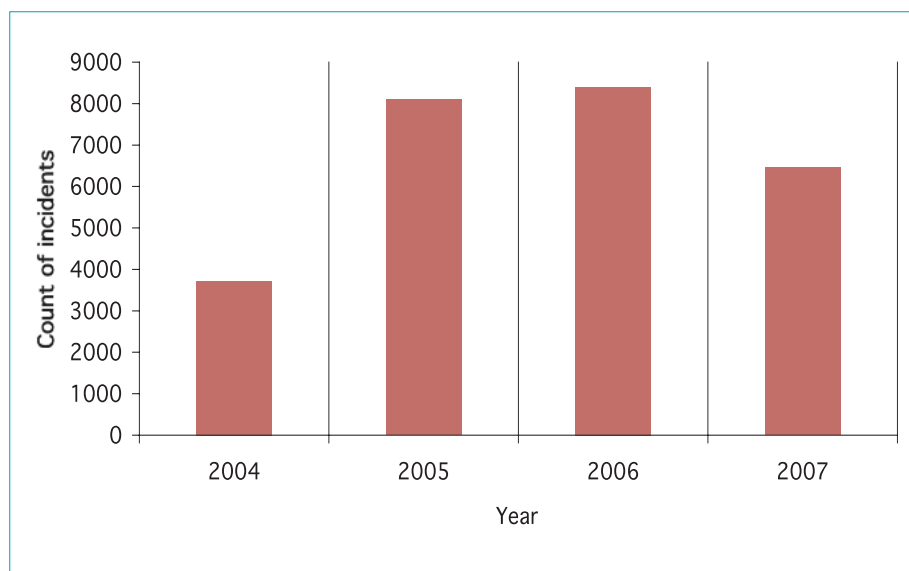


Figure 4: Count of incidents of reported chemical drums, oil or fuel fly-tipping

and tarred products’. The final two figures that complete the 6-figure code are found in a further sub-division. Thus, ‘bituminous mixtures containing coal tar’ are 17 03 01* whereas ‘bituminous mixtures without coal tar, i.e. bituminous mixtures not listed in 170301*’ are listed as 17 03 02. The presence of the “**” denotes the waste as being hazardous which means that it exhibits one or more of the ‘hazards’ expressed in the Hazardous Waste Directive⁴ and transposed into UK domestic legislation as the Hazardous Waste (England and Wales) Regulations 2005 (SI 2005/894). The relevant section of the EWC is shown in figure 1.

The two codes, 17 03 01* and 17 03 02, are an example of a “mirror entry” that is, one is the hazardous mirror of the other non-hazardous entry. Distinguishing between the two requires testing to compare the amount of hazardous substances to a defined threshold. An absolute entry in contrast will always be hazardous and no testing of the waste is necessary. For example, 17 03 03* ‘coal tar and tarred products’ has no mirror entry and so if the waste is coal tar or a tarred product it has the hazardous characteristics to be considered to be hazardous waste.

Fly-tipping: Why the phrase ‘likely to be’ hazardous waste in the introduction?

Fly-tipping is recorded on the Environment Agency’s (EA) *Flycapture*⁶ database. Since April 2004, the database has recorded a count of incidents of fly-tipping reported by local authorities in England and Wales. Local authorities submit their count on a monthly basis to the database by grouping incidents using the broad categories outlined below:

- Animal carcass
- Green waste
- Vehicle parts
- White goods
- Other electrical
- Tyres
- Asbestos
- Clinical
- Construction/demolition/excavation
- Black bags – commercial
- Black bags – household
- Chemical drums, oil or fuel
- Other household waste
- Other commercial waste
- Other (unidentified)

Implications from the Landfill and Hazardous Waste Directives

In addition to the need to differentiate between inert, non-hazardous and hazardous waste streams, the Landfill and Hazardous Waste Directives introduced a number of other controls. Of particular interest are two dates:

- 16th July 2004 - the established final disposal to managed co-disposal landfill ended; and,
- 16th July 2005 - full Waste Acceptance Criteria (WAC) came into force and wastes had to meet specific standards before being acceptable to landfill.

These are *critical* dates because of their implications for hazardous waste disposal practices in the UK. Such fundamental changes may have led to greater unlawful disposal of hazardous wastes, including fly-tipping.

Analysis of Flycapture data

Data were provided following a bespoke request to the Environment Agency. For all categories considered, *Flycapture* only began recording data in April 2004 and so reflects only nine months data collection for 2004. Where graphs below show annual totals, the nine month value for 2004 has been proportionally increased.

Asbestos

By simple text search, eight references to asbestos containing materials are identified in the EWC and all are considered to be hazardous waste (see box 1). Consequently, it is reasonable to assume that incidents of asbestos fly-tipping reflect a hazardous waste stream.

Box 1: EWC codes for asbestos containing materials

Asbestos six-figure EWC codes comprise: 06 07 01* wastes containing asbestos from electrolysis; 06 13 04* wastes from asbestos processing; 10 13 09* wastes from asbestos-cement manufacture containing asbestos; 15 01 11* metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty pressure containers; 16 01 11* brake pads containing asbestos; 16 02 12* discarded equipment containing free asbestos; 17 06 01* insulation materials containing asbestos; 17 06 05* construction materials containing asbestos

Monthly incident data (Figure 3) show an interesting trend with a pattern emerging in the monthly spread broadly repeating in 2005, 2006 and 2007. The evident drop in reported incidents every December for which an explanation is not readily apparent may be related to the seasonal holidays, businesses shutting down, local authority officers being on leave, etc. Looking to the critical dates, July 2004 and July 2005, neither appears to have driven an increase in fly-tipping of asbestos.

Chemical drums, oil or fuel

Figure 4 shows the annual trends of incidence of fly-tipping of Chemical drums, oil or fuel. As with asbestos, there is an increase between 2004 and 2005 with 2004 having 3,716 incidents and 2005 having 8,107 reported. This 118.2% rise will in part be due to the averaging method for creating 12 months from 9 months of data.

Between 2005 and 2006 the count was broadly similar with 8,402 incidents (up 3.6% on 2005). In 2007 there was a drop of 23.1% to 6,462 incidents being reported.

Figure 5 shows a low monthly count of incidents (excepting a peak in August) throughout 2004 then from early 2005 the reported incidents increases, from 337 incidents in January 2005 to 680 in June 2005.

From July 2005 and WAC coming into force there is a peak in August 2005 with increased incidents of fly-tipping being reported for the remainder of the year. Levels are consistently high until August 2007 when there is a considerable drop from 653 incidents in July 2007 to 267 incidents in August. The data do not indicate a reason for this sudden drop.

Clinical incidents

An increase in incidence of clinical waste fly-tipping between 2004 and 2005 of 1,042 incidents (up 49.8%) is shown in Figure 6. This may be explained by the averaging method used to produce 12 months data from the 9 months recorded by the EA. In 2005 there were 3,137 incidents reported – broadly similar to reported incidents in 2006 of 3,052 (down 2.7%) – before another increase to 3,631 incidents (up 18.9%, about one-fifth) in 2007.

Looking at Figure 7, 2004 month-on-month show trends of gradual increases to July followed by decreases until December. This trend then repeats in 2005, 2006 and 2007. There is no ready explanation for the peaks shown in October 2005 and November 2007.

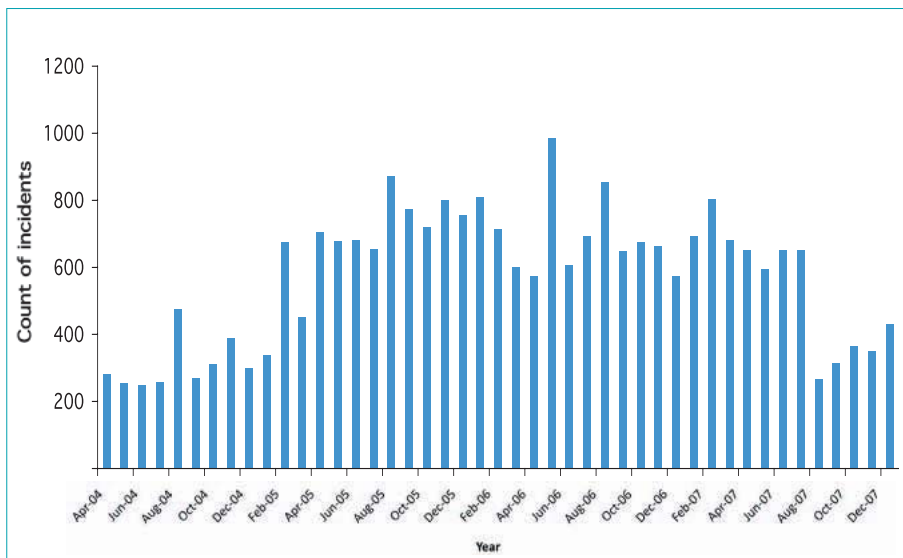


Figure 5: Monthly count of chemical drums, oil or fuel incidents reported

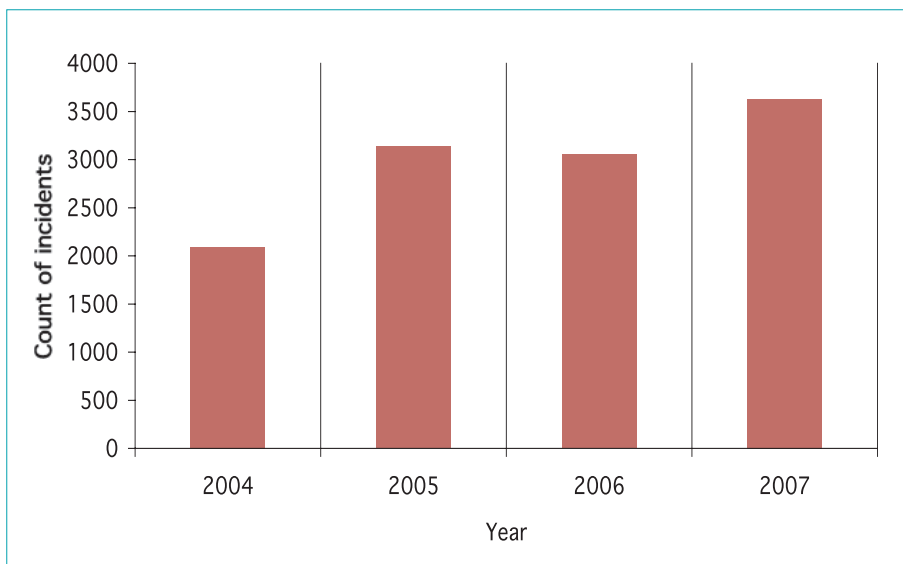


Figure 6: Count of incidents of reported clinical waste fly-tipping

Figure 2 shows the number of annually reported asbestos fly-tipping incidents. There is an increase between 2004 and 2005 of 307 incidents (up 9.9%) and for 2006 there is a small decrease to 3,402 incidents (down 1.7% on 2005) and another fall in 2007 to 3,271 incidents (down 2.2%).

Discussion

The *Flycapture* dataset has a number of limitations outlined below:

- a) **Non-specific waste groupings:** Unlike the relatively specific six-figure EWC codes, *Flycapture* categories are broad generalisations

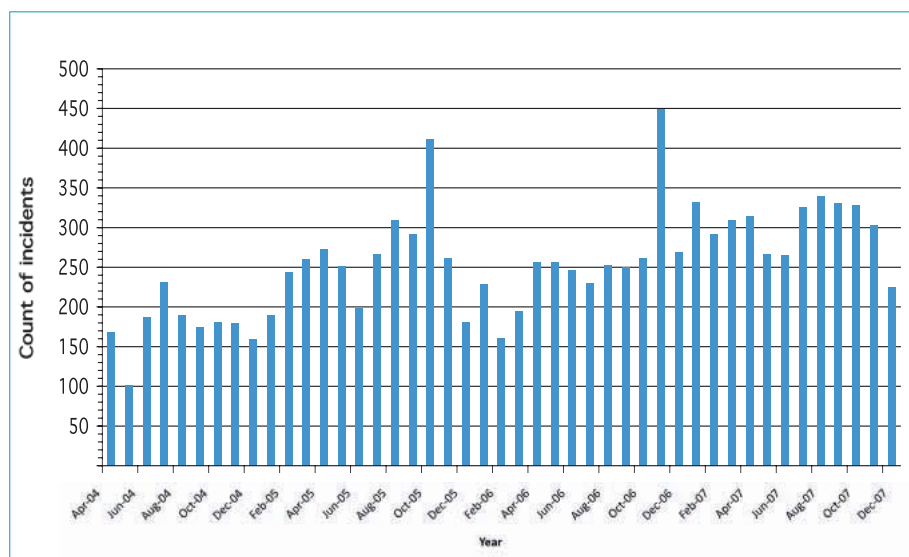


Figure 7: Monthly count of clinical waste incidents reported

Conclusion

There is no evidence from the *Flycapture* database to demonstrate that when the Landfill and Hazardous Waste Directive were applied to domestic practices in the UK, they influenced an increase in hazardous waste fly-tipping. Whilst it is true that some incidents of large scale waste fly-tipping are reported in the media, anecdotally we can consider this in terms of the total hazardous waste production in the UK: even if 1% of the total production per annum of hazardous waste was so disposed, then circa 50,000 tonnes of hazardous waste would have needed to be fly-tipped. This does not appear to be happening. The *Flycapture* database is a useful resource that is relatively new; as more years' data is collected trends in fly-tipping will be able to be examined with more certainty in future analysis.

and do not describe unambiguously a hazardous waste stream per se. It is reasonable to assume that 'asbestos' and 'clinical waste' suggest a hazardous waste stream and to consider that, 'Chemical drums, oil or fuel' may contain wastes which can be considered hazardous.

- b) **Count and not quantity of fly-tipped waste:** The database provides only a count and does not quantify the amount of waste as either a tonnage or volume. As a result it may only indicate overall trends, not the tonnage of hazardous waste lost from proper disposal paths.
- c) **Reliance on third parties for data:** *Flycapture* also relies on local authorities to provide accurate and comprehensive information to the Environment Agency. From the first author's experience of practice as an Environmental Health Officer in a number of local authorities, the data supplied may not reflect as comprehensive picture of fly-tipping as it could and data collection may vary between authorities. Moreover, it is likely that the initial reporting required a period of learning for the local authorities.
- d) **2004 data:** the increase in numbers between 2004 and 2005 may reflect the database's launch, phase-in and initial under reporting to the new database by local authorities. This data is, however, included in this analysis for completeness
- e) **2004 averaging to 12 months:** Having used the 9 months of data to develop a 12 month – full year – figure, reduced reporting as described in c) and d) above may have been exacerbated.

These limitations will have influenced the level of reported fly-tipping but overall trends should still be recognisable. Despite pressure from the Landfill Directive, Hazardous Waste Directive, etc. on the disposal of hazardous wastes there does not appear, from this initial data and notwithstanding the limitations discussed above, that a deluge of hazardous waste has started to be fly-tipped.

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Odours as sensory triggers of chemical incidents

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Introduction

Odours have long been recognised as being a valuable warning of the presence of potentially harmful chemical substances in the environment. The human nose is exceptionally sensitive to certain odorous compounds especially when present in trace amounts. Unpleasant odours, often called malodours, have historically been considered to be warning signs or indicators of impending risk to human health. Malodours can give warnings of microbial growth in food and unsanitary conditions such as faecal contamination of water. Smelling such odours in food and drink should act as a trigger not to eat or drink the potentially unfit or contaminated food/liquids therefore protecting ourselves from harm. The chemical detection of warfare agents in the First World War was rudimentary, however the characteristic smell of certain agents was widely known and therefore often provided the first indication of a chemical attack. Chlorine was recognised by its characteristic pungent odour, phosgene by a smell of new-mown hay and mustard gas by a strong smell of garlic. The presence of odours in the atmosphere can also indicate or warn of a chemical spill, a gas leak or the existence of odour producing activities such as landfills, sewage treatment works and oil refineries. Odorous chemicals can also be used with malicious intent to create disruptions and disturbances, in schools and courtrooms. Given that the first indication of chemicals in the atmosphere is often our detection of a

smell, the reliability of this sense in all situations requires examination. This article considers the basic science behind our sense of smell (olfaction) and suggests how useful this can be in the detection and early management of chemical releases, both accidental and deliberate.

Olfaction

Although significant work has been carried out in relation to understanding human olfaction, the subject area remains complex. Principally two nerves are stimulated during olfaction. The olfactory nerve is concerned with our psychological response to the odour whereas the stimulation of the trigeminal nerve processes the irritancy of the odour i.e. the physiological response. Generally most odorous compounds stimulate both these cranial nerves, leading to an interaction between the psychological and physiological responses¹. When an individual is exposed to an 'odour' which could be composed of a mixture of different odorants, one can consider the two mechanisms taking place simultaneously. Each odorant in the mixture abides by traditional toxicological paradigms where different health outcomes are determined due to the concentration of the chemical and the time (duration and frequency) of exposure². Secondly, the perception of the odour i.e. the psychological response depends on the personal traits of the individual and their emotional state during odour exposure³.

Odour thresholds

For the vast majority of odorous chemicals, sensory effects occur well before the onset of health effects i.e. the odour threshold (OT) (see Box 1) lies below the irritant threshold level therefore the perception of the odour is a real warning sign of a hazard. Despite this it should not be assumed that odour thresholds will always be much lower than toxicological thresholds. Shusterman⁴ suggested three explanatory models to describe the relationship between the odour perception threshold and the irritation threshold which should be borne in mind when assessing the risk from odorous chemicals. These simplified models (the duration of exposure was disregarded) are represented by the following graphs in Figure 1. For a small number of chemicals the irritation threshold (based on the population mean) is lower than the perception mean for that chemical (Figure 1A). Examples of chemicals that possess this type of relationship are methyl isothiocyanate and methyl isocyanate, the chemical that was released at the industrial incident in Bhopal, India. Fortunately this is an atypical situation and for the majority of odorous chemicals odour perception precedes irritation effects (Figure 1B). Examples of chemicals that fall into this category are phosphine (PH₃) and phosgene (COCl₂). In Figure 1C, the irritation threshold is a number of magnitudes higher than the odour threshold which is often thought of as the 'margin of safety'⁴. Examples of chemicals that demonstrate this relationship are hydrogen sulphide (H₂S) and a number of the mercaptans which are typical gases generated from waste water treatment facilities and landfill sites. Ethyl mercaptan has a strong odour and is added to odourless fuel as a warning agent for the early detection of fuel leaks for example.

Box 1: Olfaction

Our sense of smell

Human olfaction (our sense of smell) can be a valuable source of information about chemicals present in the environment. The point at which we perceive an odour is called the odour threshold (OT) or odour perception and the point at which we can describe an odour is called the recognition threshold (RT). OTs are often quoted for odorous chemicals, equating to the concentration at which 50% of the population can perceive the odour e.g. H₂S has an OT of 8 ppm⁶. With increasing concentration of the chemical, there may come a situation where the exposed become annoyed by the odour. This is the 'annoyance threshold' (AT). The AT may possibly be below the RT or could be above it². Another threshold on this odour concentration gradient is the 'health threshold' (HT). This is the point at which the individual begins to elicit some adverse health response such as headache, nausea, itchy eyes, running nose, etc. This threshold is a toxicological limit for this individual to this specific odour perception of the odorants. It is based on the individual's health history, their body mass, and the condition of their immune system. The degree of health effects will lie somewhere on a 'health index' for this individual.

Box 2: Sensory characteristics of odours

Odours possess four interlinked sensory parameters: character, hedonic tone, concentration and intensity, and it is these parameters which are often used to describe odours. This can assist in the identification of the source of the odorant and therefore an assessment of risk, if any, from the chemical concerned can be made. Only character and hedonic tone, can realistically describe odour 'in the field', the other two parameters being measured in laboratory settings.

Character

This parameter is a qualitative characteristic that is articulated in terms of a description of the odour e.g. 'fishy', 'fruity', 'pungent', often from defined lists. Odour descriptions are often used to help in the identification of substances where the source is not directly evident or where there are multiple sources of odour. Odour descriptors are based on the comparison of the 'unknown' odour with a more recognisable one.

Hedonic tone

The hedonic tone of an odour is a subjective judgment made by the person perceiving the odour of the relative pleasantness or unpleasantness of its smell. The determination of this odour characteristic is usually undertaken in a laboratory setting. Positive scores are the more pleasant and negative scores are for unpleasant odours.

Concentration

This parameter defines the amount of an odorous substance in air. Usually the concentration is measured in volume units e.g. parts per million (ppm), parts per billion (ppb) or as mass units e.g. mg/m³ of air for single compounds. For mixtures of odorous compounds the concentration is usually expressed as odour units per cubic metre (OU/m³) or European odour units (OU_E/m³) when the European Standard is employed. Odour units are determined by presenting samples of successively diluted odorous gas to a panel of assessors until 50% of the panel can no longer smell the odour. At this level the gas mixture is equivalent to 1 odour unit (1OU). The concentration of the original gas sample can then be expressed in terms of the number of dilutions or in the equivalent odour units.

Intensity

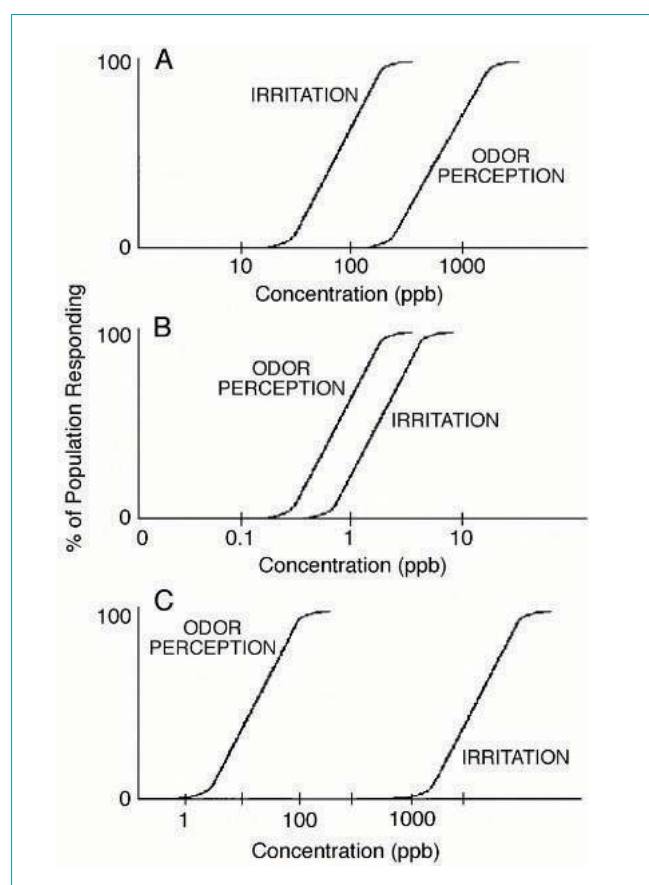
Intensity refers to the strength or magnitude of odour perception and is therefore a subjective measurement. Odour intensity scores are obtained by human assessors in a laboratory. Firstly, the odour concentration is determined, and then a range of suprathreshold dilutions are presented to the odour panelists who indicate their perception of the intensity of each dilution following the scale below.

0 = no odour, 1 = very faint odour, 2 = faint odour, 3 = distinct odour, 4 = strong odour, 5 = very strong odour, 6 = extremely strong odour.

Public health implications

As stated above the subject of olfaction and the human response to odorants is complex. The perception of odour and a description of its smell can however assist in the investigation of odour related incidents. In order to utilise the description of an odour as an indicator of the chemical being investigated, a draft 'Odour Complaints Checklist' has been developed. This checklist contains information on odour descriptions of many common odorous chemicals plus there is information (where it is available) regarding the odour threshold for that chemical. The Odour Checklist is published on the HPA website: <http://www.hpa.org.uk/chemicals/checklists.htm> and was the subject of a previous article in this report⁵.

Figure 1: Cumulative population dose-response curve for olfactory and irritant effects: A = of a potent irritant compound; B = of an intermediate potency irritant compound; C = of a weakly irritant/potent odorant compound (Source: Shusterman, 2001⁴)



Conclusions

Odours are frequently the basis of public complaints and whilst most offensive odours are not always indicators of something that could cause harm to health, the public needs to be aware of odours as a potential risk of harm. Odour is the most likely means of detection of chemicals in the environment and can aid the management of odour related incidents. There is a need for public awareness of the potential significance of unusual smells given the potential hazard from accidental and deliberate release of toxic industrial chemicals.

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Design principles for healthy housing and communities: The perceptions of planners and public health professionals

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Introduction

As disciplines, public health and town planning have common roots. Both grew from concerns to improve the health of the urban poor by making improvements in housing and the built environment of the towns and cities in which they lived^{1,2}. From these common roots and via successive design movements such as the garden cities of Ebenezer Howard³ and Modernism⁴ the disciplines had, by the close of the 20th century, grown apart in structure and in philosophy. Today's Government policies focus on sustainable communities and the new public health agenda makes attempts to bring the disciplines together once again⁵. The links between current public health priorities such as increasing rates of chronic disease and obesity, and the form and nature of the built environment are once again of interest to health and built environment planning policymakers and researchers alike^{6,7}.

In the UK, NHS London has established the Healthy Urban Development Unit to encourage public health participation in the spatial planning process, and some local planning authorities have chosen to develop 'Design Codes' or to use 'Design Review Panels' as tools to support spatial planning⁸. The degree of participation and synthesis of health concepts and determinants within such planning frameworks are unclear. This study seeks to understand how such contributions can promote health, as perceived by professionals working in both spatial planning and public health.

This study was undertaken as a dissertation for the award of MSc Public Health through the Institute of Postgraduate Medicine at Brighton and Sussex Medical School, University of Brighton. With a first degree in architecture and a career in health promotion and public health, the author sought to apply and expand his broad knowledge to the research question:

What rules do planning and public health professionals perceive to be essential if the built environment is to become health promoting?

'Rules' encompassed statutory instruments such as building regulations; voluntary arrangements such as design codes (drawn up by a planning authority or landowner); and other policies or regulations which guide or inform professionals in planning and public health roles.

