Health and safety for clean-up and recovery workers

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Introduction

This paper will identify and discuss the major occupational health and safety (OHS) hazards and risks for clean-up and recovery workers. The lessons learned from previous disasters including; the Exxon Valdez oil spill, World Trade Centre (WTC) terrorist attack, Hurricane Katrina and the Deepwater Horizon Gulf of Mexico oil spill will be discussed. The case for an increased level of preparation and planning to mitigate the health risks for clean-up and recovery workers will be presented, based on recurring themes identified in the peer reviewed literature.

There are a number of important issues pertaining to the occupational health and safety of workers who are engaged in clean-up and recovery operations following natural and technological disasters. These workers are often exposed to a wide range of occupational health and safety hazards, some of which may be unknown at the time. It is well established that clean-up and recovery operations involve risks of physical injury, for example, from manual handling, mechanical equipment, extreme temperatures, slips, trips and falls.

In addition to these well established physical injury risks there are now an increasing number of studies which highlight the risks of longer term or chronic health effects arising from clean-up and recovery work. In particular, follow up studies from the Exxon Valdez oil spill, Hurricane Katrina and the World Trade Centre (WTC) terrorism attack have documented the longer term health consequences of these events. These health effects include respiratory symptoms and musculoskeletal disorders, as well as post traumatic stress disorder (PTSD).

In large scale operations many of those workers and supervisors involved have not had any specific occupational health and safety (OHS) training and may not have access to the necessary instruction, personal protective equipment or other appropriate equipment, this is especially true when volunteers are used to form part of the clean-up and recovery workforce. In general, first responders are better equipped and trained than clean-up and recovery workers and some of the training approaches used for the traditional first responders would be relevant for clean-up and recovery workers.

Likely increase in the severity and frequency of disasters

Globally the scale and complexity of clean-up operations following natural and industrial disasters has increased over the last few decades and is likely to increase in the coming decades. There are a number of factors which are likely to contribute to an extended role for clean-up and recovery workers, these factors include;

- Increased severity and intensity of extreme weather events
- Increased number of large scale and technically complex major hazard facilities
- Increased urbanization, especially in countries like China and India which hitherto have had predominantly rural populations
- Possibility of large scale terrorist attacks
Anticipated need for increased numbers of clean-up and recovery workers

The occurrence of more large scale disaster events means that the need for clean-up and recovery workers will be protracted and in all likelihood exceed the capacity for clean-up and recovery available in the first responder workforce. Recent experience of large scale disasters demonstrated that trained emergency service workers were fully deployed and authorities were reliant on supplementing professional emergency service personnel with volunteers and workers from other industrial sectors to undertake clean-up and recovery work. For example, in the 2011 Brisbane flood a large volunteer force of about 25,000 people was assembled, the ‘Mud Army’, to assist with the clean-up, (Moore 2011). The ‘Mud Army’ volunteers were registered with Brisbane City Council but they had no particular preparation or training for the work required. There is every reason to believe that governments will continue to be reliant on a large volunteer workforce in the future.

Unlike first responders, workers from other industrial sectors or volunteers will often be relatively untrained in clean-up and recovery work, (Howard 2009), (Miller & Garrett 2009). These volunteer workers and their supervisors may be unaware of the full range of occupational health and safety risks associated with clean-up and recovery work following disasters. In the USA, Struttman (2005) found that between 1993 and 2002 over 500 volunteers died from work-related injuries. Miller & Garratt (2009) concluded that the rate of fatal injury for volunteers was comparable with the average for the USA paid workforce. No comparable studies exist for Australia, however it is likely that volunteers in Australia would face similar risks and volunteers are a significant component of the disaster recovery workforce.

Expanded responsibilities for disaster management authorities

In Australia there are new legal provisions which apply to the OHS responsibilities of disaster managers, especially in relation to the use of volunteers for clean-up and recovery work. In 2011 most Australian states /territories and the Commonwealth government adopted harmonised work health and safety legislation. For the most part the harmonised legislation is similar to the previous legislation. However, there has been one very significant change: the new harmonised legislation has clarified and extended the scope of the work health and safety legislation well beyond the duties of employers and employees. Previously work health and safety legislation provided some coverage for volunteers, as did the common law. Now the harmonised legislation has clarified the obligations of duty holders towards volunteers, (Eburn 2011)

The key legal concept in the harmonised legislation is that the prime duty holder is the Person in Control of a Business or Undertaking (PCBU). A PCBU has significant duties in relation to all those who may be affected by the business or undertaking that the PCBU is controlling. Therefore authorities in charge of clean-up and recovery work have a range of important duties in relation to the health and safety of clean-up and recovery work, even to those clean-up and recovery workers who are unpaid volunteers or work for contractors who have been employed by the clean-up/recovery authorities.
Main duties of the PCBU.

