Hazardous materials emergency incidents: public health considerations and implications

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Abstract

Objective: Hazardous materials (HAZMAT) incidents, including the deliberate release of toxic chemicals, can cause a significant drain on resources as well as heightened anxiety in the community. Recent high-profile incidents, including the 2018 illegal waste storage fire in Victoria, Australia, have highlighted the complexity but also the value of multidisciplinary approaches to HAZMAT events. This brief report examines issues from a public health perspective and reflects on the experience of such events in South Australia.

Methods: The type, location and time of HAZMAT incidents for the period 2001 to 2018 (inclusive) in South Australia were compiled and classified from a database of the state Technical Advice Coordinator.

Results: The profile of HAZMAT events was diverse, including fires, spills, unknown chemicals, sabotage and suicides. Incidents frequently occurred around transportation corridors and storage facilities. Public health agency involvement was most evident for known or suspected biological agents (toxins) and chemical toxicants with persistent exposures.

Conclusion and implications for public health: Public health agencies are likely to have a greater future role in HAZMAT management as the complexity of incidents increases (e.g. mass casualty events and events involving vulnerable subpopulations). There is a need for a national HAZMAT surveillance database to coordinate agency responses on a national level. A unified approach to risk communication for vulnerable communities is also critical.

Key words: hazardous materials incidents, emergency management, toxic chemical, hazard, risk

Hazardous materials (HAZMAT) incidents such as chemical spills, leaks, fires and the intentional release of toxic substances have the potential to adversely affect human health, ecosystems and the environment.[1] Emergency services personnel often confront unpredictable or rapidly changing circumstances. Notable international HAZMAT events include the September 11 attacks[2,3] and the Novichok release in Salisbury, UK.[4] Australian examples include the Coode Island fire in 1991, the Nuplex release in 2011 and the Tottenham warehouse fire in 2018.[5-7] Such events can disrupt community activity for months, and considerable and varied resources must be deployed in the short- and long-term. As a result, both internationally and within Australia, there has been increasing attention paid to community and emergency preparedness, response and recovery.

In the US, for example, early efforts in managing uncontrolled or abandoned wastes sites and emergency releases of contaminants resulted in the 1980 *Comprehensive Environmental Response, Compensation, and Liability Act*, also known as 'Superfund'.[8] This Act provided the US EPA with enforcement powers for pollutant release into the environment to ensure adequate remediation was undertaken. As part of this process, various US jurisdictions have structured incident response databases that provide summary information. One example from the Californian Governor's Office of Emergency Services provides publicly available information (see https://w3.calema.ca.gov/operational/malhaz.nsf/).

Emergency services and governmental authorities are chartered to respond to these incidents and may rely on additional professionals to provide expert advice at the time and/or following the incident. In Australia, the management of HAZMAT incidents is pre-determined by government procedure underpinned by regulatory frameworks. The HAZMAT authority is state-based; for South Australia, it is the Metropolitan Fire Service (MFS; professional firefighters) or the Country Fire Service (CFS; comprising volunteers). Further specialised advice has been provided since 1997 by a team of Technical Advice Coordinators (TACs), who also coordinate the advice for supporting agencies, such as the Environment Protection Agency (EPA), South Australia Ambulance Services (SAAS) and South Australia Health.[9]

Despite such multi-agency responses, in each of the Australian states, there is currently no national surveillance scheme that collates and reports on HAZMAT incidents. An Australian national version of the California EMA 'Spill Report View' (https://w3.calema.ca.gov/operational/malhaz.nsf/$defaultview) may represent such an option. National

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surveillance information presents immediate benefits and could be used to develop evidence-based public health policy, improved and efficient emergency planning and training, and – increasingly – monitor long-term health impacts on affected populations.

The aim of this brief report is to provide descriptive information on HAZMAT incidents in South Australia as reported by the on-duty TAC responder over the period 2001–2018, to illustrate the diversity of situations encountered and any obvious trends in the information collated. The outcome of this work is to raise awareness of the public health implications of emergency incidents that have the potential for significant population health impacts. This South Australian focus further highlights the need for national coordination and consistency in procedures and the establishment of a HAZMAT incident register to inform future emergency response strategies.

Methods

The profile was derived from a dataset of individual reports by the TAC between 2001 and 2018 (726 in total). The reports were collated from contemporaneous field notes made by the TACs as they were responding to the incidents. These reports were submitted monthly to the State Government and represent a record of information gathered at the incident scene, the dialogue between TACs and the responding authority, and the liaison with other support services and agencies (e.g. EPA, utility companies). Advice on the management of HAZMAT emergency incidents has been provided since 1997 by a team of TACs, who individually have 20-plus years' experience in HAZMAT incidents and providing advice. They have backgrounds in toxicology, public health and occupational hygiene.