Methodology

The aim of this study was to discover the perceptions that professionals working in public health or town planning have regarding any principles or rules that would contribute to creating health

promoting environments. Eliciting and exploring the views of this group was critical to the study, suggesting that a qualitative methodology was most appropriate.

Potential participants in the study were sampled from both professional disciplines: built environment and public health, chosen at the outset to bring different discourse into the research field. Built environment disciplines included architecture, town planning and urban design. Public health disciplines included: health promotion; health protection; multi-disciplinary public health, and public health medicine. A further criterion for inclusion was that potential participants were working at strategic or senior level within their discipline. This approach was adopted to ensure participants' professional insight was grounded in a wide range of experience and knowledge. Sampling covered two distinct settings: a county in South East England having a two-tier local government system and a unitary London borough authority. This enabled the examination of differences in organisational arrangements, particularly the interface between local government and NHS Public Health. The arrangement also meant that data would be drawn from a range of spatial settings, including inner-city, suburban and rural. A total of 11 people were interviewed, with roughly equal coverage of professional backgrounds and location.

It was decided early in the study to use interviews as the primary source of data collection, interviews being the most important technique available to the qualitative researcher⁹. The interviews were semi-structured, using a set of formal questions, with the freedom to respond with additional questions or prompts, to elicit more in-depth responses.

Photo elicitation methods, using visual images to promote discussion in qualitative studies¹⁰, were used within the interviews to broaden discussion and involved the researcher showing the participant a series of ten photographs. The photographs featured iconic forms of housing layout chosen to represent distinct design methodologies or theories which were in their time proposed to improve health or safety. Participants were asked to view the images and discuss their perceptions and assumptions about the built environments portrayed and any health-improving design features present. This visual image-based methodology supported the collection of rich data on different design typologies and how these are perceived with regard to health. The use of such 'photo-elicitation' methods¹¹ is becoming increasingly popular amongst qualitative researchers¹². It is important to guard against obvious or implied bias in the selection of images used¹³, and this was minimised by the researcher selecting images primarily from documents already in the public realm. In order to reduce bias, clear inclusion and presentation criteria for their selection were developed.

Transcriptions of the interviews were reviewed and analysed by the researcher for emerging themes and concepts and were coded and categorised accordingly.

Results

The use of the photographic images within the interviews elicited much comment from all participants whatever their background. Taken singly, the comments appear just that – a set of comments unlinked except for their common subject. However, taken together, themes begin to emerge – hinting at definitions of health and wellbeing, and positive or negative associations.

Analysis of the interview transcripts uncovered a total of 500 different categories within the interview transcriptions, which were grouped together into 70 concepts. Coding of these topics led to the emergence of five major themes: health and well-being, human needs, hazards, resources, and design principles.

The healthy built environment was the core phenomenon of interest to the study. Health is a concept that includes both lay beliefs and the canon of scientific knowledge. It is also routinely conceptually fitted to notions of a particular service – the NHS, and is used interchangeably as a positive concept and a metaphor for illness and disease. In order to understand the perceptions of participants, their observations on the meaning of health were collected. This led directly to the first of the study themes – **‘health and well-being’**. This theme categorised the differing components and definitions of health, which were broadly in synergy with the well established World Health Organization¹⁴ definitions.

The second theme of **‘human needs’** was fitted to the wide range of component concepts that participants identified as being contributory to health and well-being and to healthy built environments. These were often presented as divergent concepts, being identified to explain how harmful a place or a feature of that place could be to health and well-being. The needs that were expressed had a great similarity with those that make up the hierarchy of needs model presented by Maslow¹⁵.

The **‘hazards’** theme encapsulated the negative forces that were perceived as acting upon health and the built environment leading to poorer health and design outcomes. They are both environmental and social in dimension, and are bound by belief that their effects on health can, however, be minimised through the design solutions proposed in the design principles. These hazards included air pollution (both indoors and outdoors) and anti-social behaviour such as noise pollution and vandalism.

The **‘resources’** theme set out the concepts that can be utilised to actively support the development and implementation of design principles. Resources include policy, political and organisational factors, along with the particular skills and knowledge necessary to design for health, and the management vectors through which these resources and the built environments that are conceived are maintained.

Figure 1 shows one of the images – of a Victorian bye-law¹⁶ terrace house common to many inner cities. Overwhelmingly this typology evoked positive associations with wellbeing and neighbourliness. Having a front garden and a gate were seen as fostering security within a community where people interacted with their neighbours.



Example comments:

“well, these are happy houses”

“I guess that’s a bit of a benchmark”

“.. quite good in terms of warmth and all the current things about sustainability”

“what a lot of people aspire to”

Figure 1: Victorian bye-law terrace house (image courtesy London Borough of Lewisham)

Figure 2 shows a typical ‘cottage estate’¹⁷ – council houses built between the wars. This image elicited comments which reflected the one-time positivity of such estates and their decline and the current perception of them as problem areas.



Example comments:

“no ball games” – clearly council property, not ordinary housing”

“lots of difficult parking problems”

“unresolved space”

“gradually they have become less supportive of a healthy way of life”

Figure 2: Local Authority ‘cottage estate’ (image courtesy of London Borough of Barnet)

Figure 3 shows a housing development designed to the Radburn principle of segregated pedestrian and vehicle access to homes¹⁸ which was common to the British new towns of the 1960s and 1970s. Comments were in the main, however, directed at the architectural style, and their experimental nature and perceived extraordinariness, and the effect that strikingly different architecture may have on residents.



Example comments:
 “this looks like a university halls of residence or something”
 “interesting, looks a bit extraordinary”
 “reinterpretation of the garden city”
 “Looks like a '70s experiment and people don't like that, don't feel like they want to be experimented on, because that's obviously not a very healthy feeling to be experimented on.”

Figure 3: Radburn-type housing layout (image courtesy of Tim Crocker ©)

Figure 4 pictured a single tower block, situated as some modernists originally intended surrounded by green space¹⁹. This image provoked strong reaction, all perceiving this typology as unsuccessful in terms of promoting the health of residents, primarily because of the perceived lack of social interaction in such blocks.



Example comments:
 “Well, it's awful. It's totally out of concrete. You're living in an eyesore.”
 “A semi-rural tower block. The worst of all worlds.”
 “Tend to be unsuccessful in terms of health and social wellbeing, because they separate people out, there's no neighbourliness.”

Figure 4: Modernist tower block (image courtesy of Neil Adam, from the Teacher Resource Exchange)

Figure 5 showed a recent re-working of Victorian terraced housing whereby the streets and frontages had been re-designed as a home zone²⁰ with the aim of reducing traffic speed to walking pace and encouraging the use of the street for recreation. The potential effect of such re-design on the health of inhabitants was something which was interpreted by most participants during interview.



Example comments:
 “It completely lifts, completely lifts that street, well, it's amazing what material, how material can make you feel better and feel like somebody cares about you.”
 “a Home Zone”
 “an attempt to green what were quite barren streets previously”
 “taking away the sharp focus on a car”

Figure 5: A retro-fitted home zone in urban terraced housing (image courtesy of The Methleys, www.methleys.org.uk)

Figure 6 was an image of recently completed housing built to zero-carbon standards. Whilst some participants perceived strong positive aspects relating to health of such developments, others were left perplexed by the visual appearance and notions of communality.



Example comments:
 “Eco - it says you are thinking about the world, it says you're being communal.”
 “You need to be of a particular state of mind to like communal gardens.”
 “I think the question is: What is this? I think this is the early stage of re-conceptualisation. So we've got these kind of paraphernalias strapped on the front of the house and you really do wonder, in the long run whether that's a sensible way forward.”

Figure 6: Zero-carbon housing development (image courtesy of Design for homes/ Richard Mullane)

A further four images were shown to participants during the interviews and were of garden city housing of the 1920s; a “megastructure” of high density deck-access housing; housing of the

1980s built to Essex Design Guide²¹ principles; and a high density (post 2000)²² brownfield housing development by a volume builder.

Six 'design principles' emerged from the data, based upon the thematic analysis of the interview transcriptions. These are:

- The form, aesthetics and layout of buildings and places and whether their usage is well defined was seen as important.
- The materials used could influence perceptions through their colour and texture, and the maintenance (including weathering) and management were important in preventing anti-social behaviours such as vandalism.
- The density of development was seen as affecting the human scale and noise disturbance and privacy were both seen as being related to density.
- The issue of a building threshold was seen as crucial in encouraging social interaction and in demarking private and public areas.
- Having access or views of greenery and open space was important to mental health and wellbeing and also to encourage play and exercise for children. Poor maintenance was seen as a threat to the benefits of open space.
- Issues around environmental sustainability were seen as important aspects for health promotion environments, whereby active travel was promoted and short car trips deterred through creating walkable spaces and streets.

Discussion

Having identified the major themes emerging from the study, comparison with the literature enabled the exploration of the links between the themes and context of the core phenomena of the healthy built environment.

The six 'design principles' which emerged from the data are set in the context of basic human needs and are affected by the external forces that act on the design of healthy environments, which can be both environmental and social in dimension. These vary in that some can be minimised by design, e.g. fewer openings in walls on noisy thoroughfares, whilst others remain as active threats, e.g. anti-social behaviour. The context also includes activities which actively support the development and implementation of design principles. These include policy, political and organisational factors, along with the particular skills and knowledge necessary to design for health, and the management vectors through which these resources and the conceived built environments are maintained.

One limitation of the study is that the voices of the public and the residents of the places depicted in the photographs used are missing. Such personal reflection on places and the perceived effects on the person are very powerful, and narratives such as Hanley's autobiographical account of estate living²³ add much detail and texture to the study of health and the built environment. This study used photographs of housing types to elicit in-depth responses during interviews. These images included social, council and private housing, and many respondents expressed their perceptions of the different tenures of the housing types. However issues relating to tenure and housing market conditions were not within the remit of the study, although the impact of the economic and socio-economic factors on health was reflected within the data.

Perception is the means of making sense of the world from sensory information – and in terms of the built environment, this comes from all senses, not just the visual. Broadbent has talked of the "well building"²⁴, which conceptually might not be far away from the "healthy built environment" of this study. This "well building" has but one commodity – delight, and this sense of delight will be different for each person in turn as experienced by their sensory perceptions. The perceptions that the participants have brought to this study include those from a lifetime of experience of using and being within built environments, tempered for most with a degree of knowledge on how buildings can affect health, and in some cases, the benefits of a professional discourse from which to draw conclusions. The study methodology introduced photo elicitation as a tool to enhance interview discussions and relies upon one sense only – the visual. Participants in this study made powerful deductions based upon their visual perceptions of the photographs presented. These may be vastly different to those of the people who live and use these places, and this is a shortcoming of the methodology used.

Conclusion

There has been a rapid growth in evidence supporting hypotheses demonstrating the effects the built environment has on both physical and mental health. There is little qualitative research reported, and the perceptions of professional groups within the health and built environment disciplines were rarely heard. This study in particular found that participants working as senior professionals from both planning and public health disciplines were in broad agreement on the principles necessary for a healthy built environment shaped by the context and external conditions..

Many planning authorities are now investigating or implementing design guides, and will be subject to the mandatory code for sustainable homes. If best practice were better disseminated among those who draw up localised design guides, the chances of regional disparity in health inequalities from design would be lowered. Health as a holistic concept is largely absent from such guides, although in a world of competing priorities, a pragmatic approach to design policies may be necessary, whereby guidance is simplified rather than additional health design principles being added into the policy context. Extracting the health promoting principles in existing guidance across the policy spectrum, and making these explicit, may compensate for the need for specific health guidance.

Dialogue between public health and planning disciplines appears to be strengthening, and the recognition of each others' strengths in the potential to promote health through built environment interventions is improving. The findings and dissemination of this study could add to this.

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Marine spill modelling

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Introduction

Modelling of the dispersion of chemicals is a tool of paramount importance in the response to chemical releases and in describing the impact of chemical emissions to the environment.

Modelling of chemical releases during incidents allows those responding to predict the behaviour of unconfined chemicals in the environment, thus aiding in the selection of appropriate public health interventions. Modelling results may also be used during action planning in the event of an incident. Examples of the use of such modelling include the use of CHEMETs to indicate the direction of airborne chemicals such as the plume from an industrial fire, or the use of emissions modelling in the environmental permitting process to predict the potential effect of the emissions on the local environment.

There are a number of modelling systems available for use as tools in the event of a chemical release to the air, including CHEMET, ALOHA and NAME. However the public health applications of modelling of chemical releases, other than oil, to the seas are less well described. Marine incidents involving chemicals may be more complex than oil pollution incidents. There are a vast number of chemicals that could potentially be encountered in a marine hazardous or noxious substance (HNS) incident, and each chemical may behave in a different way once released.

The Maritime and Coastguard Agency (MCA) is usually the first agency to respond to a maritime HNS incident. The MCA will make an initial assessment of both the potential and actual pollution risk, and the potential impacts on public health. Where a potential risk to human health is identified, the MCA will contact Chemical Hazards and Poisons Division (CHaPD) of the Health Protection Agency (HPA) for advice and support¹.

Marine transport of hazardous substances

The maritime transport of hazardous substances has long been controlled by international agreements. These include the International Convention for the Safety of Life at Sea (SOLAS)² and the MARPOL Convention covering prevention of pollution of the marine environment by ships from operational or accidental causes³.

These conventions require those seeking to transport chemicals in tankers or on container ships to abide by the International Maritime Dangerous Goods (IMDG) Code or the International Bulk Chemical Code (IBC Code), which provide international standards for the safe transport of dangerous chemicals by sea. However no amount of regulation or requirements in tank construction can entirely remove the risk of accidental releases of transported chemicals into the

marine environment. In response to this residual risk a number of measures are taken, including maintaining the capability to model the behaviour of chemicals released into the sea. In the UK, such modelling for the MCA is carried out by chemical specialists using the ChemSIS model⁴ at the National Chemical Emergency Centre (NCEC) based at Harwell Oxfordshire^{5,6}.

Modelling inputs

In order to successfully model a marine spill a number of inputs of information are required (Figure 1).

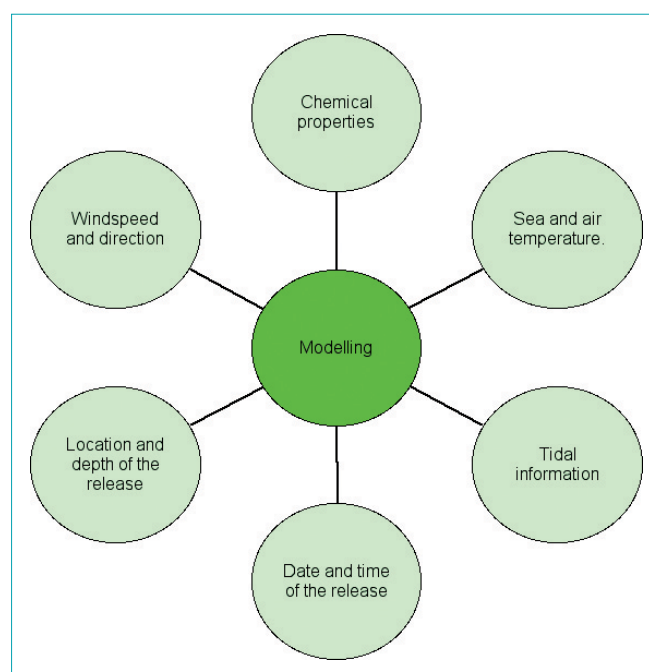


Figure 1: Information required to model marine spillages.

As with response to other chemical incidents, marine spill modelling requires knowledge of the physico-chemical properties of the chemicals involved. The specific aspect to be considered in marine modelling is the interactions between the released material and salt water. This can be generally established by assessment of a material's relative density, vapour pressure and solubility in seawater. The chemicals may then be discussed as categories with reference to their behaviour, as shown in Table 1.

The inputted data on the material's relative density, vapour pressure and solubility allow the software to project how the chemical will partition in the marine environment over time. This information allows the model to predict the effects of parameters on the spill, such as the effect of the wind and tide on spill direction and the concentrations of the chemical at different depths of water. The classification criteria agreed under the Bonn agreement⁷ are illustrated in Figure 2.

Table 1: Chemical categories for behaviour in marine environments. Source: Bonn Agreement⁷.

Group	Sub-group	Example of chemicals	Potential hazard
Evaporate	Evaporates immediately	propane, butane, vinyl chloride	Toxic / flammable gas cloud
	Evaporates immediately, dissolves	ammonia	
Float	Floats, evaporates	heptane, turpentine, toluene, xylene	Toxic / flammable gas cloud or slick
	Floats, evaporates, dissolves	butyl acetate, isobutanol, ethyl acrylate	
	Floats	phthalates, vegetable oils, animal oils, dipentene, isodecanol	Toxic / flammable slick
	Floats, dissolves	butanol, butyl acrylate	
Dissolve	Dissolves rapidly, evaporates	acetone, monoethylamine, propylene oxide	Toxic 'cloud' in water
	Dissolves rapidly	some acids and bases, some alcohols, glycols, some amines, methyl ethyl ketone	
Sink	Sinks, dissolves	dichloromethane, 1,2-dichloroethane	Persistent toxic effects on seafloor
	Sinks	butyl benzyl phthalate, chlorobenzene, creosote, coal tar, tetraethyl lead	

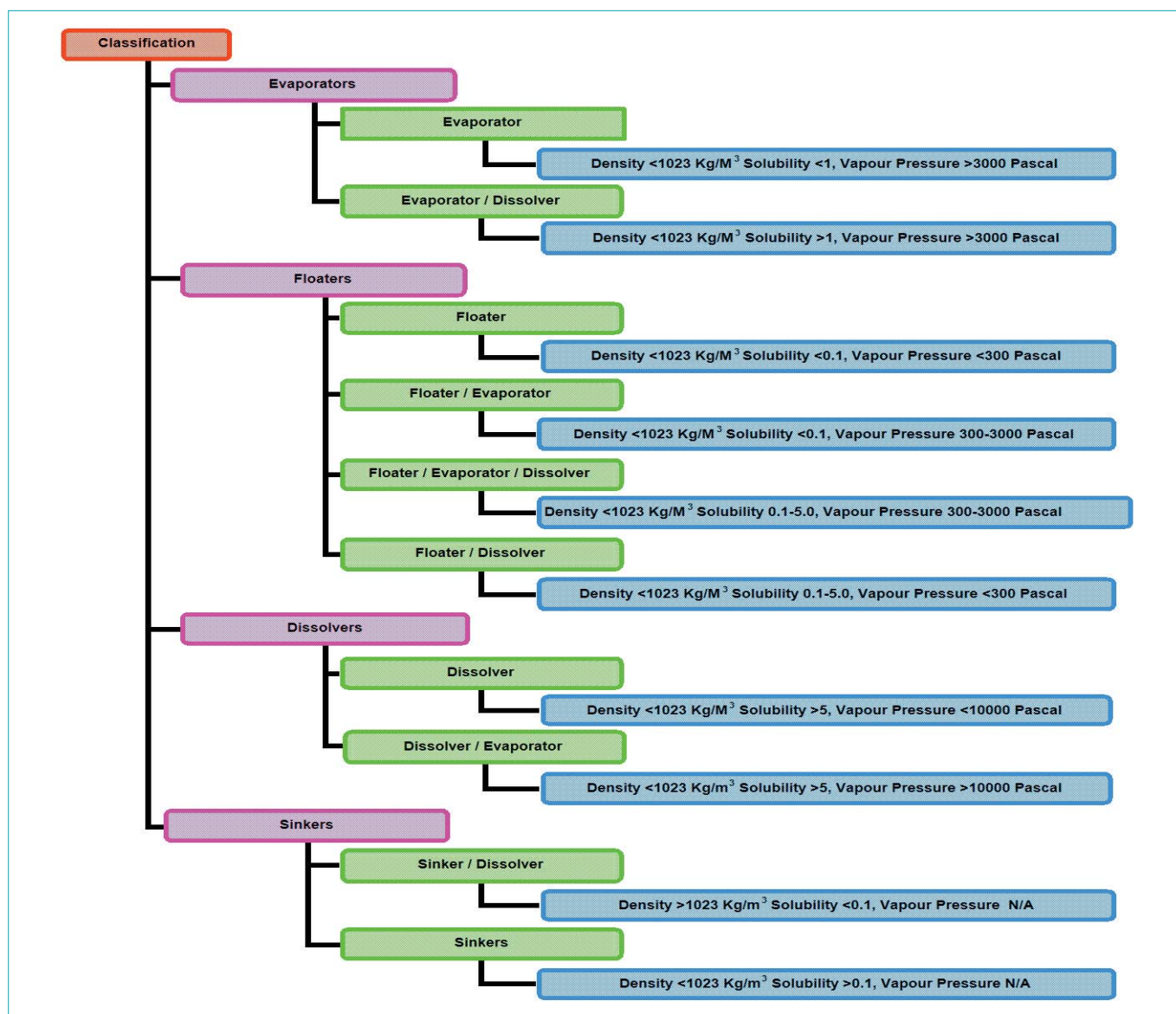


Figure 2: Classification for chemicals according to behaviour in the marine environment. Source: Bonn Agreement⁷.

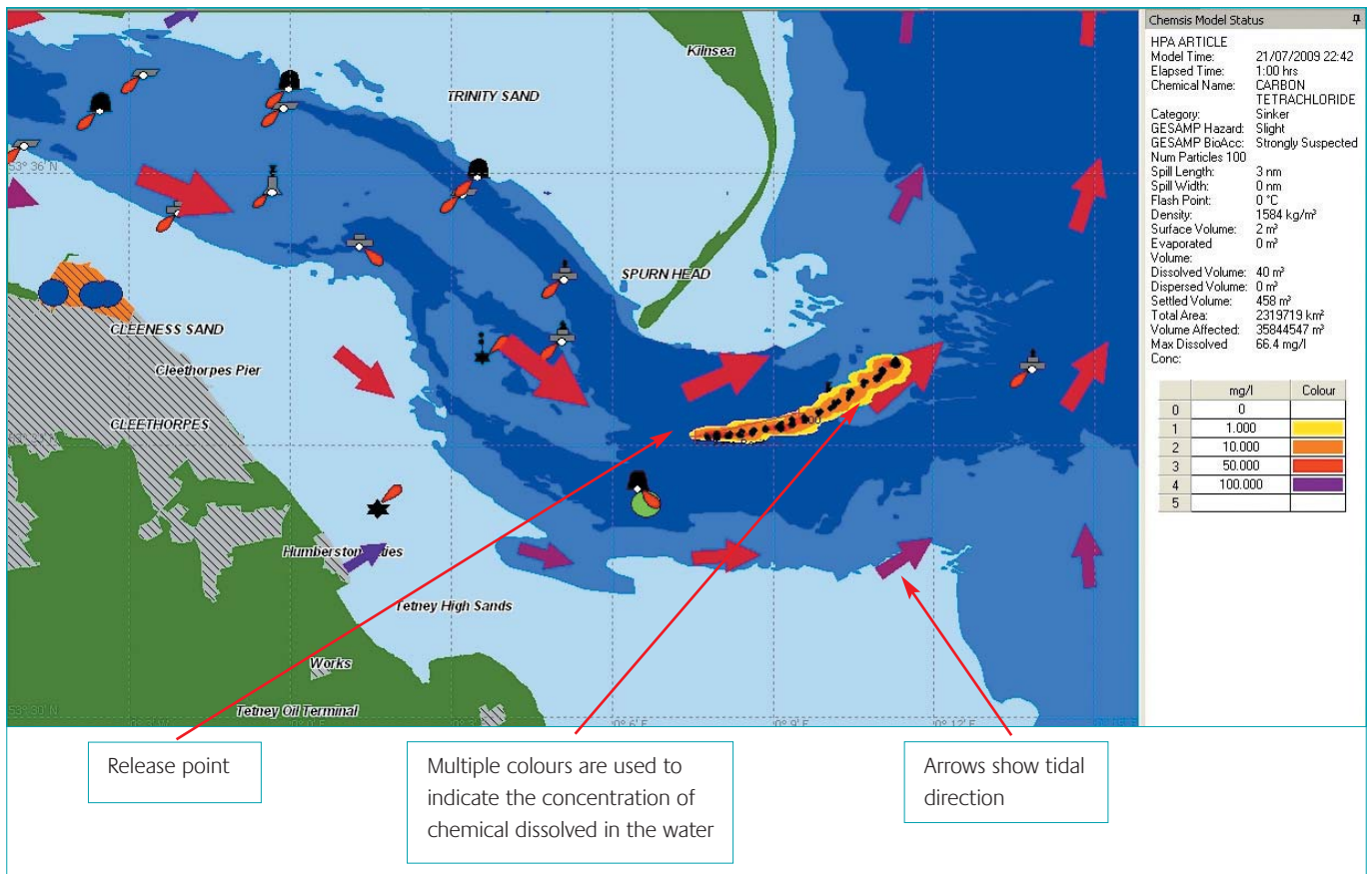


Figure 3: Output showing projections one hour after release.

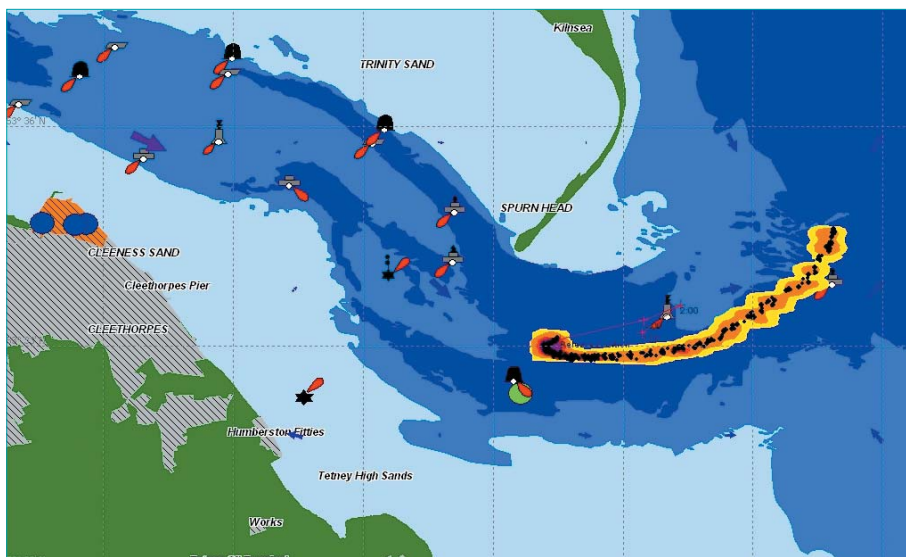


Figure 4: Output showing projections three hours after release.

