Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents

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ABSTRACT

Objective: To assess the level of preparedness of Australian hospitals, as perceived by senior emergency department physicians, for chemical, biological and radiological (CBR) incidents, as well as the resources and training available to their departments.

Methods: Detailed questionnaires were mailed to the directors of the 86 hospital emergency departments (EDs) in Australia accredited by the Australasian College for Emergency Medicine. Questions covered hospital planning, available resources and training, and perceived preparedness.

Results: Responses were received from 76 departments (88%): 73 reported that their ED had a disaster plan, with 60 (79%) having a contingency plan for chemical, 57 (75%) for biological, and 53 (70%) for radiological incidents. Specific staff training for managing patients from a conventional mass casualty incident was given in 83% of EDs, falling to 66% for a CBR incident. Forty-three per cent reported that their plan involved staff managing contaminated patients, but availability of personal protective equipment and decontamination facilities varied widely. Although 41% believed their ED could cope with a maximum of 20 patients in the first 2 hours after a conventional incident, this increased to 71% for a CBR incident. Staff training was considered the main funding priority (59%).

Conclusions: This survey raises significant questions about the level of preparedness of Australian EDs for dealing with patients from both conventional and CBR incidents. Hospitals need to review their plans and functionality openly and objectively to ensure that their perceived preparedness is consistent with reality. In addition, they urgently require guidance as to reasonable expectations of their capacity. To that end, we recommend further development of national standards in hospital disaster planning and preparedness.

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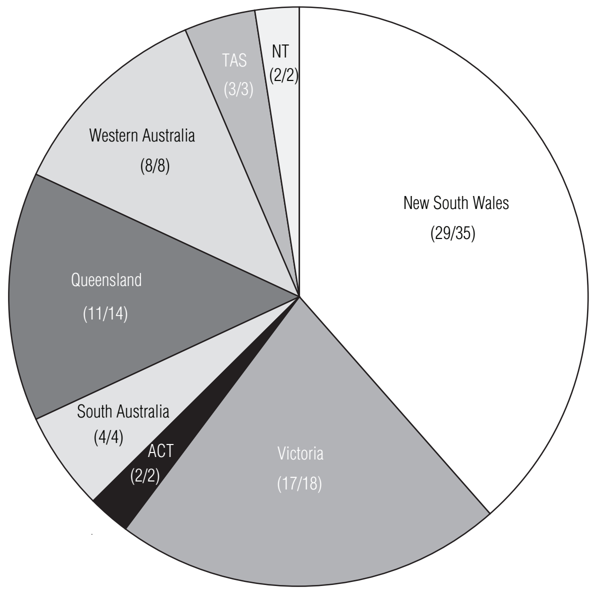
> Every year, if not every day, we have to wager our salvation upon some prophecy based upon imperfect knowledge.
>
> Oliver Wendell Holmes Jr, United States jurist (1841–1935)

The health care system, including hospitals, will clearly play a pivotal role in the response to a mass casualty incident from any cause. Incidents involving chemical, biological or radiological (CBR) agents differ significantly from conventional incidents in that they have the potential to contaminate both the people and the environment exposed. Hospitals therefore need to develop CBR annexures to their major incident plans that address issues such as decontamination, antidotes, and the avoidance of secondary contamination of the hospital, staff and decontaminated patients. If hospital staff are exposed to the agent while attending contaminated patients, they too may become casualties, further compounding the disaster.[1-4] If security is breached, the ability of the hospital to function may also be severely impaired, and may force its closure.[5,6]

There is little literature on hospital preparedness for CBR incidents, particularly in Australia. In 2001, Treat et al examined hospital preparedness for incidents involving weapons of mass destruction (WMD) in a region of the United States.[7] They concluded that "hospitals in this sample do not appear to be prepared to handle WMD events, especially in areas such as mass decontamination, mass medical response, awareness among health care professionals, health communications, and facility security". Similar surveys of 21 hospitals in a major US city in 1996 and 2000 concluded that these hospitals were poorly prepared to manage chemical emergency incidents, including terrorism.[8]

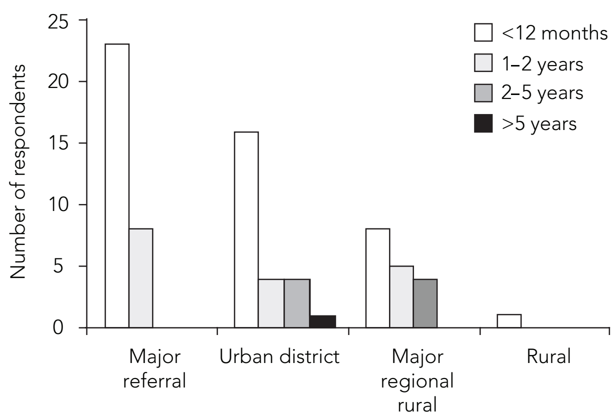
The threat and potential consequences of a mass casualty incident have now reached the point that claims of preparedness need to be supported by evidence. We believe that detailed information needs to be gathered on the training, conduct of exercises and resources available to hospitals, and realistic conclusions developed about their respective capacities to deal with large numbers of patients, both from conventional and CBR incidents. As recently suggested by Auf der Heide, disaster planning is only as good as the assumptions on which it is based.[9]

Figure 1. Distribution of respondents by state*



*Figures in parentheses are the number of respondents as a fraction of the number of emergency departments to which the survey was sent in each State. (ACT = Australian Capital Territory. NT = Northern Territory. TAS = Tasmania.)