As the primary duty holder the PCBU is expected to undertake due diligence which is defined in the harmonised legislation, see for example Section 27 of the Work Health & Safety Act 2011 (Qld), see Box 1 below.

BOX 1. Due diligence for a Person in control of a business or undertaking (PCBU)
A PCBU is required to take reasonable steps:

‘(a) to acquire and keep up-to-date knowledge of work health and safety matters; and
(b) to gain an understanding of the nature of the operations of the business or undertaking of the person conducting the business or undertaking and generally of the hazards and risks associated with those operations; and
(c) to ensure that the person conducting the business or undertaking has available for use, and uses, appropriate resources and processes to eliminate or minimise risks to health and safety from work carried out as part of the conduct of the business or undertaking; and
(d) to ensure that the person conducting the business or undertaking has appropriate processes for receiving and considering information regarding incidents, hazards and risks and responding in a timely way to that information; and
(e) to ensure that the person conducting the business or undertaking has, and implements, processes for complying with any duty or obligation of the person conducting the business or undertaking under this Act.’

Source: S27 Work Health & Safety Act 2011 (Qld)

Examples of PCBU Duties

These responsibilities of the PCBU are far reaching and extend well beyond what has normally been seen as part of the coordination role of the emergency management site control. The OHS responsibilities of the PCBU may include:

- recording incidents and reporting notifiable incidents
- consulting with workers (which includes volunteers)
- ensuring compliance with notices issued under the Act
- ensuring the provision of training and instruction to workers (including volunteers) about work health and safety
- ensuring that health and safety representatives receive their entitlements to training
- providing information about risks and hazards
- providing appropriate supervision and equipment to minimise the OHS risks

At a disaster site, the OHS obligations of the disaster manager could extend to a very wide range of occupations and workers, for example Box 2 below provides an extensive list of jobs that were involved in the World Trade Centre recovery and clean-up.
The OHS risks for clean-up and recovery workers can be divided into acute and chronic health effects. In many cases the acute risks are recognised and controls are available and used, especially in the case of first responder professional emergency service personnel. For example, well known safety hazards include; exposure to; electricity, extreme weather, rough terrain, structural collapse, hazardous atmospheres, work at heights and working on or near water. In recent years there has been increasing attention being paid to the chronic health effects from exposure to physical and psychological hazards. In particular, a number of studies have highlighted the chronic health effects for the WTC clean-up and recovery workers. Well documented chronic health effects from the WTC attack include respiratory symptoms and musculoskeletal disorders, as well as post traumatic stress disorder, (Johnson et al 2005), (Perlman et al. 2011), (Torres 2006).

In large scale operations many workers and supervisors have not had any specific occupational health and safety (OHS) training and may not have access to the appropriate personal protective equipment or other appropriate equipment, this is especially true when volunteers are used to for the clean-up and recovery workforce. In general, first responders are better equipped and trained than clean-up and recovery workers. The training approaches used for the traditional first responders would be relevant for clean-up and recovery workers.

BOX 2. Job functions of World Trade Centre Responders

<table>
<thead>
<tr>
<th>Traditional workers</th>
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<tbody>
<tr>
<td>Emergency service workers</td>
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<tr>
<td>Federal disaster responders</td>
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<tr>
<td>Firefighters</td>
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<td>Law enforcement personnel</td>
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<td>Urban search and rescue</td>
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<table>
<thead>
<tr>
<th>Non-traditional</th>
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<tbody>
<tr>
<td>Building cleaners</td>
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<tr>
<td>Building trades workers</td>
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<tr>
<td>Civil service workers</td>
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<tr>
<td>Counselors</td>
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<tr>
<td>Engineers</td>
</tr>
<tr>
<td>Environmental assessment workers</td>
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<tr>
<td>Media representatives</td>
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<tr>
<td>Mortuary workers</td>
</tr>
<tr>
<td>Nonemergency health care workers</td>
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<tr>
<td>Pastoral care workers</td>
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<tr>
<td>Public officials</td>
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<tr>
<td>Sanitation workers</td>
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<tr>
<td>Transport workers</td>
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<tr>
<td>Veterinarians</td>
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<tr>
<td>Volunteers</td>
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</table>

