Chemical Incident Report

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Editorial

Dr Virginia Murray, Director, Chemical Incident Response Service

In this Chemical Incident Report the Chemical Incident Response Service (CIRS) highlights the following for public health professionals and staff working in accident and emergency departments:

- **Mass Casualty Chemical Incidents:** following the events of 11 September 2001 in the United States where four airplanes were high-jacked, with three flown into buildings in New York and Washington, concern about mass casualties and the management of such events has risen. This Chemical Incident Report (CIR) concentrates on sharing incident reports from around the world on chemically related mass casualty events.
- **Documents on Chemical and Biological Deliberate Release** have been prepared by the Department of Health and are being circulated. The hospital response briefing document is included in full, CIRS is grateful to the authors and the Department. Identification of unusual diseases has also been addressed and a summary from this guidance is included.
- **'White powder' incidents** have occurred across the UK. Two Health Authorities provide summaries of their recent experience. Chemical contamination has been identified in one of these events

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Mass casualty incidents

Virginia Murray, Director, CIRS

A review of worldwide mass casualty events from chemical industry or transport incidents was undertaken using the Major Hazards Incident Data Service (MHIDAS) maintained solely by AEA Technology plc on behalf of the UK Health and Safety Executive's Hazardous Installations Directory. It was established in 1986 as a method for recording incidents involving the transportation, storage or processing of hazardous materials which resulted in, or had the potential to produce, an off-site impact.

This search looked for events resulting in more than 25 dead and more than 100 injured covering 1975 to 1999. 25 major mass casualty events have been identified (table 1). 24 were explosive or petroleum product fireball related and one was a chemical release. All events killed 28 or more people with all resulting in more than a hundred casualties with the Bhopal incident resulting in more than 2,000 dead with approximately 170,000 casualties. This is summarised on pages 5-8 of this Chemical Incident Report (CIR).

MHIDAS however does not include incidents from natural or malicious causes or those that have occurred since 2000. In this CIR the following incidents are summarised to provide an indication of investigation strategies and some of the lessons learnt:

- Flixborough, explosion 1974
- Bhopal, chemical release 1984
- Lake Nyos gas eruption, 1986
- Halabja and chemical agents, 1988
- Chemical terrorism in Japan, 1994 and 1995
- Fireworks in Holland, 2000
- Toulouse, France, September 2001

These and many other disasters have occurred world wide which have influenced national and international legislation. The ability of health professionals to respond to these events remains paramount.

Reference

Major Hazards Incident Data Service maintained by AEA Technology plc for UK Health and Safety Executive's Hazardous Installations Directory. Complete to July 2001

Table 1: List of worldwide mass casualty industrial and transport chemical incidents where more than 25 were killed and more than 100 were injured between 1975 and 1999 in date order (MHIDAS 2001)

Date	Country	Chemical	Incident summary	Dead	Injured
12 November 1977	South Korea	Dynamite	Large explosion on train due to watchman falling asleep & knocking over candle in a freight car. This fire spread causing load to explode at a crowded station.	57	1,300
11 July 1978	San Carlos, Spain	Propylene	Overfilled road tanker releasing cargo in campsite caught fire and bleved. Fireball killed many lightly clad campers immediately, many others died from burns later.	>200	>100
16 November 1980	Thailand	Munitions	Accident in anti-tank rocket factory led to series of explosions at ordance depot. Initial blast thought to be caused by worker making poor connection on rocket fuse.	54	353
04 August 1981	Mexico	Chlorine	Goods train derailed at high speed trying to avoid passenger train in station. 4 tank cars carrying chlorine punctured releasing contents. Gas spread rapidly causing deaths/injuries. Took 3 days to clean up liquid spill.	28	1,000
19 December 1982	Venezuela	Fuel oil	Violent explosion occurred while a fixed roof storage tank was being gauged allowing burning oil to flow into bund. After burning for 6 hours a massive boil-over occurred projecting tank contents hundreds of feet in all directions.	>153	500
31 August 1983	Brazil	Gasoline	3 tank units began leaking after train derailment. Hundreds of local residents collected/stole leaking fuel. Explosion after 12 hours.	42	>100
29 September 1983	India	Gasoline	2 rail tank cars loaded with gasoline exploded at railway station.	41	>100
19 November 1984	Mexico	LPG	LPG leak ignited, possibly by gas burner. Within minutes 2 spheres bleved simultaneously, numerous further bleves in next 75mins. only 4 out of 54 vessels intact.	>500	2,500
03 December 1984	Bhopal, India	Methyl isocyanate	Cloud of MIC released at union carbide pesticide plant following runaway reaction when water entered 45te storage tank. See page 5-8 for summary.	>2,000	170,000

Table 1 List of worldwide mass casualty industrial and transport chemical incidents where more than 25 were killed and more than 100 were injured between 1975 and 1999 in date order (MHIDAS 2001)

Date	Country	Chemical	Incident summary	Dead	Injured
10 April 1988	Pakistan	Ammunition	Ammunition dump on city outskirts went up in a series of explosions. Local residential areas showered with hundreds of rockets, bombs, shells and pieces of shrapnel which travelled up to 10km. thought to have started with fire in truck.	>100	>1000
4 June 1988	Arzamas, CIS	Industrial explosives	3 box cars of industrial explosives detonated as train approached station.	73	230
4 June 1989	Ufa, Bashkiria, CIS	Gasoline / liquid petroleum gas	Long distance pipeline carrying 30% gasoline/70% LPG thought to be leaking for 4 hours before spark from passing trains ignited gas cloud in massive explosion/fire.	>500	>500
September 1991	China	Not specified pesticide	Fire when valve on tank with 3.4 tonne of pesticide chemical hit tree branch. Driver moving through prohibited area visiting friends.	30	650
15 February 1991	Thailand	Dynamite	Truck carrying dynamite overturned at sharp bend and exploded after 1 hour. Explosion thought to be caused by cigarette. Villagers looting truck and crowding around wreckage killed in blast.	171	>100
24 March 1992	Senegal	Ammonia	Explosion & fire in ammonia tank at peanut processing factory.	41	403
22 April 1992	Mexico	Petrol/ hexane	Series of explosions in city sewers caused collapse of buildings over wide area. Cause thought to be either leak of petrol from pipeline or illegal discharge of hexane from food oil plant.	>200	>1000
28 April 1995	South Korea	Natural gas	Puncture of gas pipe by excavator & ignition by welding operations underground caused explosion & fireball. Steel plates used as temporary road surface, together with cars, buses & trucks thrown into air causing many fatalities.	100	200
31 January 1996	China	Dynamite	Explosion of 10 tonne illegally stored dynamite in basement destroyed five storey building. All property within 100m flattened.	>100	>400
14 May 1996	Yemen	Ammunition	Explosion at ammunition dump from electrical short circuit sparked blast at military compound. Camp near country's only oil refinery.	38	>100
15 April 1997	Saudi Arabia	? Gas cylinders	Muslims on pilgrimage to Mecca fled in panic when fire engulfed 70,000 tents. Cause of fire thought to be exploding gas cylinders.	343	1500
14 February 1998	Cameroon	Petrol	Two petroleum tanker trains collided and derailed near a petroleum depot. Spilled petroleum was being collected by a large crowd of people when it caught fire due to a discarded cigarette.	>120	>150
18 October 1998	Nigeria	Petrol	Blast from a leaking pipeline. Vandals had caused leak and over a 1,000 people gathered to collect fuel to sell on black market. Fire caused by cigarette or spark ,	>700	>100
16 May 1999	Pakistan	Gasoline	Tanker carrying gasoline swerved to avoid cyclist & overturned. Gasoline spilled over large area, near shops. Villagers were collecting spilt gasoline when it burst into flames, killing all nearby. Cigarette or burning match is thought to be responsible.	>60	>150
19 September 1999	Thailand	Potassium chlorate	Fruit processing plant explosion. Suspected that spark ignited illegally delivered material to factory.	35	>100
26 September 1999	Mexico	Fireworks	Explosion in warehouse of illegal fireworks factory, with up to 5 tonne gunpowder, affected crowded market and caused explosion in restaurant.	>50	>300

Flixborough, England, chemical disaster 1974

Virginia Murray, CIRS

"It was a still, warm sunlit afternoon....the day the clocks stood still. It was 1 June… and it was 4.53pm. A time to live. And a time to die. One moment the teacups were tinkling and kettles whistling. The next moment a blast of nightmarish intensity as the giant plant blew up and blotted out the sun…" This is an extract from the Humberside police report on the explosion.[1]

Incident summary

On June 1, 1974 a vapour cloud explosion destroyed the Nypro (UK) Ltd cyclohexane oxidation plant at Flixborough, England killing 28 people with 36 employees injured. Other plants on the site were seriously damaged or destroyed and the site presented a scene of utter devastation (figure 1).

The accident was traced to a poorly qualified design team that were asked to design and install temporary piping.[2] A new process, making caprolactam a monomer which can be polymerised to a form of Nylon from hydrogenation of phenol, was extended to produce 70,000 tons at Flixborough in 1971. This used a chain of six huge metal reactor vessels placed in line. Reactor 5 developed a cracked section on 27 March 1974 and was taken out of line by inserting temporary piping which included two 'dog legs' in its design. These did not withstand the June 1 changing temperature and pressure conditions and ruptured, releasing a cloud of approximately 14 million cubic feet cyclohexane vapour. An enormous black mushroom cloud laden with debris rose to over 1.6 km above the plant. Falling debris started small fires up to 5 km away. Outside the works there were 53 recorded casualties with 'hundreds more' suffering relatively minor unrecorded injuries. 1,821 houses and 167 shops and factories were damaged

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Despite efforts to try and establish the source for the Flixborough, Bhopal and Halabja some of the photographs used within this CIR we were unable to determine the origin of the copyright. Should anyone know this information or could lay claim to the pictures please do not hesitate to contact CIRS who are willing to pay a fee for the use of these photographs should that be appropriate.

Figure 1: Site effects of explosion at Flixborough 1 June 1974 © http://www.acusafe.com/Incidents/Flixborough1974/incident-flixborough1974.html

Bhopal chemical disaster 1984

Henry Powles, work experience student, CIRS and Elinor Battrick, CIRS Support Scientist

Where is Bhopal? Map from http://207.21.216.160/midtown/pilgrim_anc-india.htm

The incident[1,2,3,4,27,28.]

The incident occurred at approximately 0030 on Monday 3rd December 1984 in the suburbs of Bhopal, India[28]. It was to be one of the worst industrial air pollution disasters in the world, affecting nearly 200,000 people[28]. The source of the incident was a large pesticide factory owned by Union Carbide[1]. One of the intermediates of the pesticide production was methyl isocyanate (MIC)[2]. MIC was stored in underground tanks, with a capacity of 3840 gallons in each[2].

On the day of the incident there was an increase in temperature in one of the tanks to 38^0C (close to the boiling point, table 1[4]). The increased pressure exceeded the design value of the tank causing it to rupture a relief valve. Approximately 40/41 tonnes of MIC vapours escaped through a 33m high atmospheric vent-line[27]. The sodium hydroxide scrubber designed to neutralise MIC was not in operation at the time. When it was eventually switched on the scrubber was unable to cope with the volume of MIC released[26]. The release continued for about 90 minutes into the cool, dry stable atmosphere of Bhopal[27.]

MIC has a molecular weight of 57.05 with a density twice that of air (at 20^0C)[29]. Therefore it would have been expected that the plume would slump, engulfing the factory and surroundings. In fact the evidence suggests that the worst affected area was approximately 500m downwind from the site[29]. Of the 100 workers present at the time, only one was affected[26]. Chemical scorching effects observed on the vegetation were not present in the first several hundred metres[25].

Table 1: the chemical properties of methyl isocyanate	
Structure	$CH_3N{=}C{=}O$
Boiling point	39 ^{0}C
Chemical characteristics	Reacts violently with water and compounds with an active hydrogen with the evolution of heat.
Vapour pressure at 20^0C	348mm Hg
Vapour density	Boiling point of MIC is 1:2 (where 1 is air).
Decontamination of small amounts of liquid and gaseous MIC	Soaking with large quantities of water (evolves gaseous products and heat)

Immediate Management of the Incident [1,6,7,8,10,11,12,13,25,26,30.]

During the initial 48 hours following the incident no measurements of atmospheric MIC were taken. Neither the techniques nor the instrumentation were readily available. The sampling team did not arrive until almost 48 hours after the incident[26]. They had no idea what they were looking for in terms of chemicals. MIC degrades in the environment in a matter of hours and thus no meaningful results were obtained[26]. As stated there were thousands of people affected by this release of whom three hundred were brought to the morgue8 on the first day and 260 the following day[30]. It is clear to see the immense problems with treating so many people when the agent causing the effects was unknown. Hence symptomatic treatment was administered[1].

Early post-mortems revealed that the organs were cherry red in colour and the lungs were roughly twice as heavy as normal. The main features observed were pulmonary oedema with inflammation of the trachea, bronchitis and in the later stages bronchopneumonia[6]. From the clinical symptoms it was hypothesised that hydrogen cyanide may have been the agent responsible [1].

Sodium thiosulphate is administered to patients in the early stages of treatment for hydrogen cyanide exposure [CIRS handout]. Hence, in the absence of any conclusive evidence about the agent, apart from symptoms, sodium thiosulphate was administered and some relief was seen[1]. A letter to the Lancet states "It has been claimed that sodium thiosulphate was therapeutically effective. However, no hydrogen cyanide seems to have been released with the MIC and it is unlikely that MIC is metabolised to or leads to the release of cyanide in the body"[7]. From this statement it is clear that confusion surrounded the exposure agent and the effectiveness of treatment. A study into the effects of sodium thiosulphate on MIC exposed rats concludes that it does not protect them against acute and sub acute effects of MIC[8]. This suggests that in addition to MIC the population was also exposed to cyanide, which would explain the clinical improvements following treatment with sodium thiosulphate.

There was little toxicological understanding of MIC at the time, hence the symptoms were not related to the agent. It is now known that MIC is a lachrymator and attacks the eyes, skin and respiratory system[25]. The pathological features are similar to those induced by hydrogen cyanide. Had this chemical been determined to be the main causative agent, there might have been a less horrifying death toll in the early stages of the incident.

Summary of some of the reported failures in the early incident management

- lack of environmental sampling to determine what the chemical was, leading to reliance on symptomatic treatment only.
- lack of toxicological data on the agent in question. No hazard data sheets for clinical effects, treatment and possible long-term health effects.
- no contingency plan for the emergency services.
- no detailed meteorological data, so no modelling could be done subsequent to the incident to plot the movement of the plume.
- lack of appropriate systems within the factory in the event of an emergency.

Medium Term Incident Management Incident[1, 6,10, 11,12,13,672]

Five days after the incident the death toll was reported to be 2500[26]. Many of those that died lived in the slums of JP Nagar & Chola Kwenchi. Most were exposed whilst sleeping in dwellings with no proper doors or windows[26.] In addition many of the workers at Bhopal train station were found dead approximately two hours after the release[26.] Many large animals were also affected and subsequently died[2].