Figure 2. Time since the major incident plan was last revised, by hospital classification (*n* = 76*)



* Two respondents did not answer the question.

Table 1. Plans for dealing with internal incidents, and whether tested (*n* = 76)

Incident	Plan: Tested	Plan: Not tested	No plan	Don't know	No answer
Department evacuation	11 (14%)	55 (72%)	4 (5%)	4 (5%)	2 (3%)
Loss of power supply	28 (37%)	40 (53%)	3 (4%)	3 (4%)	2 (3%)
Loss of water supply	9 (12%)	39 (51%)	8 (11%)	16 (21%)	4 (5%)
Extended operations*	8 (11%)	44 (58%)	14 (18%)	5 (7%)	5 (7%)

* > 1 shift.

It is not only impossible to prepare completely for all potential scenarios, but also difficult to define the extent to which hospitals should be expected to prepare. Issues such as whether all hospitals in a given geographical area require specific CBR annexures to their major incident plans, how many casualties they should be able to decontaminate, whether hospital staff should have access to, and be trained in the use of, high-level personal protective equipment (PPE), and how frequently plans should be exercised, remain unclear. In addition, there is little coordinated collection or record of individual hospital capabilities in Australia, at either a state or national level.

Methods

A questionnaire was mailed in December 2003 to the directors of the 86 emergency departments in Australia that are accredited for training by the Australasian College for Emergency Medicine (ACEM), representing a mixture of adult and combined adult and paediatric units. The questionnaire was sent again to centres that did not respond within 6 weeks.

The data collected were descriptive and quantitative, with most questions having set answering options. Data were entered into an SPSS database. A strict process of de-identification ensured that the authors remained blinded to the identity of each respondent's hospital, and respondents were assured in a covering letter that no specific hospital would be identifiable by its responses. The study was approved by the Royal Adelaide Hospital Research Ethics Committee.

Results

Demographics

Responses were received from 76 (88%) of the 86 emergency departments. ACEM classifications of the hospitals that responded were major referral, 31 (41%); urban district, 26 (34%); major regional rural, 18 (24%); and rural, 1 (1%). The distribution of respondents by state is shown in Figure 1; the disproportionate number of non-respondents from New South Wales did not reach statistical significance. Annual emergency department attendance was reported as less than 20 000 by two departments (3%), 20 000–40 000 by 43 (57%), and more than 40 000 by 31 (41%).

Table 2. Plans for dealing with patients from chemical, biological or radiological incidents at individual hospitals, by ACEM classification (*n* = 76*)

	Chemical			Biological			Radiological		
ACEM classification	Yes	No	Don't know	Yes	No	Don't know	Yes	No	Don't know
Major referral	28 (37%)	3 (4%)	0	28 (37%)	3 (4%)	0	27 (36%)	4 (5%)	0
Urban district	19 (25%)	5 (7%)	1 (1%)	18 (24%)	6 (8%)	1 (1%)	15 (20%)	8 (11%)	2 (3%)
Major regional rural or rural†	13 (17%)	5 (7%)	0	11 (14%)	7 (9%)	0	11 (14%)	7 (9%)	0
Total	**60 (79%)**	**13 (17%)**	**1 (1%)**	**57 (75%)**	**16 (21%)**	**1 (1%)**	**53 (70%)**	**19 (25%)**	**2 (3%)**

ACEM = Australasian College for Emergency Medicine. * Two respondents (3%) did not answer the question.
† Major regional rural and rural ACEM categories were combined to ensure the single rural respondent was de-identified.

Table 3. Frequency of disaster training for hospital staff (*n* = 76)

Type of staff	Never	> 5-yearly	2–5-yearly	2-yearly	1-yearly	< 1-yearly	Don't know	No answer
Medical	7 (9%)	2 (3%)	11 (15%)	13 (17%)	23 (30%)	15 (20%)	2 (3%)	3 (4%)
Nursing	5 (7%)	0	9 (12%)	10 (13%)	26 (34%)	18 (24%)	6 (8%)	2 (3%)
Administration	9 (12%)	0	9 (12%)	10 (13%)	7 (9%)	7 (9%)	19 (25%)	15 (20%)

Planning

Seventy-three of the 76 respondents (96%) reported that their department had a major incident or disaster plan in place, with a further two having a plan in development. Forty-four (60%) of these had a local risk assessment performed during the development of that plan (with a further eight being unsure); at least 18 of these assessments (41%) were undertaken by a professional body (with a further 12 [27%] being unsure). Sixty-five per cent (48/74) of hospitals with a major incident plan had revised it in the previous 12 months (including the two sites developing plans), with a further 17 (23%) having revised it 1–2 years previously, eight (11%), 2–5 years previously, and one (1%), over 5 years previously (Figure 2).