As one would expect, the time of the release is required for the model to allow for changes in tidal direction. The model additionally requires an indication of the volume of chemicals that have been released and the rate of their release over time. Other information required to determine the behaviour of the release include the temperature of the seawater, wind speed/direction and if the chemical was released on the water’s surface or at depth.

The chemical properties data are combined in the mathematical model with the circumstances of the release and environmental conditions to produce a number of projections of the behaviour of the spill over time.

The ChemSIS modelling package is based on a geographical information system (GIS) and the output from the model projects the released chemical’s trajectory onto a multiple layered marine chart. The input of the location of the release, the tidal information embedded into the software and the imputed wind conditions allow the model to predict the trajectory of the spilled chemical over time. This gives indications to the user as to if and when a spill is likely to make landfall, and/or if it will be directed to fishing areas. The model includes bathymetry information on the depth of water surrounding the coastline.

Modelling outputs

The outputs from the modelling are displayed in two formats. Figures 3-5 show an example of the mapping output for a fictional release of 500m³ of carbon tetrachloride over five hours at the mouth of the Humber estuary, amounting to a total surface release of 2500m³.

Figures 3-5 show a map of the Humber estuary. The chemical was released south of Spurn Head in the mouth of the Humber; the point is indicated in Figure 3. These images are a projection of the predicted chemical dispersion and concentrations of the chemical in the water at one hour intervals for the five hours after the release. The

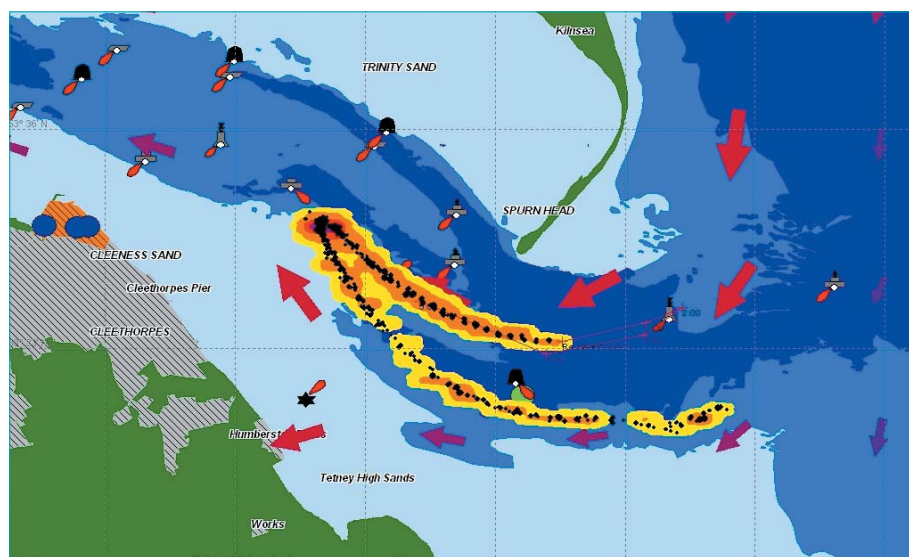


Figure 5: Output showing projections five hours after release

concentrations shown are those projected for the water at a depth of 10-20m.

The arrows visible on the screenshots indicate the tidal forces in that area of the chart at the time of the screenshot. The display shows that after one hour the chemical is being swept out of the estuary into the North Sea away from land based receptors. However due to the changing tides over time this chemical is swept back into the estuary toward potential receptors, such as members of the public using the amenities at Cleethorpes. The black dots in the display are an illustration of the position of the particles and describe the location of the chemical in the model. The multicoloured (yellow, orange, red and purple) areas provide an illustration of the modelled concentration of the chemical in the water in that area.

The dialogue box on the right of the display provides useful information about the modelled spill and the chemical involved. In this case it allows the reader to note that the GESAMP UN advisory body consider the chemical to be a 'slight' toxicity hazard and that the chemical is strongly suspected of being bioaccumulative in marine life⁸. It also provides details of the maximum dissolved concentration of the material in the water and a scale describing the concentrations of the chemical in the water column. The results may be viewed for varied depths of water to show the change in concentrations at differing depths. Obviously the concentrations may vary at depths depending on the released chemical's properties. Secondly the GIS allows layers to be added to the mapping to include sites of scientific interest, areas used for shellfish cultivation and varied other marine information.

Figure 6 shows the second output from the model. This second output illustrates the fate of the released chemical in the water over time. It compartmentalises the released chemical into five states.

- Dispersed – The volume of the chemical that has formed small undissolved droplets in the water column.
- Surface – The volume of the chemical that is present as a slick on the water's surface.
- Evaporated – The volume of the chemical that has evaporated from the marine environment to become gaseous.

- Dissolved – The volume of the chemical that has dissolved into solution.
- Settled – The volume of the chemical that is undissolved and sunk to a depth of more than 5m.

The different coloured lines on the graph indicate the volume of the chemical in the compartments over time after its release. In this example the total volume is 2500 m³ of carbon tetrachloride. The previous output from the model identified the chemical as a 'sinker', suggesting that the chemical was likely to enter the settled category initially.

Figure 6 shows that the 2500 m³ release occurred over five hours from midnight until 5am. The chemical behaviour can then be

interpreted from the proportion in the listed compartments. The model suggests that the chemical would initially sink to the bottom of the estuary, as it is sparingly soluble and has a higher density than sea water. Once on the seafloor the chemical will slowly dissolve into solution. Eight hours after the incident, the model predicts that most of the chemical that has settled at the bottom of the sea would have dissolved into the seawater. For many chemicals, including many dense acids, this would be the marine 'fate' of the chemical. However dissolving into solution is not the end fate of carbon tetrachloride. The chemical is expected to evaporate from solution. The graph shows that the total amount of the chemical that has evaporated into the air increases over time. Twenty four hours after the release, the chemical is modelled to have almost fully evaporated from solution as the evaporated volume is near 2500 m³.

Public health uses

The results of the modelling have many potential applications. The evaluation of the interaction of the chemicals and the water allow for a timely assessment of the potential pathways of the released chemicals to human receptors. This knowledge will indicate, for example, if materials would evaporate from the sea to form gas clouds or would remain dissolved. This will have an obvious effect on potential exposure routes and hence the public health risk assessment. This combined with the geographical information on the trajectory presented by the model provides useful information in establishing if a source-pathway-receptor-linkage has the potential to be formed. For example, if the model suggests that a spillage is likely to form a slick that threatens public bathing areas, this output would allow for proportional public health responses to be taken. For events that are modelled to be unlikely to affect human receptors, the model may be used to ensure that the public are not disrupted unnecessarily. In addition to the information on possible acute direct exposures, the model also provides information that may be of use to establish if areas used for seafood would be contaminated by chemical releases.

Further to the information supplied by the model for use in producing exposure risk assessments, the outputs from the model may be used as a tool in directing the appropriate response to a release. For example if a chemical release is modelled to form a persistent slick on the water's surface, the information suggests

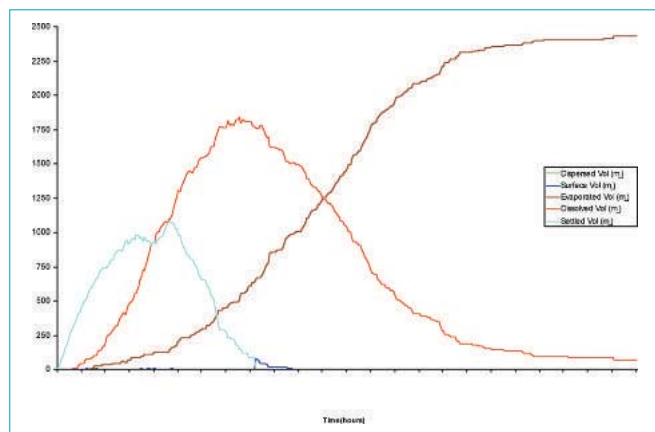


Figure 6: Modelled fate of released chemical in the water over time.

that the use of booms may be appropriate generally in geographically targeted areas. A second example could be the sinking of a tanker carrying phosphoric acid in deep water. If the model suggested that the released chemical was not persistent, dense and quickly dissolving, the informed decision may be to allow the slow release of the chemical rather than mounting an intervention such as an attempt to recover any remaining chemical from the ship's tanks, which could potentially endanger human life.

Acknowledgements

I would like to thank Fabian Daniel and Dan Haggarty of NCEC for their assistance in the production of this report.

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Natural Hazards and Climate Change

Global Launch of the International Day for Disaster Reduction: Hospitals Safe from Disasters

(14 October, 2009, Royal Marsden Hospital, London, UK)



International Day for Disaster Reduction

Hospitals Safe from Disasters

14 October 2009 - London

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Introduction

The International Day for Disaster Reduction (IDDR) was held on 14 October 2009 - a United Nations International Strategy for Disaster Reduction (UNISDR) and World Health Organization (WHO) initiative, supported by the World Bank, which the Health Protection Agency (HPA) had the great honour of hosting. This was the first time this event has been held outside Geneva or New York. It was the culmination of the 2008-2009 World Disaster Reduction Campaign: Hospitals safe from disasters¹ (the Second Session of which was reported in the previous issue of the Chemical Hazards and Poisons Report²). The day marked the Global Launch of IDDR.

The prestigious invitation to host the Launch came from Margareta Wahlström, UN Special Representative of the Secretary-General for Disaster Risk Reduction, and Dr Eric Laroche, Assistant Director-General Health Action in Crises, WHO. They stated that WHO and UNISDR are grateful for the UK government's commitment to fostering an all-hazards approach, both nationally and globally, particularly in light of the risks associated with climate change and, more recently, the influenza H1N1 pandemic in 2009.

The Launch shared many global disaster risk reduction issues. These were raised by the speakers reviewing the World and European strategies with individual country activities providing more specific examples. Increasing the awareness of hospital safety was a common theme, which is why the HPA asked the Royal Marsden Hospital NHS Foundation Trust to host the meeting with the help of NHS London. The day was recorded and a pod cast was shared live with colleagues around the world via the WHO and UNISDR web sites. The pod cast can be viewed in full on the HPA website.³

Summary of presentations

Dr Fiona Godlee, Editor in Chief, British Medical Journal (BMJ), moderated the day, facilitating the discussion that followed the sections and introducing the speakers while providing invaluable coverage in the BMJ.^{4,5}

Dr David Heymann, Chairman of the HPA, opened the day by placing it in the global context of climate change, the increasing number of disasters that are going to have to be faced and the urgent need for health service protection.

Sir John Holmes, UN Under-Secretary General for Humanitarian Affairs and Chair of the International Strategy for Disaster Reduction was due to attend, but because of the earthquakes in Indonesia (Box 1) was unable to come. However, Sir John's speech was delivered by the UNISDR Deputy Director Helena Molin Valdes. Disaster risk reduction is vital for protecting the health of populations, but needs to be done with hospital and health system safety in order to reduce the impact of disasters world wide. The joint UNISDR/WHO two year campaign on hospitals has done much to bring the disaster risk reduction community and the health sector closer together and to begin to work collaboratively.⁶ Through this two year endeavour, the importance of hospitals to be prepared for disasters has really come to the fore, as has the need for disaster risk reduction and emergency preparedness planners to include hospital safety as a central part to their work.

The packed audience was then made aware of the very real difficulty of keeping hospitals safe even in the UK, as Dr Craig Carr told the story and showed dramatic pictures of the fire at the Royal Marsden that occurred on 2nd January 2008. Andy Wapling, Head of Emergency Preparedness, NHS London, launched the Review of five London hospital fires and their management January 2008 – February 2009. This included the fire at the Marsden and four others in London.⁷ These London fires illustrated two events where whole hospital evacuation was necessary, but also provided a summary of the issues essential for all hospital emergency planners to be aware of in order to prepare their own hospital plans in case of fire. The Department of Health has included this in their 2009 interim strategic national guidance.⁸ In addition, a review of the issues of evacuation and sheltering of hospitals in emergencies, commissioned by WHO, was also published at the time of the launch, showing that hospitals are vulnerable to both natural and man-made disasters and that hospital evacuations do occur globally.⁹

Dr Mihai Pisla, Chief of Disaster Medicine Centre, Republic of Moldova presented their Safe hospital programme: Moldova experience. He

showed how the Republic of Moldova has taken the Pan American Health Organization (PAHO) generated Hospital Safety Index¹⁰ and successfully applied it. Dr Gerald Rockenschaub, Regional Advisor, WHO Regional Office for Europe (WHO-Euro) emphasised the holistic all-hazards approach towards disaster. He reminded us that coordination and a multi-sector approach is needed, as disasters do not 'respect borders'. This was reinforced by Dr Darren Walters from the World Association for Disaster and Emergency Medicine.

The second half focused more widely on disasters and health.

- Dr Per Kulling, Seconded National Expert, Health Threats Unit, Health and Consumers Directorate General (SANCO) at the European Commission, presented a review of the EU disaster risk reduction activities focusing on health.
- Dr Eric Laroche, Assistant Director-General Health Action in Crises, WHO, launched the Thematic Platform on Disaster Risk Reduction for Health¹¹. This innovative and prescient document draws together the best guidance and practices from the world's experts on disaster risk reduction and healthcare protection, emphasising more firmly the need to bring together disaster risk reduction with response and recovery efforts.
- Justin McCracken, Chief Executive of the HPA, illustrated how the work of the HPA facilitates the collection of evidence, the drawing up of guidelines and the sharing of knowledge in order to support the emergency preparedness of the UK and to communicate with international partners about best practice.
- Dr Penny Bevan, Director of Emergency Response, Department of Health, summarised the wide range of work being lead by the UK DH in this area.

Outcomes of the International Day for Disaster Reduction

This momentum will not be lost. The UNISDR Science and Technical Committee also released its first publication, Reducing Disaster Risk through Science, which underlined the necessity of a critical evidence base to substantiate action.¹² The day reaffirmed one of the Global Platform targets set by UNISDR in June, that there should be global structural evaluation of all schools and hospitals by 2011, and further, that action plans should be developed and implemented for safer hospitals and schools by 2015.¹³ WHO dedicated its 2009 World Health Day to the similar theme of saving lives by making hospitals safe in emergencies, and held a Global Safe Hospitals Programme Development Workshop in the Philippines in December 2009.

The launch was an accolade for the HPA, raising its profile and voice both nationally and internationally, leading to closer collaboration with the WHO, UNISDR and WHO-Euro in areas such as capacity building for emergency management, emergency medical services and crises related to public health activities, and ingraining the need for the UK to act upon the evidence and, where possible, to lead by example.

Box 1: Press release from WHO 14 October 2009 (Paul Garwood)

Earthquakes, cyclones and tsunamis that struck the Asia and Pacific regions [during September and October 2009] destroyed or damaged over 300 health facilities, leaving hundreds of thousands of people without adequate health care in the immediate wake of the tragedies.

On 30 September, an earthquake measuring 7.6 on the Richter scale hit off the Indonesian island of Sumatra. Among the casualties was one of the two buildings at the main hospital in the city of Padang, which collapsed, cutting off vital health services at the worst possible time.¹⁴



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Overview of sources of information on health and social effects of flooding

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Background

Recent floods in the United Kingdom in summer 2007 raised awareness of the potential health impact of flooding on the population^{1,3}.

The Pitt Report², published in 2008 on the summer 2007 flooding, identified four recommendations which highlighted the need for good evidence on the impact of flooding on the health and wellbeing of people (Box 1).

Box 1: Health and wellbeing recommendations from Pitt Review²

- The Department of Health and relevant bodies should develop a single set of flood-related health advice for householders and businesses which should be used by all organisations nationally and locally and made available through a wide range of sources.
- Local response and recovery coordinating groups should ensure that health and wellbeing support is readily available to those affected by flooding based on the advice developed by the Department of Health.
- The Government, the Association of British Insurers and other relevant organisations should work together to explore any technological or process improvements that can be made to speed up the drying out and stabilising process of building recovery after a flood.
- The monitoring of the impact of flooding on the health and wellbeing of people, and actions to mitigate and manage the effects, should form a systematic part of the work of Recovery Coordinating Groups.

Routine health data are already used by the Health Protection Agency (HPA) and other health care organisations to provide information on health effects of flooding, but this may incompletely reflect the morbidity burden created.

There is a dearth of information on the long term impacts of flooding. Since 2008 the Environment Agency (EA), HPA and London School of Hygiene and Tropical Medicine (LSHTM) have collaborated on a project with the overall aim to determine the degree to which floods in the UK have impacts on health beyond those of the injuries and deaths that occur during or immediately after the period of flooding.

A need was identified by the project co-ordinators to investigate a broader range of information sources to determine the completeness of data on morbidity following flooding (e.g. hospital emergency departments, voluntary agencies, prescribing data and loss adjusters). This piece of work aimed to identify and define information sources, alternative to routinely available data, to measure morbidity from flooding in England and Wales.

Methods

Agencies to approach were identified from discussions with representatives of the HPA, EA and LSHTM project collaborators. Those approached included voluntary agencies (e.g. Samaritans), NHS agencies (e.g. emergency departments), local authorities and national public bodies (e.g. Flood Hazard Research Centre). Where local agencies rather than national bodies were contacted, then offices in areas affected by floods in 2007⁴ were prioritised. In addition, Health Protection Units (HPUs) and Strategic Health Authorities of flood affected areas were contacted, both to inform them of the piece of work and invite any further contact suggestions. Organisations and agencies were initially contacted by letter, followed by email and telephone calls.

A combination of semi-structured interview and structured questionnaires was used to explore the information sources available at each agency. The agencies to be contacted formed a multidisciplinary group from a broad range of professional backgrounds and this was vital to the success of the project. Although questions about health and data were immediately familiar to some agencies, others required more exploration and open questions about any data that they may store. Therefore, the approach with each agency was unique and allowed the flexibility to explore different topics as appropriate.

Data collection on any of the following areas was investigated: hazards and exposures, physical health, and mental and social health. The "hazards and exposures" section covered the factors that were not specific health outcomes, but were factors on the pathway to poor health outcomes (e.g. crime, loss of home, loss of livelihood etc). Data were classified by temporal relationship to flooding, according to the World Health Organization's categories⁵ (see Box 2).

Box 2: WHO criteria for classifying health effects by temporal relationship to flooding⁵

- *Immediate outcomes*
- during or immediately after the flooding
- *Short term outcomes*
- in the days or early weeks following the flooding
- *Long term outcomes*
- may appear after and/or last for months or years

Results

During the two month study period in July and August 2008, 42 organisations and agencies were invited to participate, culminating in 35 semi-structured scoping interviews. This resulted in 26 structured interviews being undertaken about different sources of information.

A summary of sources of alternative information on the health effects of flooding was collated (Table 1). A large proportion of the information was in the form of reactive pieces of work done at local level (e.g. by local authorities) in response to the 2007 summer floods. This included house to house surveys, recording applications

Table 1: Summary of organisations that collect data for each type of exposure and health outcome

	Hazards/exposures	Physical Health Factors	Mental Health Factors
Immediate Outcomes	e.g. cold, floodwater, loss of possessions <ul style="list-style-type: none"> • Citizens Advice Bureau • Environment Agency • Hull City Council • Malvern Hills District Council • Merton Council • National Flood Forum • Oxfordshire County Council • Red Cross • Rural Stress Helpline • Sheffield City Council • South Yorkshire Community Foundation • Tewkesbury Borough Council 	e.g. drowning, injury, electrocution, hypothermia <ul style="list-style-type: none"> • Gloucester Royal Hospital A&E • Hull City Council • National Flood Forum • Red Cross • Rural Stress Helpline • Sheffield City Council • South Yorkshire Community Foundation 	e.g. fear, bereavement, helplessness <ul style="list-style-type: none"> • National Flood Forum • Red Cross • Rural Stress Helpline • Sheffield City Council
Short Term Outcomes	e.g. loss of home, crime <ul style="list-style-type: none"> • Citizens Advice Bureau • Environment Agency • Flood Hazard Research Centre • Gloucester City Council • Gloucestershire County Council • Malvern Hills District Council • Merton Council • National Flood Forum • Oxfordshire PCT • Red Cross • Rural Stress Helpline • South Shropshire District council • Sheffield City Council • South Yorkshire Community Foundation • Tewkesbury Borough Council • Warwickshire County Council 	e.g. injury, carbon monoxide poisoning <ul style="list-style-type: none"> • Flood Hazard Research Centre • National Flood Forum • Malvern Hills District Council • Red Cross • Rural Stress Helpline • Sheffield City Council • South Yorkshire Community Foundation 	e.g. anger, distrust, panic attacks <ul style="list-style-type: none"> • Flood Hazard Research Centre • National Flood Forum • Red Cross • Rural Stress Helpline • Sheffield City Council
Long Term Outcomes	e.g. disrupted services, loss of livelihood, lack of insurance <ul style="list-style-type: none"> • Citizens' Advice Bureau • Flood Hazard Research Centre • Gloucestershire County Council • Herefordshire County Council • National Flood Forum • National Flood Forum • Oxfordshire PCT • Rural Stress Helpline • Sheffield City Council • South Yorkshire Community Foundation 	e.g. exacerbation of chronic conditions <ul style="list-style-type: none"> • Cardiff University (HPA survey) • Flood Hazard Research Centre • National Flood Forum • South Yorkshire Community Foundation • Rural Stress Helpline 	e.g. depression, post traumatic stress disorder <ul style="list-style-type: none"> • Cardiff University (HPA survey) • Flood Hazard Research Centre • National Flood Forum • Rural Stress Helpline • University of Worcester

Table 2: Example of information obtained from an organisation using a structured interview

CITIZENS ADVICE BUREAU	
Overview: A central database is fed by selected computerised reports from local offices. The extent of data in a report and investigating questions is specific to each case. The central database holds reports covering a range of problems and can be searched using key words such as 'Flood', using the Bureau Evidence Retrieval Tool. Flooding data were shared with the insurance industry (Financial Inclusion Task Force) and were also used for the Pitt Report.	
Data collection	
Data type?	Housing; economic; employment; social support
Method of collection? e.g. survey	Letters/calls from clients
Nature of data storage?	Computerised database
Use of well-established data collection tools?	No
Use of well-established classification systems?	No
Time-scale	
Immediate/short-term/long-term?	Immediate, short- and long-term
One off/ ongoing report?	Ongoing
Planned for future?	Yes
Dates of data collection?	July 2007 onwards
Place	
Total area from which data collected?	National
Smallest level down to which data is available?	Individuals
Measure of exposure to flooding?	No
Sociodemographics	Gender; age; ethnicity; marital status; income bracket; employment status; tenure
Measures of vulnerability	Disability; chronic illness
Strengths of data	Information is available down to an individual level, including knock on effects of flooding. Case selection for the central database is done by local bureaux meaning data are representative of the local area.
Weaknesses of data	The central database does not include all case reports as a sample is selected by each local bureau and sent in.

for flooding grants, logging reported housing problems etc. Sources of ongoing, routine data were in the minority and mostly collected by agencies with telephone help lines (e.g. Citizens Advice Bureau, Rural Stress Helpline).

From the structured questionnaire, specific information was obtained from the various organisations.

An example of the type of information collected during the interviews is shown in Table 2. This shows information on data held by the Citizens Advice Bureau (CAB), which was thought to be more thorough than that from other local organisations. In particular the CAB showed the value of a local organisation working over a longer time frame in a community collecting data routinely.

More detailed data were collected by an academic study group⁶. The processes used to gather their data on physical and mental health were rigorous and involved using well established instruments such as the somatic health questionnaire and the General Health Questionnaire.

In addition the following issues were identified:

- data from most alternative sources of information are not routinely available for access by the HPA or Environment Agency.

- most routine data collection is undertaken by help lines, such as Citizens Advice Bureau.
- much of the work that has been done is in the form of small scale projects at local level.
- more data exist on the hazards/exposures of flooding (e.g. crime / loss of livelihood) than on physical and mental health.
- academic studies provide the most detailed datasets.
- relatively little information is available about the long term impacts of flooding.

Discussion

This piece of work found that several sources of information, alternative to routinely available datasets, have the potential to supply a wide variety of information on the consequences of flooding. However, most of the data available appear to be on "hazards/exposures" related to flooding (e.g. homelessness) rather than the physical and mental health outcomes.

The wide range of health impacts from flooding suggested in the literature (both physical and mental, and ranging from immediate to long term) are not reflected by routine health data collected in England and Wales. Use of these existing data sources would be insufficient to provide material to support the final health recommendation from the Pitt Review²: "The monitoring of the

impact of flooding on the health and wellbeing of people, and actions to mitigate and manage the effects, should form a systematic part of the work of Recovery Coordinating Groups.”

We have found that evidence for health outcomes secondary to flooding does exist within data sources that are not currently being utilised. Investigation of alternative sources of information, in conjunction with routine data sources, has the potential to provide a more accurate reflection of the health and social impacts of flooding. Further work is required in investigating and validating these potential sources.

Gaps in data

Relatively few agencies collected data on physical and mental health outcomes (e.g. gastrointestinal complaints, respiratory difficulties, anxiety), whereas a large proportion collected data on the “hazards” (i.e. more social factors such as loss of home, use of a rest centre). This is to be expected from the agencies’ prime response roles. Therefore there is a scarcity of data on the long term impacts of flooding. There is potential to address these gaps if these agencies are able to expand their current health consequence data collection.

Limitations of study

- The sample of agencies investigated aimed to represent the range of sources available, but was by no means able to cover all alternative information sources.
- The nature of the information received was informer dependent, and this could have been unrepresentative of the views of others even within the same organisation. Most agencies did not have a named contact, and depended on the invitation letter being forwarded to the most appropriate individual. The individuals interviewed ranged from chief executives, to emergency planning officers, to researchers.
- Time and resources did not allow for rigorous methodology such as recording interviews or other social science methods.