Two weeks after the tragedy a community based survey was carried out to discover the number exposed and the clinical symptoms of the survivors[10]. The main findings of the survey were that the first four symptoms reported by the survivors were:

- burning eyes
- coughing
- watering eyes
- vomiting.

Other symptoms included photophobia, difficulty in opening the eyes, diarrhoea and shortness of breath. Examination showed further eye conditions including red eye[10]. Within a month of the incident the death toll had reached 3100[2] (figure 2)

Figure 2: Victims of the gas leak © http://www.greenpeace.org/~toxics/toxfreeasia/updates/jan28.html

Long-Term Incident Management (Health Studies and Surveillance)[11, 12, 13, 14, 15, 17,18,19]

Three years after the incident, a follow up survey of the exposed population was carried out[11.] The survey indicated a number of trends.

- the greater the exposure, the greater the incidence of eye irritant symptoms and loss of vision.
- those tested in the higher exposed areas were twice as likely to suffer deterioration in their visual acuity than those in the lower.
- other symptoms of chest pain, breathlessness and vomiting or nausea were more common in the more exposed groups.
- in the more exposed groups the incidence of cataract was double and of breathlessness 2.7 times that in the unexposed population.
- the results suggested that there was a threefold excess of eyelid inflammation in the highly exposed population.

The article suggested "the acute superficial interpalpebral erosion is probably similar in chemical nature to the 'burns' caused to the lung by the exothermic reaction of MIC with water in mucous secretions." In the eye this damage healed relatively quickly without scarring. In the lung there is evidence to suggest that the damage is of a more permanent nature. [11]

Seven years after the incident, a third study was established, using bronchoalveolar lavage[12]. The study found an increase in total lung inflammatory cells with increasing exposure to the gas. The report goes on to suggest that the respiratory morbidity in the MIC exposed subjects could be due to the effects of neutrophils and lymphocytes on the lung. Progression from macrophagic alveolitis to neutrophilic alveolitis was seen[12,13].

Ten years after the disaster another cross sectional survey into the respiratory morbidity of the disaster was carried out[14]. The findings of the survey were that there was reduced lung function severity which was correlated to the degree of exposure. The symptoms and the reductions in lung function that were detected were comparable with those of chronic airflow limitation and in particularly with disease of the small airways[14].

The effects of MIC on pregnancy[15]

A study to investigate the effects of MIC on pregnant women was undertaken nine months after the incident. Of the 865 women pregnant at the time 43.8% spontaneously aborted. 14.2% of live births died within 30 days compared with the pre disaster rate of 2.8%. Further it was reported that there was a higher incidence of termination in the 1st trimester compared to the 2nd and 3rd trimester. The report does not say what the mechanism of the toxicity was but that MIC exposure caused selective foetal toxicity. The majority of birth defects were found to be spina bifida[15].

The Cytogenic effects of exposure to MIC[17]

A study on 154 individuals exposed to MIC aimed to identify the presence of chromosomal variations. The report states that 8 out of 53 exposed individuals in the study had 46 chromosomes without any sign of chromosomal aberration. Chromosomes 5, 9, 11, 14 and 16 appeared to be more susceptible to damage by MIC. In addition an increase in the number of chromosomally mosaic cells from 2% in unexposed individuals to 22% in gas-exposed people was observed. A proposed explanation for this finding is an increased number of cells with premature centomeric divisions. The chromosomes were found still to have deletions even after many division cycles. 45 individuals had a variety of chromosomal aberrations that have the potential to result in neoplastic transformations or complicated pathology in later years[17.]

The carcinogenic effects of exposure to MIC.[21,22]

In 1987 a study was undertaken to predict the probability of carcinogenicity of MIC. The study concluded that MIC had a potential to cause cancer in rodents[21.] It was observed that the potency was low and dependent on the duration and concentration of the exposure [21.] In 1999, a case-control study was carried out into the cancer patterns around Bhopal. This was done using relative risks from the cancer register and controls from a tobacco survey. The cancers studied were of lung, oropharynx and oral cavity and the conclusion of the research was that the full extent of excess risk might not be seen until 2004[22].

Lessons learnt

This disaster has highlighted to the world the possible dangers to the health of the public potentially posed by the chemical industry. Several lessons were learnt from the events that followed Bhopal and as a consequence chemical incident management underwent some major changes. In brief the lessons learnt were:

- requirement for a multidisciplinary approach to incident management.
- requirement for biological samples to be taken in any incident where the exact nature of the causative agent is unknown
- requirement for environmental samples to be taken as quickly as is feasible.
- requirement for rapid epidemiological investigation.
- need for emergency plans to be in place and to be tested on a regular basis.
- need for training of local scientists and health physicians in the management of chemical incidents. (Local scientists have been trained and continue the monitoring of the long-term health effects[24])
- need for ongoing research into the toxicological effects of both well-known and new chemicals.

In addition the difficulty with assigning health effects to a particular point source or incident is that there are generally other confounding factors. These may be factors such as smoking and age or the presence of other industries. Greenpeace carried out surveillance of pollution in the area surrounding the chemical plant.[23] Hot spots of high pollution were found, including VOC, chloroform, carbon tetrachloride and chlorinated benzenes. These were found in drinking water wells around the site. This water was still consumed despite warnings[23].

Due to the effects caused by the pesticide factory in Bhopal developing countries have reassessed their method of risk assessment of industry. There has been an enormous improvement in chemical incident management since the incident in 1984. With constant evolution of incident management, the likelihood of such an incident occurring again will be reduced.

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Lake Nyos disaster, Cameroons, 1986

Virginia Murray, CIRS

Incident summary

The naturally occurring disaster at Lake Nyos on the night of 21 August 1986 has resulted in considerable speculation as there is relatively little scientific information available to determine the cause of the event.[1]

In summary the reported deaths of approximately 1,700 people and 3,000 cattle was associated with a gas burst from Lake Nyos in the Cameroons. This cloud of gas estimated to have a volume of 1.2 km^3 erupted from the lake killing or rendering unconcious humans and animals as far away as 10 km.[2] Survivors near the lake recalled hearing a wind and some reported a smell of gunpowder or rotten eggs before suddenly losing consciousness.

Main clinical and post-mortem findings

In total 845 survivors of the incident attended hospital for treatment over the weeks following the incident. Of these a review of hospital notes showed that the main signs and symptoms were cough 262 (31%), headache 220 (26%), and skin lesions resembling burns 161 (19%). The distribution of sites of these superficial and deep skin lesions were reported to be primarily on the face but also on legs, abdomen and elsewhere. Most of these lesions were superficial and healed within two weeks. Other symptoms were reported. Of particular note were the 51 patients among those admitted and attending hospitals who had weakness of arms or legs including footdrop and wristdrop. These patients also improved within two weeks.[1] Many of those who died were reported to have prominent skin bullae. In the four cases autopsied, pulmonary congestion and oedema were found. Following review these signs were thought to be associated with prolonged coma prior to death.[1]

Probable cause

It is likely that the main gas released was carbon dioxide since it was found to be abundant in the lake water. Carbon dioxide is 1.5 times denser than air at normal temperature and could have flowed down the valleys. It has been deduced that the cloud was composed of carbon dioxide that ex-solved suddenly from the lake hypolimnion (the lower layer of water in a lake) as a presumed consequence of of a hydrodynamic instability. The August air temperatures around Lake Nyos were significantly below the long term average. It has been suggested that this would be consistent with a hypothesis of degassing during short term climatic cooling. However a similar interval of low temperatures occurred in the early 1970s without know gas release. Therefore air temperature is not a singular predictor of mixing and degassing. [3]

Lessons learnt

The toxicology of this event does not fully explained the incident. Some lessons have been learnt:

- naturally occurring chemical incidents can lead to significant impacts upon the population exposed.
- the absence of immediate medical investigations, including autopsies, made the recreation of events in this disaster almost impossible. [4]
- investigators took too long before arriving in the remote area where the incident took place. [1]

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The use of chemical warfare against the Kurdistan Population 1988

Elinor Battrick, CIRS Support Scientist

The incident

The incident began on Friday 17th March 1988, very early in the morning, in a city known as Halabja, Kurdistan[2,5]. It is apparently the worst terrorist attack on a civilian population using chemical weapons. Twenty or more chemical and cluster bombs were dropped over Halabja, resulting in the immediate death of 5000 civilians and the subsequent injury of thousands more[1]. Almost 75% of those killed or wounded were women and children[5,7].

The city of Halabja has a population of approximately 45,000 and lies within 11 kilometres of the Iranian border, in Northern Iraq[1]. Many of the residents of Halabja are farmers or cattle breeders.[2]

On the day of the attack and for two days following, the town was bombarded with planes laden with chemical weapons. In addition to the cluster bombs 100 litre canisters containing cocktails of chemicals were dropped[5]. At the same time, artillery was used to bombard any escape routes, such that the civilians were forced to remain in the contaminated area.[2]

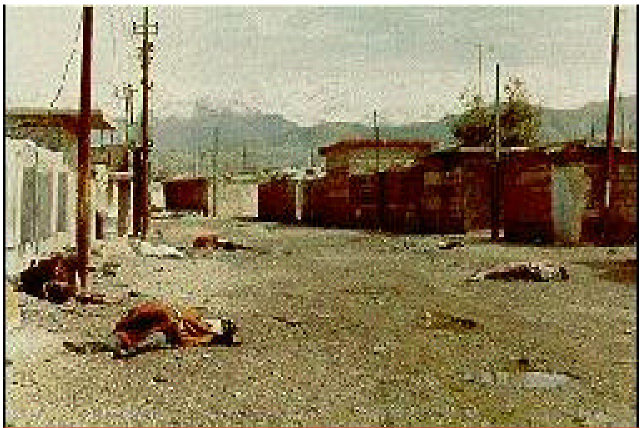

Figure 1 City of Halabja after the attack. © http://www.angelfire.com/nt/Gilgamesh/h alabja.html

Immediate Management of the Incident

The city of Halabja was completely devastated. There are many accounts of the horrors that faced those who visited after the assault[1,2,4,5,6,7,9]. The bodies of those killed in the assault were found scattered around the town as if they had fallen immediately (figure 1). Some were seen in the entrance of their houses sheltering their children, others in vehicles as they attempted to leave the city[1].

A Middle East correspondent for The Guardian wrote

"The skin of the bodies is strangely discoloured, with their eyes open and staring where they have not disappeared into their sockets, a greyish slime oozing from their mouths and their fingers grotesquely twisted"[1]. Figure 2 was taken within days of the attack[1].

Figure 2 – Victim of chemical assault immediately after. © http://www.angelfire.com/nt/Gilgamesh/h alabja.html

The nature of the incident meant that it was not managed effectively and thus there is little factual information available from the early stages following the disaster. A few victims were given brief and immediate treatment which involved taking them to the United States, Europe or Iran. The majority of them returned to Halabja[15].

Chemical Agents

It is still largely unclear what agents were used. However there have been a number proposed. According to the findings of Iranian physicians, mustard (figure 3), nerve and cyanide gases were used against the civilians of Halabja[1,5].

Table 1 – Possible chemicals used on the city of Halabja.

Chemical	Clinical presentation
Mustard Gas	Nausea, lacrimation, corneal ulceration, inflammation and blistering of the skin, Class 1 Human carcinogen, genetic abnormalities
Sarin, tabun and soman	Muscarinic (parasympathetic) effect e.g. increased secretion, lacrimation, miosis, bronchospasm; diarrhoea, micturition Nicotinic (sympathetic and motor) effects e.g. hypertension, weakness, fasciculation ; Central CNS effects e.g. apprehension, hyperexcitability, convulsions, respiratory failure

Initial post-mortem examination of the bodies of those killed at Halabja showed that the suffocation of most victims was due to the inhalation of cyanide gas[1]. However there are conflicting views on this. One source states that cyanide gas was not thought to be the major agent used but was produced by the breakdown of soman[11]. On examination of the chemical structure of soman it is likely that cyanide was released from the breakdown of tabun not soman as tabun has a CN group whereas soman has a flourine atom.

Environmental Sampling

There was no environmental sampling carried out in the hours or days following the incident. Several defence agencies have the capability to detect chemical agents. However the area is restricted and as such environmental sampling has never been carried out[14]. It is impossible to determine the exact composition of these chemical weapons. Halabja is thought to be that it is contaminated even now, as no clean up has been carried out. 13 years later Halabja's residents still live in the rubble that was once their home[13]. Contamination of soil and water may be responsible for some of the adverse health effects being seen in residents of Halabja even today[14].

Long-term Health Effects

No medical team either from Iraq, Europe or America or from any international agency has monitored either the short or long-term environmental or health effects of this attack[15]. In 1999, a professor of medical genetics, Christine Gosden, travelled to Halabja[12]. She was accompanied by a film director, Gwynne Roberts, who had made several trips to Halabja since the incident in 1988[12]. Professor Gosden was particularly worried about the adverse health effects of this chemical cocktail on women and children.

Comparative Study – Long-term Health Effects

A comparative study was carried out by Professor Gosden[15]. A radio broadcast was made the day before the arrival of the team asking individuals who were still symptomatic to come to the hospital to record their problems. On the first day 700 people came to the hospital, of which 495 had two or more major problems. The most commonly seen symptoms were eye, skin, respiratory and neurological disorders[15,11].

Working with local doctors Gosden compared the frequency of conditions such as infertility, congenital malformations and cancers (including childhood cancers) in those who were in Halabja at the time, with an unexposed population from a city in the same region. It is unknown what confounding factors were accounted for during this study. The results of the study show a three to four fold increase in all conditions compared[15].

Paediatric Adverse Health Effects

An interesting finding was that an increasing number of children were dying from leukaemia and lymphoma each year in Halabja and these were occurring in much younger children than in the control population[11]. There is no treatment available in the region. Other paediatric conditions that were frequently seen were major heart defects, harelip and cleft palate[15].

Figure 3 – Blistering of skin in victim of Halabja. © http://www.angelfire.com/nt/Gilgamesh/h alabja.html

Neuropsychiatric Disorders.

Many of the casualties of Halabja and their descendants are reported to have neurological impairment or long-term neuromuscular effects[11]. Doctors are unable to see patients with psychiatric disorders as there is a lack of resources.

Complications with Pregnancy

On consultation with members of the clinical team at Halabja, Gosden was informed that there were no women in normal labour. There was an increased number of miscarriages in addition to perinatal deaths and infant deaths. A large proportion of babies born alive had major malformations. The frequency of these complications in women from Halabja was considered to be more than four times greater than in the control city.[15]. Professor Gosden wrote "The real situation is probably much worse than the data suggests, because many people are just dying at home from undiagnosed cancers, leukaemias' and unseen defects"[11].