Source: Reissman & Piacentino (2011)
Oil Spills

Globally oil spills are a relatively rare occurrence considering the amount of oil which is transported and stored. Nevertheless, in the 37 years between 1967 and 2004, 119 ‘major spills’ have been documented, (Mariner Group 2005). The health consequences for workers engaged in clean-up and recovery of oil spills has not been well researched, (Moore & Burns, 2011).

Crude oil and refined fractions are toxic, although the level of toxicity and toxic end points depend on the chemical composition of the crude oil which can vary considerably depending on the source. Volatile fractions can be absorbed via the respiratory route and solid/liquid hydrocarbon fractions can be dermally absorbed, (Feuston et al. 2007). The volatile fractions, mainly benzene, toluene, and xylene, will evaporate within hours of the crude oil being exposed to the air. Therefore it is at the early stages of a spill where these compounds are thought to present the main health risk. Oil also contains higher molecular weight toxic compounds which are less volatile, such as polycyclic aromatic hydrocarbons (PAHs) and naphthalene, (CDC 2010)

In some cases crude oil is set on fire as a way removing from the water surface. If this method is used then adjacent workers can be exposed to smoke and other combustion products, (CDC 2010)

Dispersants are also commonly used to disperse oil from the surface waters. Dispersants are either applied from boats or from the air. According to the CDC (2010) the BP Gulf of Mexico oil spill was;

‘…unique because of the large-scale use of dispersants to break up the oil slick. By late July, more than 1.8 million gallons of dispersant had been applied in the Gulf. Dispersants contain detergents, surfactants, and petroleum distillates, including respiratory irritants such as 2-butoxyethanol, propylene glycol, and sulfonic acid salts.’

Workers can be exposed when applying dispersants with hand held sprays from boats and when loading spray tank for boats or aircraft. A range of health effects have been reported from the use of dispersants including skin and eye irritation, skin rash/redness, skin dryness, nausea, respiratory distress, headaches and dizziness, (CDC 2010).

Exxon Valdez oil spill

In March 1989 the Exxon Valdez ran aground in the Prince William Sound in Alaska and released about 11 million gallons of crude oil into the sea. Although approximately 11,000 workers were involved in the clean-up and recovery operation there have not been any large scale follow up studies on the health effects of working on this operation. Nevertheless the studies that have been conducted give cause for concern about the health effects. Gorman et al (1991) analysed the Alaska Workers Compensation database and found that there were 1,812 claims made in 1989 arising from work related to the clean-up. Of the accepted claims, 44% were related to sprains and strains, cuts, lacerations and contusions, 14% for respiratory illness and 2.4% dermatitis, (Gorman et al 1991). Typically the workers compensation claims largely reflect the acute health effects.
For chronic health effects a number of follow up health surveys conducted on clean-up and recovery workers suggested elevated rates of respiratory disease, depression, anxiety, substance abuse, post traumatic stress symptoms and social conflict. Notably these effects were still being reported in the most recent 2009 survey: 20 years after the oil spill, (Moore & Burns 2011, Osofsky et al 2010, and Solomon & Janssen 2010). Although it is possible that some of the chronic health effects reported were caused or exacerbated by other related factors, in particular the loss of jobs and income in the fishing industry, there is enough evidence to show that the risks for clean-up workers must be considered as part of recovery planning.

Gorman et al (1991) conducted a health hazard assessment towards the end of the Exxon Valdez clean-up. In their assessment they found that the authorities and Exxon had developed and generally implemented OHS plans for the recovery workers. However in their review of the OHS arrangements they identified a number of areas for improvement and consequent recommendations in the event of future oil spills which are summarised below in Box 3.

**BOX 3. RECOMMENDATIONS FROM EXXON VALDEZ OIL SPILL**

Conduct chemical resistance tests for crude oil and "weathered" crude oil on a variety of chemical protective clothing (CPC) in order to select the best type based on need, availability and environmental conditions.

Conduct tests to determine the effect that repeated decontamination has on the effectiveness of the protective clothing and the develop criteria for when to discard protective clothing.