Suggested recommendations

The value of work done at a local level (particularly by some local authorities) needs to be recognised. Consideration should be given to using such work as a template for national level data to be collected on health and social impacts of flooding.

Sources of information that have been identified should be investigated further to establish their validity in informing about the health and social outcomes of flooding.

Work around investigating the long-term health effects of flooding should be encouraged (both research and routine data collection) in order to fill in current knowledge gaps.

Developing more formal links to voluntary agencies and public bodies may provide opportunities to work with stakeholders to develop guidance on data collection for health and social consequences of flooding.

Acknowledgments

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Adapting UK dwellings for heat waves

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Introduction

The European heat wave in August 2003 lasted 10 days and resulted in the premature deaths of over 35,000 people. More than 2,000 of the victims were in the UK, mostly elderly and vulnerable residents living in the South East of England. At the time the heat wave was reported as being a 1 in 100 year event. However, with mean summer temperatures predicted to rise by up to 4.2°C by the 2080s¹, the South East of England is expected to regularly experience such severe heat waves by the latter part of this century.

In response to this, the Engineering and Physical Sciences Research Council (EPSRC) is funding a multi-institutional, three year, £2m project to examine Community Resilience to Extreme Weather (or CREW), which began in the summer of 2008^{2,3}. The aim is to develop a set of tools for improving the capacity for resilience of local communities to the impacts of extreme weather events, such as flooding and heat waves. In the research described here, ways of adapting existing dwellings to reduce the impact of future heat waves are investigated.

Methodology

Previous research, such as that by the Chartered Institute of Building Services Engineers (CIBSE)⁴, has looked at the effect of combined adaptations over whole summer periods for a range of building types. The research conducted for this project uses computer simulation (IES Virtual Environment⁵) to identify adaptations, both to buildings and occupant behaviour, which will reduce overheating in existing dwellings specifically during heat wave periods. The research will then rank the adaptations for a range of dwelling types common to the South East of England (the target area for the project) and which exhibit the greatest tendency to overheat.

Dwellings are selected based on housing data from a range of sources, including the UK Government's English House Condition Survey⁶ and the Energy Saving Trust's Homes Energy Efficiency Database (HEED)⁷.

The first dwelling type to be assessed (and presented here) is the 19th Century terraced house, which is very common in the UK. Figure 1 shows the computer model, which consists of a short row of three houses. Downstairs there is a living room at the front and a dining room and kitchen at the rear, whilst upstairs are three bedrooms and a bathroom. The main house construction is of solid brick walls. It is

assumed that the properties have been modernised to some extent and are double-glazed (with uncoated glass) and have 100mm of loft insulation.

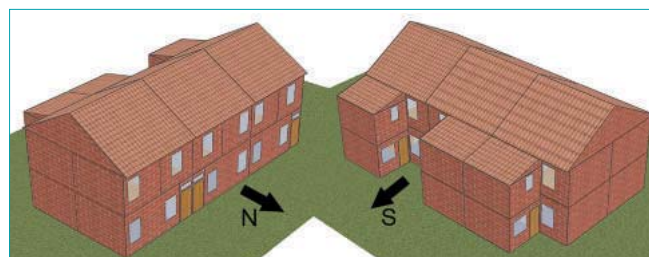


Figure 1: Terraced houses simulation model front and rear

Adapting the dwellings

The adaptations considered for the houses so far are all passive, i.e. they require no energy use for their day-to-day operation and hence will not themselves contribute to carbon dioxide (CO₂) emissions (as opposed to air conditioning, for example). Table 1 shows a list of the adaptations, grouped into three main categories: insulation, solar control and ventilation.

Table 1: Potential passive dwelling adaptations

Category	Adaptation
Insulation	Increase loft insulation from 100mm to 300mm thick
	Add external wall insulation to solid walls
	Add internal wall insulation to solid walls
Solar	Use internal window blinds, closed during the day
	Fit external window shutters, closed during the day
	Fit 1m deep overhangs above south-facing windows
	Paint the external walls a light colour to reflect solar radiation
	Paint the roof a light colour to reflect solar radiation
Ventilation	Fit low emissivity double glazing to reflect solar radiation
	Night ventilation: allow ground floor windows to open at night
	Window rules: prevent window opening if outside air is warmer than inside air

Computer simulation results

The computer simulations were run for the base case house (in Figure 1) and repeated for each adaptation in Table 1. A simulation heat wave period lasting four days (27th – 30th June) was chosen, during which the outdoor dry bulb temperature peaked at over 35°C each day. Figure 2 shows the effect of a few selected adaptations on the main bedroom temperature during a hot 24 hour period. During the night, the most effective adaptation for reducing the temperature is

external wall insulation, with external window shutters performing better for daytime hours.

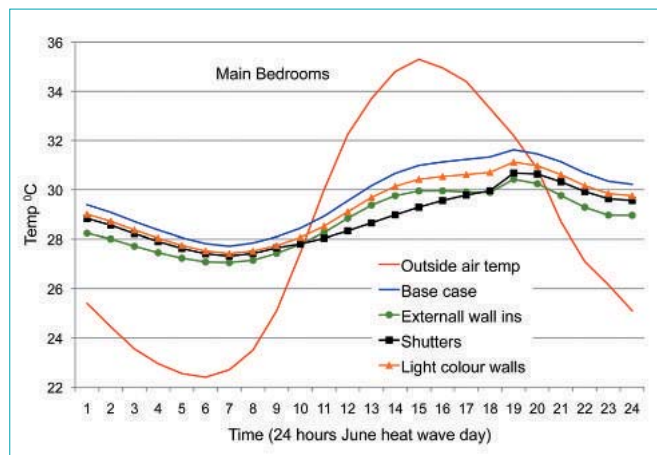


Figure 2: Effect of selected adaptations on main bedroom temperature

CIBSE publish recommended comfort threshold temperatures⁸, which state that for dwellings, bedroom temperatures should not exceed 26°C and other areas 28°C, for more than 1% of occupied hours.

In order to assess the effectiveness of the adaptations, the results were analysed in terms of the number of degree hours over these CIBSE comfort threshold temperatures. One degree hour is one degree Celsius over the threshold temperature for one hour, so for example if the bedroom temperature reached 30°C for two hours there would be 8 degree hours over the threshold. Degree hours therefore give a better representation of the severity of overheating than purely reporting the percentage of hours that the threshold temperature has been exceeded. Figure 3 shows the degree hour

reductions achieved over the 4-day heat wave period for the occupied hours, where the threshold temperature for overheating is 26°C for bedrooms and 28°C for living rooms. The houses were assumed to be occupied by a ‘typical’ family, where the parents are at work and the children at school during daytime hours.

The simulation results show that external wall insulation has the greatest single impact, reducing degree hours over threshold temperatures by 32% for bedrooms and 43% for living rooms. Other adaptations have much less effect, such as increasing the level of loft insulation, which only results in a drop of 1% to 2%. It can be seen that some adaptations perform better for different rooms, with a light coloured roof reducing degree hours for the main bedrooms by 9%, but only by 2% for living rooms.

A ‘full’ combination of adaptations comprising (from Table 1) external wall insulation; external window shutters; light coloured walls and roof; increased loft insulation; night ventilation to ground floor rooms and modifying window opening rules, resulted in no degree hours over the threshold temperature for living rooms and only 3 degree hours over for the main bedrooms (a 96% reduction) for the 4-day heat wave.

Summary and Future Work

Heat waves are likely to pose a significant health risk in the coming decades and much of the existing building stock will need to be adapted to reduce this risk. Those responsible for housing refurbishment need to be able to determine the most effective adaptations for each building type, particularly for buildings that house high-risk individuals, such as those with health problems or the elderly. This investigative work will provide that information by ranking the effectiveness of adaptations for a range of dwelling types. The research demonstrates that overheating can be tackled, in most cases, by passive adaptations. Simulations are also being carried out for

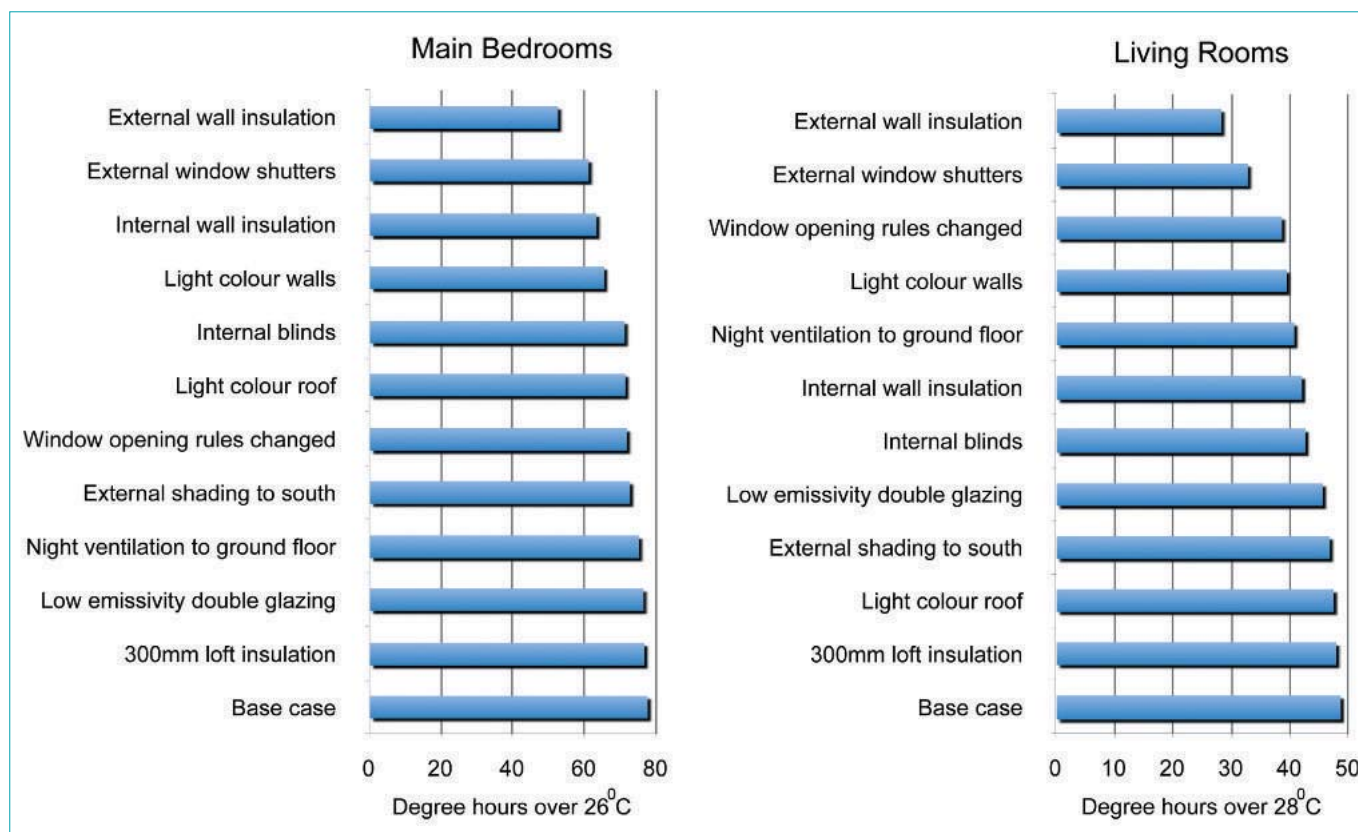


Figure 3: Degree hour reductions for single adaptations for a 4-day heat wave

various combinations of adaptations and these results will be presented in full in later publications.

It is important that the impact on winter heating loads of any recommended adaptations is known and the research will assess this in future simulations. The accuracy of the simulation results will also be evaluated by comparison with monitored data from real dwellings over the next two years.

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Health co-benefits of climate change action: How tackling climate change is a ‘win win win’

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Aim

The purpose of this paper is to start to set out the main health benefits we could anticipate from action to mitigate and adapt to climate change. The expected audience is policy makers and public health professionals. The paper is intended as a tool for discussion to consider the role of the health sector and the implications for future policy development.

Introduction

Climate change is the biggest challenge we face in the 21st Century¹. It will affect our environment, our economy, and our security^{2,3}. The ultimate impact of all of these changes will be on our health and well-being. Those who are poor will be the first hit and worst affected, widening health inequalities between and within countries. Even the most conservative estimates of the effects are profoundly disturbing and may elicit negative psychological responses such as denial, depression and powerlessness. The health sector has a crucial role in our collective response to this threat, and we must identify and use the many opportunities for health gain. Our challenge is to provide leadership, a positive vision and a strategy for evidence based action.

Why is climate change important for health and well-being?

- **Global** - The causes and consequences of climate change are global and our response must be collective and worldwide. Whilst

the direct impacts in the UK are expected to be moderate⁴, the impacts elsewhere will have repercussions throughout the world resulting in indirect impacts on the UK (e.g. population movement, conflict, food and energy shortages that will threaten our infrastructure).

- **Magnitude** - Climate change will affect every aspect of our lives and societies. Predictions suggest that extreme weather events, together with reduced food and water security, will have a severe effect on the public health of billions of people⁵.
- **Urgent** - Climate change is affecting the health and well-being of millions already from diseases such as malnutrition and diarrhoea to malaria⁶. Modelling suggests that the world is close to an increase in surface temperature beyond which climate change would be irreversible^{7,8}.
- **Economic** - The Stern review⁹ demonstrated that 5-20% of annual global GDP would be lost through climate change if we do nothing. This compares to the cost of 2% of annual global GDP of action to reduce global greenhouse gas emissions and prepare for climate change.
- **Health** - Climate change acts as an amplifier of existing health risks, but action against climate change now has substantial health co-benefits¹⁰. Current structures and processes of health care can also contribute significantly to our emissions. Health professionals have an important role in leading both public and political responses by highlighting impacts on health.

Climate change poses unprecedented challenges at all levels and in all spheres of our lives. These challenges include information for decision-making; addressing poverty and equity; applying existing and developing new technological solutions; socio-political changes to our lifestyles and cultural norms; and institutional governance, accountability and co-operation¹.

Table 1: What are the health effects of climate change in the UK?

Direct ⁴	Indirect ¹
<ul style="list-style-type: none"> • Increased heatwave-related illness and deaths • Declining cold-related illness and deaths • Respiratory effects of increased ground-level ozone • Injuries and death caused by extreme weather-related events • Flood-related health effects, such as mental health impacts • Drought-related health impacts • Increased incidence of sunburn and skin cancers • Increased exposure to biting insects and vector-borne diseases • Changing distribution of infectious diseases • Increased food and water-borne diseases • Increased allergic conditions with extended pollen seasons and changing pollen distribution 	<ul style="list-style-type: none"> • Exacerbation of global health inequities • Resource-related conflict (e.g. oil, gas, food, water) • Mass population displacement and migration as a result of extreme weather events, famine, drought, conflict and infrastructure collapse • Economic consequences of responding to climate change in UK and abroad, reversal of development successes • Impacts on global biodiversity <p>Plus:</p> <ul style="list-style-type: none"> • Impacts of reduced availability of cheap oil for energy, and for manufacture of pharmaceuticals, plastics, medical supplies, equipment etc¹¹.

Why should the UK health sector be involved in action on climate change?

• The Climate Change Act 2008

- *Climate change mitigation* - the Climate Change Act¹² committed the UK government to cut greenhouse gas emissions by one third by 2020 and by 80% by 2050. All sectors will need to contribute if the government is to meet this ambitious, but essential target.
- *Climate change adaptation* - the Act also gave the government the power to ask public sector organisations to report on their assessment of the risks climate change poses to them, and the actions they are going to take in response. For the health sector this means actions to prepare for the anticipated direct and indirect threats to health (heatwaves, floods, extreme weather events, migration).
- **Climate change is a major threat to public health, civil order and the economy.** Its effects are already being felt. In the UK, there were 2000 premature deaths in the 2003 heatwave¹³ and psychosocial morbidity was reported following UK floods of 2007¹⁴. The health sector needs to ensure that it is resilient to these extreme weather events, and an integral part of this response must be to minimise the threat as much as possible.
- **The NHS is a significant emitter of greenhouse gases.** Reducing carbon emissions from the NHS would have a significant impact on total UK emissions¹⁵. The NHS acts as provider, commissioner and consumer, and with over 1.3 million staff, the NHS could play an important advocacy role in encouraging others to tackle climate change. As the largest public sector emitter, there is a profound opportunity to be a leading exemplary organisation. The NHS is iconic and touches every community and person in the country.
- **Health co-benefits** - action to mitigate and adapt to climate change can have substantial benefits for health, as discussed in the following section.

So where might climate change action benefit health?

There may be some direct benefits for health in the UK from climate change (e.g. warmer winters may result in less cold-related illness and death²). However, many of the opportunities for health benefit depend on how we approach the challenge of climate change.

- Protecting health from climate change - Even if our greenhouse gas emissions dropped to zero immediately, our climate will continue to change over the next few decades, because of the 'latency' effects of greenhouse gases already emitted. Many of the projected health risks are preventable or controllable by the application of well-known interventions¹. Preparing for these now will lessen future morbidity and mortality.
- Social determinants of health - The causes of poor health and the causes of greenhouse gas emissions responsible for climate change are often the same¹⁶. This implies that there are common 'upstream' solutions that will bring broader benefits when applied, and help to reduce inequalities across several domains. Examples include housing and urban design, income and education.
- Lifestyle choices - Small changes to lifestyle can bring substantial health co-benefits and a reduction in carbon emissions. For example, tackling the obesity crisis through promoting healthy diets and active transport can combat climate change and improve health. Moderating consumption and promoting a local

economy can also have wider benefits beyond the direct benefit to health and the environment.

- Strengthening current health action - Since climate change will mostly worsen existing health issues, it has the potential to motivate and release resources to strengthen our existing actions thus improving health now¹⁷, as well as in the future. An example would be improving climate-sensitive disease and death surveillance (e.g. impacts of flooding, heatwaves, vector-borne disease).
- Health promoting policy development - Climate change is already influencing political and economic decision-making now. By framing climate change as a health issue, health professionals can move to a 'health in all policies' position and ensure strong climate change action is taken to minimise the impacts of climate change on health¹.

'Win-wins': Tips to help people improve health and save carbon at the same time⁴⁶

1. Keep warm, keep cool, keep well.

Insulation keeps warmth indoors in winter and heat out in summer so reducing the risk of cold and heat related illness and death^{19,20}. Health professionals could prevent the emission of 100,000 tonnes of carbon dioxide by advocating successfully for insulation in just 10 households⁴⁷.

2. Have one 'meat free' day a week.

A high meat intake is associated with an increased risk of some cancers, ischaemic heart disease and diabetes^{25,26}. In contrast, diets that are low in meat consumption are associated with longer life expectancy⁴⁸. Meat production contributes to climate change through methane production, deforestation, and associated transportation²⁶. If everyone in the UK stopped eating meat for a day a week, the carbon dioxide saved would equal taking 5 million cars off the road⁴⁹.

3. Walk or cycle at least once a day.

Walking more than 1.5 miles per day reduces risk of myocardial infarction by 50% in older men⁵⁰. If everyone in Britain made one less car journey every week it would reduce car travel by at least ten per cent, which would mean an annual saving of almost 7 million tonnes of carbon dioxide⁵¹.

4. Be a safe driver.

If drivers did not exceed the 70mph speed limit on motorways 300 deaths and serious injuries would be prevented per annum. Nearly 1 million tonnes of carbon dioxide emissions from excess speed would be avoided each year⁵².

5. Create safe, green spaces.

Contact with natural environments can improve physical³³ and mental health³⁴. Health professionals can 'prescribe' activities to improve health that are sustainable and enhance our resilience e.g. gardening, allotments, green gyms, environmental volunteering, NHS Forest⁵³ - creating urban green spaces helps protect us from heatwaves and flooding.

Saving carbon dioxide means saving lives too - now and in the future!

Table 2: Which interventions in the UK provide the best combination of health gain and climate change action?

Domain	Intervention	Health Gain	Contribution to climate change mitigation (tCO2 saved pa ¹⁸)	Contribution to climate change adaptation	Cost/ Feasibility/Barriers
Healthy homes	Cavity wall insulation (CWI) Loft insulation (LI) Condensing boiler (CB)	Less cold-related illness and death in winter. Less income spent on heating - less fuel poverty ¹⁹ . Less heat-related illness and death in heatwaves ²⁰ . Can help address inequalities ²¹ .	1.74/household (CWI) 1.25/household (LI 270mm) 0.88/household (CB) 1.2/household (referral to Fuel Poverty Scheme) Housing currently accounts for about 25% of UK emissions ²² .	Insulation keeps heat out in heatwaves ²⁰ .	Existing programmes - e.g. Warm Front grant scheme ²³ . Savings to NHS far outweigh costs of housing improvement to address excess cold (payback period estimated to be <4months) ²⁴ . Concerns re accessibility for 'hard to reach' individuals ¹⁹ .
	Halve meat and dairy consumption	Less cancer ²⁵ , ischaemic heart disease ²⁶ , obesity ²⁶ .	1.92 /person Livestock production produces 22% of global emissions. ²⁷	Less deforestation may reduce flooding ²⁸ . Up to 15 times less water to produce a kg of wheat than a kg of beef ¹ .	Cultural values on meat and milk. Possible public concern re negative impact on calcium, B12 intake etc.
Active transport	Walk/bike vs car use (per 1000 miles)	Increased physical activity - less obesity, cardiovascular disease, cancer, diabetes mellitus, improved mental health. Fewer deaths and injuries from accidents. Less vehicle related pollution (air, noise). Better access to community services ²⁹	0.29 - 0.48 /person Domestic transport currently accounts for 24% of UK emissions ³⁰	Less vehicle fuel combustion leading to less ozone related morbidity and mortality ³¹ , and less urban heat generated ³² .	Public concern re road safety. Transport industry - move to low carbon vehicles.
	Fuel efficient driving style Speed limit compliance	Reduced injuries/deaths from accidents. Less income spent on fuel.	0.80 /car 0.30 /car		Driving culture. Behaviour change.
Community	Green spaces	Improved physical and mental health ^{33, 34} . Less violence and aggression ^{35,36} . Improved air quality ³⁷ . Increased likelihood of physical activity ^{38,39} . Can help address inequalities ³³ .	0.02 per tree or 0.3 per hectare planted. 30% reduced use of air conditioning through shading in US ⁴⁰ .	Less flooding ⁴¹ , urban cooling during heatwaves ³² .	Competition for land e.g. for buildings, roads. Maintenance and public concern re safety.
	Promote local economy	Can encourage less vehicle use with resultant reduction in illness and death from air pollution, accidents, lack of physical activity. Fosters community cohesion/social capital ^{42,43} . Better security of supply for locally produced items.	Fewer CO2 emissions through reduction in transport of people/goods	Lessened impact of climate-related events elsewhere.	Incentives and barriers. Behaviour change. Planning policy.
Cleaner energy	Low carbon energy sources	Less outdoor and indoor air pollution - less cardiovascular/respiratory illness and death ⁴⁴ .	The power sector currently accounts for 37% of UK emissions ⁴⁵ .	Less ozone related illness and death ³¹ . More energy security, particularly post 'peak oil'.	NIMBY-ism. Industry. Local deterioration in air quality with biomass combined heat and power plants.

Table 2 provides a simple analysis of how interventions in five key domains could have substantial health gains, whilst also contributing to climate change mitigation and adaptation. This builds on earlier work estimating the reduction in carbon footprint from public health interventions¹⁸. At present, there is insufficient information to quantify potential health gain, but further research in this area would be extremely valuable.

The box gives simple actions that everyone can take to improve health and take action against climate change. They could be used at several levels e.g. individual action, for health professionals to advise patients, or at a population level, to engage with partners who can influence wider health determinants e.g. local authorities.

Conclusions

Climate change is a significant risk to health in the UK- it is inevitable and will have a substantial impact, both directly through extreme weather events and indirectly through global effects causing food and water insecurity, conflict and migration. As a good corporate citizen, the health sector must be committed to contributing to the UK's reduction in UK emissions, in its various roles as provider, commissioner, consumer and advocate. And, taking action against climate change presents many opportunities for health gain, including healthier lifestyles, addressing social determinants of health, and health promoting policy development. The health sector has a crucial role in minimising the threats and maximising the opportunities of climate change.

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Regional impacts of climate change

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Introduction

Human activities have significantly contributed to global warming. During the Twentieth Century, average global temperature increased by 0.74°C^1 and these increases are linked to anthropogenic emissions of greenhouse gases². These emissions also affect atmospheric and oceanic circulation currents, precipitation, humidity and the frequency of severe weather events.

The health impacts of climate change are already being felt across the globe, with the World Health Organization (WHO) estimating that in the year 2000, climate change was estimated to have caused over 150,000 deaths worldwide³. Table 1 details the resulting mortality from a number of heat events in the last decade.

Table 1: Examples of heat events in the Twenty First Century

Source EM-DAT (2007) <http://www.emdat.be/>

Country	Date	Fatalities
India	May 2002	1,030
Italy	July – August 2003	20,089
France	August 2003	19,490
Germany	August 2003	5,250
UK	August 2003	2,045
France	July 2006	1,388
Netherlands	July 2006	1,000

However, the area of health impacts is one that has not yet received adequate attention from researchers. Furthermore these impacts need to be assessed on a very location-specific basis as health impacts vary across the globe. Fortunately in the UK we have robust climate modelling and the latest projections, UKCP09⁴, allow region-specific climate outputs.

This article is written based on selected findings of my Masters in Public Health (MPH) dissertation. The project investigated the possible association between temperature and crude mortality (i.e. total number of deaths) in the West Midlands and then used this association to predict the regional changes in mortality given the temperature increases predicted by the UKCP09 models.

Methodology

It has long been understood that morbidity and mortality incidence rates show seasonal variation due to the effects of heat and cold.

Indeed, early theories dated back nearly 2,500 years with Empedocles (490 – 430 B.C.) linking body temperature to health⁵. More recent work has identified a strong association between temperature and total daily mortality for a number of cities around the world. This relationship exhibits a V-shaped curve where mortality is high at colder temperatures, then decreases to a Minimum Mortality Temperature (T_{MM}) as the temperature warms and then from this trough mortality again begins to increase as it gets hotter. Due to behavioural, physiological and built/natural environmental adaptation, the T_{MM} changes significantly throughout the world, as illustrated in Table 2.