Data have been categorised at several levels. We identified the responder groups, nature of incidents, time of incidents, class of chemical involved, whether fire was involved, and whether the incident was deliberate or accidental, etc., as represented in Table 1. The number of incidents was recorded in each calendar year, as well as the region in which the incident occurred (metropolitan, rural/regional), and the responding agency (MFS, CFS, SAAS). Incident magnitude was classified as small (less than 99kg or 99L), medium (100–999 kg or L), large (1,000–9,999 kg or L), or very large (10,000 kg or greater). The chemicals involved in the incident have been grouped according to their main chemical class (pesticides, gases, acids and alkalis, solvents, and fuels and oils).

Results

Table 1 summarises the emergency HAZMAT incidents occurring in South Australia from 2001 to 2018, inclusive.

During the 18-year study period, there were reports of HAZMAT incidents approximately weekly. The incidents were on average twice as common in metropolitan areas than in rural/regional areas. Hence, the Metropolitan Fire Service (MFS) was the responding authority twice as often, on average, compared to the Country Fire Service (CFS), with the ambulance (SAAS) and EPA being less commonly involved. This may in part be due, for example, to the EPA being the responding authority for radiation incidents.

The proportion of incidents within each incident magnitude category remained relatively unchanged over the review period, with 89% of incidents with reported quantities under 1000 kg or 1000 L, and 50% classified as small (<99kg or L) incidents. Only one or two incidents each year were very large, and these were either petroleum fuels or transport bulk tankers.

Irrespective of classification, all HAZMAT incidents predominantly occurred during daylight hours between 0600 and 1800 hours (72%), with fewest incidents occurring between 0000 to 0600 hours (6%). Transport-related incidents represented 6% of all incidents during the period, road accidents accounting for 93% of these. Fires accounted for 15% of all incidents and deliberate acts (including suicides attempts and malicious damage) up to 9%. Accidental spills or leakage represented 40% of all incidents in the period.

The most common classes of chemicals involved were fuels (26%), pesticides (20%), acids (16%), alkalis (9%) and gases (15%).

Discussion

The HAZMAT incidents in South Australia over the study period showed a diversity of substances and exposure settings, such as a robbery attempt (see below), deliberate poisonings, traditional spills and white powder/unknown chemical incidents. Temporal changes are instructive. For example, the prevalence of reported accidental spill and leakage incidents (41%) differs from a previous report for South Australia,[9] which observed predominantly road transport incidents. Shifts in incident type, e.g. pesticides versus fuel, facilitates ranking for investigative purposes, thereby enabling more detailed evaluation of causative factors and risk mitigation management. Thus, the dataset may provide policy and service planning guidance if collated and interrogated. The justification for a national database of HAZMAT incidents would foreseeably be in the integration of incident scenarios, thereby providing a basis for specialised training and cost-benefit modelling of impacts and services nationally. In our experience, further consideration should be given to the acquisition of additional information in the record, such as toxicity or measurement data during incidents that may enable more detailed future evaluations. This could be achieved by establishing a detailed structured reporting process with further engagement and agreement with the major authorities such as the MFS and CFS.

The nature of HAZMAT releases to the environment can become particularly significant for nearby communities when substances are either incorporated into water run-off or are of a volatile nature, enabling atmospheric release and propagation. The collated data presented here show that a large component of the chemicals involved are gases, fuels and acids that may be released via aerosols or vapours. This particularly applies to fires where the potential for widespread dispersion and atmospheric exposure raises the need for vigilance and the coordination of public health services to ensure that large-scale incidents are met with proportionate emergency management responses.[10] The management of complex mixtures, and their pyrolysis products in the event of fire, presents considerable challenges to HAZMAT responding agencies. Perceived inadequacies in regulatory and governmental responses have been associated with the management of such major events across Australia (e.g. the Melbourne CBD fires in illegal dumping sites and the Morwell coal fire[11]). Extensive community exposures and reactions have prompted high-level government enquiries into the management of these types of incidents, reinforcing the need to maintain

Table 1: Summary of emergency hazardous material incidents, South Australia 2001–2018.