Ensure that a core of key safety and health personnel remain available at the operations headquarters and in the field during the clean-up process rather than rotating personnel in and out. This would promote more consistent training and enforcement of safety and health procedures from work site to work site.

Ensure that emergency response plans provide for the assessment of exposures to volatile organics in the very early stages of clean-up when exposures would be the greatest.

Exposures to diesel fumes should be minimized though strategic positioning of the sources downwind of the workers where possible or through the use of temporary, vertical exhaust or stack extensions.

Implement a surveillance system for tracking injuries and illness so that injuries and illness incidence can be tracked in real time to enable monitoring and the development of prevention strategies during the clean-up and recovery operation.

*Source:* Gorman et al (2011)
Gulf of Mexico oil spill – Deepwater Horizon

On 20 April 2010 the BP Deepwater Horizon oil well in the Gulf of Mexico blew out killing eleven men and injuring thirteen. The resultant discharge from the well released millions of barrels of crude oil into the Gulf of Mexico. This was one of the worst ecological disasters experienced in the USA. Extensive clean-up and containment operations were conducted on the shoreline and on the sea. Solomon & Janssen (2010) summarised the possible health effects for workers and residents exposed to the Gulf Oil spill based on previous studies and concluded that it was too early to assess the longer term health effects. However, these authors observed the pattern of reports for acute health effects.

“In Louisiana in the early months of the oil spill, more than 300 individuals, three-fourths of whom were clean-up workers, sought medical care for constitutional symptoms such as headaches, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. These symptoms are typical of acute exposure to hydrocarbons or hydrogen sulfide, but it is difficult to clinically distinguish toxic symptoms from other common illnesses.” (Solomon & Janssen 2010)

In May 2010 BP requested National Institute of Occupational Safety & Health (NIOSH) to evaluate the health hazards for the offshore clean-up workers and subsequently the health hazard valuation was extended to onshore workers, (King & Gibbons 2011). NIOSH monitored levels of chemicals, measured noise levels and conducted health surveys and focus groups in a range of locations. The NIOSH investigation was significant because it measured potential exposures while clean-up work was being undertaken and has provided very useful information about exposure levels in an oil spill clean-up.

King & Gibbons (2011), the NIOSH investigators, concluded that although there was a potential for exposure to toxic substances the results of air monitoring indicated that exposures were generally well below the occupational exposure levels for individual chemicals. However, in symptom surveys workers reported a range of symptoms and the NIOSH (p12-2011) report concluded that:

“… mixed low-level exposures to crude oil, dispersant, and other chemicals; heat stress, psychosocial strains, ergonomic and other injury hazards; and pre-existing personal health risk factors all may have contributed to health symptoms reported by response workers. An additional potential contributing factor for the acute respiratory symptoms reported by some response workers is the formation of reactive aldehydes and ozone from the environmental photochemical activity on volatile hydrocarbons [Goldstein et al. 2011]. Nonspecific symptoms such as headache, eye and respiratory irritation, and fatigue were more commonly reported by responders who self-reported exposures to oil, dispersants, or other chemicals compared to workers who self-reported no such exposures. While no one hazard or exposure can explain the increased reporting of such symptoms among this group of workers, eliminating or reducing all such hazards in as comprehensive a manner as possible will decrease the likelihood of health effects during future responses such as this”

Based on their findings of their health hazard evaluation King & Gibbons (2011) made a number of recommendations to improve OHS in future large scale disasters. Their recommendations are summarised below.
• Record occupational history in the injury and illness surveillance system. A record of occupational exposure history would enable information on chemical exposure could to be collected and related to the onset of symptoms, use of PPE or other protective measures. This information could assist in diagnosis of illness and provide information for further studies.

• Use pre-placement medicals. Pre-placement medicals can help identify workers whose health concerns need to be addressed and workers who may need to have restrictions on the type of work they do. (NB In their study of volunteers, Miller & Garrett (2009) also supported more thorough selection and skill matching for volunteer workers).

• Improve health risk communication. Risk communication needs to be relevant, timely and specific. It is also needs to be easily understood. The NIOSH investigators received reports from a range of people about instances of poor health risk communication.