Table 2: Minimum mortality temperatures (T_{MM}) for a number of locations in order of increasing T_{MM}

Location	T_{MM}
Netherlands	15.5°C^2
UK	$15.6 - 18.6^{\circ}\text{C}^6$
North Finland	18.0°C^7
London, UK	18.0°C^8
Sofia, Bulgaria	18.0°C^8
Budapest, Hungary	19.6°C^9
Paris, France	$20.6 - 23.6^{\circ}\text{C}^{10}$
Barcelona, Spain	$21.0^{\circ}\text{C}^{11}$
Boston, America	$22.0^{\circ}\text{C}^{12}$
Valencia, Spain	$22.0 - 22.5^{\circ}\text{C}^{13}$
North Carolina, America	$22.3 - 25.3^{\circ}\text{C}^{14}$
Athens, Greece	$22.7 - 25.7^{\circ}\text{C}^{15}$
Milan, Italy	23.4°C^9
Sydney, Australia	$26.0^{\circ}\text{C}^{12}$
Taiwan	$26.0 - 29.0^{\circ}\text{C}^{16}$

Daily maximum, minimum and mean Central England Temperature (CET) data were obtained from the British Atmospheric Data Centre (BADC). The use of these three sets of temperature data allowed the effect of extremely cold nights and extremely hot days to be investigated, along with effect of average temperature changes. The CET series has measured air temperature between a roughly triangular area of the United Kingdom (enclosed by Preston (Stonyhurst), Bristol (Pershore) and London (Rothamsted) since 1659¹⁷. The CET is a composite series using data from three observing sites from which heterogeneities have been carefully removed. It is the longest instrumental record in the world.

Daily mortality data were obtained from the West Midlands Public Health Observatory (WMPHO) and broken down into three geographical areas the Outer, Middle and Inner Bands (Table 3 details the Local Authorities that constitute the three bands).

Temperature/mortality relationships were then analysed using the statistical software Stata¹⁰. Fractional polynomial regression analysis allowed parametric modelling of the 'U'-shaped curved relationships. The lowest temperature in this model was then read off to provide the T_{MM} .

Table 3: Local Authorities in the Outer, Middle and Inner Bands

Band	Local Authority
Outer	Bridgnorth, Bromsgrove, Cannock Chase, East Staffordshire, Lichfield, Malvern Hills, Newcastle-under-Lyme, North Shropshire, North Warwickshire, Nuneaton and Bedworth, Oswestry, Redditch, Rugby, Shrewsbury and Atcham, South Shropshire, Stafford, Staffordshire Moorlands, Stratford-on-Avon, Tamworth, Warwick, Worcester, Wychavon, Wyre Forest
Middle	Coventry, Dudley, Sandwell, Solihull, Walsall, Wolverhampton
Inner	Birmingham

Results and discussion

Figure 1 shows there was no significant trend in annual T_{MM} between 1981 and 2007 for either mean or maximum CET.

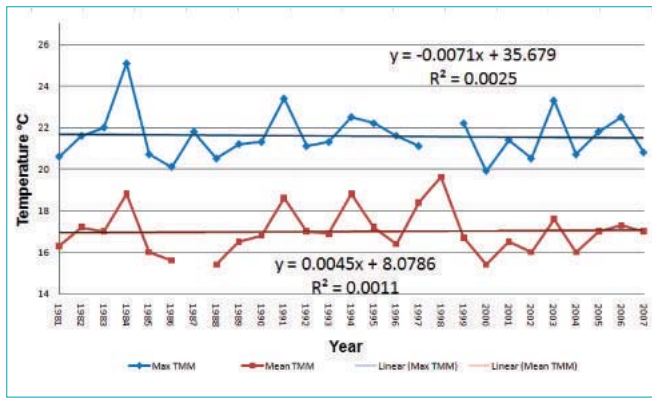


Figure 1: Annual Maximum and Mean CET T_{MM} for West Midlands Government Office Region

Figure 2 shows that the Outer Band T_{MM} was around a degree higher than the Middle and Inner Band T_{MM}. This is the opposite relationship to what was accepted as, due to the Urban Heat Island (UHI) effect, the urban centre of the West Midlands is around 2 degrees hotter than the rural outer areas of the Region.

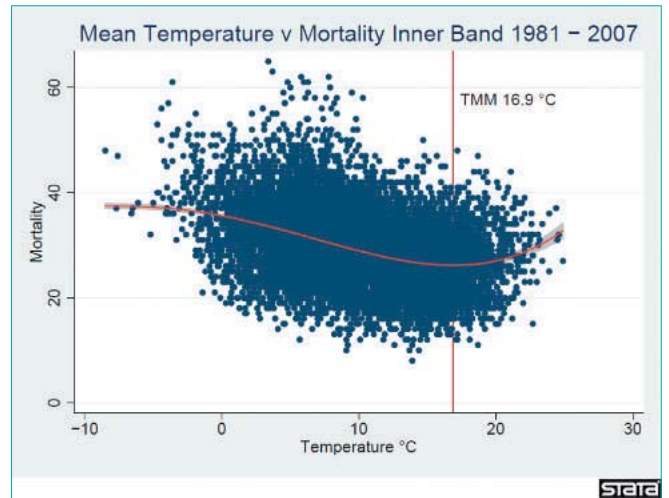
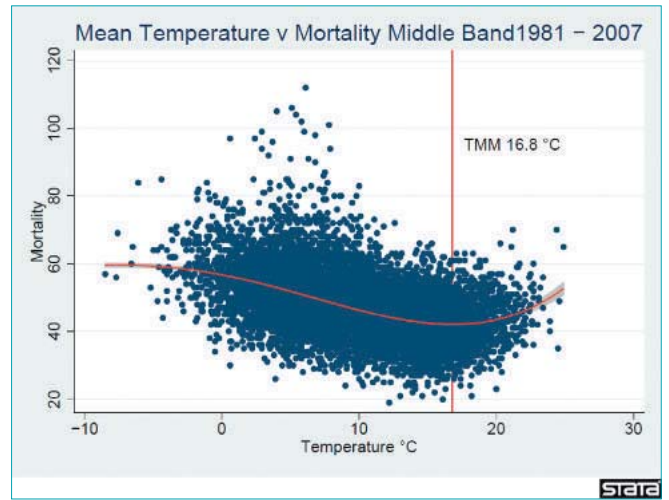
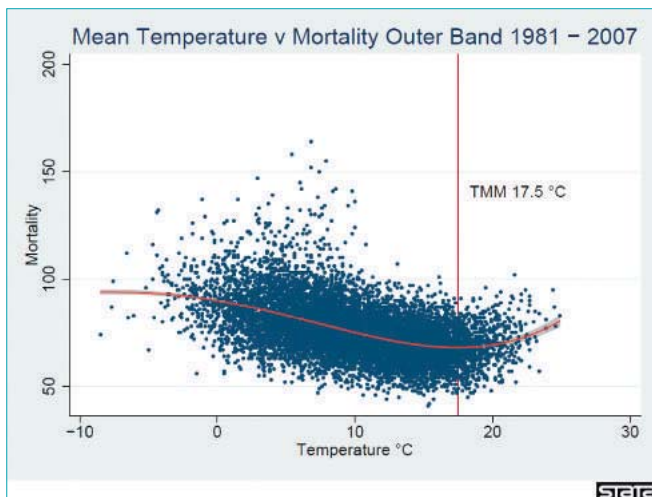


Figure 2: Mean CET T_{MM} graphs for Outer, Middle and Inner Bands

Figure 3 shows the winter T_{MM} is beyond the temperatures recorded over this period and temperature increases of up to 10°C above the mean temperature recorded over this period will result in a drop in mortality.

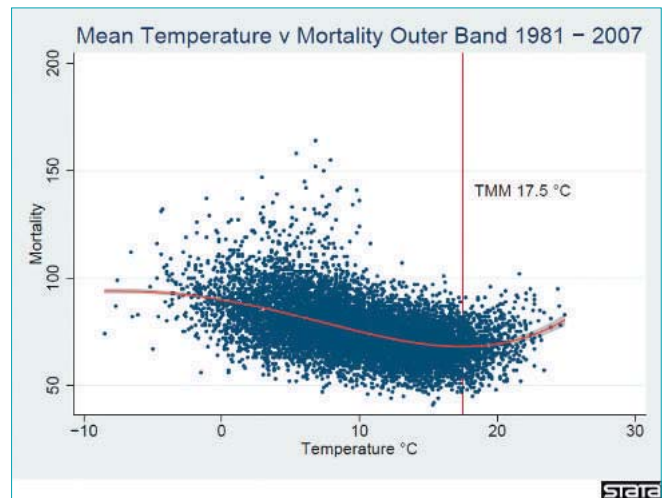


Figure 3: Mean CET T_{MM}, winter 2000 to 2007

Figure 4 shows the summer T_{MM} is 1°C above the current mean temperature. Therefore mild increases in temperature will result in a drop in mortality. Increases greater than 2°C will result in an increase in mortality.

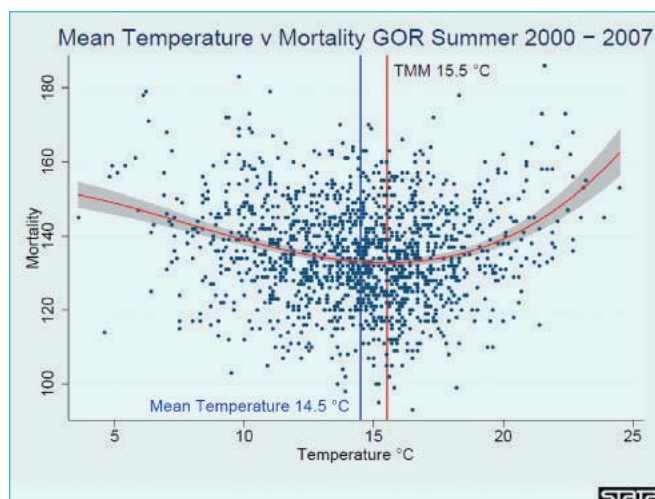


Figure 4: Mean CET T_{mm} , summer 2000 to 2007

Combining the changes in mortality for summer and winter mortality, calculated by using the UKCP09 projections, produced the changes in daily mortality summarized in Table 4.

Table 4: Predicted net change in annual mortality in the West Midlands Government Office Region for the Low, Medium and High UKCP09 climate scenarios

UKCP09 climate scenario	Timeslice	Net change in annual mortality	Change in winter mortality	Change in summer mortality
Low	2020s	- 182	- 0.5%	- 0.3%
	2050s	- 547	- 1.9%	- 0.4%
	2080s	- 1,131	- 4.6%	- 0.3%
Medium	2020s	- 255	- 0.8%	- 0.3%
	2050s	- 693	- 2.7%	- 0.3%
	2080s	- 912	- 4.6%	+ 0.5%
High	2020s	- 182	- 0.5%	- 0.3%
	2050s	- 766	- 3.1%	- 0.1%
	2080s	- 766	- 6.0%	+ 1.9%

It is worth pointing out that these results estimate only the direct effects of temperature and so it is reasonable to treat the West Midlands in an isolated bubble. For the UK, the indirect effects of climate change are likely to pose the most significant challenges. These indirect effects could include the health effects of changing energy security, food security, immigration, wider economic effects and rising sea levels. However, the present investigation does not examine the changes in morbidity due to temperature increases.

These results are broadly consistent with the latest Department of Health (DH)¹⁸ report on the human health impacts of climate change, that predicts by 2050, heat-related deaths in England and Wales could increase to around 2,800 cases per year, but this is likely to be offset by milder winters leading to a fall in cold-related winter deaths of up to 20,000 cases per year.

Conclusion

Although this investigation predicted a reduction in crude mortality, the conclusion of my dissertation was that climate change mitigation and adaptation was still crucial when the wider impacts of global warming are considered. This is true regionally but especially when one considers the impacts outside the developed world. In the medium to long term, the potential health gains described in this

report will likely be offset by impacts such as melting ice sheets, rising sea levels, desertification and more frequent extreme weather events. In the short term, the most deprived in the Region will be most susceptible to climate change impacts and if the Region is to reduce health inequities, action needs to be taken to minimise the negative and maximise the positive health impacts of climate change amongst the most vulnerable in society.

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HPA Project Updates

Merger of two HPA Divisions: Chemical Hazards and Poisons Division and Radiation Protection Division

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- 1. Director, Centre for Radiation, Chemical and Environmental Hazards (CRCE), HPA Radiation Protection Division**
- 2. Head of Chemical Hazards and Poisons Division and Deputy Director, CRCE, HPA**

Since the formation of the Health Protection Agency, the headquarters of the Chemical Hazards and Poisons Division and the Radiation Protection Division have been co-located at Chilton, Oxfordshire. There are clear synergies between the work and expertise of the two Divisions, and, for the past four years, we have worked closely together within a single Centre (the Centre for Radiation, Chemical and Environmental Hazards (CRCE)). The natural progression of this close working is to merge the two Divisions, which we plan to do from April 1st 2010.

Merging the two Divisions has a number of benefits. Most importantly, it will enable the resources available to CRCE to be used in the best interests of the protection of human health and to strengthen our links with internal and external stakeholders. The merger will remove any organisational barriers to developing synergies of expertise and will allow us to optimise the allocation of resources, including a re-balancing of effort within the Centre. In particular, it will assist us in strengthening our work in the following areas:

- modelling of the movement of pollutants
- biokinetic studies on the uptake and distribution of pollutants in the body
- health effects studies on the mechanism of action of potential harmful agents
- response to emergencies and incidents
- development of service delivery
- training of healthcare professionals
- provision of consistent expert advice to the frontline.

To support this sharing and consolidation of expertise, we have brought CRCE's epidemiology resources together and also raised the profile of the National Poisons Information Service, by moving it to report directly to the Centre Director. We have also established cross-centre working groups on emergency response procedures and research requirements. A programme of themed workshops is being started to bring together experts from the chemicals and radiation areas in order to discuss topics of mutual interest. A review of the Centre's analytical chemistry capability has also been initiated, in order to define future requirements and strategy in this area.

Change can be an unsettling time, not just for those engaging in the change, but also for those who interact with them. We would like to assure our partners (both internal and external to the HPA) that our vision for the Centre is to build on the strengths of both Divisions. A notable strength of the Chemical Hazards and Poisons Division has been its regional presence and close working with partners in Local and Regional Services and locally based agencies. We are considering strengthening this regional presence, using the merger to broaden the scope of our local support to radiation advice as well as chemical advice. Similarly, we expect the closer collaboration enabled by the merger to strengthen our research, particularly for chemical toxicology, and hence the evidence base from which our advice to Government and frontline partners is derived. Finally, the merger will enable us to provide services and training which cover both radiation and chemicals. This will both contribute to improved public health protection in the UK and enable us to earn additional income to support the development of our advice.

The most obvious change will be that the names of the two Divisions will no longer be used from April. All staff will belong to the Centre, and those in locations away from Headquarters will be known by the location of their office – eg 'CRCE Nottingham'. From this date, the duty desk emails will also change, eg 'crce-nottingham@hpa.org.uk'. However, as indicated above, the function of these units will continue to be an integral part of the service provided by the Centre.

Public health (environment) physicians: training, continuous development and network



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Chemical Hazards and Poisons Division, London

Introduction

In a few European countries, Public Health (Environment) physicians are specifically trained to lead investigations into the environmental causes of ill health. However, there is currently little co-ordination of Public Health (Environment) physicians across Europe, and the specialisation has developed at different rates within EU countries. This fragmentation means there is variation between EU countries in their capacity to address environmental issues and their ability to implement the EU strategy to ensure its citizens' live in healthy environments.

The European Union, through the European Environment & Health Action Plan 2003-2008, called for capacity development in environmental health.¹ By identifying the need to strengthen the position of the environmental public health it was considered vital to understand how these professionals work in all the 32 EU countries, what qualifications they hold, how they are trained and registered/certified.

PHEEDUNET

Project No: 2006335: Project completion date December 2009; Funded by EU Public Health Executive Agency.²

A project called Public Health Environment EDUcation and training NETwork (PHEEDUNET) was established with the aim to create a European network of Public Health (Environment) (PH (E)) physicians (Project No: 2006335).² . Partners in this project include:

- Radboud University, Nijmegen Medical Centre and Hulpverlening Gelderland Midden, Netherlands
- State Environmental Health Centre Lithuania
- National Centre of Public Health, Hungary
- Paediatric Environmental Health Speciality Unit, Spain
- European Academy for Environmental Medicine, Germany
- Health Protection Agency, England

The partners identified the need to build a network designed to improve the capacity in environmental public health by co-ordinating training across Europe. The number of PH (E) physicians in each country is small and the number in training even smaller. Thus, bilateral exchange of experience and expertise between countries and regions in Europe would enrich all countries ability to train and maintain their public health (environment) workforce. A European framework would be beneficial since many environmental problems are similar between countries, making collaboration and similar training advantageous and would help to increase the viability of specialist courses. A need to identify all short and long courses available for training in this area was identified.

Definitions

Initially PHEEDUNET partners were tasked with comparing the various definitions used for the disciplines associated with PH (E). This work determined more clearly what is meant by environmental public health, which is part of the wider domain of public health, and showed that there is a clinical discipline as well as environmental medicine and environmental health (figure 1). It showed to the partners that there is a substantial overlap which should allow for joint training both between countries and between disciplines. It also aimed to establish via this network, the training needs of PH (E) physicians and their registration and/or certification requirements in all EU countries.³

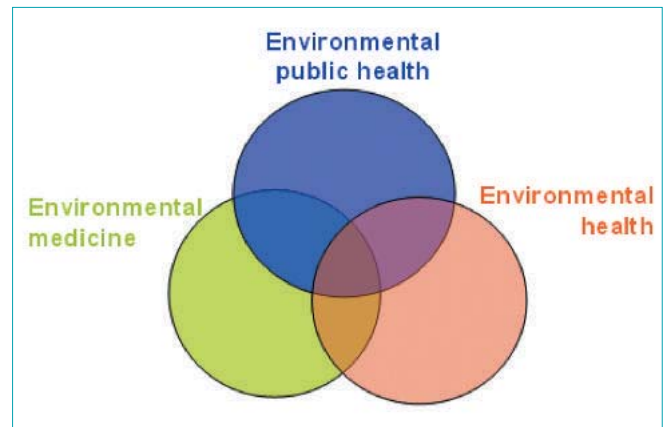


Figure 1: inter-relationships between environmental public health, environmental medicine and environmental science

Training inventory

The next task for the PHEEDUNET partnerships was to build an inventory of training/course programmes. Thus training programmes from the UK, Netherlands, Belgium, Germany, Austria, Luxemburg, Switzerland, Poland, Spain, Portugal and other countries were collected and evaluated.

Most courses identified are at Master of Science level available through universities. Whilst it is hard to establish the level at which these courses are aimed at, it was found that the UK in particular has rich training programmes in environmental health and public health but these are not often closely linked. The UK in addition has targeted courses on environmental epidemiology, risk communication; higher level applied environmental health for public health (in contrast to environmental sciences) and applied toxicology for public health. Frequently the HPA is associated with these courses.

From the point of view of the PHEEDUNET project, the training levels used in the UK were considered to be very informative as they would allow the introduction of the field to professionals and the use of advanced courses in both Masters and Continuous Professional Development programmes (table 1).⁴

Table 1: Competency Levels (adapted from Ruggles et al ⁴)

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

Certification/registration

Given European rules for medical specialisation, some level of harmonisation is to be expected in Europe. However, the formulation of the registration rules is and will remain country specific. This has turned out to be the most complex area and so far the registration rules for the UK and the Netherlands have been evaluated. It is apparent that there is the development of the competency based regulations rather than predominantly skills based rules.

Proposed outcomes

For the PHEEDUNET project the strategic objective is to use the network to promote co-operation between European countries in developing the specialisation of PH (E) physicians. By so doing, EU and associated countries will be better placed to tackle environmental health issues when they arise as well as implement health protection measures. The UK may be in a position to help facilitate this development with colleagues from PHEEDUNET and elsewhere.

Therefore PHEEDUNET should be able to promote co-operation between countries and allow for the maintenance of skills through continuous professional development. It is hoped that the network will allow trainees from one country to take courses delivered in another, and thus allow countries with limited capacity to access resources and skills in another. The courses identified are not necessarily only available to physicians, but for practical reasons they are the starting point as physicians generally have clear rules on registrations.

Ultimately, it is expected that PHEEDUNET will develop a proposal for a joint programme of training and CPD courses across EU countries that would be co-ordinated by the network. Indeed it is considered by the network that this will help environmental public health training and registration in the UK as it is recognised as one of its key areas health protection.⁵

Although establishing the network requires some investment, we anticipate that the network will become sufficiently valuable to the specialisation for it to possibly become self-funding. Limiting the aims of the network to training and CPD should also keep ongoing administration costs for such long-term maintenance small.

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The Alerting System for Chemical Health Threats – Phase II



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Background

The aim of the Alerting System for Chemical Health Threats – Phase II (ASHTII) project is to improve the speed and effectiveness of public health response to toxic exposures following deliberate or accidental chemical incidents. Currently, no standardised format or protocol for sharing information or issuing alerts about chemical incidents between EU Member States exists. Therefore, the European Union Public Health Programme funded the Alerting System and Health Surveillance System project (ASHTI), which demonstrated that poisons centres are a feasible resource to detect sentinel events and culminated in outlining the concepts required to establish a Rapid Alert System for CHEMical health threats (RAS-CHEM).

The ASHTI project was successful in envisaging an improved communication structure required for a successful rapid Alerting System for chemical Health Threats. The second phase of the ASHTII project will improve upon the current data transfer systems and information sharing. It will develop mechanisms (and strategies) for analysing and reporting information between health professionals, from poisons centres to national public health officials.

Project progress

RAS-CHEM has been extended to include a tiered-access alerting system for chemical health threats; the lower tier of RAS-CHEM is comprised of the European Union Poisons Centres (EUPC) Forum, which enables poisons centres to communicate with each other directly. The higher alerting tier, RAS-CHEM, is reserved for national public health authorities and government health ministries to communicate events that may have potential public health impact (either nationally or internationally). This is shown in Figure 1.

For both facets of the alerting system to operate successfully, the incorporation of standardised terminology to describe clinical effects has been recommended. A standardised chemical agent classification system is also under review for inclusion in the system. Guidance has been developed for adding chemical agents to RAS-CHEM in the future.

Within the project we have engaged with a range of European national public health officials and health ministries, which has demonstrated that a range of mechanisms exist for reporting chemical health threats in participating Member State countries. Extensive high level discussions about ASHTII and feedback on the project have been very positive. RAS-CHEM is viewed as a practical and valuable addition to the European Union and the Health Emergency Operation Facility. EU exercises are planned for Winter 2010/ 2011 to determine and evaluate how all European Member States respond to national and international deliberate or accidental chemical health threats. This is an opportunity to highlight further gaps in reporting such events and evaluate RAS-CHEM as an early warning alerting tool.

Partners

Associate partners:

- European Association of Poisons Centres and Clinical Toxicologists (EAPCCT)
- Giz-Nord Poisons Centre, University Medical Centre Göttingen (UMG), Göttingen, Germany
- Guy's and St Thomas's Medical Toxicology Unit (GSTFT), UK
- Centre Hospitalier Universtaire de Lille (CHRU de Lille), France
- Health Emergency Situations Centre (HESC), Vilnius, Lithuania
- General Faculty Hospital, Prague, Czech Republic.

Subcontractors:

- National Poisons Information Service, UK.

Collaborating partners:

- World Health Organization Switzerland
- World Health Organization Europe
- Health Emergency Situation Centre, Lithuania
- Ministry of Health, Czech Republic
- National Poisons Information Centre (Nordic countries), Norway
- Centro de Informacao Antivenos, Portugal
- National Centre for Epidemiology, Surveillance and Health Promotion, Italy
- BICHAT representative, Germany
- BICHAT representative, France.

We are very pleased to announce that we also have three new collaborating partners:

- National Institute of Health, Rome, Italy
- American Association of Poison Control Centres (AAPCC), USA
- National Poisons Information Centre, Ireland.

The ASHT project runs from October 2008 to September 2011 and is partly funded by the European Commission (Grant Agreement Number 2007210). If you would like further information about the

project or would like to become a collaborating partner please contact asht@hpa.org.uk or visit www.hpa.org.uk/ASHTII

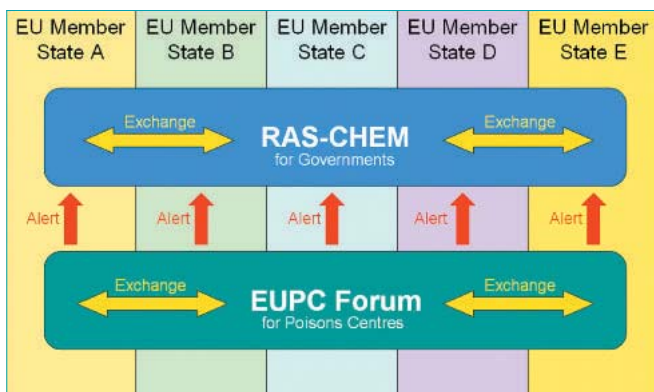


Figure 1: RAS-CHEM and EUPC forum reporting process.



Photo: ASHTII Workshop, Göttingen, Germany, October 2009.

Left rear: Al Bronstein, Stacey Wyke, Hugo Kupferschmidt, Herbert Desel, Kevin Manley, Gabija Dragelyte, Nick Edwards

Left front: Rob Orford, Raquel Daurte-Davidson, Alison Good, Daniela Pelclova, Monique Mathieu-Nolf, Andreas Schaper



A UK Recovery Handbook for Chemical Incidents

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Background

History has shown that major chemical incidents have happened both in developed and developing countries. Although rare, these incidents can cause mass disruption, many casualties and fatalities and can have long-lasting effects on the communities involved. On the 2nd of December 2009, commemorations for the 25th anniversary of the Bhopal disaster reminded everyone of such incidents and highlighted how important proper recovery is in such events. Chemical incidents will occur again in the future and therefore responders must be prepared not only for the initial response but also for the subsequent recovery phase. This phase is key to the restoration of normality in the areas affected by a major chemical incident. The term recovery refers to all aspects of society: health, environmental remediation, social and economic issues¹. This holistic approach means that responders must not only be competent in their area of specialisation but also be able to interact and plan for contingencies alongside other agencies that have roles in recovery.