Long-term Management of Halabja

In November 1998, some ten years after the attack on Halabja the Washington Kurdish Institute (WKI) hosted a seminar for Halabja[10]. Participants included Iraqi Kurdish doctors, medical school deans, international Non-Governmental Organisation representatives, Kurdish political leaders, scientists and various officials. Its purpose was to consider the feasibility of humanitarian, medical and research responses in the area[3]. In 1999 with a grant from the US Department of State's Bureau for Democracy, Human Rights and Labour, the WKI and Professor Gosden began to study the feasibility of treatment and research in Halabja. In a further meeting later in 1999 various agencies, including those at WKI agreed to establish the 'Halabja Post-Graduate Medical Institute' in three centres in Northern Iraq. The aims of this Institute are to integrate humanitarian and medical responses, while laying a sensitive and ethical foundation for stringent science, necessary to determine the long- term health effects of chemical weapons. As yet no results from this institute have been published[3].

Lessons learnt

The tragedy should yield valuable lessons for those concerned about responding to future chemical and biological emergencies. Unfortunately, as far as can be ascertained, very little has been done to treat the population and in doing so to address a human tragedy and learn more about the long-term effects of chemical weapons[13]. The weapons used in the attacks and their effects have not been quantified nor have methods of treatment for the survivors been developed[3]. The establishment of the 'Halabja Post-Graduate Medical Institute' is one step towards our understanding of the chemical weapons used on Halabja.

The attack on Halabja illustrates the importance of timely environmental and biological sampling, in order to manage a chemical incident as effectively as possible. However, in the case of Halabja this was not carried out.

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Chemical terrorism in Japan, 1994 and 1995

Henrietta Harrison, Toxicology Information Scientist, CIRS

Two incidents have been reported from Japan where a chemical weapon, sarin, a nerve agent, has been used on civilians. These are:

- Matsumoto, 1994, when 7 died and 200 were injured
- Tokyo Underground, 1995, when 12 died and over 5,000 were injured

These incidents were summarised in CIR October 1999 and can be viewed on our web site (www.medtox.org.uk/cirs/reports/oct1999.pdf)

The Japanese experiences have been well documented including some of the difficulties that the Japanese authorities encountered. These included

- lack of information for the emergency responders
- difficulties with communications in an emergency
- lack of decontamination
- secondary contamination leading to adverse health effects in emergency responders
- lack of appropriate antidotes

Japanese authors have recommended that these experiences should be used as useful learning tools for others who may potentially be involved in a major incident.

Three cohort studies one, two and three years after the Matsumoto sarin attack have been published.[1,2] The odds ratio in the three year study showed that almost all the symptoms were high in the sarin–exposed group suggesting a positive relationship between symptoms and grades of exposure to sarin.[1] The reported symptoms were eyestrain, blurred vision, fatigue, shoulder stiffness, asthenia (weakness or loss of strength) and headache. The authors comment that these cases may prove to have post-traumatic stress disorder. In another study significant EEG changes were noted 2 years post exposure.[2]

References

1. Nakajima T, Ohta S; Fukushima Y; Yanagisawa N. Sequelae of Sarin Toxicity at One and Three Years After Exposure in Matsumoto, Japan. J. of Epidemiology. 1999 9, 337-343,
2. Sekijima Y, Moriha H, Yanagisawa N. Follow-up of sarin poisonings in Matsumoto. Ann Int Med. 1997:127 (II): 1042

Fireworks factory explosion, Enschede, Holland, May 2000

Virginia Murray, CIRS

Incident Summary

A fire broke out at the SE Fireworks warehouse/factory in Enschede in Holland at approximately 13.00 hours on Saturday May 13 2000. The firework depot held a stock of approximately 100 tonnes of explosives used in making fireworks. These explosives were detonated from a smaller fire leading to a not very big 'bang' followed by a massive detonation which created a fireball.[1] Many of the locals who were watching the fireworks started to run away after hearing the first smaller 'bang'.

The warehouse was located in a working class neighbourhood and Dutch television reported that a 500 square metre area around the warehouse was destroyed. 400 houses were seriously damaged by the explosion with some reduced to rubble.[1]

21 people died including four fire fighters with over 600 injured. Of the 58 casualties who were admitted, 18 were operated on immediately or within a few hours. The health care response included:

- activation of the major incident response plan by the local hospital
- a field hospital, which was set up initially too close to the site of the fire as there were concerns that an ammonia tank from a local beer brewing factory might also explode, and therefore had to move during the response
- six trauma teams from other Dutch hospitals came to help along with 8 or 10 teams from Germany who were brought in by helicopter.[2]

Site information

The warehouse building was constructed in 1977 when it was originally outside the town proper. Subsequently the authorities allowed the construction of low-income housing around the warehouse. It was also reported that the town of Enschede was home to a second firework storehouse which apparently has a mobile home park close by.

In total 20 firms in the Netherlands have licences to store fireworks long-term for professional displays and 40 other firms store fireworks for individual consumers. The Dutch Firework Foundation is reported to have told the media that most of the 20 long term stores were bigger that that at Enschede and some were located in populous areas like the Hague and Leiden. The SE Fireworks warehouse was said to have met all existing legal and licensing requirements and had been inspected as recently as four days before the explosion.

Lessons learnt

Concern about the location of fireworks warehouses must be paramount. Many similar explosions have been reported around the world, see page 22-23 for a UK example. It is essential that all sites and depots are documented and that there is close collaboration between organisations such as health authorities, fire brigades, local environmental health departments, planning authorities and trading standards in sharing this information in a timely fashion to include planning and response.

Sources of information

1. World Socialist Web Site: http://www.wsws.org/articles/2000/may2000/fire-m16.shtml
2. Torbojorn Messner, Sweden Personal communication, October 2001

Toulouse, France factory blast, 21 September 2001

Henrietta Harrison, Toxicology Information Scientist, CIRS

Incident summary

On Friday 21 September 2001, France suffered its worst civilian accident for two decades. Approximately two thousand five hundred people injured, 650 hospitalised and twenty-nine killed when an explosion completely destroyed the AZF petrochemical and fertiliser factory.

The factory was the biggest fertiliser producer in France; it is situated 2 miles (3 km) outside the city; and had a by-pass running next to it. Dozens of drivers on the by-pass were caught in the full blast, thousand of buildings were damaged, 600 houses or apartments were destroyed and 1,400 families were left homeless in the explosion that measured 3.2 on the Richter scale and left a 50m crater. The force of the explosion blew windows out up to 2 miles away in the city centre and cut off telecommunications to the area.

Hundreds of residents ran into the streets in panic. The police immediately sealed off the area in fear of a cloud of fumes from the explosion that was described as a big, yellow mushroom and thought to be toxic. Many people later reported experiencing stinging eyes and throat and a strong smell of ammonia. Authorities shut down the airport and the subway as a precaution and a nearby industrial area was also closed. Two schools were destroyed in the blast and 70 others remain closed. A local hospital was badly damaged.

The official explanation for the explosion was that a warehouse containing 300 tonnes of ammonium nitrate self-combusted. However, a leading French scientist has been quoted as saying that “the chemical involved was a relatively stable product and there is no precedent for such a spontaneous explosion.” On 5 October the French Environment Minister remarked that the explosion could have been due to a terrorist attack as one of those found dead in the factory had a police record and was known to have Islamic fundamentalist sympathies. The Toulouse prosecutor, however, has consistently said he is “99% certain” the blast was an accident. To fuel the terrorist theory the coroner was also quoted as saying that the “terrorist” was dressed in several layers of clothing “in the manner of kamikaze fundamentalists going into battle or on a suicide mission.” His family, however, said that this was normal for him as he was very thin and concerned about the size of his bottom.

The most likely cause of this explosion is that an error was made with chemical storage. However many questions and issues have been raised:

- The factory, originally built in 1924 on a green field site, is now surrounded by homes, shops and schools. Despite multiple requests from local groups to relocate the factory, it remained in a residential area. Now more than 25 lawsuits have subsequently been taken out by those injured in the explosion, or those who lost their homes.
- Demonstrations against the planned reopening of the factory continue in Toulouse.
- The emergency services did not have a plan of the factory, thus hampering the rescue of casualties.
- Environmental and Health and Safety inspectors, during their last visit in May did not inspect the storage tower.

Lesson learnt

National debates are now being demanded in France regarding chemical plants in or near residential areas, an issue that is estimated to affect several hundred factories around the country and a total of 10 million French people.

Sources of informaiton

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2. http://news.bbc.co.uk/hi/english/world/europe/newsid_1571000/1571011.stm
3. http://news.bbc.co.uk/hi/english/world/europe/newsid_1557000/1557554.stm

DOCUMENTS ON CHEMICAL / BIOLOGICAL DELIBERATE RELEASE

Dr John Simpson, Regional Epidemiologist, CDSC South East on secondment to Department of Health

The following documents have been published by the Department of Health and are available via the Department and their Regional Directors of Public Health or from the Public Health Laboratory Service web site http://www.phls.co.uk.

Resource	Source
Chemical	
Guidelines for action in the event of deliberate release of chemical agents (nerve agents, mustard) + key points	DOH
Guidelines for planning for deliberate chemical release	DOH
Immediate checklist for deliberate chemical release	DOH
Biological	
General information about anthrax, smallpox, botulism and plague	PHLS
Guidelines for planning for overt and covert deliberate release of biological agents (anthrax, smallpox, botulism, plague)	DOH
Immediate checklist for overt and covert deliberate release of anthrax, smallpox, botulism and plague	DOH
Interim guidelines for action in the event of a deliberate release of anthrax, smallpox, botulism or plague	DOH
Unknown	
Interim guidance for the investigation and management of outbreaks and incidents of unusual illness	PHLS
Advice on dealing with suspicious packages and packages suspected of containing anthrax	PHLS

Other material that has been prepared is also being circulated. The Hospital Chemical and Biological Incident Response briefing document is provided below. The authors of this document are Dr John Simpson, Regional Epidemiologist, CDSC South East on secondment to Department of Health, Mr Tony Bleetman, Consultant in Accident and Emergency, Birmingham Hartlands Hospital, Mr Kevin Mackway-Jones, Consultant in Accident and Emergency, Manchester Royal Infirmary, Mr Derek Burke, Consultant in Accident and Emergency, Birmingham Childrens Hospital and Mr Mark Prescott, Consultant in Accident and Emergency, Royal Shrewsbury Hospital in collaboration with the Mass Casualty Working Group.

Comments on the following should be telephoned to Mr Bleetman on 0121 424 2000.

Hospital Chemical and Biological Incident Response

A Department of Health briefing document
23 October 2001

Background

This document outlines the hospital response to a major chemical or biological incident. It has been developed following the considerable work undertaken by the National Focus for Chemical Incidents, the Department of Health steering group on personal protective equipment (PPE) and decontamination facilities, the Chemical Incident Response Service and other expert parties. It is a valuable extension to present contingency plans for incidents involving contamination. Whatever the agent involved the initial approach will be the same. The number of casualties involved will vary according to the incident.

The results of a recent survey by the National Focus for Chemical Incidents have shown that the level of preparation for chemical incidents nationally is variable. This document provides generic guidance to prepare for and deal with any chemical or biological incident, accidental or deliberate release, including mass decontamination. It should be used to supplement existing organisational plans or as the basis for developing new plans where none exist.

The approach for decontaminating suspected biological agents will initially be the same as for chemicals, although the post-decontamination support would be different.

Generic Emergency Department Decontamination Plan

Triggering the Decontamination Plan

A chemical or biological incident may be heralded by any of the following triggers:

- Warning from the emergency services, industrial sites, the military or other sources
- The unannounced or unexplained presentation of small or large numbers of casualties with collapse, skin blistering/ burns, visual disturbance, sweating, breathing difficulties, lacrimation, salivation, convulsions, muscle tremors, hoarseness or major GI disturbance. Casualties presenting with thermal burns secondary to an incendiary device may also be contaminated.
- A combination of the above.

Activating the Decontamination Plan

The plan will be put into effect if a trigger event occurs. It would be usual in large scale chemical and biological incidents to activate the major incident plan and notify:

- The Emergency Department,
- The control team (senior manager, senior doctor, senior nurse) who would normally respond to a conventional major incident,
- Local emergency services,
- On-call Public Health,
- Chemical Incident Provider Unit (or National Poisons Information Service),
- The Environment Agency on 0800 807 060,

- Local water company (mains and waste may have separate providers)

Principles

- In chemical and biological incidents, the actions in order of priority are: containment, decontamination, resuscitation, primary treatment and definitive care.
- Patients must be decontaminated before entering the Emergency Department using the approved rinse-wipe-rinse method.
- All casualties and emergency service personnel arriving at the hospital from the scene are considered to be contaminated, unless they have been decontaminated by the approved rinse-wipe-rinse method.
- High-volume low-pressure drenching at scene with water does not exclude the need for rinse-wipe-rinse decontamination.
- Staff receiving contaminated casualties must be in full PPE.
- Primary triage (triage sieve), by an appropriately trained member of staff wearing PPE, will take place on arrival outside the Emergency Department and prior to decontamination.
- During decontamination, only simple life saving first aid (simple airway opening manoeuvres, bag-valve-mask ventilation, pressure on wounds) will be possible.
- After decontamination casualties should be triaged for emergency medical care.
- With the help of the Chemical Incident Provider Unit, an attempt should be made to identify the agents involved.

Departmental Preparation

- Minimum departmental equipment should include: body, hand, eye and respiratory PPE buckets, sponges and soft brushes, detergent, cloth or paper towels, blankets or sheets access to a (preferably warm) clean water supply.
- An Incident Triage Officer is nominated, clothed in PPE, clearly identified and deployed at the entrance to the Emergency Department.
- A decontamination team of 2-4 personnel is formed, clothed in PPE, and deployed to the decontamination area at the entrance to the Emergency Department.
- Decontamination is carried out by the decontamination team under the direction of the Incident Triage Officer.
- If the number of contaminated casualties exceeds the departmental capacity, mass casualty decontamination procedures will be commenced.
- The Emergency Department should be cleared of non-incident patients using procedures developed for conventional major incidents.
- Exit routes from the department to the rest of the hospital must avoid areas of contamination.

Reception and Triage

- The Incident Triage Officer will use the triage sieve to prioritise patients for decontamination (Appendix 1).
- The triage and treatment priorities for contaminated children are as for adults.
- In general, for an equivalent level of exposure, children are more likely to exhibit greater toxic effects than adults.
- Children are more susceptible to hypothermia

Decontamination

- All clothing must be removed from contaminated casualties.
- All clothing and personal effects will be treated as contaminated items.
- Walking casualties should be encouraged to self-decontaminate where possible.
- Current evidence suggests that water plus detergent (10 ml added to a bucket of water) is the decontaminant of choice for most chemical and biological contaminants.
- The facial area should be decontaminated prior to the application of any ventilation equipment.
- Mucous membranes and eyes should be decontaminated with water or normal saline only.
- For single casualties, a full decontamination using the rinse-wipe-rinse method is recommended (Appendix 2).
- For mass casualties, other improvised methods of delivering high-volume, low-pressure water should be sought while awaiting single casualty decontamination (Appendix 3).
- At the end of decontamination, contaminated clothing, equipment and effluent, where at all possible, should be stored in a safe area for appropriate disposal.
- Personal items of worth (mobile phones, wallets etc) should be retained for possible future return to their owners.
- Wherever possible, keys should be decontaminated and returned to their owners at the earliest possible opportunity.