World Trade Centre (WTC) Terrorist attack September 11 2001 (9/11)

Following the attack and the collapse of the buildings many thousands of people were exposed to dust, smoke and combustion products. People were exposed to novel mixtures of toxic substances of varying composition. The collapse of the two World Trade Centre buildings produced complex mixtures of pulverised material, unlike that which may normally be encountered in industrial or community settings. Despite high levels of airborne dust and smoke there have been a number of well documented cases where rescue and recovery workers were not supplied with the appropriate respiratory protection. This was particularly true for clean-up and workers like truck drivers, (Torres 2006).

The sheer scale this event on New York City residents and workers and the fact that the attack was targeted to strike at the largest city in the USA has resulted in an unprecedented number of studies on the health and safety of first responders and recovery workers. The National Institute for Occupational Health and Safety (NIOSH) has funded four studies as shown in the Table 1. below.

Table 1. WTC Health effects studies funded by NIOSH

<table>
<thead>
<tr>
<th>Groups studied</th>
<th>Size (on Dec 31, 2010)*</th>
<th>Other distinguishing characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Department of New York***</td>
<td>35,473 screened so far; 55,488 treated in past 12 months</td>
<td>Established in 2001: provides screening, monitoring, and treatment</td>
</tr>
<tr>
<td>New York and New Jersey WTC Clinical Consortium***</td>
<td>29,372 screened so far; 53,112 treated in past 12 months</td>
<td>Provides screening, monitoring, and treatment through environmental and occupational health clinics to an ethnically and socioeconomically diverse population up to 15% of patients do not have insurance yearly</td>
</tr>
<tr>
<td>WTC Environmental Health Center***</td>
<td>52,290 examined so far; 21,500 treated in past 12 months</td>
<td>Began in 2005 as a privately funded programme at an asthma clinic in a New York City public hospital</td>
</tr>
<tr>
<td>WTC Health Registry***</td>
<td>75,651 responded to first survey; 68% adults responded to second survey</td>
<td>Closed cohort recruited in 2003-04; 50% recruited through lists provided by entities such as employers and government agencies, and the remaining 70% self-enrolled, surveys done 2-3 years and 5-6 years after 9/11, includes children</td>
</tr>
</tbody>
</table>

*WTC-World Trade Center 9/11-Sept 11, 2001. **Number of people screened and treated are from the National Institute for Occupational Safety and Health. ***Data from WTC Medical/Work Group of New York City****

Source: Perlman et al 2011

Perlman and colleagues have reviewed the results from these studies and concluded that after
10 years the findings across the four studies are generally consistent. They found there was strong evidence for elevated rates of PTSD and respiratory illness, including irreversible loss of pulmonary function, (Perlman et al 2011). Figure 1 below shows results for the prevalence of PTSD in four different cohorts of people who were exposed to the event and/or its aftermath. Figure 2 below shows the relationship between exposure and reduced lung function firefighters and emergency medical workers.

**Figure 1. Course of PTSD symptoms in exposed groups.**

![Course of PTSD symptoms in exposed groups](chart)

Data are from Bradbill and colleagues; “analysed is restricted to individuals enrolled in the World Trade Center Health Registry who did not have a diagnosis of PTSD before 9/11. PTSD=post-traumatic stress disorder. No PTSD=negative screen for probable PTSD (as assessed by a PTSD checklist score ≥61) at both timepoints. Late-onset positive screen at follow-up survey only. Resolved=positive screen at baseline survey only 9/11– Sept 11, 2001.

Source: Perlman et al (2011)
In their review of the four NIOSH funded studies Perlman et al (2011) identified two lessons for the future. Firstly, reliable and accurate measures of exposure are essential to control exposures and for the appropriate treatment of exposed people. The authors note that current studies have relied on exposure estimates based on questionnaires completed by study participants. Secondly, it is possible that the incidence rate of disaster related health effects, in particular respiratory illness could be reduced by early reporting of symptoms, screening, outreach and treatment.

Currently emergency service personnel often have access to hand held gas detectors which can give read outs of concentrations of atmospheric contaminants but these gas detectors typically measure a small number of commonly encountered toxic gases. Exposure monitoring conducted by emergency services is generally not going to provide sufficient information about exposure to a wide range of complex gas/dust mixtures as was found in the aftermath of the WTC attack.