The HPA therefore felt that detailed guidance was necessary to establish good practice based on lessons identified from responding to and recovering from emergencies both in the UK and internationally. Table 1 lists incidents which involved chemicals that had significant impacts on communities. From these, parallels can be drawn, lessons identified and practical management options chosen for the recovery phase of chemical incidents.

Chemical Recovery Handbook

By mirroring the well received UK Recovery Handbook for Radiation Incidents¹², the HPA has been tasked by our partners to develop a UK Recovery Handbook for Chemical Incidents. These partners include:

- Department for the Environment, Foods and Rural Affairs (DEFRA)
- Food Standards Agency (FSA)
- Northern Ireland Environment Agency (NIEA)
- Home Office
- Scottish Government.

Development of the Handbook will take three years, the results of which will be released in May 2012. On completion, the product is intended to provide a user-friendly online reference handbook in PDF format, which will aid all relevant government departments, agencies, local authorities and other stakeholders involved in the recovery phase of a chemical incident.

There are thousands of different chemicals which could be potentially involved in a chemical incident. Rather than attempting to study a large number of these, the UK Recovery Handbook for Chemical Incidents will concentrate on a select list of chemicals with a wide range of toxicological and physiochemical characteristics, including examples of those previously involved in chemical incidents.

The main aim of the project is to develop a framework for choosing an effective recovery strategy and a compendium of management options soundly based on science, taking into account acceptable, practicable and achievable practices through the involvement of various stakeholders. For this reason, updates will be provided periodically within this publication and any feedback, comments or suggestions will be appreciated and considered.

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- 10 Trade and Environment Database (TED) Case Study- Minamata Disaster

Table 1: Summary of some major chemical incidents

Date	Incident	Incident Type	Chemicals Involved	Fatalities	Injured	Summary
2001	World Trade Center, New York (USA)	Terrorist attack	A 'chemical cocktail' containing asbestos, carbon monoxide, respirable silica, dioxins, polyaromatic hydrocarbons, inorganic acids, oxides of nitrogen and sulphur and metals	2,993 (mainly non-chemical)	6,000 (mainly non-chemical)	A series of coordinated suicide attacks on four commercial passenger jet airlines by Al-Qaeda. Two planes were intentionally crashed into the World Trade Center ^{2,3} .
2000	Enschede, Netherlands	Explosion at a fireworks storage plant	A 'chemical cocktail' composed of gunpowder, charcoal and heavy metals	22	947	An explosion occurred in a fireworks storage plant in which 100 tonnes of explosives were detonated ⁴ .
1995	Tokyo, Japan	Terrorist attack	Sarin, acrylonitrile and methyl cyanide	12	5,510	Members of the religious cult 'Aum Shinrikyo' punctured newspaper wrapped bags and released a chemical mixture into the carriages of underground trains on three lines during the morning rush hour ^{5,6,7} .
1984	Bhopal, India	Industrial chemical incident	Methyl- isocyanate (MIC)	2,000 (reported initially) 4,000 (reported 15 years later)	250,000 (reported to have permanent disabilities)	54,000 lbs of extremely toxic MIC were released from a stock for approx. two hours. The gas cloud covered an area of 2.5km wide and 4.5km long over a densely populated area exposing approx. 200,000 people ⁸ .
1975	Seveso, Italy	Industrial chemical incident	2,4,5- trichlorophenol (TCP), ethylene glycol and 2,3,7,8- tetrachoro- dibenzo- para- dioxin	1 (as a direct cause)	Many (no exact figure)	A safety valve failed and a toxic cloud containing dioxins was released into the atmosphere. This contaminated humans, animals, crops and land in the vicinity ⁹ .
1932-1968	Minamata, Japan	Industrial pollution	Inorganic and organic mercury (methyl mercury)	101 (direct cause) 800 (contributing factor)	No clear figure	Company malpractice led to the by-products of the chemical processes used for the manufacturing of plastics being dumped into Minamata Bay. As a consequence of approx. 32 years of pollution many diseases and strange occurrences, like cats committing suicide, within the community were observed ^{10,11} .

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Can Environmental Health Practitioners add value to the Health Protection Agency?

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Introduction

Within day to day health protection work there are many times when Local Authority (LA) Environmental Health (EH) department's and the HPA's paths may cross – from infectious disease outbreak investigations to chemical fires, carbon monoxide incidents, areas of contaminated land, odour nuisances and flooding. There are many 'grey areas' regarding where one Agency's roles and responsibilities start and the other's finishes. Many investigations require, and benefit from, the skills of both LA and HPA staff, however the level of joint participation may depend on the strength of the relationships that currently exist across the organisations.

The HPA and LA EH departments are complex in their makeup and it's not surprising that staff within the organisations are sometimes unaware of the full range of services offered by the other and do not always have a mutual understanding of the different departments and divisions that exist within them.

In order to improve and enhance these relationships, the West Yorkshire HPU embarked on a unique partnership with the five West Yorkshire LA EH departments. An Environmental Health Practitioner (EHP) was seconded from one of the West Yorkshire EH teams into the HPU on a full time basis for a two year period.

You may ask... *'Why is this unique?' and 'Is it a true partnership?'*...

The unique quality of this secondment lies with the way in which this post is funded – with 50% of the funds from the HPU and the five West Yorkshire LA's each contributing the remaining 50% - 10% per LA!

Is it a true partnership...? A lot of people who work in partnership continue to act as individual organisations and deliver pieces of work separately, but they have meetings and call it partnership working. This secondment in West Yorkshire aims to fade our organisational boundaries allowing us to develop joined up solutions to the health protection issues faced in West Yorkshire.

Shared vision of health and a balanced mix of skills and competencies

EH departments have their origins firmly in sanitary reform and the public health movements. However, over time they have evolved and strands of work have become separated into specialist functions and teams. Many services that used to be joined together now work in silos – housing, food safety, land contamination, pollution etc - competing for funding and having to tackle competing priorities.

With the constraints that EH departments are facing many are finding that they have had to become fixed on the delivery of a narrower agenda and a number of factors prevent involvement in addressing some of the wider determinants of health. Many EH departments reported that they do not have available resources to deliver the new approach and initiatives called for by the modern public health agenda – so this must be done through investment in partnerships such as this secondment in order to provide a win: win situation for all partners.

In 2001 the Chief Medical Officer's analysis of the public health workforce noted that EHPs were the only local government professionals considered to be a full time public health practitioners^{1,2}. In September 2002 the Chartered Institute of Environmental Health (CIEH) and the Health Development Agency published a shared vision for the development of environmental health over the next 10 years: "Environmental Health 2012"³. This document recognises EHPs as key partners in delivering the public health agenda placing them alongside other public health professionals to work in partnership to protect and improve the health and quality of the lives of individuals and communities and to reduce health inequalities^{2,3}.

Partnerships, like this secondment in West Yorkshire, provide a way to strengthen the frontline response to health protection aiding with coordination and facilitating partner organisations to develop and plan services and interventions more effectively, ultimately leading to greater benefits for all. EHPs are able to add value through a wealth of skills and knowledge of public health and a broad perspective on how the activities of the local authority and other professionals/ agencies can improve health and wellbeing together. EHPs have a unique contribution to make through a primary focus on maintaining health rather than curing illness. In such times as we now find ourselves, where LAs are facing tough decisions regarding the allocation of resources and prioritisation of health protection work, the HPA can act as a 'critical friend' to LAs, offering authoritative and impartial health protection advice that can be used to steer LAs in the decision making process.

So what has been achieved within West Yorkshire in the first 12 months of the secondment...?

The first six months of the secondment were very much about familiarisation with the HPU and HPA as a whole, as well as becoming 'known' in all the West Yorkshire EH departments.

Over the following six months we have managed to achieve:

Greater awareness and clarity of roles and responsibilities

The HPU and the five local authority environmental health departments involved in the partnership appear to have a greater awareness and clarity of each others' roles and responsibilities and the services and skills that each organisation has. Personnel within all organisations involved in the partnership have been very positive and supportive of the role.

The profile of the HPU has been raised within all fields of EH work – pollution control, contaminated land, housing, gypsy liaison, animal health; previously, many operational staff within the LA's believed that the HPU only linked with the LA regarding communicable diseases and food safety.

Also the staff within the HPU have become more aware of the diverse nature of the work undertaken in EH teams and the legislative pressures that EHPs have to work within.

Inclusion of HPA representatives at a variety of West Yorkshire wide EH-related meetings

There are a number of established EH groups and meetings across the region, which the HPU and the Chemical Hazards and Poisons Division (CHaPD) of the HPA have not previously been part of, for example:

- Yorkshire and Humber Pollution Advisory Group (with land/ air/ noise sub groups);
- West and North Yorkshire Health & Safety Liaison Group;
- West Yorkshire Principle Food Officers Group.

The secondment appears to have facilitated the inclusion of HPA staff into such groups and it is hoped that this will lead to a closer alignment of shared health objectives in all our business plans and help with the development and delivery of shared practices, policies and procedures.

Sharing of good practice and pooling of expertise

The role is facilitating the sharing of good practice and pooling of expertise across West Yorkshire. There have been West Yorkshire wide shared training events, particularly focusing around lessons learnt from outbreaks and investigations. A further training session is planned for later in the year around the chemistry of urban air pollution, with local case studies.

The development of consistent approaches and shared policy/ practice across West Yorkshire

Work is ongoing in relation to the development of a West Yorkshire shared web-based tool in relation to suspected cases of food poisoning. It is hoped this will aid in the development of a consistent approach to investigation across the West Yorkshire region and make for more efficient use of limited resources. Local contact information has been added into the Carbon Monoxide Action Card⁴, recently produced by CHaPD, and the Action Card has been shared with the LA health and safety and private sector housing teams.

Challenges that lie ahead

Whilst it is clear to see that the secondment has already been beneficial to the HPU and all the West Yorkshire EH departments, the following challenges still lie ahead in the last 12 months of the secondment:

there is a lot that we would still like to do in what seems a very short time;

- keeping visible;
- delivering tangibles;
- determining value added;
- consideration of how to progress the roles after June 2010.

Conclusion

There are now many EHPs permanently employed in a variety of the divisions of the HPA:

- working alongside Health Protection Nurses in HPUs;
- Environmental Scientists in CHaPD;
- working within the Regional Microbiology Network, liaising with LAs on issues such as food sampling and environmental swabbing.

Many HPUs are taking EHPs on secondments for various periods of time – anywhere from 3 months to 12 months – on both a full time or part time basis. However, few HPUs, if any at all, have secondments similar to that in West Yorkshire where all organisations involved have made a financial contribution and have a 'shared resource'.

The unique partnership arrangement in West Yorkshire provides not only a 'win' for the LA EH departments and the HPU, but also a 'win' for the seconded EHP. This is an interesting time to be part of the HPA.

Acknowledgements

Amanda Kilby, West Midlands CHaPD, Mark Brown, Greater Manchester HPU and Dr Naima Bradley, CHaPD – all of whom have given me useful advice during my secondment. Staff in the West Yorkshire HPU – all of whom have made me feel part of the West Yorkshire HPU team.

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A preliminary assessment of information in The Health Protection Agency (HPA) chemical incident database

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Introduction

The Chemical Hazards and Poisons Division (CHaPD) of the Health Protection Agency (HPA) assists front line health protection specialists with the management of environmental events and chemical incidents in order to minimise the public health effects of exposure to chemicals. All information regarding incidents, advice given and actions suggested by CHaPD staff are recorded on an on-line acute chemical incident database. All events reported to CHaPD that conform to the definition of a chemical incident (see Box 1) are entered into the database. This provides a mechanism for the identification of chemical hazards with potential public health implications¹. Quarterly reviews of the database are carried out to inform policy and strategic development within the agency in its role to improve public health. Currently the database is being redesigned and updated to further address the needs of CHaPD in the management of chemical incidents. This current project is designed to ensure that the information recorded in the database is being used effectively to enable better management of chemical incidents and, where possible, identify the cause of incidents. In turn, the analysis of the database may be used as evidence to inform local procedures for incident management.

Box 1: Definition of incident

All incidents representing “an acute event in which there is, or could be, exposure of the public to chemical substances which cause, or have the potential to cause ill health” should be included in the national CHaPD database. All incidents with an off-site impact are to be included, as well as on-site incidents where members of the public are affected. (For the purposes of the definition, hospital staff and emergency services personnel should be regarded as members of the public).

Objective

This investigation examines the information gathered by CHaPD while responding to acute chemical incidents in England and Wales. The data gathered on exposure, mortality, morbidity and the cause of the incident are analysed to assist in procedure development and management of future incidents. This requirement was highlighted in the Chemical Incidents 2005 Report¹.

Methodology

After retrospective analyses of the incidents recorded in the on-line chemical incidents database for the period 1st January to 31 December 2007, a preliminary set of 60 incidents were randomly selected from Wales and the 9 Government Office Regions (GOR) in England. These incidents were reviewed and 20 (2 per region) were analysed for this review.

An initial assessment of the information contained in the on-line logs was carried out in order to try to complete the fields relating to exposure, causes, morbidity and mortality. Where information was not available on the log, those within CHaPD who were involved in the incident were contacted for further details.

Results

Initial Assessment

On initial examination of the chemical incidents recorded on the online system, 8 of the 20 incidents had very thorough records: exposure, evacuation and cause could be determined on examination of the logs. The cause of incident 4 was stated as probable (see table 1) in the log and after follow-up this was confirmed. The estimated numbers of individuals exposed and symptomatic was recorded for 95% (19 out of 20) of incidents before any further investigations. In addition, 19 out of the 20 incidents reported the evacuation status of the incidents, with 60% (n=13) reporting evacuation of the premises in which the incident took place and/or nearby properties. There was poor recording of the causes of incidents (45%, n=9); this may be due to the fact that often this information is not available initially and is only available after the event and requires follow-up. Attention is often focussed on the public health implications during chemical incidents and the surveillance function which plays a very important part in public health protection and prevention is overlooked.

Table 2 shows the HPA incident and emergency plan definitions of event levels. Level definition is dependent on the scale, nature and likely impact on resources. All incidents, with the exception of three were classed as Level 1. Apart from the three exceptions (two of which were Level 2 and one was Level 3) the majority of incidents were small scale events. These Level 1 incidents can be managed locally and without having a large impact on HPA resource.

Number potentially exposed

Exposure assessment data in the incidents used in this study was felt to be good and possibly indicative of the ease with which this information can be obtained. Generally number exposed in an incident does not require follow-up investigations and the information is often recorded immediately by those emergency services in attendance of the incident. Table 3 shows the numbers of

Chemical Incidents

Table 1 show the incidents that were selected for inclusion in the study.

Table 1: List of incidents analysed

Reference (GOR)	Brief description of incident	Cause
1 (North East)	1,6 hexamethylene diamine leak at COMAH (Control of major accident hazards) site involving 37 casualties.	Cause of incident not described (faulty valve/pipework after follow-up).
2 (North East)	Hydrogen telluride fire at an industrial site with 15 casualties.	Cause unknown. (no further info on follow-up)
3 (North West)	Chemical fire at an industrial site involving evacuation.	Cause unknown.
4 (North West)	Chemical blaze at an industrial site. About 62 000 litres of waste on fire, drums exploding and landing on M6, which was closed in both directions. Vast number of cylinders at risk.	Cause most probably accidental. (confirmed after follow-up)
5 (Yorkshire & Humber)	One worker showered with sulphur dioxide during explosion; self presented at accident and emergency department, who sought decontamination advice.	Blocked valve caused pulse release of sulphur dioxide
6 (Yorkshire & Humber)	Power failure on a coke oven plant leading to a release of coke oven gas - this is the normal failsafe. Visible yellow-brown haze over the steelworks; the released gas was 50% water vapour.	Caused by power failure.
7 (East Midlands)	Fire at an adhesives factory, solvents involved.	Caused by static electricity.
8 (East Midlands)	Large fire at fridge recycling plant. Fire and Rescue Service requested information on hydrochloric acid, caustic soda and ammonia. Information passed onto local HPU.	Cause unknown. (no further info on follow-up)
9 (East of England)	Swimming pool chemicals mixed incorrectly, chlorine released. 51-100 exposed but 12 symptomatic and attended accident and emergency.	Caused by human error.
10 (East of England)	20 people exposed to sodium chloride and hydrochloric acid at a public swimming pool. Pool evacuated with 4 taken to hospital suffering respiratory symptoms.	Caused by human error.
11 (West Midlands)	Spill of phosphorus oxychloride at a chemical company who attempted to clean up spill with water. This resulted in the liberation of hydrochloric acid fumes.	Caused by human error.
12 (West Midlands)	Kerosene leak in property. Family experiencing adverse health effects and moved to alternative accommodation.	Caused by carpet fitter putting hole through pipe.
13 (London)	Carbon monoxide in a flat in a block of flats. 10 people transferred to accident and emergency department (6 by ambulance).	Cause unknown. (no further info on follow-up)
14 (London)	Fire with exploding acetylene cylinders; evacuation of local area.	Cause not stated. (no further info on follow-up)
15 (South East)	Sodium hypochlorite fire at fun park with evacuation and 4 exposed.	Cause not stated. (no further info on follow-up)
16 (South East)	Over chlorination of outdoor swimming pool in Sussex. 18 people potentially affected, one self presented at accident and emergency department with skin irritation, shortness of breath distress. Decontamination advice given by National Poisons Information Service.	Cause is human error.
17 (South West)	Ammonia leak at hotel. 8-12 people exposed and symptomatic. Evacuation with road closure.	Cause of leak not stated. (no further info on follow-up)
18 (South West)	Loss of 40 tonnes of petrol and continuing loss of 1 tonne per hour from the oil refinery/terminal.	Cause unknown. (no further info on follow-up)
19 (Wales)	Teenager fell through asbestos roof and sustained serious injuries. Advice about decontamination sought by ambulance.	Cause not stated.
20 (Wales)	Spill of hydrofluoric acid. More than 10 casualties.	Cause of incident not stated. (no further info on follow-up)

the population exposed during incidents and the number of those who sustained symptoms relating to their exposure. The numbers exposed and numbers with symptoms are grouped together for ease of recording.

Given that most incidents were classed as Level 1 it might be expected that the numbers exposed during chemical incidents would not have a large impact on the general population and that those

with symptoms would be less, as indicated in Table 3.

It is noteworthy that the Level 3 incident did not result in population exposure. This was probably due to the fact that information for the public was available early on in the incident to “go in, stay in, tune in”, as well as the closure of a number of schools to prevent public exposure. Had this information not been issued so early on in the incident, there may have been significant public exposure to emissions from the incident.

Table 2: HPA's Level Classification of incident²

Level	Impact	Expected Resource Commitment
1	An incident that has limited local impact although possibly requiring liaison with other responders	Incident response can be managed within the capacity and resources of a single HPU with consultation and support from specialist Divisions
2	An incident that has wider local impact but which can be managed within local or regional resources.	Incident response can be managed within the capacity and resources of two or more HPUs with support from specialist Divisions
3	An incident that has significant impact on resources of one or more parts of the agency. A SCG and STAC will convene and there is likely to be much media interest	Incident response will be managed by at the resources from at least one region of HPA with any required support from specialist Divisions. EOC likely to open and CEO or Deputy Director to decide on the need for NECC
4	An incident that has severe impact on many resources thereby causing major disruption to parts of the HPA. CCC in addition to one or more SCGs and STACs will convene	Incident response will be managed by HPA National Command and Control set-up through NECC. This will be supported by one or more EOCs and the incident is likely to involve more than one region
5	A catastrophic incident that has an overwhelming impact upon the agency. Immediate response will be required with national management. CCC and possible multiple SCGs will convene	Incident response will be managed by HPA National Command and Control set-up through NECC. Response at all levels of the Agency will be required and those agencies without specific duties (in the event) will be expected to support other Divisions. The incident is likely to be protracted and/or have a significant recovery element

Adapted from Incident & Emergency Response Plan²

Abbreviations: CCC – Civil Contingencies Committee
STAC – Science & Technical Advice Cell

SCG – Strategic Co-ordination Group
NECC – National Emergency Coordinating Centre

Table 3: Number of people exposed to chemical incidents and experiencing symptoms

Number exposed (grouped)	Number of incidents
0	5
1-10	4
11-25	6
26-50	3
51-100	1

Number symptomatic	Number of incidents
0	7
1-10	8
11-25	3
26-50	1
51-100	0

Most of the symptoms exhibited by exposed populations were mild and did not have a major impact on hospital resources. However, in the case of one incident where there were 27 casualties it was necessary to send those affected to two hospitals.

In one event the information with regards to the clinical management of those exposed was sought from two different sources. This information was conflicting which led to confusion and had a potential implication on resources. This highlights the need for all those involved in chemical incident response to have clearly defined roles and the importance of remaining within their remit. Information is often misrepresented when relayed through a chain rather than from the expert directly to the front line responders.

Evacuation

The HPA has developed a sheltering or evacuation checklist³ to be used in chemical incidents. Previously evacuation was the first option during chemical air pollution events but it has now been realised that generally sheltering may be more appropriate and effective in protecting population health⁴. Figure 1 shows that sheltering was the preferred option in two chemical incidents and evacuation procedures were implemented in 13 events. However, due to the small numbers of incident in this preliminary study it is not possible to state whether this is the general code of practice. In previous yearly statistics evacuation did not rise above the order of 30 %⁵. Evacuation in some cases was due to the health and safety procedures of premise involved

in the incident and in other cases evacuation was carried out by the emergency services, often as a precautionary measure if there is a potential risk to properties through fire or explosion. During 20% of incidents neither evacuation nor sheltering was required to protect public health as these events were very localised and contained.

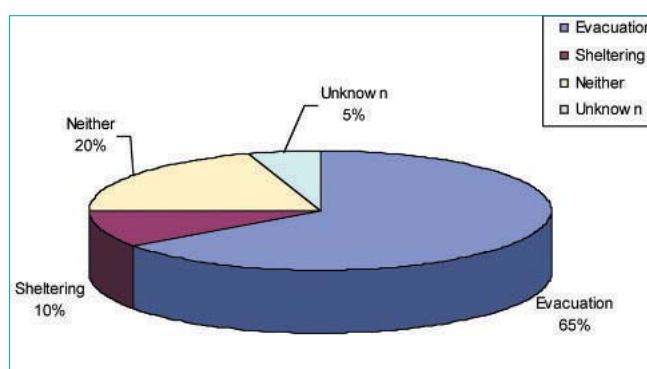


Figure 1: Emergency responders' method chosen method to protect public health

Cause

This is the parameter which is most difficult to ascertain for chemical incidents. Often the cause of an incident is only available after the incident; this information can often be collected through follow-up with other agencies involved or at debrief meetings. It was not

unexpected to find that in only 9 incidents (of the 20) that the cause of the incident was logged before any follow-up.

Generally, even after follow-up by CHaPD, it was not possible to find the cause of the incidents. It was often found that follow-up was not carried out or that a debriefing had not been held. In addition, investigations can be lengthy and CHaPD may not always be informed of the final outcome. For the purposes of this report the causes of chemical incidents have been grouped as shown below:

- 1 **Human error:** The chemical incident occurred as a result of poor procedural execution of individual(s) involved.
- 2 **Technical Fault:** The chemical incident resulted due to failure in equipment
- 3 **Other Accidental:** Those chemical incidents which involve more sensitive sites and for which terrorism has been ruled out but no further details are available
- 4 **Unknown:** the cause of the chemical incident could not be ascertained

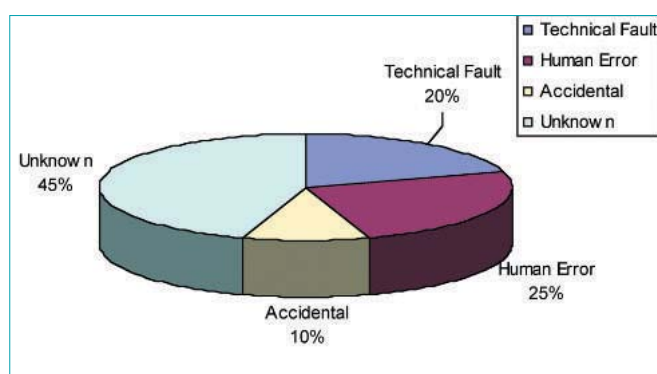


Figure 2: Cause of chemical incident

Figure 2 shows the difficulty in ascertaining the cause of chemical incidents with 45% of events with unknown cause.

Conclusion

This review demonstrated the intrinsic difficulties which are encountered in determining the causes of chemical incidents even after those involved undertake follow-up investigations. CHaPD are involved, where possible, in follow-up, debriefing meetings and other information gathering forum. However, it is not always possible to obtain the information required to determine the cause of the incident. It is often much easier to get information with regards to general exposure of populations, and mortality/morbidity data can be gathered from emergency responders and hospital staff who will often have accurate information of those who have sustained symptoms during the incident, as opposed to approximate estimates of population exposure.

This study has highlighted a number of areas that could be addressed to ensure that more robust information is obtained from future acute incidents:

- 1 Where it is not possible to obtain all details with regards to exposure, evacuation and cause during an incident, scientist(s) involved could attempt to carry out follow-up enquiries at a later date to obtain this information.

- 2 Periodic reviews of the causes of different types of incidents in each region may highlight improvements to ensure that repetition of incidents do not occur. This may also highlight types of events where new procedures may be required. This may involve working with regulatory bodies such as the local authorities and Environment Agency. The database could also be modified to encourage and possibly generate such reviews on quarterly basis (or otherwise).
- 3 Outcome of debriefing meetings should be properly documented in the database and relevant information from any reports by the regulatory body should be recorded especially if the cause was identified as lessons can often be learned from this.
- 4 Debriefing should take place with the intention of learning lessons and updating procedures where necessary.
- 5 Regulators of installations should ensure that the incidents are not repeated by carrying out a thorough investigations and reviews and introducing policies and training where applicable to ensure safer working environment.
- 6 Communication protocols need to be more clearly defined to ensure that the correct information is being relayed to the appropriate person. Roles of individuals and organisations need to be specified and these need to be strictly adhered to during incidents to avoid mistakes during the management of events.