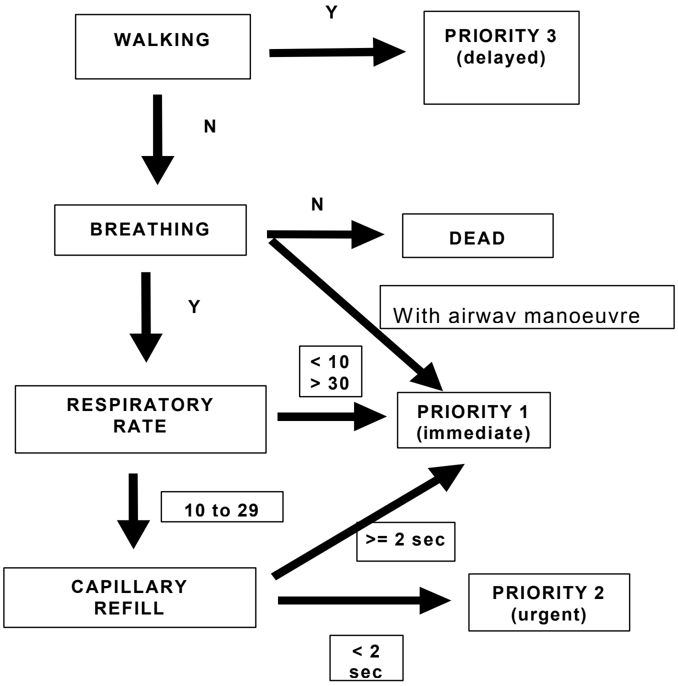
Post Decontamination Care

- Patients leaving the decontamination area should be covered as soon as possible (preferably in a warm, draft-free environment) to prevent hypothermia and restore their dignity.
- Patients will then be triaged and treated as appropriate.
- Advice should be sought from Chemical Regional Service Provider Units (RSPUs) for further patient and staff care and monitoring.
- Biological sampling is likely to be of benefit, and appropriate sampling kits should be used (Appendix 4).

Staff PPE

- Appropriate PPE should be worn by all personnel who come into contact with contaminated casualties.
- On leaving the decontamination zone, staff should remove their PPE in a safe manner and leave it in the contaminated area for later, safe disposal (Appendix 5).

Appendix 1: Triage Sieve



Appendix 2: Rinse-wipe-rinse method of casualty decontamination

The following equipment is required:

- scissors (to remove clothing)
- a water source (preferably warm)
- a bucket (5-10 litre capacity)
- decontaminant: detergent 10 ml – approximately three squirts – added to a bucket of water
- a sponge or soft brush.

1. Having exposed the patient, rinse the affected areas. This first rinse helps to remove particles and water-based chemicals, such as acids and alkalis. Wash from top downwards.
2. Wipe the affected areas with a sponge or soft brush using a detergent solution. This first scrub helps to remove organic chemicals, petrochemicals and biological agents that adhere to the skin.
3. Rinse for a second time. This second rinse removes the decontaminating solution and residual contaminant.

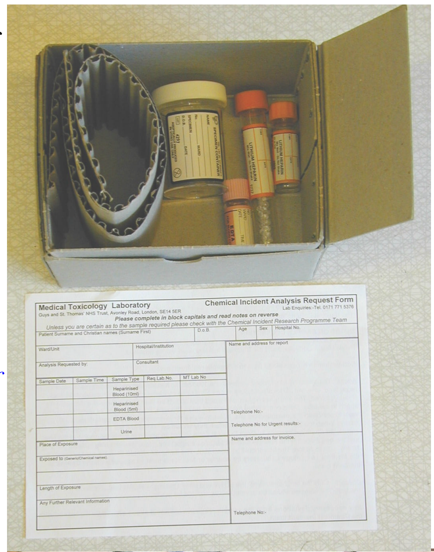
- This process should not take more than 3 to 5 minutes.
- Repeat steps 1 to 3 only if skin contamination remains obvious.
- It may not always be possible to guarantee that a casualty is totally decontaminated at the end of this procedure. Remain cautious & observe for ill effects in the patient and in staff.

Appendix 3: Improvised methods for delivering high-volume, low-pressure water

- The siting of any improvised high-volume, low-pressure water decontamination facility should take account of the potential for local groundwater contamination. Where possible, advice should be sought from the local water authority and the Environment Agency (0800 807 060).
- Drench hoses (fire hoses or similar).
- Liaison with the Fire Service to set up an 'emergency decontamination corridor system' or 'ladder pipe decontamination system'.
- use of sprinkler systems in building (e.g. municipal car park)
- use of swimming pools and swimming pool changing facilities, (many hospitals will have a hydrotherapy pool).
- multiple shower units in other facilities such as schools, hotels, sports clubs.

Appendix 4: Chemical Incident Sampling Kit

The kit contains 1 box for transport of specimen, 1 x 10mL plastic and 1 x 5mL glass lithium heparin blood tubes, 1 x 5mL EDTA blood tube, 60mL urine container, 1 x Chemical Incident analysis request form and corrugated cardboard packing.



Appendix 5: Removal of Personal Protective Equipment (PPE)

NOTE: If the PPE is breached at any time during casualty decontamination, the staff member should be treated as a contaminated casualty and should immediately undergo full "buddy" PPE decontamination followed by full casualty decontamination (after removing the suit).

Thoroughly wash your 'buddy' down from head to toe, front, sides and back for at least three minutes, paying particular attention to crevices, underarms and between the legs. The last pair of staff members will wash each other down. An assistant wearing gloves will remove the boots. Using a large pair of scissors, the assistant will cut the suit along the legs, back and arms. The wearer walks backwards, away from the cut suit allowing it and the hood to fall to the floor. The last person in a suit will be assisted by a decontaminated staff member in gloves and a hood with respirator unit.

Acknowledgement: Glenn Mannion and Sarah McCrory, Medical Illustration at Birmingham Hartlands Hospital

INVESTIGATION AND MANAGEMENT OF OUTBREAKS AND INCIDENTS OF UNUSUAL ILLNESSES

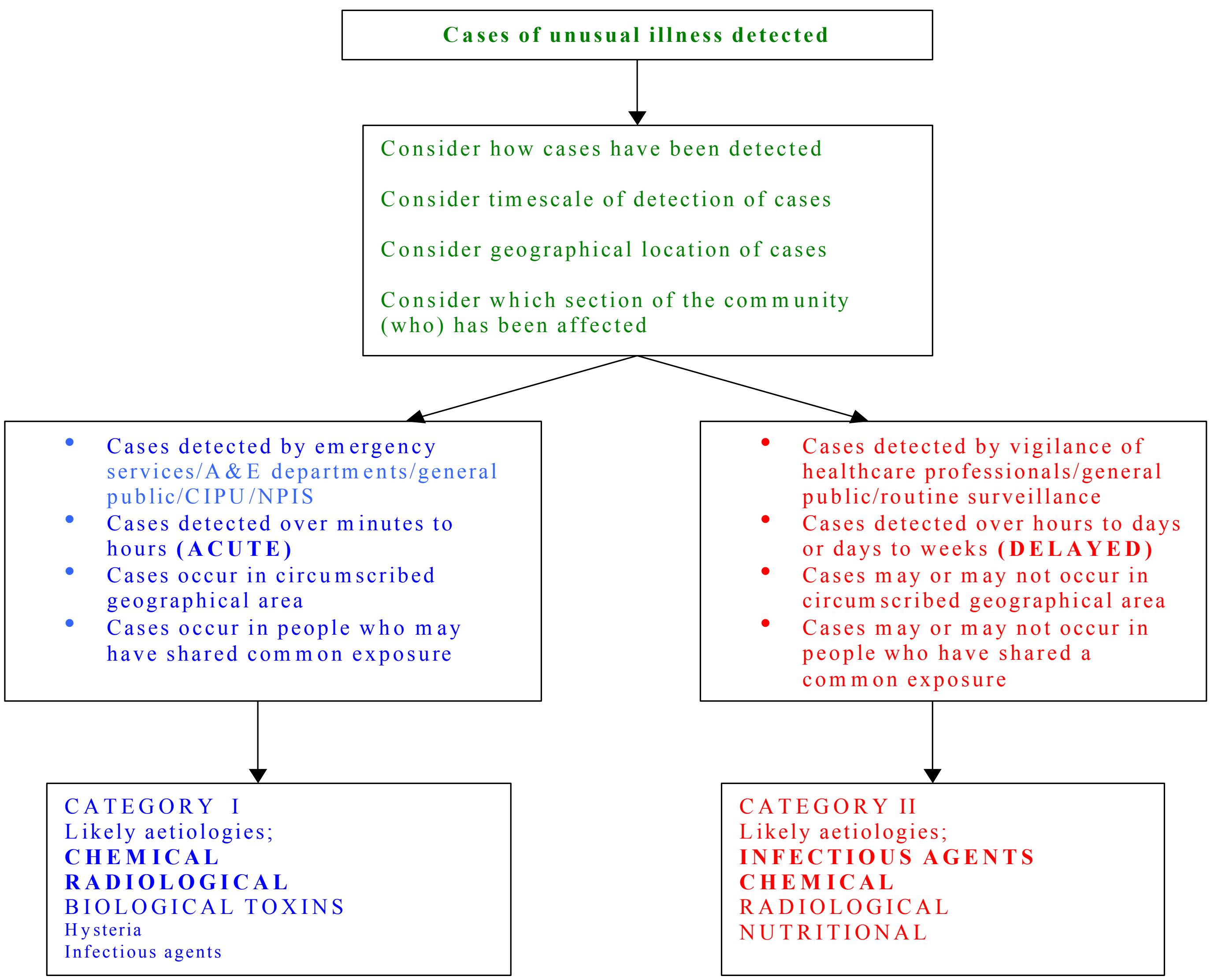
Dr Jane Jones, SpR in Public Health Medicine, on secondment to CIRS from the North Thames Training Scheme for Public Health Medicine

Outbreaks and incidents of unusual illnesses might have any one of a number of aetiologies; infectious, chemical, nutritional, radiological or even hysterical. In recent years it has become apparent that in a few instances chemical or biological agents have been deliberately released by motivated groups. Guidance has recently been produced for those working in the NHS in England who are responsible for health protection (e.g. consultants in communicable disease control (CsCDC), regional public health groups, microbiologists and specialist centres etc.) on the investigation, management and response to outbreaks of unusual illness where it is not immediately apparent what the aetiology might be. It includes circumstances where the exposure may be deliberate either as malicious acts or the unlikely event of terrorism.

Some crucial factors in responding to unusual outbreaks or incidents of illness include;

- a high level of awareness of the possible occurrence of such outbreaks/incidents, including those due to deliberate release.
- early consideration of the range of possible aetiologies based on the clinical and epidemiological information available
- early expert clinical assessment of patients to con-

Algorithm 1; Initial classification of outbreaks/incidents of unusual disease.



sider the most likely cause before tests results become available and so that rapid action can be taken

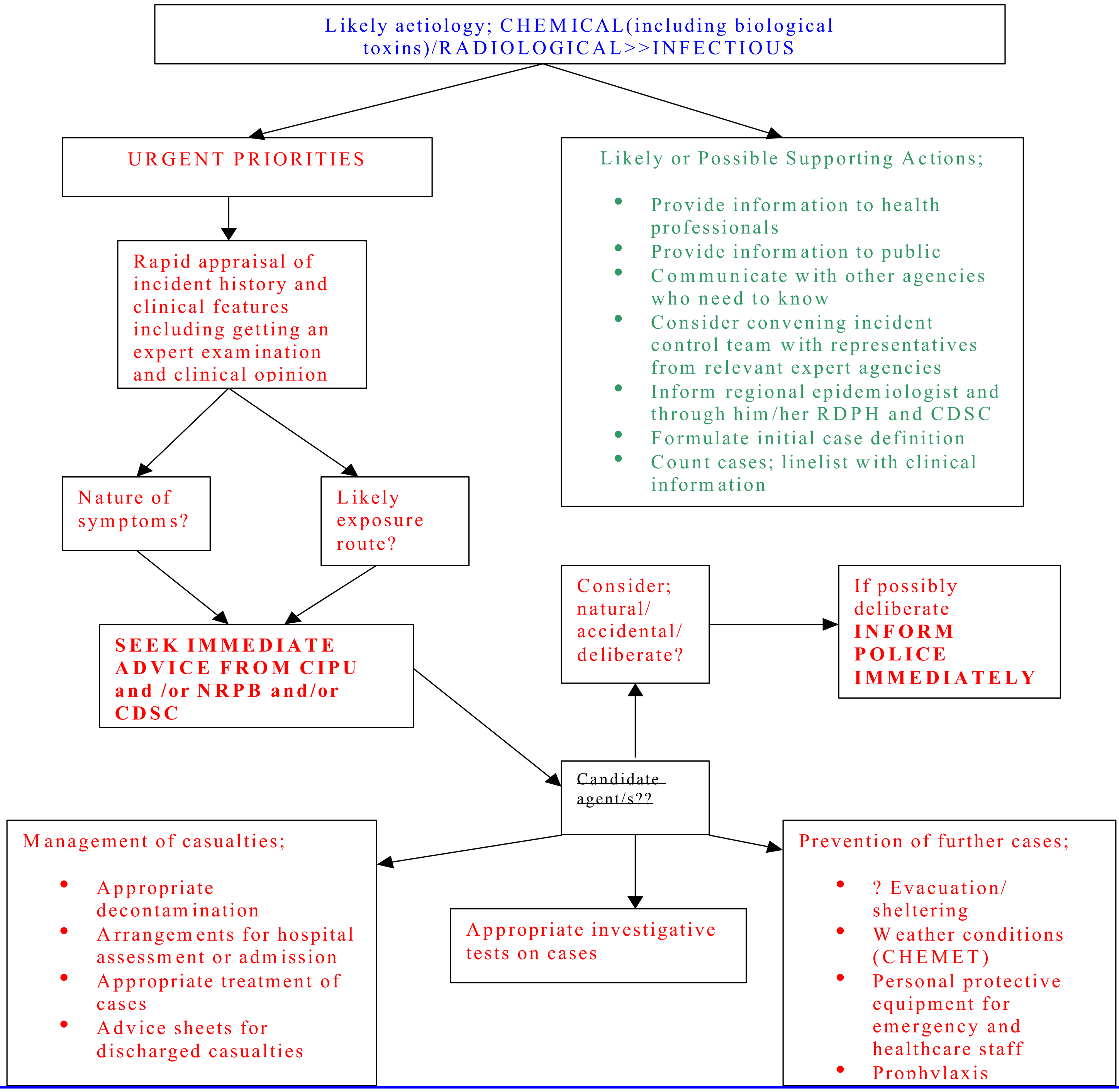
- early expert advice and support from all the relevant health disciplines concerning rapid relevant investigations and management
- rationalising the approach to laboratory investigations so that local officials do not have to negotiate with a series of laboratories and to minimise unnecessary exposure of laboratory personnel to dangerous agents
- effective ongoing communication between the different sectors of the health service and between the health service and other relevant agencies.