	Year (2001-2018)																		
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
Location																			
Metropolitan	16	17	24	21	39	42	32	29	25	28	30	26	13	17	14	15	10	12	
Rural/Regional	10	19	16	13	21	17	18	21	14	16	6	6	12	1	13	7	7	7	
Unknown	2	1	1	0	4	12	8	7	8	9	6	7	3	6	4	5	6	7	
Total Number of Incidents	28	37	41	34	64	70	58	57	47	53	42	39	26	24	31	27	22	26	726
Agency																			
MFS	13	10	16	19	30	49	39	39	30	26	31	18	13	10	12	9	5	13	382
CFS	12	20	19	11	19	13	8	6	4	13	4	8	9	6	11	10	12	8	193
Ambulance	1	4	3	3	6	8	7	6	9	10	6	7	5	5	6	6	0	3	95
EPA	1	0	0	0	2	0	0	1	0	0	1	0	0	2	0	1	0	2	10
Other agency	1	3	3	1	7	3	5	5	5	4	1	6	1	1	2	3	5	0	56
Size of incident[a]																			
Small (<99kg or L)	3	6	3	7	11	12	4	13	4	2	6	5	5	4	7	2	2	16	112
Medium (100-999kg or L)	4	2	8	4	5	2	2	4	2	7	3	2	0	1	1	1	2	8	60
Large (1000-9999kg or L)	1	4	2	3	0	1	5	1	0	4	0	0	1	1	0	2	0	1	26
Very Large (>10000 kg or L)	1	1	3	1	2	1	0	2	3	2	0	3	1	1	2	0	0	0	23
Hazardous materials involved																			
Pesticides (including insecticides, herbicides and fungicides)	6	11	10	11	13	19	14	8	11	18	8	11	12	5	7	6	7	4	181
Gases	4	4	8	7	11	13	8	10	14	12	10	4	5	3	9	3	3	5	133
Acids	7	2	6	13	14	18	12	10	6	12	8	8	3	4	9	10	1	1	144
Alkalis	4	4	6	2	19	3	6	7	4	3	7	3	2	1	1	0	2	5	79
Solvents	4	1	6	4	9	3	4	4	2	3	4	2	1	1	2	1	3	1	55
Fuels	14	14	5	10	23	22	16	17	8	15	10	14	17	9	17	15	1	6	233
Metals	0	1	2	0	4	0	2	5	3	1	3	5	0	1	2	0	5	1	35
Biological toxins	0	0	0	0	2	1	0	3	2	0	0	0	0	0	0	0	1	0	9
Batteries	0	0	0	1	0	0	2	1	1	0	1	0	2	0	0	0	1	3	12
Transport related incidents	5	6	2	6	2	3	3	1	2	2	1	1	4	1	0	1	1	1	42
Fire related incidents	5	6	9	4	4	10	7	7	6	8	3	6	5	5	8	5	6	3	107
Deliberate incidents	2	3	4	1	3	6	0	5	6	7	5	4	4	2	3	4	2	6	67
Accidental spill or leakage	8	10	15	17	34	25	31	28	25	21	22	10	7	7	10	7	8	8	293
Others	5	11	11	6	19	26	17	15	8	15	11	18	8	9	10	11	6	6	212
Time of incident reported to TAC																			
0000-0600	0	2	5	3	5	1	2	5	2	2	1	1	2	2	0	3	4	2	42
0600-1200	8	12	21	11	19	30	22	20	19	18	10	13	10	5	9	10	5	6	248
1200-1800	11	14	11	14	23	27	27	21	16	19	17	16	13	11	14	9	5	13	281
1800-0000	9	9	4	6	17	13	7	11	9	14	14	9	3	6	8	6	8	5	155

Note:

a: The volumes of chemical were the estimated quantities of substances involved in the incident, as reported to the Technical Advice Coordinator. The quantities were provided by the incident controller or based on the size of containers. In many situations there may not have been a spill – e.g. advice was sought on managing a deliberate ingestion of toxic material.

and strengthen the collaboration of agencies and integration of approaches. This may best be achieved through a national HAZMAT database.

While large-scale events may attract media attention due to the scale of potential impacts, small-scale incidents accounted for 50% of the classified incidents in our study. These more unpredictable types of events may have greater significance with respect to emerging threats. Two incidents are noteworthy. Firstly, a seemingly harmless residential activity of scrubbing the coral from a fish tank led to house occupants suffering vomiting and respiratory distress and requiring extended hospitalisation. The TAC, in consultation with field emergency services, identified an extremely potent toxin (palytoxin) released by the handling of zoanthid coral. This incident received international attention[12] and resulted in a state health advisory.[13] In the second noteworthy incident, and one of the first documented uses in Australia of the explosive triacetone triperoxide (TATP; also known as 'Mother of Satan'), the potential for public harm was circumvented by the explosive being used at night, even though it was within the CBD area. This failed robbery attempt left the responding agencies with challenges in the disposal of the chemicals and in being able to restore a safe environment in an area popular with families and small children.

These examples illustrate not only the benefit of efficient integrations of HAZMAT services and multi-agency cooperation but also the need for risk communication to the broader community. Risk communication is implicit in the framework for risk assessment and management and there are many opportunities for community engagement through current social media platforms that could be explored when insights from the analysis of HAZMAT incidents are gained. This

work also provides a model that other state and national authorities may use to develop or establish a HAZMAT incident register or public health surveillance system, such as that described in Europe.[14,15]

Conclusion

This brief review provides some perspective on the diversity of HAZMAT incidents and trend changes that have occurred in South Australia over the past 18 years. Review of the available data also suggests that collation of additional incident data on toxicity or exposure may provide further information enabling improved response efficacy, reinforced by applied research findings on exposure mitigation. Such a recommendation would ensure that evidence-based information is available for public health policy development in emergency response.

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