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Conferences & Workshops

International Workshop on Disaster Risk Reduction: Dialogue between Scientists and Stakeholders

UN International Strategy for Disaster Reduction, Europe Office and European Commission, DG Research. 29-30 October 2009, Brussels

Paul Fisher and Virginia Murray
Chemical Hazards and Poisons Division

Overview

This was a fascinating conference that brought together the most eminent researchers in this field of Disaster Risk Reduction (DRR) in Europe. It gave an overview of DRR research and how the UN International Strategy for Disaster Reduction (UNISDR) can work with the European Commission (European Research Area) to better facilitate and co-ordinate research, tools and data systems. DRR has obvious implications for public health and how climate change will affect the severity and frequency of disasters.

The conference described how the Hyogo Framework for Action has been implemented through UNISDR Global, National and Regional Platforms that work to coordinate activity at various levels. The Hyogo Framework for Action is a global blueprint for disaster risk reduction efforts during the next decade. It has, as its goal, the reduction of disaster impacts by reducing human losses by 2015, and in the reduction of losses to social, economic and environmental assets of communities and countries. Throughout the conference there was a particular focus on the key topics of vulnerability and climate change whilst concentrating on excellently presented EU funded research programmes on natural disasters (Box 1).

The conference was full of information so we think the best approach is to share some highlights from the event and summarise briefly developments in climate change, global monitoring and economics of DRR. Highlights included:

- Southern Europe, Japan and Western US have a similar Earthquake hazard but the vulnerability in Southern Europe is 10 fold that of Japan and 100 fold that of the US due to the infrastructure in place.²
- Research that showed there have been 324 tsunamis (including palaeo-tsunamis) in Europe since 6150 BC.³
- Assessment of impacts of natural disasters will be increasingly difficult as the type, magnitude and number of disasters are changing and with a changing population vulnerability. For example the largest number of casualties in Japan is now from landslides.⁴
- 95% of money is spent ex-post disasters and only 5% on DRR before events.⁵

Climate change

The climate change session with presentations from the Intergovernmental Programme on Climate Change (IPCC) 4th Report (2007) was of particular interest.⁶ The political and scientific process behind the international climate change agenda was outlined. This included how IPCC with its three working groups (on the science,

mitigation and adaptation) feeds into the United Nations Framework Convention on Climate Change political process. This has two strands (mitigation and adaptation) and has fed into the Kyoto Protocol with its three mitigation measures (clean development mechanism, joint implementation and emission trading). The next IPCC report, the 5th Report is not due till 2014 but there will be a Special Report in 2011 on 'Managing the Risks of Extreme Events and Disasters to Advance Adaptation'.⁷

Global Monitoring

Three related but different global monitoring systems were presented:

- GEO is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS)^{8,9} This emerging public infrastructure interconnects an array of instruments and systems for monitoring and forecasting changes in the global environment and as of September 2009 members include 80 Governments and the European Commission and 56 Participating Organisations. This 'system of systems' is intended to support policymakers, resource managers, science researchers and many other experts and decision-makers. One of the nine strands of GEOSS is health and comprehensive data sets supporting the prevention, early warning, research, health-care planning and delivery, and timely public alerts have been developed.
- GMES (Global Monitoring for Environment and Security) is the European initiative for the establishment of a European capacity for Earth Observation. Its website is dedicated to the EU-funded R&D activities that support the implementation of the GMES initiative.¹⁰ It has the largest fleet of satellites and atmosphere/earth-based monitoring instruments in the world. It aims at sustaining a European Earth observation capacity with the GMES Emergency Service as a flexible product available to various emergency response actors with investment made available by the EU and SWIFT, a FP7 Coordination and Support Action
- GEM (Global Earthquake Model) is an Organization for Economic Co-Operation and Development (OECD) public-private partnership.^{11,12} An internationally sanctioned program initiated by the OECD (Organization for Economic Co-Operation and Development), aiming to build an independent, open standard to calculate and communicate earthquake risk around the world that is designed to be dynamic: an (updatable) model, not a map, with global: cover also less developed/monitored areas (uniform standards), open access: a (transparent) tool to use for everybody supported by public-private partnership (non-profit foundation): combining the strengths (and objectives) of both sectors

Economics of DRR

At present 95% of money is spent ex-post disasters and only 5% on DRR. A better balance is required. For example the economic costs of disasters are considerable with the Kobe earthquake still having an identifiable effect on the Japanese economy 10 years after the event.

Resource Box 1 – selected links to research projects

Climate change Adaptation and Mitigation Strategies: ADAM
<http://www.adamproject.eu/>
 Climate change: PESETA <http://peseta.jrc.ec.europa.eu/>
 Drought Watch: <http://www.eu-watch.org>
 Earthquakes LESSLOSS: <http://www.lessloss.org/>
 Earthquakes SAFER: <http://www.saferproject.net/>
 Earthquakes Neries project: <http://www.neries-eu.org/>
 Flood risk maps: Risk-EOS <http://www.riskeos.com/>
 FLOODsite <http://www.floodsite.net/>
 Forest Fire Information System: EFFIS <http://effis.jrc.ec.europa.eu/>
 Global Monitoring for Environment and Security: GMES
<http://www.gmes.info/>
 Global Disaster Alert and Coordinating System: GDACS
<http://www.gdacs.org/>
 Group of Earth Observation: GEO
<http://www.earthobservations.org/>
 Landslide mapping: InSAR <http://volcanoeyes.usgs.gov/insar/>
 Natural Disaster Hotspots: A Global Risk Analysis
<http://geohotspots.worldbank.org/hotspot/hotspots.html>
 Plain flood early warning: EFAS <http://efas.jrc.ec.europa.eu/>
 Tsunami early warning system: Nearest
<http://nearest.bo.ismar.cnr.it/>
 Volcanic - Mia Vita: http://www.kell.it/earth-observation/projects_en.htm
 Vulnerability ARMONIA: <http://www.ist-world.org/ProjectDetails.aspx?ProjectId=46f1c981ed3b4821947cd3624b820fb4>

A standard approach is required to formulate the monetary implications of DRR, similar to the Stern Report for climate change. At present a number of different approaches are used, for example, replacement value, depreciation value and value of life costs that can result in an order of magnitude difference in final costs. Insurance also plays a big part in disasters with more developed countries having a wider coverage and lower vulnerability. In 2005, Hurricane Katrina caused \$125 billion of damage of which \$65 billion was covered by insurance. In comparison the 2008 Sichuan Earthquake caused \$85 billion of damage and \$300 million was covered by insurance

Initial outcomes from the meeting included

The meeting was so well received by all the participants that it is hoped that this meeting will be repeated possibly every two years. The presentations were of a particularly high standard and can be accessed on the PreventionWeb site.¹³ In addition UNISDR and EU (European Research Area) have agreed to work together more closely and it is likely that the UNISDR Science and Technical Committee will act as a link between the two organisations.

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Symposium on Healthy and Sustainable Homes and Communities at the Health Protection Agency 2009 conference

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Introduction

This year's Health Protection Agency (HPA) Conference held at the University of Warwick included for the first time a full-day symposium on Healthy and Sustainable Homes and Communities. It focussed on the wide array of issues which contribute to our health through the homes and communities we live within. Supported by the Chartered Institute of Environmental Health, this symposium was an opportunity to re-acquaint ourselves with the enormous contribution that living conditions have played and continue to play in improving our health. Using evidence from new studies and initiatives, the relationship was brought right up to date through a focus on the contemporary issues surrounding environmental sustainability. Just as Victorian public health and planning disciplines understood the health hazards of poor sanitation, poor air quality and overcrowding, the healthy and sustainable homes and communities symposium identified the new health hazards for a modern age and the era of climate change, and what we must do together to minimise the effects of these.

The symposium was split into morning and afternoon sessions with a total of 13 presentations followed by questions and answers and two brief plenary sessions summarising the key aspects which came out from the symposium.

Presentation summaries

The following section of this report summarises the key aspects of the presentations and highlights relevant questions and answers,

New technologies

Derrick Crump of Cranfield University began the day with a focus on indoor air quality and the potential hazards from Volatile Organic Compounds (VOCs) in the home¹. Traditional thinking in building regulations had put the emphasis for improving indoor air quality on ventilation to reduce the concentration of VOCs, however Derrick argued the case eloquently for the control of the source and in particular for low-emitting products, both in the building products forming the building envelope, and in the products and fixtures within the home. The first step could be agreeing a means of labelling VOC emissions from the building materials themselves.

The perceived hidden hazards within new technologies designed to support sustainable living was the conundrum addressed by HPA Chemical Hazards and Poisons Division's (CHaPD) Catherine Keshishian. She described the risks from mercury within the new energy efficient compact fluorescent light bulbs when exposed through accidental breakage². The extremely low levels of likely mercury exposure, coupled with advice on safe clean up minimise any likely harm, and were put into the context of the far greater environmental release of

mercury from the additional electricity generated in order to run the older incandescent bulbs.

Perceived harms in the adoption of new technologies were again central to work presented by Simon Mann of the HPA Centre for Radiation, Chemical and Environmental Hazards (CRCE)³. The new technology being wireless computer networks, with the perceived harm from their widespread adoption in schools being the associated electromagnetic fields. Laboratory testing of school specification laptops showed that exposures are well within current guidelines – the regulatory maximum of 100 mW, and less than that associated with mobile phone usage.

Gemma Yarwood, also of CRCE picked up on similar themes during her presentation on the health risks associated with radiofrequency fields emanating from mobile phones and the base stations required to support the network⁴. No evidence was found for non linear responses of cells and tissues to radiofrequency fields during tested conditions, and the search continues for a proven interaction mechanism or for non-thermal biological effects from low level radiofrequency fields.

Childhood and community health

Gaynor Walker of CHaPD Birmingham and Catherine Alves of the West Midlands East Health Protection Unit presented their collaboration which led to the establishment of a community engagement study day with nursery and childcare staff on issues affecting childhood health in this setting⁵. With the majority of children now placed in some form of formal childcare setting before schooling begins, successful engagement with this sector such as that demonstrated by this project must be key to protecting children's health in the community.

Other aspects of protecting children's health were discussed by Tina Endericks of HPA LaRS London Region. Tina's exciting interactive work with young people led to the development of a UK Children's Environment and Health Strategy in response to the European Action Plan⁶. This UK Strategy is available at the HPA website⁷. One of the issues which children felt was important to both their physical and mental health was to have access to safe open and green space, which was picked up in the next presentation.

Where you live, including the quality of green and shared spaces can have a huge impact on your mental health, and Aideen Silke of NHS Greenwich, and Greenwich Council led participants through the latest work in the London Borough where so much has been done to define the links between housing and mental health. The next stage of this work goes beyond establishing this evidence base into a recently begun case-control study to pilot low cost physical and social interventions on estates to improve mental health and wellbeing. The results of this three year study will be of interest to anybody concerned with reducing health inequalities for the residents of social housing estates⁸.

Building design and climate change

My own presentation sought to define the design principles for healthy

housing⁹ that I had established during my MSc dissertation research undertaken at the University of Brighton¹⁰. In addition to the environmental sustainability features touched on by other presenters, I found that the form and density of buildings and neighbourhoods, the materials used, availability of green and open space and the importance of having a distinct threshold to each accommodation unit were all design features which promoted physical and mental health. These were found to be linked to basic human needs of the type explained by Maslow¹¹, and were affected by potential hazards in the environment and the pervading housing policy and resource systems.

Andy Dengel from BRE (formerly known as the Buildings Research Establishment) gave a fascinating presentation¹² highlighting the need to engage with Government and with builders, building products manufacturers, architects and homeowners on ongoing development and implementation of the Code for Sustainable Homes¹³ with regard to indoor air quality. There are a great many challenges identified if new houses are expected to meet the top level (level 6) of the code requiring them to be zero-carbon by 2016, not least in their design, the adoption of new technologies, and in the need for health concerns such as indoor air quality to become more widely understood by the housing industry.

Angie Bone presented the scoping project she undertook for CHaPD looking at the impacts on occupant health of adaptations to improve energy efficiency¹⁴. Angie introduced the fact that 70% of the dwellings required in the UK by the year 2050 were already built, and thus adaptation of this stock was key for both energy efficiency and the mitigation of climate change effects. Indoor air quality was an issue which spanned hazards such as radon, VOCs, carbon monoxide and mould growth with good ventilation being fundamental to reducing these hazards. The lack of knowledge both in the building trade and by the public of ventilation was highlighted as an area requiring further research, as was the health impact of energy efficient homes under current climatic conditions and those expected in the near future.

The need for adaptation of homes specifically to militate against heat wave was explored by Stephen Porritt of DeMontfort University, in research forming part of the Community Resilience to Extreme Weather (CREW) project¹⁵. Heat waves in the UK are expected to become more frequent as the climate warms, with the potential for catastrophic effects, such as the 35,000 excess deaths in Europe during the 2003 heat wave. Computer simulations of the effects of various building adaptations were modelled on common UK dwelling types, finding that a mix of passive home adaptations could reduce indoor air temperatures to acceptable levels during a heat wave.

Following on from heat waves, it was timely to have input from the Met Office. Wayne Elliott gave a fascinating presentation on the move from weather forecasting to forecasting for health¹⁶. Established and emerging evidence explains a number of relationships between weather and health outcomes, and with projected increases in the incidence and severity of extreme weather events in future years, the need to move forecasting from uncertainty to probability.

The final presentation provided an overview of climate change predictions and their health impacts, from Paul Fisher of CHaPD Birmingham¹⁶. This presentation provided the wake-up call, if any were necessary, on the rapidly changing nature of our climate and the health related repercussions of this. With a focus on the West

Midlands, the increases in summer mortality associated with temperature change were compared with a reduction in winter related mortality, showing a net gain in mortality when average temperatures increase by 8 degrees from the 2004 baseline.

Quiz

The presentations session closed with a fun and informative quiz hosted by Steve Owens - the head of Environmental Management at the HPA¹⁸. "How green are you really?" asked questions as diverse as the amount of household food waste produced annually in the UK (6.7 million tonnes); and the annual business mileage of the HPA staff team (32 million miles).

Plenary session highlights

The closing plenary session was preceded by personal viewpoints from Professor Anthony Kessel – the HPA's new Head of Public Health Strategy, and Dr Gabriel Scully – Regional Director of Public Health for the SW of England.

Anthony discussed the current level of engagement by the public health body in environmental matters – highlighting the conceptual, historical and ethical issues presented. He argued that there had in the past been a degree of disconnect between the public health workforce and environmental issues, which was thankfully narrowing.

Gabriel looked at the public health challenges facing our towns and cities now and compared these with those of the 19th century sanitary revolution. With the growth in housing needed today, there was an opportunity to design communities which enhanced health; however he identified the retro-fitting of existing communities as more problematic. Gabriel also shared some of the frustrations inherent in attempting to reduce his carbon footprint whilst cycling to appointments, only to find that NHS organisations have moved to the most unsustainable locations, highlighting that the health sector still had a lot to learn.

Symposium summary

In addition to the varied subjects covered across all of the equally excellent presentations, the symposium was enhanced by the active and incisive questioning by participants, many of whom stayed for the duration of the day.

The sessions identified many areas warranting further investigation and research, and what appears to be essential in taking these issues forward is the inter-disciplinary approach exemplified by the symposium. Architects, planners, housing developers and providers, scientists, social scientists and public health professionals will need to continue and strengthen the dialogue begun at the symposium if they are to begin to respond to the 21st century health challenges facing our homes and communities.

This was the first time many of the presenters had presented to such a wide multi-disciplinary audience and it is hoped that the relationships begun this September in Warwick will continue and that the symposium will become a regular feature at future conferences.

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Community engagement study day

Gaynor Walker¹, Rea Alves²

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Background

At the time when the HPA West Midlands region began to role out its plan for the Children's Environment and Health Action Plan for Europe (CEHAPE)¹, the HPA was approached by a private nursery for information about common childhood diseases in addition to the information that had already been circulated by their local authorities. Following informal discussions with nursery staff and a nursery manager, it became apparent that there was a need for additional support and information on the following topics: communicable disease control, chemical hazards and poisonings. On 25th March 2009, the West Midlands East Health Protection Unit (HPU) and the Birmingham office of the Chemical Hazards and Poisons Division (CHaPD) held an educational event for independent providers of childcare services within the Birmingham and Solihull area.

Aims

As part of the CEHAPE regional goals, the West Midland East HPU's business plan, CHaPD Birmingham's business plan and the West Midlands Gastro Intestinal group, the educational day was identified as a useful vehicle to:

- provide evidence based, specialist health protection advice
- work with stakeholders to design and deliver training to at risk groups.

Outline of the day

The HPA has a framework of working together², and speakers were invited from both local stakeholders and partner organisations. A venue within central Birmingham was sought for easy access to invited delegates from the two selected areas. Invitations, accompanied by information about the topics that would be delivered, were circulated to private nurseries that had been identified by the HPU. Sixty-five places were offered on a first come, first served basis and 99 people contacted the HPU, with all 65 places allocated. Fifty-one people attended the study day.

The day was organised as a series of lectures, covering the following topics:

- meningitis
- hand hygiene
- asthma update
- managing outbreaks of diarrhoea and vomiting
- mumps, measles and rubella (vaccination?)
- norovirus
- tuberculosis

- chemical incidents in the home.

The chemical session focussed on poisonings in the home. It started by explaining possible routes of exposure and associated statistics (provided by NPIS Annual Report) and briefly discussed classic symptoms that parents should be aware of. The presentation then closed with providing practical advice for preventing poisonings in the home. Particular topics of indoor air quality (carbon monoxide and environmental tobacco smoke) were of interest to parents, as well as the associated hazards of using mercury-containing thermometers.

Discussion

Partnership working format

Engaging with working sectors and communities on a face to face level is an underused but effective way of disseminating information. The day was well received and delegates were responsive to the information presented to them. Working with partner organisations is, and should be, best working practice. Partnership working ensures information is circulated and received in the most effective and easy to understand way, and a mixture of organisations brings diversity to the day. The environment encouraged delegates to ask questions and participate in discussing topics they are unsure about.

However, a number of delegates expressed the view that the day's format of presentations was too formal and did not allow for a great deal of interaction between the delegates and speakers. If this event is to be repeated, consideration could be given to encouraging delegates to participate more actively, e.g. workshops.

Awareness raising in the nursery community

The delegates indicated that this opportunity was extremely beneficial, they were now able to recognise the symptoms of particular infections and poisoning and give parents accurate information and advice regarding communicable disease control. It also gave them the confidence and impetus to begin writing policies for their own setting.

It was highlighted that there was a lot of information within the sessions, and if the project is repeated it is advisable to consider having the sessions spread over a longer period of time.

Although discussions and a questionnaire were completed beforehand with some nursery nurses regarding their training needs, the sample size was quite small. If the project is repeated, a formal training needs assessment is recommended before planning the event. The final feedback from delegates on the day was better than expected and highlighted in the conclusions and within the final circulated report.

Future community days

Ninety-nine individuals requested a place on the study day. This suggests that there is a need for regular information sessions with this particular community. There was little or no attendance from those

who work in Solihull, suggesting that the chosen location in central Birmingham was not ideal or close enough for those people to travel to. It is thought that, if the project is repeated, each town and city could be engaged with locally.

Conclusions

Nearly all (91%) of those who completed the evaluations said that they would attend another study day similar to this one. The HPA could give more consideration to using educational events such as this to engage with local communities, to help reduce incidents of diseases, and health hazards within infants and children.

The HPA, working alongside partner organisations, could successfully play an active and crucial role in educating communities and circulating information to support workforces and community groups in protecting themselves against disease and health hazards. It was implied that this would be welcomed by communities.

Suggested recommendations

- From the number of individuals who applied for a place on this educational event it is clear there is a need for more events targeted at the private nursery worker community. Therefore as part of its business plan, the West Midlands East HPU could run a series of similar events throughout its geographical area.
- To ensure the needs of the targeted community is met, it would be useful to conduct a needs assessment prior to the next educational event.
- Invitations to this educational event were sent out to independent childcare establishments in both Birmingham and Solihull. It was clear from those who attended that delegates would prefer to attend events locally, which could be considered if it is repeated.
- A number of delegates expressed a view that they would have liked to have more interaction with the speakers. The organisers of the event could look at more activities which would encourage delegates to take a more active part.
- The success of the day was due to the successful partnership working between HPA, stakeholders and partners. We therefore recommend that the HPA continue to involve its partners and stakeholders in any further events of this nature.



Figure 1: Delegates at Community Engagement Day receiving chemicals and poisons training.



Figure 2: Asthma training from an Early Years Medical Needs Advisor

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World Future Society workshops and conference, 16-19 July 2009, Chicago

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Introduction

The theme of the World Futures Society annual conference was 'Innovation and Creativity in a Complex World'. This was a fantastic platform to hear about futures thinking from a wide range of experts, and proved to be an interesting and insightful event.

The evolution of humans, an increased ability to gaze into future possibilities combined with the desire to create a world that allows people to maximise their potential and happiness are important aspects of our hopes for future generations. Some evidence suggests that based upon the values and ethics demonstrated by children of the digital era there is in fact great hope for the future. Whilst there is great potential, there are also great challenges, including population expansion, increasing inequalities, climate change, irreversible environmental degradation, and leaps in technological advances.

Creativity will be an essential tool in facing some of the global challenges ahead, and whilst artistic creativity is vital, in futures thinking creativity refers to new ways of operating. In this context creativity is not a luxury but a logical requirement for any organisation that wants to effectively evolve as new knowledge emerges. Creativity is something that can be taught and includes tools that have been developed to systematically breakdown assumptions in order to identify paradigm shifting ideas and concepts.

Perhaps the role of creativity in contributing to the future can be considered in light of inevitable change. Striving for new ways of considering future possibilities, from a realistic view of what currently is:

'Change – complexity – uncertainty – expansiveness – these are both the challenges and the opportunities of what is emerging around us – the double-edged sword of the future. Instead of attempting to avoid or resist the inevitable flow of time, we should consciously and intelligently face tomorrow. We should become educated on the future. We need to evolve our capacities for understanding and thinking about the future – to develop our future consciousness, that is, our awareness of the possibilities, complexities, challenges, and opportunities of the future and our psychological and social capacities to flourish in this reality'.

Futures methodologies

A number of seminars and workshops described different approaches to futures work. Some interesting tools have been developed to model potential futures at a global scale e.g. the

International Futures Model², but there appears to be a significant gap in how emerging technology is considered. The impact of new technologies has often been unpredictable and dramatic, and therefore ignoring technological developments will reduce the confidence in modelled scenarios. Other models have been developed to understand and create the future, which can be used to help consider plausible futures. The Institute for Alternative Futures (IAF) described plausible futures studies as consisting of three main steps, each building on the previous step:

1. Environmental scanning

Environmental scanning involves the identification of emerging trends and developments using a range of sources on a continuous basis. The IAF recommends using **STEEP** as the framework (**S**ocial, **T**echnological, **E**nvironmental, **E**conomic, **P**olitical and **V**alues) with an emphasis on values. Scanning for values can be done via popular media, sociological research and PEW poles for example³. Other sources for scanning include novels, movies and art, which can be important for identifying trends in the social, political and value framework.

2. Forecasting

Forecasting builds on the evidence from scanning to help create estimations of a specific topic in the future. IAF recommends developing a range of forecasts, starting with a 'best guess' (Alpha forecast), what could go wrong (Beta forecast) and path to success (Delta forecast) – they call this their aspirational approach. A 2001 project by IAF and Manchester University delivered a set of forecasts considering the drivers of genomics for the Economic and Social Research Council (ESRC)⁴.

3. Scenarios

Scenarios are alternative descriptions/stories of how the future might unfold and should be used to explore future challenges and opportunities. Strategies that fit with the different scenarios can then be developed. The IAF prefers an aspirational approach to scenario work which builds on the alpha, beta and delta forecasts (see above) over the traditional scenarios approach. Traditional scenario work usually takes two drivers and plots four scenarios but IAF believe this approach is not broad enough, less quantitative and misses the inclusion of an aspirational future to work towards.

The Environment Agency and HPA's horizon scanning methodology and tools not only meet the recommendations of the IAF but actually offer additional benefits⁵; these are provided by the use of technology to store and analyse the scanning information, and not limiting scanning by key words. The IAF's recommendation that forecasts should be based upon scanning evidence also aligns itself with the Environment Agency's approach. Briefing papers produced by the Environment Agency outline emerging issues, identifying the risks and opportunities, and this is reflected (with different terminology) in the IAF's Alpha, Beta and Delta approach.

Public sector futures

Governments are responsible for making collective decisions for and on behalf of the whole country. Government action can affect the future to a great extent and foresight can increase the likelihood that the future can be improved and decreases the chance of harm. Therefore futures methodologies and thinking are essential within government agencies and associated bodies. But the practice of foresight in government is more difficult than foresight in the private sector. Government decisions are scrutinised, the decisions taken apply to all and are accountable to the public therefore decision makers are more cautious i.e. decisions are safe and changes are made incrementally and must be based upon concrete evidence making it difficult to consider possibilities. There is a drive to generate positive outcomes, with little reward for avoiding crises that don't happen. However a global review of government foresight identified some areas of good practice including The Finland Committee for the Future, Alternatives for Washington and the European Foresight Knowledge Sharing Platform.

A number of projects and initiatives that are focussed on futures methods were discussed at the conference, including the Centre for Research in Futures and Innovation⁶ at the University of Glamorgan. This is a new centre that aims to be a European centre of excellence in futures and innovation research. It is managed by the chair of the UK node of the Millennium Project⁷ which is a global, participatory futures think-tank, with over 30 nodes around the world. Recent outputs include the 2009 state of the future and the Futures Research Methodologies reports^{8,9}.

A more forward looking framework of governance is anticipatory democracy which aims to combine citizen participation with future consciousness to deliver a government that transforms less desirable characteristics to more desirable features. Table 1 shows these targets of transformation.

The target characteristics will be more achievable if robust futures methodologies are evolved that can provide an evidence base, and systematic way of continually preparing for the future. The Environment Agency and Health Protection Agency collaboration aims to provide a platform to build futures methodologies upon that could help develop a more anticipatory democratic approach, but will need to consider how public participation could enhance this process.