The guidance initially classifies outbreaks/incidents into two broad categories on the basis of their basic epidemiological features and the mode of presentation. This is summarised in Algorithm 1.

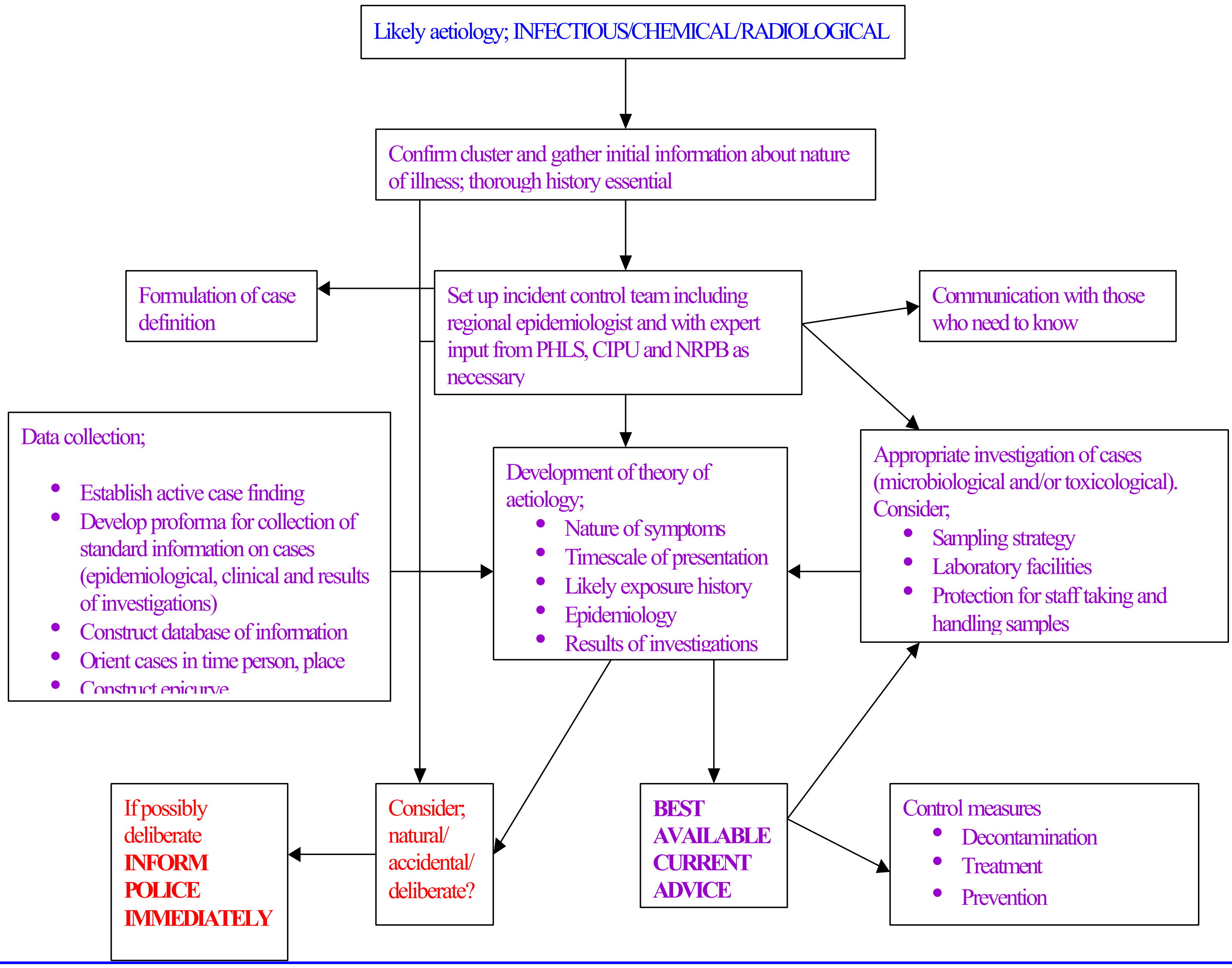
The same overall objectives apply to the management of both category I and category II outbreaks/incidents. These are:

- to care for the sick

Algorithm 2; Management of Category I outbreaks/incidents



Algorithm 3; Management of Category II outbreaks/incidents



- to control the source
- to determine the extent of the possible incident / exposure
- to prevent others being affected
- to monitor the effectiveness of the measures taken
- to prevent a recurrence
- to consider whether the cluster may be the result of deliberate action

For both categories it is likely that broadly similar tasks will need to be carried out to manage the outbreak/incident. The difference between them lies in the speed with which the overall objectives must be achieved, and hence the priorities given to different tasks. These are summarized in Algorithms. 2 and 3. In the guidance the further management of the outbreak or incident is described according to the broad classification.

Some general clues have been suggested for determining whether an outbreak / incident might be the result of deliberate action. None of the features shown in Box 1, page 20, are specific for outbreaks / incidents with deliberate explanations. However, should any of these features be present, the possibility of such an explanation should be considered. Where deliberate action is suspected the matter must be discussed with the police.

Other features of the guidance are;

- provision of checklists for necessary actions
- a list of contact numbers for expert support agencies
- references to supporting documents
- appendices outlining likely features of radiation exposure and epidemic psychogenic illness

The full document can be found at http://www.phls.co.uk/advice/Unusual-Guidelines.pdf.

Box 1: Clues that may indicate that an outbreak/ incident of unusual illness may have a deliberate explanation

- Prior warning received of malevolent intent
- Large number of ill people with similar disease or syndrome
- Large number of unexplained disease, syndrome or deaths
- Single case of disease caused by an uncommon agent
- Unusual illness in a population
- Recognised illness occurring in an unusual setting within a community
- Illness affecting a key sector of the community
- Higher morbidity and mortality than expected with a common disease or syndrome
- Failure of a common disease to respond to usual therapy
- Multiple unusual or unexplained disease entities coexisting in the same patient without other explanation
- Disease with an unusual geographic or seasonal distribution
- Multiple atypical presentations of disease agents
- Similar typing of agents isolated from temporally or spatially distinct sources
- Unusual, atypical, genetically engineered, or antiquated strain of agent
- Endemic disease with unexplained increase in incidence
- Simultaneous outbreaks of similar illness in non-contiguous areas
- Atypical transmission routes e.g. by aerosol, food or water
- Ill people presenting around the same time
- Deaths or illness among animals that precedes or accompanies illness or death in humans
- Illness only among people in proximity to common ventilation systems

The guidance was written by Jane Jones as a results of discussion between Dr Angus Nicholl, Director of Communicable Disease Surveillance Centre, Colindale and Dr Virginia Murray, CIRS who both contributed to the final version. Dr Jill Meara, National Radiological Protection Board, also provided information. Helaina Checketts, Librarian, Medical Toxicology Unit assisted with the literature search.

'WHITE POWDER' INCIDENTS

CIRS is grateful to the following two health authorities for sharing their experiences with the 'white powder' incidents.

Learning points from suspect letter in Liverpool postal sorting office

Dr Emer Coffey, Specialist Registrar in Public Health on behalf of the Health Protection Team at Liverpool and Sefton Health Authorities: Dr Kate Ardern, Consultant in Public Health Medicine, Dr Richard Jarvis, Consultant in Communicable Disease Control, Fred O'Grady, Zonal Emergency Planning Officer, Dr John Reid, Director of Public Health (Sefton).

A letter leaking white powder was found at a postal sorting office in Liverpool early one October morning. In the light of the anthrax scares in the United States, a major incident response was initiated by the emergency services and the public health team. Thankfully, by 8pm that evening the powder had turned out to be harmless sand. The purpose of this brief report is to focus on a few specific issues about the public health response to a bioterrorist threat which arose.

The incident

At 06.45 hours on 16 October, the first day-shift of postal workers found a letter leaking white powder. A manager put the unopened envelope in a polythene bag on a desk and all the staff were evacuated to a courtyard. The emergency services were notified. Air-conditioning was switched off and the police cordoned off the building. By 08.30 hours there was media interest both locally and nationally.

A multi-agency incident response was set up at police headquarters. It was decided to treat the six staff-members who had handled the suspect letter as potentially exposed to a biological agent. Five of them were decontaminated on site using a mobile decontamination unit. Their clothes were bagged and they were sent to hospital for prophylactic antibiotics. The sixth exposed person had already gone home and it was decided to give him decontamination advice and antibiotics at home.

Liverpool Daily Post & Echo Syndication department. Contact Tony Hall on 0151 472 2589

The suspect letter was retrieved by fire-officers wearing gas-tight suits and sent to a specialist laboratory in DSTL, Chemical and Biological Sciences, Porton Down, by helicopter for testing. We were advised this would take 8 hours. Contingency plans were made for positive, equivocal and negative results.

Dealing with the approximately 300 other staff-members who were being held in a yard outside became a major issue. Their contact details were taken. Information leaflets were designed and given to them to advise them that they were not at risk and they were allowed home. NHS Direct helpfully agreed to take calls from those with concerns or questions.

Issues: *Risk assessment:* During the day, several other suspect packages were reported both locally and nationally. The need for explicit risk assessment of these packages by the police became obvious. The PHLS interim guidelines for health professionals dealing with packages suspected of containing anthrax which were published a few days later are very welcome although a lack of clarity remains over the testing of low-risk samples.[1]

Triggering of different levels of multi-agency response

There is potential for confusion over the appropriate level of response by different agencies if it is not known whether terrorism is involved. Local agreement of the appropriate level of response is needed which should be based on risk assessment and should take into account the resources and logistical support required.

Dealing with an unfamiliar agent: We were all dealing with an unfamiliar agent for which we needed national guidance before being able to advise on health issues. PHLS, CDC websites and national experts were useful resources.

Definition of exposed and unexposed groups: Exposed and unexposed groups need to be defined rapidly to reduce the scale of the incident and reduce unnecessary public anxiety.

Public information/reassurance: These types of incidents are novel and can easily create public anxiety. The public need simple clear information about both the incident and what to do with a suspect package. Use could be made of the media who are interested anyway in view of the international situation. As for all major incident responses, we again learnt the importance of good communication and the need to divide strategic and operational roles.

Contact details: tel 0151 2852209 fax 0151 2852007
e-mail emer.coffey@liverpool-ha.nhs.uk

Reference 1. PHLS interim guidelines for health professionals dealing with packages suspected of containing anthrax. *http://www.phls.co.uk/advice/Suspect_mail.pdf*

Hoax or terrorism? Responses and lessons.

Dr Alex Stewart, SpR in Public Health, Dr Paula McDonald, CCDC and Bernard Schlecht. Communicable Disease Unit [CDU], Chester, CH2 1UL

The Incidents: Two separate incidents occurred on consecutive days in the mailroom of the local office of an international business.

Incident 1: 17 October 2001

A pre-paid envelope opened automatically by machine spilled a talcum powder-like substance contaminating the gloves and overalls of several people and the machine. The package was contained, the room secured and the police contacted. In the light of the background of the company and international concern over anthrax the substance was analysed at DSTL, Chemical and Biological Sciences, Porton Down. As expected this was negative for anthrax.

Incident 2: 18 October 2001

The second package was stained and leaking crystals. Two contacts developed stinging eyes and one person developed a blotchy rash. Mersey Ambulance decontamination unit was mobilised and Silver Command set up. PHLS guidance issued that morning to health, but not police, rated the incident as low risk and it was treated as a chemical incident. However, it was felt unlikely that any laboratory would be willing to analyse the crystals without excluding anthrax. DSTL was again asked to help and identified commercial wallpaper paste.

Problems and Points

- The Mersey Ambulance decontamination unit arrived in 40 minutes. The previous day it was being used elsewhere and was unavailable. Further investment is needed in expanding capacity in decontamination facilities since the maximum flow is six persons per hour.
- The anthrax PCR was available overnight but toxicological results took >40 hours since background bacteria grown needed to be screened for other pathogens. The results were not available to guide management. There does not seem to be an easy way round this. Discussion with CIRS indicated that in most cases management can be based on the presenting symptoms.
- High profile organisations need to examine ways to reduce the disruption caused by such packages. Advice from occupational hygienists*, eg on ventilation, working environment and equipment, would help, as would a Portacabin for screening mail.

* British Institute of Occupational Hygienists, Suite 2, Georgian House, Great Northern Road, Derby DE1 1LT [01332 298087]

FIREWORKS

Exploding fireworks have presented significant problems to emergency services and other public health providers. An example of a mass casualty incident is given on page 12. Incidents have occurred in the UK and the following provides an example of some of the difficulties in managing these events.

Mobile container holding 700 kg fireworks set on fire in a residential area

Dr Paula McDonald CCDC, Dr Catherine Quigley, CCDC, Cheshire and Wirral Communicable Disease Unit and Rod Tann Emergency Planning Officer, Merseyside Emergency Planning Unit

Notification of Incident

Cheshire and Wirral Communicable Disease Unit provides a chemical incident response on behalf of three Health Authorities, including Wirral Health Authority.

The unit was contacted at 12.15 hours on 7 November 2000 by an Emergency Planning Officer from the Merseyside Emergency Planning Unit. He reported that a fire had occurred in a temporary firework shop operating from a mobile container in a supermarket car park in the Wirral District of Merseyside. The container held 700 kg of fireworks and the fire had started at about 22.30 hours on 6 November. The supermarket is in a residential area, and as there was a risk of explosion, local residents had been evacuated from their homes to a church hall and local hotels. Once the fire had been put out, there was still residual smoke from the container being blown around the houses. No public health advice had been sought during the incident. Advice was now sought as to whether it was safe for residents to return to their homes. No casualties had been reported.

Action Taken

The Chemical Incident Response Service was contacted for advice on the adverse health effects of firework fumes. The constituents of these fireworks were not known. CIRS advised that the fumes were likely to contain sulphur products and products of combustion. All can cause skin and eye irritation and respiratory symptoms. Late pulmonary oedema/pneumonitis can occur after 24 hours, but only in people who had had significant exposure, probably with initial symptoms at the time. People with pre-existing respiratory problems would be more likely to develop respiratory symptoms.

The local A&E department was informed of the incident and written information about the incident and advice on management of casualties was faxed out to A&E and to local GP practices. The A&E department were also sent copies of detailed factsheets on sulphur products and products of combustion produced by CIRS. A&E and general pratitioners were asked to notify any suspected casualties to the Communicable Disease Unit.

The original request was for advice as to whether it was safe for local residents to return home. CIRS advised that it should be established that the houses were clean and well-ventilated, and that fumes were not lingering – ideally by sampling, but if this could not be done, then smell could be used as a guide. Residents should also be given advice about possible health effects of the fumes.

Outcome

It was not possible to arrange for environmental samples to be taken, but the rest of the advice from CIRS was implemented, and residents were allowed to return to their homes.