Fixed air pollution monitors are found in many cities and these can provide information of airborne contaminants but similarly to the personal gas detectors these monitors are programmed to measure for a fixed range of ‘normal’ pollutants. In 9/11 the US EPA made
announcements that the air was safe to breath, presumably based on results from static air quality monitors in NYC, (Torres 2006).

The best way to give accurate and reliable estimates of exposure is use the methods normally employed by occupational hygienists. These methods include the active collection of gases and dusts in the breathing zone of the worker then analysing the collected substances/mixtures or using passive diffusion badges which can be obtained for a wide range of substances. Bongers et al (2008) have reviewed a number of approaches to exposure assessment following chemical disasters. These authors made the point that ‘In an ideal situation, every member of the potentially exposed population would be carrying personal samplers during a chemical incident to provide data on individual exposure’ however they acknowledge that this situation would be impossible in practice, (Bongers et al 2008).

Real time exposure monitoring is also essential to provide information on which to base future health studies and to clarify entitlements to compensation. It should be noted that legal actions arising from the Bhopal disaster are still continuing and one of the factors accounting for this extraordinary delay is the lack of clarity about who was exposed and to what chemicals.

**Hurricane Katrina**

On 29 August 2005 Hurricane Katrina struck the US Gulf coast. New Orleans was the major city affected and the effects of Katrina were exacerbated by the breaking of levee banks and a subsequent storm Hurricane Rita. An active injury and surveillance system was established by the Centres for Disease Control and Prevention (CDC). In an analysis of non-fatal injuries following Hurricane Katrina, Sullivent et al (2006) found that over 7,543 non-fatal injuries were reported among residents and relief workers in the two months following the hurricane. Clean-up was the most common activity being undertaken at the time of injury for both residents and workers and the main mechanisms of injury were falls and cuts.

Real time analysis of the reported injury enabled the timely development of injury prevention strategies, including the use of flyers, radio and television to communicate prevention information residents and recovery workers, (Sullivent et al 2006).

In reviewing the results of their study Sullivent et al (2006) concluded that the injury surveillance and prevention activities are essential during the recovery and clean-up phase of disasters. These authors also recommended that the system of surveillance could be improved by:

- Implementing a standardised data set of data elements for collecting injury information,
- Integrating injury prevention into operational plans
- Including an injury prevention expert in operational planning meetings
- Develop clear lines of communication and allocate responsibilities for injury prevention among all health service providers.
Conclusions

There a number of recurring themes which have emerged from the examples discussed in this paper. The principal theme is that much more could be and should be done to plan for the OHS of clean-up and recovery workers. In Australia there is now a legal framework which requires the OHS arrangements for workers and volunteers (paid and unpaid) to be included in operational and strategic emergency plans. Emergency managers (PCBU)s must be aware of the OHS hazards and risks and must have arrangements in place for controlling and minimising those OHS risks.

A continuing theme in the published studies is that it always difficult to estimate the level and type of exposure to hazardous chemicals. Most studies have relied on reconstructing exposure scenarios from modeling and qualitative surveys of people who were exposed. At the time of a disaster exposure measurement may seem like an unnecessary activity, given the political and economic imperatives to re-establish services and critical infrastructure. However exposure assessment is essential to provide information on which to base preventive actions aimed at minimising the risk of adverse health effects. Information gained from exposure assessment is also essential to provide appropriate treatment for those affected.

Emergency management authorities need to ensure that in the event of a disaster which involves hazardous chemicals they have access to appropriately qualified personnel and equipment suitable for monitoring exposure and analysing collected samples in real time. Plans also need to include triggers for when biological monitoring is essential for evaluating exposure of workers and the public.

Monitoring and surveillance systems for injury and illness need to be established from the beginning of the recovery and clean-up phase. Occupational exposure history should also be collected when recording details of any injury or illness. Real time information about the occurrence of injury, illness and near misses can be used to develop and implement prevention strategies which can be implemented during the clean-up and recovery phase.

Disaster management plans at the strategic and operational levels need to include the clear allocation of responsibilities for OHS. Those in control of the clean-up and recovery operations must establish and communicate OHS risk assessments and establish clear lines of communication from the frontline workers (including volunteers) to the PCBU.

Emergency management authorities must ensure that there are adequate stocks of PPE to meet any conceivable disaster and that there are adequate numbers of people available to instruct clean-up and recovery workers in its use. Emergency management plans should include arrangements for monitoring and reviewing the effectiveness of PPE and other safety equipment.
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