Emerging technologies

A number of new technologies were discussed at the conference, including genome sequencing, transhumanism, robotics, renewable energy and 'Nanotechnology, Biology, Information technology and Cognitive science (NBIC)'. There is information within the joint Environment Agency and HPA Horizon Scanning database about all these

technologies, which indicates the scanning method is comprehensive. An example of a new technology relevant to health is genome testing, commercial companies are already offering cheap genetic testing kits that can be used by individuals. Common use of such testing could create a large amount of public anxiety and confusion about the significance of results. In the future it might be possible to relate results from genetic testing to susceptibility and improve understanding about how genes and the environment impact upon health.

In addition to new technologies, new initiatives were also discussed which could dramatically influence the future. Examples included the Singularity University¹⁰, that is 'an academic institution in Silicon Valley whose stated aim is to assemble, educate and inspire a cadre of leaders who strive to understand and facilitate the development of exponentially advancing technologies and apply, focus and guide these tools to address humanity's grand challenges'. This is an interesting development that involves some well-known futures thinkers and multi-national organisations. Another example focussed on business models with ethical aims, where business models are created that help with the initial set-up costs and then make profit over the following years as the money is paid back. The main purpose is to improve the standard of living for those in severely resource constrained environments, but also make a profitable business at the same time. This social entrepreneurship is increasing in popularity and more background can be found on the Santa Clara University website¹¹.

There was also stark warning about the lack of preparedness for bioterrorist attacks, the technology is already rapidly advancing that will allow an individual to produce and release a bio-engineered agent with potentially massive effect¹². A proposed strategy to combat such threats was also suggested: 'To prevent bioviolence requires policies that focus on humanity as a species and that are implemented everywhere with centralized governance. Antibioviolence policies must be global.' Incentive schemes need to be altered by governments to help realise a peaceful world, and the potential costs of failure have never been higher.

Evaluation

The collaboration between the Environment Agency and the Health Protection Agency to develop joint horizon scanning tools and methods is using sound and state of the art methods to build an evidence base of emerging science and technology. The Environment Agency already uses this evidence to identify issues, which help prepare and inform strategy. There is also an appetite for greater collaboration and consideration of how to improve the use of scenarios in their futures work. The HPA has identified broad horizon scanning as an essential component to a comprehensive health protection service, and demonstrates the commitment to build on the collaboration and improve how horizon scanning can be performed and used. This conference confirmed the importance of this work and provided invaluable context from many perspectives.

Table 1: Anticipatory democracy targets and aims

Targets of Transformation	Transformed characteristics
Current-issues driven government	Emerging-trends oriented governance
Short-term decision-making	Long-term and strategic planning
Individual agency plans and objectives	State-wide plans with shared vision and goals
Piecemeal solutions to immediate problems	Holistic approaches to cross-cutting issues

Personal reflections

This conference really helped to put horizon scanning in context, and consider some of the very broad issues that will effect how humanity evolves and responds as the world changes. Listening to talks from a wide variety of disciplines continually reinforced the idea that the future will strongly depend upon human behaviours.

Whilst science continues to expand and discover amazing and sometimes unforeseeable things, it is useful to reflect on the place of these advances. What we know, what we don't know, where we are and where we want to be. Our knowledge is limited, and science should acknowledge that not only is it the 'best estimate of truth', it is also subject to observation bias given all science is obtained through human observations. This bias doesn't make science wrong, far from it, as demonstrated by the many applications that reliably make use of scientific endeavours. However it is important to acknowledge that this bias could distract from reality, on a subtle but potentially important level.

There will be an ever increasing need for flexibility and joint working to facilitate adaptation and best practice without trying to consider things in splendid but pointless isolation. Greater collaboration will present many challenges and opportunities to contribute to more sustainable human existence. Whatever the future, holds you can be certain it will be uncertain!

Key messages

- the ability for humans to impact the environment is ever increasing
- new technology already available presents opportunities to influence people on a scale previously unimaginable
- the future of the world will depend more and more upon human behaviours
- understanding influence and behaviour will be critical if governments are to provide useful direction and guidance that encourage sustainability and ethical choices.

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Report on the Dutch Workshop ‘in-vitro modelling of human bioavailability of lead from soils: application to risk assessment of soil quality’

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Bioavailability and bioaccessibility in land contamination risk assessment

In order to assess the potential health effects from exposure to chemicals a benchmark criterion (e.g. Health Criteria Value or index dose), below which adverse health effects are minimal, can be derived from a critical toxicity study. This will involve a particular chemical species, medium of exposure and dose. In chemicals risk assessment, the term bioavailability refers to the fraction of a chemical that can be absorbed by the body through the gastrointestinal system, the pulmonary system and the skin. It can be expressed as the ratio of an absorbed dose to an administered dose. Relative bioavailability compares the extent of absorption between two or more forms of the same chemical, or the same chemical administered in different media or different doses.

Recent research has established that the absorption of inorganic chemicals, such as arsenic and lead, from contaminated soils following ingestion exposure is lower than the absorption of their soluble forms from water and other media used in toxicological studies^{1,2,3}. This is due to various site-specific factors; specifically the source characteristics for both the chemicals and the contaminated soils. These characteristics themselves then exert varying influences on the oral bioavailability of that substance.

Due to the complex and variable nature of chemical bioavailability, site-specific information relating to both the soil and chemical characteristics present is important to allow a more realistic assessment of the risk associated with that specific chemical in that environment. The measurement of bioavailability requires animal (*in vivo*) studies, however, their routine, site-specific, use would be time- and cost-prohibitive as well as raising ethical issues about animal experimentation. Therefore, recent efforts have focused on developing practical and economical bench-top (*in vitro*) procedures to measure the fraction of contaminants in soils that, following ingestion, would be available for absorption into systemic circulation. This extractable fraction is referred to as the amount that is “bioaccessible.” However, research efforts have been ongoing to adequately validate *in vitro* extraction methods against appropriate *in vivo* (animal) data to allow their routine use as a surrogate of animal models.

Workshop

A workshop on the ‘*In-vitro* Modelling of Human Bioavailability of Lead from Soils: Application to Risk Assessment of Soil Quality’ was jointly organised by the Dutch National Institute of Public Health and the

Environment (RIVM) and the Netherlands Organisation for Applied Scientific Research (TNO) and took place on May 14, 2009 in the Netherlands. This workshop was itself a follow up of an international review undertaken for the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM) on a project report entitled ‘Relative Oral Bioavailability of Lead from Dutch Made Grounds’⁴. The project report⁴ describes the application of two different *in vitro* test methods (i.e. RIVM’s *in-vitro* digestion (IVD) and TNO’s GastroIntestinal Model (tiny-TIM)) to estimate the oral bioaccessibility of lead to a set of samples which were collected from Dutch made grounds.

The report concludes that the IVD and Tiny-TIM methods produced contrasting estimates for the oral bioaccessibility and the relative bioavailability factor for lead. The IVD method gave a relative bioavailability of 0.67 (50th percentile) whilst the Tiny-TIM method gave a value of 0.12 for (50th percentile) for the same samples. These contradictory findings could have considerable implications in risk assessment and management, and at the workshop external reviewers were requested to consider the findings of the report⁴ in light of the questions in Box 1.

Box 1: Review Questions⁵

1. What are the strong and weak aspects of both *in vitro* digestion models? How can the weak aspects be improved?
2. Ideas about the main reasons for the large differences in bioaccessibility obtained with each model
3. How well have both models been compared to human and animal bioavailability data?
4. Is it possible to indicate, based on the present information, which model you expect to give the most realistic estimate of relative bioavailability? This includes both the determination of the bioaccessibility, and the translation of bioaccessibility to a relative bioavailability factor for lead in soil. Which model is that and why do you think so?
5. What is your recommendation in order to be able to appoint or develop an *in vitro* digestion model that can be safely applied in human health risk assessment of contaminated soils? Do you think one of the presently discussed models can be used for this. A balance needs to be sought between the additional experimental research, the reliability of the method, the costs, and the time frame before implementation.

The workshop gathered together five reviewers: Mike Beringer and Karen Bradham from the US Environmental Protection Agency, Stan Castreel from University of Missouri, Pat Rasmussen from Health Canada and Sohel Saikat from the UK Health Protection Agency. Representatives from RIVM, TNO, Dutch Soil Protection Committee, the Dutch VROM Ministry and the Bioaccessibility Research Group of Europe (BARGE) were also in attendance. Research scientists from

RIVM and TNO presented their respective *in-vitro* methods, highlighting the scientific/physiological rationale of these methods, their validation and strengths.

Workshop conclusions

After discussion it became clear that there was a broad consensus on the research findings and possible way forward. Based on the data, both models were considered not yet appropriate for measuring bioavailability data. For regulatory acceptance, the need for correlation of *in-vitro* models with *in-vivo* data was emphasised. The chosen model should preferably be simple to use, sensitive to changes in lead and soil specific characteristics and accompanied by QA/QC procedure. The detailed conclusions drawn at the end of the workshop are given in box 2 (without any modification)⁵:

Box 2: Conclusions Drawn at the Workshop⁵

- For a regulatory framework, expensive tests like *in-vivo* studies can be run. For site specific studies, a cheap and simple method with a high throughput should be used.
- The selection of the best *in-vitro* model should be predominantly based on how well its results correlate with *in-vivo* data. For a large range of bioavailabilities a robust relationship between *in-vitro* and *in-vivo* data should be demonstrated. In addition, the selected model should be
 - simple (feasible to be run at more than one location)
 - responsive to different lead and soil characteristics
 - accompanied by rigorous Quality Assurance/Quality Control data requirements
- For both IVD and TIM methods more validation with *in-vivo* data is needed. This should be done by measuring the bioavailability of lead in made grounds in young swine.
- Information on the soil and lead characteristics in relation to their influence on bioavailability indicates the suitability of an *in-vitro* method for different soil types. In other words: The use of the *in-vitro* method is limited to the soil and lead characteristics the model was validated for.
- *In vitro* digestion (IVD) model could be used but attention should be paid to the reproducibility of the method (e.g. more replicates or adding more soil but keeping the soil:liquid ratio the same). Simplifying the IVD method to only the gastric phase should be considered.
- TIM could be used but a lower solid/liquid ratio in the gastric phase is needed (try 0.05, 0.1 and 5 to see influence of soil mass).
- All the different 'bioaccessibility terms' (absolute, relative to PbAc, relative to food) make the discussion of this subject overly complex. Therefore, in the future the use of the term absolute bioaccessibility is preferable as much as possible.

Significance and relevance to the UK

Lead is a common soil contaminant in various parts of the UK. In general, the source of this lead is geogenic due to mineralisation and subsequent weathering (originating from the underlying geology) and exacerbated by past mining and smelting operations. Anthropogenic sources such as spreading of sewage sludge to land, atmospheric deposition from coal fires and motor vehicles also contribute to the overall lead burden in soil. The health effects of lead have been well studied – they include reduced cognitive development and intellectual performance in children.

In contaminated land exposure assessment modelling in the UK, a default lead bioavailability estimate is used in the derivation of generic assessment criteria i.e. Soil Guideline Values (SGV). This lead SGV is, however, currently under review by the Environment Agency and may include a review of the default bioavailability estimate used. A SGV for a chemical refers to a concentration in soil at which exposure to that chemical is equal to toxicologically-based Health Criteria Value or tolerable concentrations, and thus provides a means of assessing risks to human health in relation to different land uses.

Reliable site-specific bioavailability data for lead may be used to improve the accuracy of exposure and risk assessment modelling. However, the determination of bioavailability requires either the measurement of blood lead levels in a potentially exposed population sample or the use of suitable animal model(s) as a surrogate for human exposure to contaminated soils. These options are unlikely to be acceptable in the UK. In recent years, like the Netherlands, the interest in the UK has been in the development/exploration of suitably validated *in-vitro* bioaccessibility methods. The recent findings in the Netherlands^{4,5} can, therefore, inform relevant parties in the UK of the current state of science in the development and application of *in-vitro* method for measuring lead bioaccessibility as surrogate of bioavailability.

Conclusion

The current state of science and lack of authoritative guidance on the use of *in-vitro* bioaccessibility data, indicates it may be appropriate to remain cautious about the interpretation of *in-vitro* data and where appropriate, ask for details about the methods used and provision of multiple lines of evidence to increase confidence in data supplied.

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Water Challenges and Health, Royal Society for Public Health, London 3 November 2009

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Provision of sufficient quantities of safe drinking water is key in ensuring a high standard of public health. Climatic and environmental changes, together with population growth, are affecting the provision of drinking water in many countries, including the UK. This brings challenges to the water industry and public health practitioners.

This one day conference brought together experts from different water backgrounds to review and discuss these challenges and their effect on the availability of water at current levels of consumption. It focused on water resources in the UK, water borne disease, rainwater harvesting, grey water reuse and sewage effluent recycling.

Speakers on the day included:

A keynote address was given by Prof Jamie Bartram from the University of North Carolina at Chapel Hill on water challenges and solutions.

- Dr Peter Marsden, Drinking Water Inspectorate (DWI) – Tap Water Consumption

As the Principal Inspector of the DWI, Dr Marsden discussed the facts and derivation of figures regarding water consumption in the UK and the methodology behind a survey, which showed an interesting finding that whilst men tend to consume more fluid than women, women tend to drink more tap water!

- Dr Gordon Nichols, Health Protection Agency (HPA) – Waterborne Disease in the UK

Dr Nichols from the Gastrointestinal, Emerging and Zoonotic Infections Department (GEZI) of the HPA discussed the past, present and future problems of drinking water derived from mains and private water supplies and presented findings based on research and surveys regarding waterborne outbreaks.

- Dr Jim Foster, DWI – Emerging Drinking Water Quality Issues

Dr Foster is Deputy Chief Inspector of the DWI and during his presentation, emerging drinking water issues in regard to chemicals and pathogens were highlighted. In addition, current research and future research areas were discussed and identified during the presentation. Dr Foster concluded that a robust regulatory process exists, which covers emerging issues as well as known ones and that few emerging pathogens are relevant to drinking water in England and Wales.

- Dr Lisa Barrott, Chartered Institution of Water and Environmental Management (CIWEM) – Effluent Reuse

Dr Barrott forms part of the Water Supply and Quality Panel at the CIWEM and provided an overview of issues such as health impacts and public perception regarding effluent reuse.

- Mr Reginald Brown, Building Services Research and Information Association (BSRIA) – Developing Standards for Grey Water

Mr Brown is Head of Energy and Environment at the BSRIA and covered problems associated with risk assessment and the management and monitoring of grey water systems. Mr Brown expressed during his presentation that water quality guidelines should be based on end use and risk assessment, but generic guidelines are possible.

A second keynote address was given by Rt Hon John Gummer MP on the water challenge we face. Mr Gummer is currently the chairman of Sancroft and Veolia Water UK and was previously the Secretary of State for the Environment between 1993 and 1997.

- Mr Blane Judd, Chartered Institute of Plumbing and Heating Engineering (CIPHE) – Using Water Wisely

Mr Judd is Chief Executive of the CIPHE and gave an overview of new appliances and systems and problems associated with plumbing practices. In addition, key health issues were addressed during the presentation. Mr Judd concluded that it is important to employ competent plumbers to design, install and maintain plumbing systems and use current Standards and preferably UK certified products wherever possible.

- Dr Fayyaz Memon, University of Exeter – Rainwater Harvesting

Dr Memon provided an overview of rainwater harvesting and several proposed systems and technologies and discussed their viability during the presentation.

- Mr Geoffrey Bond OBE, Papplewick Pumping Station Trust; Water Education Trust (WET) – The Environment, Water and Education

Mr Bond provided the history of Papplewick Pumping Station and presented the development of the Papplewick Pumping Station Trust and its volunteers. Mr Bond also discussed the aspirations of the trustees for nationwide water education.

The Global Water Initiative: Implications of regional climate variability on water resources in Africa, University of Cambridge, 21-23 September 2009

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Background

One of the targets of the United Nation's Millennium Development Goals is to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. In 2008 about 2.8 billion people were living in river basins with some form of water scarcity, either physical or financial¹. There is concern that water scarcity may be exacerbated by climate change. Already temperature and rainfall patterns are changing. For example climatic changes in coastal areas of Western Africa are resulting in unpredictable effects on water resources². These impacts are not restricted to developing countries. In California, where much of the available water is held in glacial stock, changes in average temperatures resulting in faster rates of melting may result in a greater proportion of the run-off escaping³.

The Global Water Initiative

The Global Water Initiative (GWI) is a collaborative project between the Cambridge Centre for Energy Studies and the University of California, San Diego, to address the issue of present and future impacts of climate change and air pollution on water availability and water related risks in California, the Himalayas and West Africa.

The GWI organised two workshops, one in California and one in Cambridge, with the intention of bringing together experts from around the world to examine the science, technology and policy issues around water and water resource management and how to adapt in view of climate change as well as other future stresses.

The GWI's September 2009 workshop, held in Cambridge, had a particular focus on African regions. It was attended by over 100 delegates from the two universities as well as other academics, leading African meteorologists and decision-makers.

Held over three days, the workshop consisted of a number of plenary sessions, with over 25 presentations, interspersed with breakout sessions, poster presentations and discussion. The issues that were addressed over the three days fell under the broad themes of Climate science, Communication, Data Issues, and Adaptation.

Climate science

A number of speakers presented on the features of the climate in Africa and used different models to describe projections of how climatic conditions might change in the future.

Climate modelling involves complex mathematical calculations incorporating processes such as wind, ocean currents, surface temperatures and human activity to predict climate. Although most models agree that the earth will warm up in the coming years, there is some degree of uncertainty in all these models with regard to extent of change and timescale. The uncertainty in climate projections arises because of the large number of variables involved e.g. ocean currents, land surface features,

aerosols and the carbon cycle⁴. One of the key sources of uncertainty lies in predicting how levels of carbon dioxide emissions will change, which in turn depends on estimating economic and social growth in the coming years⁵. Other factors that introduce uncertainty are limitations in knowledge and lack of computers with processors powerful enough to calculate all possible interactions between the different variables⁵.

Communication

The communication of uncertainty in climate projections by researchers to policy-makers was raised as a hurdle in climate change mitigation. Along similar lines, it was felt that the research community should proactively engage with policy-makers, and that in Africa, the research agenda should be more responsive to local need.

Data issues

Data constraints were reported around the validity of measurements of local weather conditions on a day to day basis e.g. levels of rainfall and temperature. Concerns were also raised regarding the timeliness and management of data flow between local weather stations and upstream meteorological centres. Linked to this were discussions about existing local capacity, and the need to develop this further to enable more effective collection, transfer, analysis and use of data.

Adaptation

The final theme was climate change adaptation to ensure that effects on food and health are minimised. Some measures have already been trialled, such as introducing alternative crops as dietary substitutes of staple foods. Whilst such measures may help in addressing problems of food scarcity, they require considerable cultural shifts which may not be acceptable.

And...population

Although not a focus area for the workshop, concerns about population growth emerged. It became clear that climate change mitigation on its own, without addressing unsustainable population growth, would not be sufficient to tackle current and future issues around resource scarcity.

References

- 1 **United Nations. The Millennium Development Goals Report 2008.** Available at: http://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2008/MDG_Report_2008_En.pdf#page=42
- 2 **Cambridge Judge Business School, Centre for Energy Studies. Global Water Initiative.** Available at: <http://www.futureofenergy.org.uk/index.php?page=cambridge-ucsd-global-water-initiative> (accessed on 20/11/2009).
- 3 **Dettinger M. California's experiences with regional sustainability assessments. Presented at the GWI workshop: Implications of regional climate variability on water resources in Africa, University of Cambridge, 21-23 September 2009.**
- 4 **Pope V. 2007. Models 'key to climate forecasts' [online].** Available at: <http://news.bbc.co.uk/1/hi/sci/tech/6320515.stm> (accessed 20/11/2009)
- 5 **Met Office: Climate Projections [online].** Available at: <http://www.metoffice.gov.uk/climatechange/science/projections/> (accessed on 20/11/2009).

Upcoming conferences and meetings of interest

International Conference on Children's Health and the Environment – February 2010



The 5th International Conference on Children's Health and the Environment is organised by INCHEs – the International Network on Children's Health, Environment and Safety. The objectives are to provide an international forum for the latest research findings in paediatric environmental health; to provide insight in the field of science and policy interface; to define the relationship between environmental contaminants and children's health; to identify opportunities to minimise childhood exposure to environmental contaminants; to build a multi-sectoral platform of knowledge at an international level; to initiate policy review and future directions in research in the field of children's environmental health.

The conference takes place from 1 to 3 February 2010 at the Institute of Science in Bangalore, India.

For more information, see <http://www.inchesnetwork.net/>

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



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

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

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

Environmental Quality and Human Health – SEGH, June 2010



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

The SEGH 2010 conference takes place from June 27-July 2, 2010 in Galway, Ireland.

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

Network Conference on Persistent Organic Pollutants (POPs) – April 2010

The 4th Network Conference on Persistent Organic Pollutants has an overall plenary theme of 'Recent and Potential Additions to the Stockholm Convention'. Key research areas to be discussed include: human exposure (trends, pathways, biomarkers); human health impacts; measurement and modelling of environmental levels, fate and behaviour; advances in the sampling and measurement of POPs; ecotoxicology; formation, sources, emission inventories and release pathways; regulatory aspects.

The 2010 POPs conference will be held at the University of Birmingham on 20-21 April 2010.

For more information, see www.gees.bham.ac.uk/research/projects/nercpops/conference4.shtml

Training Days 2010

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

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

One day training events

How to respond to chemical incidents

3 February 2010, Holborn Gate, London
 26 February 2010, Holborn Gate, London
 Further autumn 2010 dates to be announced

This course is designed for all those on the public health on-call rota, including Health Protection Unit staff, Directors of Public Health and Primary Care Trust staff; hospital emergency department professionals; paramedics, fire and police professionals; and environmental health practitioners who may have to respond to incidents arising from the transport of chemicals.

Aims:

- to provide an understanding of the role of public health in the management of chemical incidents
- to provide an awareness of the appropriate and timely response to incidents.

Topics covered:

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

There will be a charge for these events; please see page 88 for booking details. A maximum of 40 places are available.

Understanding public health risks from contaminated land

11 March 2010, Holborn Gate, London

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

Aims:

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

Topics covered:

- principle and current issues relating to the management of contaminated land incidents and investigations including:
 - the toxicology underpinning derivation of tolerable concentrations
 - Soil Guideline Values
 - the local authority perspective on implementing Part II A
 - the risk assessment process
 - the nature of public health risks from contaminated land and risk communication
- process for public health response to contaminated land issues
- types of information available and potential limitations of risk assessment models used by different agencies investigating contaminated land
- roles and responsibilities of different agencies involved in investigating and managing contaminated land.

There will be a charge for these events; please see page 88 for booking details. A maximum of 40 places are available.

Training Days 2010

Incidents during transport of hazardous materials

29 April 2010, Holborn Gate, London

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

Aim:

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

Topics covered:

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

There will be a charge for these events; please see page 88 for booking details. A maximum of 40 places are available.

Operational lead workshop

March/April 2010, Holborn Gate, London

This course is designed for environmental health practitioners, but will also be of interest to Health Protection Agency and NHS staff who have responsibility in responding to or preventing lead poisoning cases.

Aim:

- to understand the role of environmental and public health practitioners in managing cases of lead poisoning.

Topics covered:

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

There will be a charge for these events; please see page 88 for booking details.

Training Days 2010

Carbon monoxide workshop

25 May 2010, Government Office of the West Midlands, Birmingham
October/November 2010, London
March 2010, North West region

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

Aims:

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

Topics covered:

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

There will be a charge for these events; please see page 88 for booking details.

Odour workshop

TBC, Holborn Gate, London

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

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

Aims:

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

Topics covered:

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

There will be a charge for these events; please see page 88 for booking details. A maximum of 40 places are available.

Training Days 2010

One week training courses

Introduction to environmental epidemiology

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

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

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

The fee for this course will be around £700. A maximum of 20 places are available.

Please see page 88 for booking details about this event.

Essentials of toxicology for health protection

24-28 May 2010, King's College, London

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

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

The fee for this course will be around £600 for HPA staff and £1000 for non-HPA staff. A maximum of 30 places are available.

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

Please see page 88 for booking details about this event.

Training Days 2010

Essentials of environmental science

November 2010, King's College London

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

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

The fee for this course will be around £600 for HPA staff and £1000 for non-HPA staff. A maximum of 30 places are available.

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

Please see page 88 for booking details about this event.

Table 1: Competency levels (HPA Workforce Development Group)

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

2010 calendar of chemical training courses

Date	Title	Length of event	Level of event*	Venue
3 February 2010	How to respond to chemical incidents	One day	1	Holborn Gate, London
15-19 February 2010	Introduction to Environmental Epidemiology	Five days	3	London School of Hygiene & Tropical Medicine
26 February 2010	How to respond to chemical incidents	One day	1	Holborn Gate, London
11 March 2010	Understanding public health risks from contaminated land	One day	2/3	Holborn Gate, London
March 2010	Carbon monoxide workshop	One day	2/3	North West region
March/April 2010	Operational lead workshop	One day	2/3	Holborn Gate, London
29 April 2010	Incidents during transport of hazardous materials	One day	2/3	Holborn Gate, London
24-28 May 2010	Essentials of Toxicology for Health Protection	Five days	3	King's College, London
25 May 2010	Carbon monoxide workshop	One day	2/3	Government Office West Midlands, Birmingham
October/ November 2010	Carbon monoxide workshop	One day	2/3	London
November 2010	Essentials of environmental science	Five days	3	King's College, London
Autumn 2010	How to respond to chemical incidents	One day	1	Holborn Gate, London
TBC	Odours Workshop	One day	2/3	Holborn Gate, London

*Please see Table 1 for details of competency levels

Booking Information

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

Those attending CHaPD courses will receive a Certificate of Attendance.

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

Other training events

CHaPD staff are happy participate in local training programmes across the country and develop courses on other topics. To discuss your requirements, please contact Karen Hogan on 0207 759 2872 or at chemicals.training@hpa.org.uk

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

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