A local GP reported that five members of one family had presented with mainly respiratory symptoms following the firework incident

Discussion

Age	Symptoms	Treatment
41	Coughing, tight chest, headaches. Not asthmatic, but history of respiratory problems	Bronchodilator
10	Coughing. Known asthmatic, but not on treatment for years	Bronchodilator
9	Coughing. Known asthmatic	Bronchodilator
8	Coughing, tight chest . Known asthmatic. PEFR within normal limits	Already on bronchodilator
5	Vomited X2, headaches. Not asthmatic	Not given

- This incident is an illustration of the communication problems which can occur during incidents which occur outside the framework set up to respond to incidents at COMAH sites. Despite the potential seriousness of the incident, which a firefighter described to a TV reporter as a "huge bomb" which "could cause severe damage", a multi-agency silver command centre was not set up, and the Health Authority was not informed until the incident was almost over. This meant that local health services could not be briefed about possible effects of the incident.

- Environmental samples would often be helpful in guiding the public health management of an incident, but are often difficult to arrange.
- It is not always possible to ascertain the exact nature of chemicals that the public may have been exposed to. This incident is an example of a situation in which general advice has to be given.
- An unguarded container of fireworks left in a residential area is clearly a potential public health hazard. It has been established that the Local Planning Authority had not authorised – nor would have authorised- this activity. The supermarket, however, believed that they did not need planning permission to put the container in their car park. The Fire Service had registered the container as mode A (up to 1 ton of fireworks). The Fire Service are unable to refuse registration provided appropriate storage conditions are met. One of the conditions of the registration was that there should be 24 hour security for the container, and that the fireworks should be removed immediately after Bonfire Night. However, the firm contracted to remove the fireworks had a problem with their vehicle and did not collect them on 6 November. The security contract for the fireworks finished that night and was not extended, even though there had been attempts to break into the container on previous nights. The registering authority were not informed that the container was unguarded.

Acknowledgements

With thanks to Harry Eggar, Assistant Divisional Officer, Mersey Fire Service, and Don Gilfoyle, Mobilising Officer, Wirral Borough Council, for information used in the report.

IPPC and Health Authority Consultation: Update for October 2001

Graham Robertson, IPPC Co-ordinator, CIRS and Elinor Battrick, Locum IPPC Support Scientist, CIRS

Introduction

Previous issues of the Chemical Incident Report have discussed how implementation of the regulatory regime for industrial installations of Integrated Pollution Prevention and Control (IPPC) is bringing new responsibilities to Health Authorities (CIR January, April and July 2001). The integrated approach to these regulations requires a number of agencies to act as statutory consultees. Their role is to assess applications submitted by operators of specific installations, which require authorisation (i.e. a permit) under IPPC. Health Authorities should comment upon (where appropriate) the potential for any human health effects in their area, which may be attributable to the installation. They are required to base these opinions on paper format application documents (written by the applicant) and from knowledge regarding the health of the local population, which is available to the Health Authority.

The Directive and UK Regulations

These new responsibilities owe their origins to the EC Directive 96/61 on IPPC, which has been implemented through the Pollution Prevention and Control (PPC) Act 1999 and operationalised in England and Wales under the Pollution Prevention and Control (England and Wales) Regulations SI 1973 2000. Under IPPC, installations have been classified into various industrial activity types, each of which has then been further subdivided into three categories according to its possible polluting effect. These are (in decreasing order of pollution producing potential): Part A1, Part A2 and Part B (CIR April 2001 p. 23-25). For A1 and A2 installations, regulation is integrated because emissions to all three media (air, water and land) are considered. For Part B installations regulation is not integrated since emissions to air only are considered. Hence, Part A1 and A2 installations are subject to IPPC, whilst Part B installations are subject to PPC only.

The various regulators

Operators of installations are required to obtain authorisations (permits) from their regulator both to commence operation of new installations and to continue to operate existing installations. For Part A1 installations the regulator is the Environment Agency (EA), whilst for Part A2 and B installations the regulator is the local authority for the area within which the installation is based.

The statutory consultee role of Health Authorities applies to Part A1 and A2 installations only. For Part A2, consultation takes place only where the operator wishes to operate a new installation. For Part A1, however, it takes place both for new installations and for existing installations. For existing installations, transfer from pre-existing regulatory regimes to IPPC is taking place progressively according to a timetable. The timetable for the period to the end of 2003 is summarised in Table 1. This timetable is considered to be provisional since not all sector activities have yet been included and some of the dates may change. Applications for new processes, however, are to be submitted as and when they are ready. Hence, for new installations, applications for any activity sectors and in any of the three categories could be submitted at any time.

For existing A1 installations, the consultation process has already commenced. Hence, Health Authorities have already commented upon applications for A1 installations in the ‘paper, pulp and board manufacturing’ sector. For existing A1 installations in the ‘cement and lime manufacture’, the ‘gasification, liquefaction

Part A Activity Sectors	Relevant Period for Part A(1) Installation Applications
Non-Ferrous Metals	01Oct01 - 31Dec01
Tar and Bitumen *(Part 1)*	
Glass and Glass Fibre	01May02 - 31Jul02
Other Mineral Fibres	
Ferrous Metals *(Part 2)*	
Coating, Printing and Textile Treatments	
Treatment of Animal and Vegetable Matter and Food Industries *(Part 1)*	
Organic Chemicals *(Part 1)*	01Jan03 - 31Mar03
Organic Chemicals *(Part 2)*	01Jun03 - 31Aug03

Table 1: IPPC activity sectors, relevant sections of Schedule 1 of the PPC Regulations and submission timetable (from current to end of 2003)

and refining' and the 'ferrous metals' activity sectors, applications have also recently been submitted and are now being passed on to the Health Authorities.

Volume of work generated by IPPC and allocating resources

Figure 1 indicates the regional breakdown for the 121 IPPC applications submitted within the 6 NHSE regions served by CIRS during the period up to the end of September 2001. However, this is just the tip of the iceberg, since it is estimated that, overall, approximately 7000 applications requiring Health Authority assessment will be submitted in the **period up to** mid-2007. Those Health Authorities who have already received applications will be aware they tend to consist of bulky A4 sized folders (sometimes several volumes), are relatively technical and that finding the necessary information to identify the potential for human health effects can sometimes be time consuming. CIRS who have now reviewed approximately 75 applications, observe that the quality of applications is also highly variable. Given the tight timescale for response (only 28 days), it would be valuable if Health Authorities could consider further the allocation of resources to handle the expected workload over the coming period. Health Authorities are also urged to talk to their local regulators regarding expected applications for A1 and A2 installations. This will enable Health Authorities to determine the number of applications from each sector and category, which are likely to be submitted to them over the next 6 years.

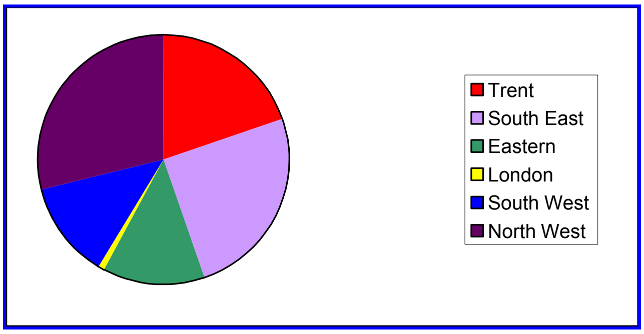


Figure 1: IPPC applications received by CIRS for overview assessment from its six NHSE regions (up to the end of September 2001)

It should be borne in mind that the statutory consultee's role is to provide informative comment to aid the regulator. The end point of the Health Authority consultation is a response placed on a public register. CIRS reviews of IPPC applications aim to provide overviews and identify issues of concern. Hence, the work undertaken for Health Authorities by CIRS serves primarily as briefing documents. They should not, therefore, be included in the response to the EA without further interpretation and consultation. This is because Health Authorities need to use the information and analyses provided, combined with their local knowledge and discussion with their EA contact, to develop an opinion on the application. It is this opinion, which should form the Health Authority response on the public register.

Guidance and databases to facilitate response

In the absence of guidance on what is expected for IPPC consultation responses, a number of the Regional Service Provider Units (RSPU), in conjunction with their Health Authorities/Boards and regulators, have been developing their own guidance and formats for response. For England and Wales, there have been two notable recent developments.

The first of these is the recently published first draft of 'IPPC: A Practical Guide for Health Authorities' produced by the Chemical Hazard Management and Research Centre (CHMRC)', based at Birmingham University. This was posted on the web during August of this year. Its purpose is to identify the practical principles that should underpin the process of consultation and response. The document is currently available on the Department of Health web-site: www.doh.gov.uk/ipcc/index.htm, the EA web-site: www.environment-agency.gov.uk/business/techngDuide/ippc and the CHMRC web-site. CIRS is grateful to Andrew Kibble from CHMRC who presented this at our iterative group meeting on 4th October. He stated that comments on the guidance are welcomed, and the current intention is that it will be reviewed in early December 2001 to take into account those received.

For Scotland, the Scottish Centre for Infection and Environmental Health (SCIEH) have been working in collaboration with SEPA to develop their own IPPC guide for Health Boards. This has now reached the stage of an advanced draft and should be available for comment within Scotland in the near future. Information provided by Dr Colin Ramsay, SCIEH at the CIRS iterative training day held at Guy's on 4th October suggested that they are following a different approach to that being developed within England and Wales. A more detailed assessment of their approach may well be valuable and helpful.

The other significant development has been the iterative production of an IPPC response database/checklist produced by collaborative development between CIRS and its NHSE regions, via the series of bimonthly meetings reported in previous issues of the Chemical Incident Report. The first draft of this database plus an accompanying navigation document are now in the final stages of development and are to be piloted amongst the CIRS NHSE regions from mid-November. The database is designed to represent the consensus of opinion between CIRS and its NHSE regions on what should be included in a response that represents current 'best' practise. It also serves to encourage a level of standardisation, quality assurance, transparency and audit ability for responses.

Areas for further development

It is recognised, however, that some IPPC applications are particularly sensitive for a variety of reasons. Such reasons might include:

- the area surrounding the site being known to be particularly contaminated (hence of particular toxicological concern)
- the presence of morbidity and/or mortality clusters
- high levels of uncertainty regarding possible human health effect
- records of significant complaints and/or off-site accidents
- presence of local pressure groups, MP enquiry and media interest.

For such cases, a more sophisticated assessment should be considered, which might require, amongst others: reference to similar processes in operation locally, nationally or elsewhere in Europe or the World; literature reviews and digests for possible and probable health effects associated with the industry concerned and/or with specific processes; further examination of the quantities, state and potential human health hazards of all chemicals entering the installation and leaving as products, co-products, by-products, wastes and emissions to air water and land during incidents at all scales including major disasters; examination of disaster recovery issues; and carrying out some form of health impact analysis (HIA) to assess the potential impact of the installation in its wider social context, using current 'best' practise health impact assessment methodologies.

Health impact analysis

Such work may take considerably longer than the 28 days allowed. However, the long lead in times for many of the activity sectors should allow work to be planned and crucial areas of analysis to be conducted well in advance. Some or the work may also be regarded as complementary rather than supplementary to IPPC. For example, HIA could be viewed as part of the wider public health assessment activities of Health Authorities. Hence it could be conducted relatively independently of the applicant's IPPC application and in advance of it. Then, as and when needed, the relevant HIA findings could be fed into the IPPC consultation assessment. To facilitate the development of such adapted HIA approaches, the first meeting of a working group comprising interested parties with experience in the public health and HIA fields has recently taken place.

Future iterative IPPC meetings

Further regular meetings between CIRS and its six NHSE regions have been planned for January, May and October of next year with additional dates to be decided in due course. Observers from CHMRC, SCIEH, other CIRSPU and the Food Standards Agency will be asked.

These meetings will focus on the ongoing and iterative development of the database and navigation document plus all of the other issues discussed above. It is envisaged currently that they will also focus on specific issues pertinent to industrial activity sectors who will be submitting applications in the forthcoming period. CIRS will continue to keep readers informed of further developments as they arise. In the meantime, should you require further information on any of the above please contact CIRS. tel 020 7771 5383, or email: Graham.Robertson@gstt.sthames.nhs.uk

The authors would like to give special thanks to both Ivan House (Medical Toxicology Unit, Guy's and St Thomas' Hospital Trust) for developing the IPPC response database and to the representatives from our six NHSE regions for their support and collaboration in its development and for their ongoing contributions to the IPPC iterative development meetings.

CHEMICAL INCIDENT HEALTH IMPACT PREDICTION: Estimated health impact and public health response in the event of a chemical incident in South Essex

Giovanni S Leonardi, Consultant in Environmental Epidemiology, CIRS

This project was conducted at the London School of Hygiene and Tropical Medicine in collaboration with Tony Fletcher and Simon Stevenson and at South Essex Health Authority in collaboration with Dr Amelia Cummins, CCDC, in 1997-9. The study considered that the Health Authorities have a responsibility for planning their response to environmental hazards, and that usually they have little more than a general framework for response and a list of major industrial installations. The project was an attempt to use modern technology to support the role of the Health Authority in planning their response to chemical incidents.

The project was based around an in depth analysis of the possible consequences of a hypothetical incident close to residential areas in South Essex. The aims were twofold:

- to look at the possible health impact of a local incident, in this case a hypothetical fire at a crude oil tank;
- to illustrate an approach based on a Geographical Information System (GIS) for analysis of any air pollution related incidents in the health sector.

The methods used involved linkage of estimated exposure data with health data and population data, use of epidemiological evidence for health impact assessment and consideration of planning implications.

Taking as an example a local oil refinery as a case study, estimated patterns of airborne contaminant concentrations from a hypothetical fire were applied to available data on the residential and daytime populations. The Health and Safety Executive (HSE) supplied modelled exposures based on this fire with plausible values for quantity and quality of burnt oil. From this, health impacts in terms of numbers of possible fatalities and hospital admissions were calculated.

Figure 1 illustrates the GIS procedure which allowed linkage of the hypothetical plume of smoke with the local population. An estimate was thus derived of the total number of people potentially exposed to different concentrations of air pollutants.

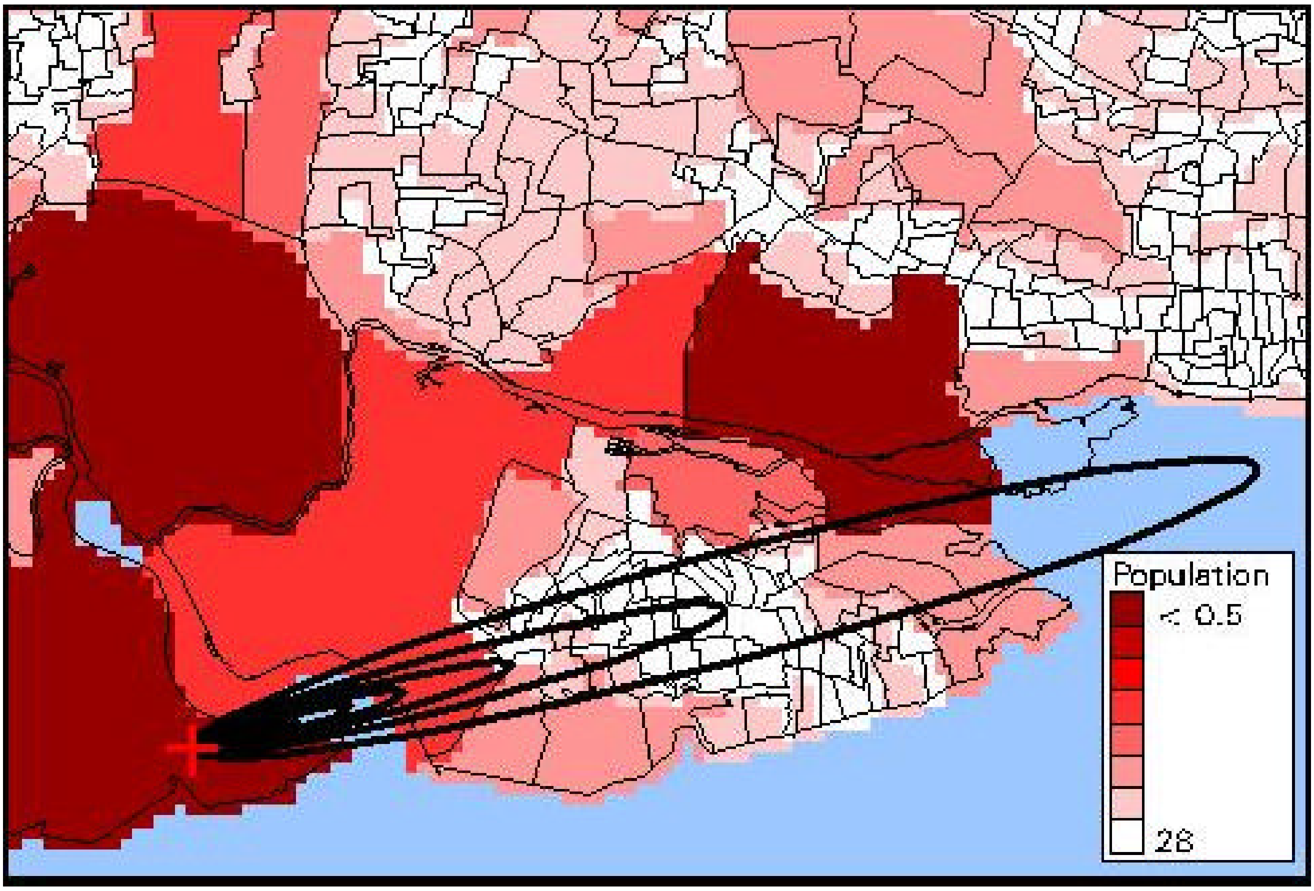


Figure 1. Hypothetical plume path divided into exposure bands used to calculate day time exposed population. Each small square represents a grid square of 100 metres with a corresponding population value (Home Office data) a white area is most densely populated, dark red least densely. ©ED-Line and Crown

Figure 2 illustrates the GIS procedure which allowed linkage of the hypothetical plume of smoke produced by the fire with the data on vulnerable subgroups of the local population. From this, an estimate was derived of the number of people with pre-existing respiratory disease who might be at risk from high concentrations of air pollutants.

Conclusions on the hypothetical incident

- HSE dispersion studies provide an estimate of the concentrations of substances in smoke produced by combustion of crude oil. Of these substances sulphur dioxide and soot particles are likely to represent an immediate hazard to the health of the population
- The estimated total size of health impact from this exercise is reassuringly low with less than one death predicted and respiratory irritation expected in a few exposed individuals.
- Those with pre-existing heart and/or lung disease might experience a worsening of their symptoms.
- In the event of a fire at a tank of crude oil in another location, different from the one studied here, nearer to residential areas, the health impact on the population might be more severe.

Conclusions on the methods used

- GIS tools readily offer the possibility to overlay areas of estimated distribution of products of combustion by distribution of the resident population. Further adaptation would be required to apply GIS to follow up populations after they have been exposed to a chemical incident.
- The role of HSE's Major Hazard Assessment Unit in producing dispersion studies of toxic chemicals was central to the exposure estimates. This approach may be used more widely within the emergency-planning framework.
- Exposure-response factors for toxic substances can be obtained from the epidemiology literature and may be of value in emergency planning.

Reference: Leonardi GS, Fletcher A, Stevenson S. Estimated health impact and public health response in the event of a chemical incident in South Essex. London School of Hygiene and Tropical Medicine: London, UK. A report to the Emergency Planning Coordination Unit of the Department of Health, August 1999.

Acknowledgements:
This project had financial support from the Emergency Planning Co-ordination Unit of the Department of Health. Particular thanks to David Carter, Health and Safety Executive, Chris Grundy, GIS Centre, London School of Hygiene and Tropical Medicine; and Suk Athwal and Gian Amat, Home Office Emergency Planning Division.

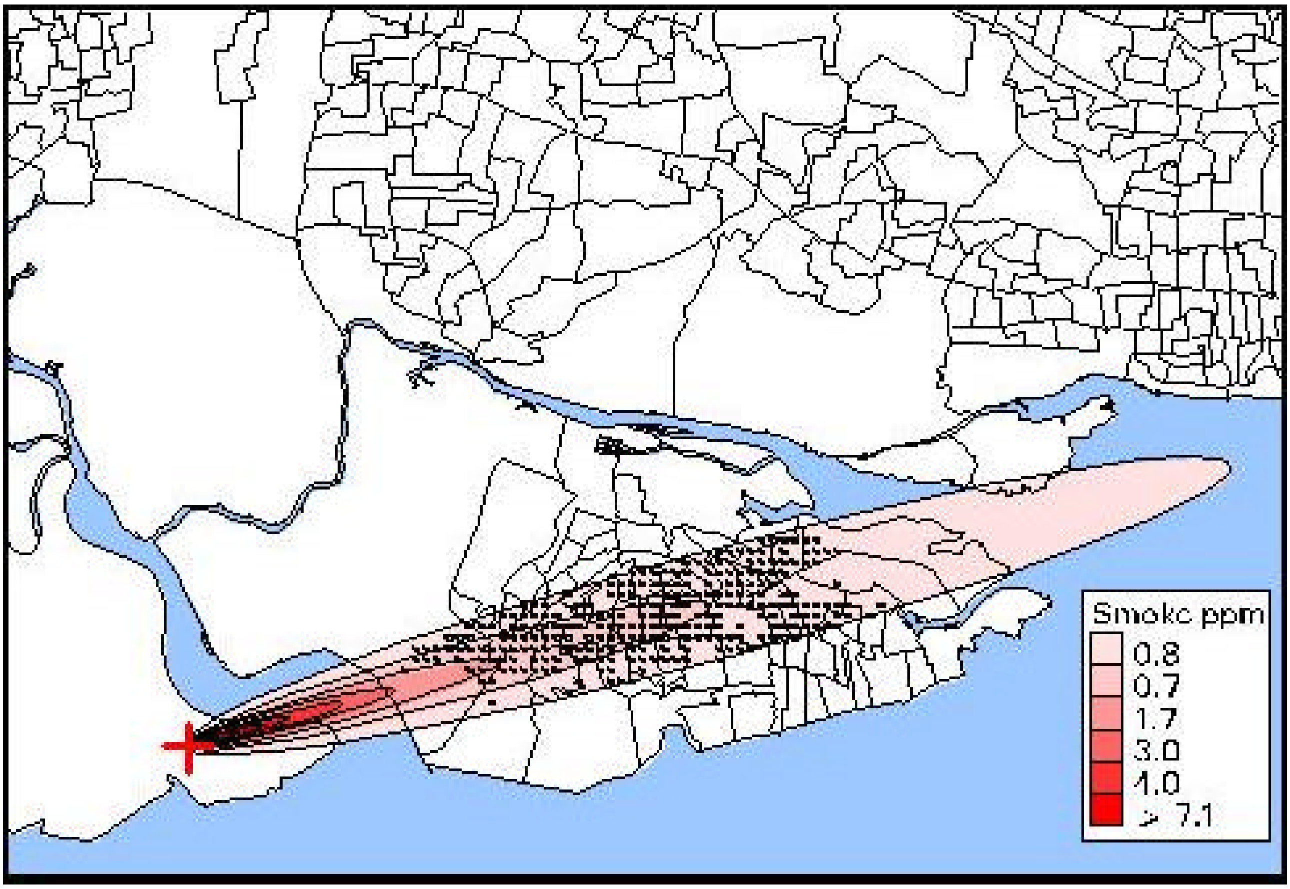


Figure 2. Hypothetical plume path divided into exposure bands for smoke particles and location of postcodes of residence (black dots) for the exposed population. ©ED-Line and Crown

COMMUNICATIONS DURING MAJOR INCIDENTS: Recent developments and lessons learnt. Part 2

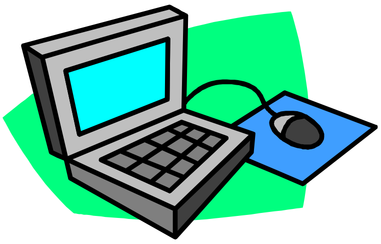
Kaetrin Carnegie-Smith, Independent consultant in Public Health Medicine, Correspondence to: kcs.foxglove@dial.pipex.com

The first part of this paper published in the July 2001 Chemical Incident Report; 21[1] concentrated on the use of

- *Telephones and telephone exchanges.*
- *Faximilie machines (FAX)*
- *Protecting communications*

This paper details some of the other practical problems that have arisen with the use of technical communications during major incidents. Lessons about good practice may be learnt from the study of past experience.

1. Computers.



Most senior managers now use their computers to store policies and plans, give direct access to FAX facilities and receive and transmit both internal and external e-mail messages. Those who have a particular interest in computing often update their personal data disk, which they carry constantly. This means that, in the event of a major incident, they can work at any computer and still have all the necessary information in the form they require. Some miserly finance departments consider that it is not cost-effective to provide laptop computers for those key workers who would be out-posted during an emergency. Having a known contact number and FAX facility for a senior member of staff representing the NHS at County Hall or at Police Headquarters (should it be necessary to set up a Joint Health Advisory Cell) is most useful.[2] The security systems relating to computers continue to cause problems as hackers take perverse pleasure in defeating all anti-hacking devices.[3,4)]

Example: The release and rapid dissemination of the "love bug" computer virus in 2000 demonstrated just how readily our existing communications systems can become "infected."

During power failures computers should be switched off and unplugged as data corruption may occur during any power surge on restitution of the supply. Back-up disks, regularly up-dated, prevent loss of important data during any power outage.

The future implications of these new threats require to be considered as part of any strategic planning process for future major incidents.

2. Private electronic mail (e-mail).

This form of communication has extended rapidly during the past few years. It is available to most departments in the NHS and to those with a home computer. Cyber cafes and public libraries have opened this facility to the entire population. Within the NHS certain specialist information/databases are available through the Internet. The internal "NHSnet" is widely used for the fast transmission of information.[3,4] Again this service relies upon a functional telephone line, a computer and electric power. The server providing the system may develop technical difficulties, and messages may be delayed or even lost. Many have found once the system or machine fails that they have become wholly reliant upon their computer. Often the same is said about e-mail which provides cheap and rapid transmission of lengthy documents and short messages. Service developments in this sphere are progressing so fast that it is difficult to keep abreast of them.[10]

3. The World Wide Web – solutions and challenges.

Perhaps the greatest change in communication has occurred with the availability of the World Wide Web to so many. Individuals can obtain information about virtually any topic whilst sitting at their console, possibly in their home. As with all advances, this ready availability of information and goods has both positive and negative features. The cyber revolution has altered the power of the individual to influence many.

The esteemed retired academic, Professor D.A. Henderson, wrote an important paper about how he considers that the practices he had adopted throughout his professional life were no longer appropriate.[6] He refers to discussions on the abuse of biological agents. In the past a conspiracy of silence has been the preferred response for fear of encouraging those with malicious intent. Now he feels that response organisations must be seen to prepare in an open manner for such terrible events. His justification for this is both the ready availability of information and the facility to purchase biologically hazardous items on the Internet. Open access to information swings the balance of risk analysis away from neutral and towards a position requiring overt preparedness. The likelihood of hoax or copy cat reactions arising from observation of an incident or exercise diminishes when the perpetrators appreciate how well the responding services are trained. In his view, it is no longer a question of if but when such incidents will occur.

The cyber revolution empowers individuals and favours networks. The quality and accuracy of information on the Internet is variable. "Net warriors" have already emerged, using the net to influence or modify social perceptions and to conduct "information" (misinformation) operations. For addicts the variable quality of medical information available on the WWW has lead to "cyber-chondria", the latest form of imagined diseases and depression.

Future adverse technical and social developments may be more difficult to counteract. Therefore constant surveillance is essential.

4. The increasing role of NHS Direct.

In the past telephone banks were set up within a hospital to deal with the multiple enquiries following a health scare. Now that NHS Direct has extended to cover the country it has the facility to augment normal services within an hour or two of any health scare or major incident. The network has developed to the extent that unknown to callers routine services can be diverted to another part of the country whilst the local NHS Direct deals with calls relating to the incident. This particular facility could be of importance if the NHS Direct premises replete with communications equipment were to be considered as a contingency base for the co-ordination of the NHS responses, in the event of the Health Authority Offices being unavailable during an incident.

The NHS Direct staff may require a script relevant to the particular incident. Special staff training to differentiate those callers who were victims from the worried well, may also be required. The existing level of training is such that minimal additional input would cope with all but the most catastrophic incident. Few Health Authorities have modified their Major Incident Emergency Plans to accommodate fully this recent service development.

The web-site of NHS Direct can display updated messages about any incident. As more people start to use the NHS Direct services as their prime source of reliable information so the value of these services during an emergency will increase. The Department of Health web-site mainly relating to policy issues appears less pro-active in relation to major incidents than that of NHS Direct.

5 When all else fails.

In various places protracted power failures have shown the folly of relying entirely upon high tech communications equipment. In each such event the solution was to have messengers to deliver essential messages. This was summarised by Colonel Wilson of the USA Army in January 2001: "We must place a safeguard on over-reliance on technology by emphasising *people* over *things*."[7] These wise words imply that all emergency plans should include both simple as well as high tech. means of communications.

Public warnings relating to a major incident are now given by media public service broadcasts. Many of these relate to health and the content may have been suggested by those co-ordinating the Health Authority response. During a power cut, unless there are emergency generators or an unlimited source of battery power, television and radio broadcasts reception will cease, other than on car radios.

Although emergency plans were enhanced in preparation for any technical problems associated with the Year 2000 and the Millennium bug, subsequent staff or equipment changes may necessitate further amendments. It may be wise to ensure that all NHS emergency plans provide answers to the following questions:-

1. Have NHS Trusts and Health Authorities identified contingency courier services or systems?
2. Does a courier contract exist at present, before an incident occurs? (Commercial courier services will give priority to existing clients rather than new ones during a time of crisis.)
3. If existing members of staff are required to fulfil this courier role, do they require training?
4. Do they require additional insurance, vehicles or personal protection equipment in order to fulfil this role?

Conclusion.

These papers give a brief overview of the practical elements of technical communications available to aid the NHS response during a major incident. The range and scope of existing technical equipment should suffice for a rational and sustained response to the simpler type of major incident. The rate at which new developments in technical communications reach the market requires frequent reappraisal and modification of existing emergency plans.

It is clear that most of the main communications systems require a constant supply of electricity. As global warming continues, experts predict that there will be more storms and exceptional weather conditions. Both have caused major problems of damage to supply lines for electricity and telephones. Contingency plans must include alternative power supplies or other solutions to ensure that adequate communication can be maintained within and externally to the NHS, throughout any major incident.

During a major incident, having total reliance upon sophisticated high tech communications equipment is foolhardy without contingency plans involving simple low tech solutions. Ultimately it devolves upon people to ensure the timely transmission of important messages.

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Water-related chemical incidents: October 1997-April 2001

Faith Goodfellow, CIRS Research Engineer—Water

The Chemical Incident Response Service (CIRS) has co-sponsored with the Engineering and Physical Sciences Research Council a four-year research project conducted as part of the Engineering Doctorate (EngD) Programme in Environmental Technology at the University of Surrey. The project has been conducted with the aim being to improve the public health response to chemical incidents. Over the four-year project, I have been involved in the management of numerous chemical incidents, largely involving water pollution. In the period from October 1997 until April 2001 a total of 246 water-related chemical incidents have been reported to CIRS. These incidents were defined as involving primary or secondary contamination of water, including surface waters, groundwater, marine water and drinking water. A detailed table of these incidents can be found on the CIRS website.

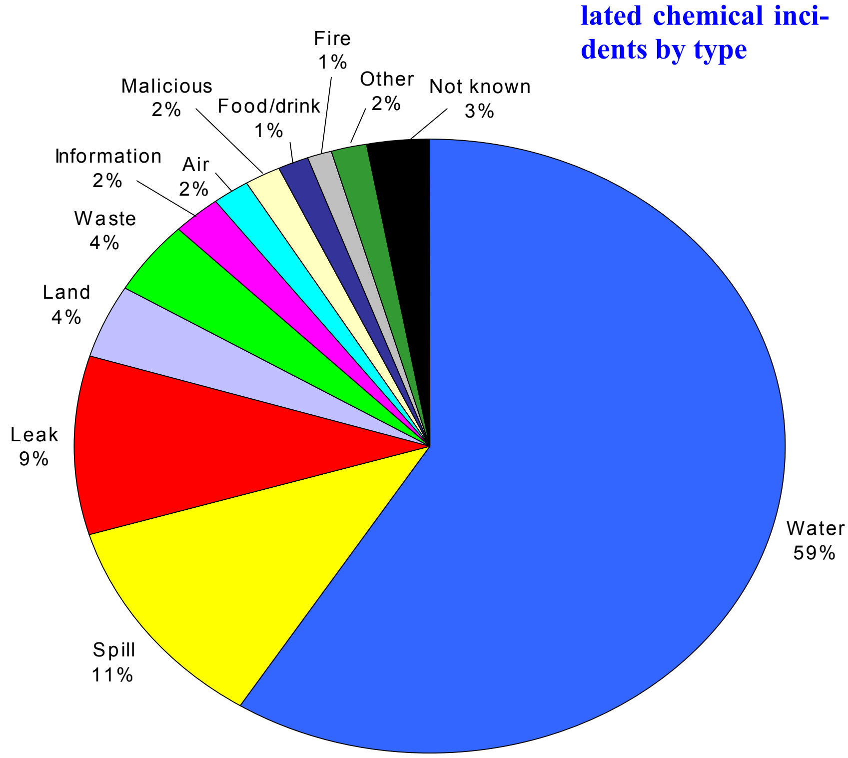
Not all the incidents that have been identified as involving water pollution have been categorised as water incidents under the type category used in the CIRS database.

Figure 1 illustrates the incidents as documented by type. Figure 2 a and b illustrates the most common chemicals involved in water-related chemical incidents.

The most frequently occurring chemicals are:

- Hydrocarbons :
- Iron
- Lead
- Nitrates
- Copper
- Petrol·
- Kerosene·
- Cyanide
- Manganese
- Pesticides

Figure 1 Water related chemical incidents by type



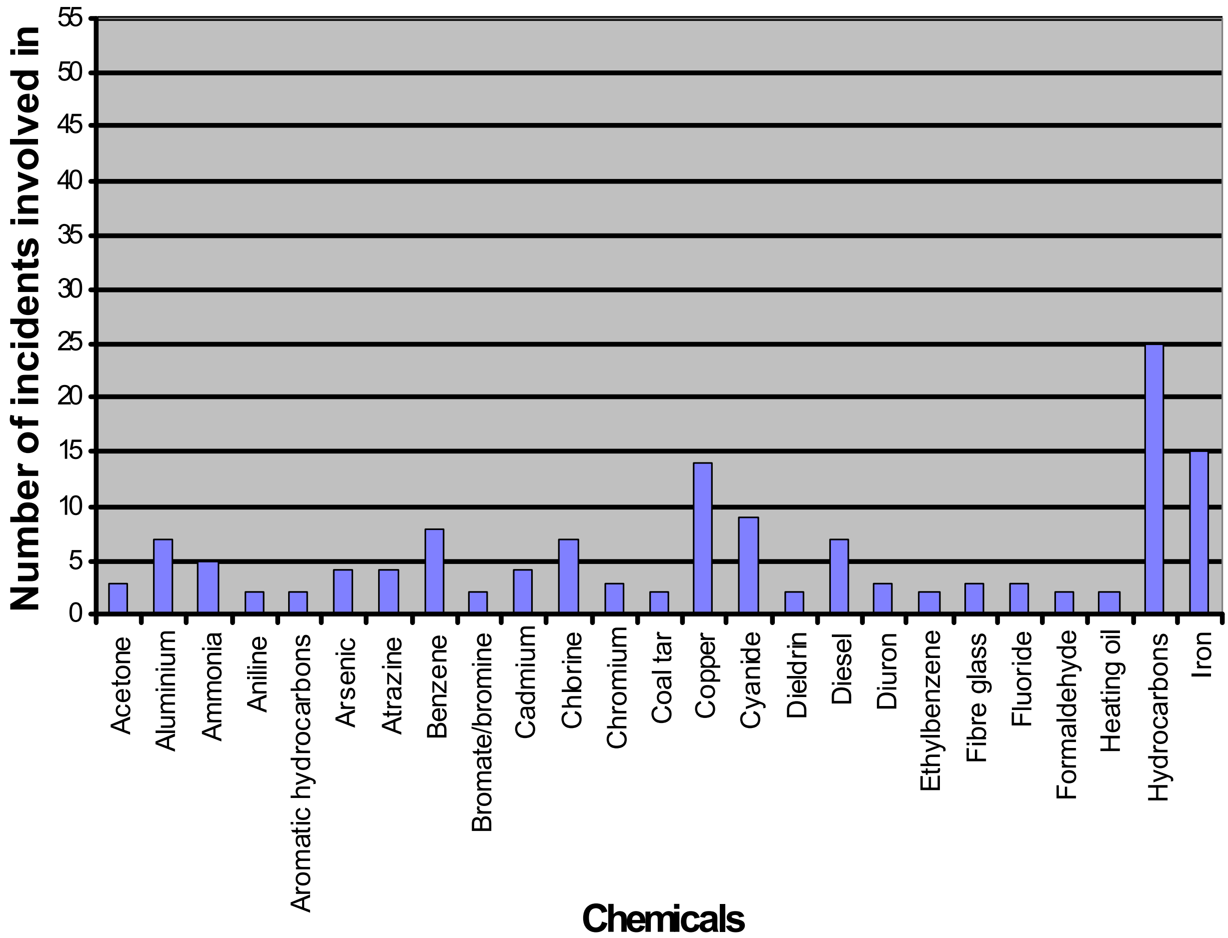


Figure 2 a

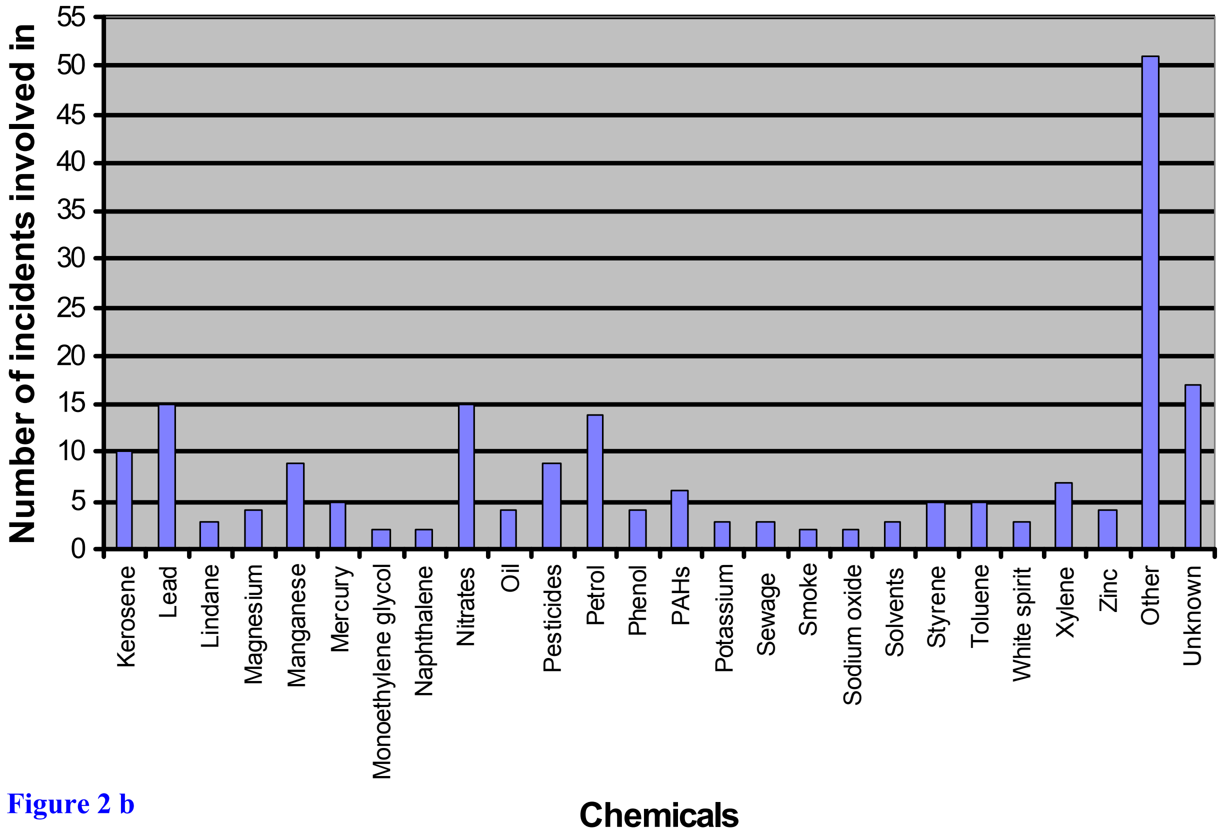


Figure 2 b

CIRS Training for 2001

CIRS Air Contamination Training Day *Thursday 22nd November 2001*
(for CsCDC, CsPHM and Specialist Registrars and Local Authority Environmental Health Officers).
This specialist training day, developed over the last three years, will cover a selection of issues focused on the management of acute and chronic air contamination incidents. The day will be of most benefit to those who have already attended a general training day on how to respond to chemical incidents, or have been involved in the management of air related chemical incidents. A maximum of 30 places are available.

CIRS Water Contamination Training Day *Friday 7th December 2001*
(for CsCDC, CsPHM and Specialist Registrars and Local Authority Environmental Health Officers).
This specialist training day, developed over the last three years, will cover a selection of issues focused on the management of acute and chronic water contamination incidents. The day will be of most benefit to those who have already attended a general training day on how to respond to chemical incidents, or have been involved in the management of water related chemical incidents. A maximum of 30 places are available.

All the training days listed for 2001 will be held in the Sherman Education Centre, 4th Floor Thomas Guy House, Guy's Hospital, by London Bridge Station London SE1 9RT
Those attending CIRS course will receive a Certificate of Attendance and CPD/CME accreditation or points
Places will be confirmed as reserved upon a receipt of a £25 refundable deposit. For those working in organisations without Service Level Agreements with CIRS a charge of £100 for attendance at each course will be made. **For booking information on these courses and further details please contact Rico Euripidou or Henrietta Harrison on 0207 771 5381**
Please call the Chemical Incident Response Service on 0207 771 5383 if you would like information on other courses .

Training days for 2002 For your diaries!!

Tuesday February 12	How to respond
Tuesday 19 March:	Environmental management
Thursday 18 April:	Environmental Epidemiology
Tuesday 21 May:	How to respond
Thursday 20 June:	Food Training day
Thursday 18 July:	To be announced

The following dates will be specified in January 2002 CIR

September:	Environmental management
October:	How to respond
November:	Waste Management
December:	To be announced

CIRS Staff Developments

Virginia Murray, Director

Giovanni Leonardi: CIRS is delighted that Dr Leonardi has joined us as our Consultant in Environmental Epidemiology.
Giovanni Leonardi graduated in medicine at Bologna University. He specialised in public health in Italy and Great Britain. After obtaining a MSc in Environmental Epidemiology and Policy at the London School of Hygiene and Tropical Medicine in 1994, he has worked as an epidemiologist on air and water pollution studies in Central and Eastern Europe. He has looked in particular at associations between air quality and the immune system. He is married with two children. Also he is keen on the good air quality that can be found by walking in the Dolomites and other mountains.

Joan Bennett: Joan is retiring from CIRS at the end of November. Joan joined the Medical Toxicology Unit in February 1989 as personal assistant to Virginia Murray. She has worked closely with her on many successful projects since then. Joan has assisted with all aspects of the Chemical Incident Response Service since it began as a research programme in 1989. I am sure you will all recognise the name if not the face on the end of our office telephone. Joan would like to say goodbye and send best wishes to everyone for a successful future. Virginia and all those at CIRS will miss her enormously and thank her for all her support over the years. We wish her a long and happy retirement .

Faith Goodfellow: Faith has completed her four years Engineering Doctorate with CIRS and the University of Surrey. Over the years it is likely that you will have had specialist support provided by Faith in water incident management. Many of you will know that she, with Fiona Welch and Emma Eagles, have been developing this into the CIRS book for next year on Environmental Management of Chemical Incidents. I know she is very grateful for all the support and encouragement received from Health Authority colleagues and other organisations over this period. CIRS is very sad that she will be moving on to an exciting new job on the completion of her Doctorate and will miss her expertise.

Emma Eagles: The CIRS team congratulate Emma Woodey on her marriage on 22 September to Chris Eagles. Please note she is Mrs Eagles now!

Chemical Incident Report
Edited by Dr Virginia Murray, prepared and distributed in collaboration with Dr Giovanni Leonardi, Joan Bennett, Elinor Battrick, Henrietta Harrison, Ivan House, Kay Sheridan and the staff of the Chemical Incident Response Service.