All plans were reported to contain a clearly defined command structure, with the vast majority addressing the issues of security (95%), a media centre (95%), and an information centre for relatives (89%). Backup communication equipment was available in 79% of departments, with 42% reporting training in its use. Seventy-five per cent reported ready access to specialist CBR advice, from sources such as poisons information centres (46%), Emergency Management Australia (30%), the Internet (28%), fire services (11%) and local specialists (3%).

Eighty-three per cent (63/74) of respondents reported that their department had action cards for use in a major incident, with 92% (56/61) of these describing ready access to them. Fifty-four per cent (41/74) had tested their department's method for activating extra staff. In case of an internal incident, most had plans for evacuation of the emergency department, loss of power or water supply, and extended operations, although substantially fewer had tested these plans (Table 1).

Sixty (79% overall) described their major incident plan as containing a contingency for dealing with patients from a chemical incident, 57 (75%) from a biological incident, and 53 (70%) from a radiological incident (Table 2). Fifteen (20%) reported that their major incident plan had been activated once in the past 12 months, six (8%) twice, and one on three occasions. Occasions included chemical releases, two "white powder" incidents, an outbreak of food poisoning, and a "nuclear facility leak". Eleven of these departments reviewed their major incident plan afterwards.

Twelve directors (16%) reported that their hospital had been involved in incidents when they considered the major incident plan should have been activated, but was not. Half of these were at major referral centres, three at urban district hospitals, and three at major regional rural hospitals. The incidents included chemical incidents, fires, transport crashes, power failures, a storm and "extreme workload". Three incidents involved eight patients presenting to the hospital, with other single episodes of 10 and 25 patients.

Resources, education and training

Eighty-three per cent of respondents reported that their department conducted specific staff training for managing the response to a conventional mass casualty incident, which fell to 66% for one involving a CBR agent. The frequency of training is shown in Table 3.

Table 4. Equipment available at hospitals ($n = 76$)

Specific equipment	Yes	Don't know	No answer
PPE			
Helmet	58 (76%)	1 (1%)	1 (1%)
Boots	53 (70%)	0	1 (1%)
Chemical-resistant gloves	54 (71%)	3 (4%)	2 (3%)
Highest level of PPE*		4 (5%)	4 (5%)
Level A	5 (7%)		
Level B	11 (14%)		
Level C	34 (45%)		
Level D	18 (24%)		
Decontamination facility		0	1 (1%)
No facility	8 (11%)		
Outdoor hose	18 (24%)		
Indoor	21 (28%)		
Single outdoor	25 (33%)		
Erectable outdoor	22 (29%)		
2 or more fixed outdoor	16 (21%)		
Characteristics of facility			
Privacy screens	47 (62%)	0	5 (7%)
Separate sexes	13 (17%)	3 (4%)	4 (5%)
Water runoff control for decontamination facility		7 (9%)	0
None	52 (68%)		
Stormwater containment	5 (7%)		
Underground tank	8 (11%)		
Deployable tanking	5 (7%)		

PPE = personal protective equipment.
* A = fully encapsulated suit with self-contained breathing apparatus (SCBA).
B = chemical protective or charcoal suit with SCBA or airline.
C = chemical protective or charcoal suit with air-purifying respirator.
D = work clothes (uniforms or overalls).

Table 5. Responsibility for performing decontamination at the hospital ($n = 76$)

	Initial response	Continued response
Hospital staff	32 (42%)	17 (22%)
Police	0	0
Fire	50 (66%)	61 (80%)
Ambulance service	1 (1%)	1 (1%)
Health department	0	1 (1%)
Other	1 (1%)	1 (1%)
No answer	2 (3%)	2 (3%)

Table 6. Previous time hospitals were involved in a mass casualty exercise

Type of exercise	Never	No. of years previously > 5	2–5	1–2	< 1
Non-CBR					
Tabletop	7 (9%)	2 (3%)	8 (11%)	10 (13%)	49 (65%)
Field	8 (11%)	14 (18%)	13 (17%)	12 (16%)	29 (38%)
CBR					
Tabletop	10 (13%)	23 (30%)	4 (5%)	14 (18%)	25 (33%)
Field	13 (17%)	37 (49%)	3 (4%)	10 (13%)	13 (17%)

CBR = chemical, biological or radiological.

There was wide variation in the type of decontamination facility available to the emergency departments. Eight (11%) had no facility, three (4%) relied solely on a simple outdoor hose, and a further five (7%) only had an indoor shower. Only 16 (21%) hospitals had two or more fixed outdoor showers, while 30% had an erectable outdoor shower, although its size and capacity were not queried. While privacy screens were relatively common (62%), separate sex decontamination facilities were not (17%), perhaps consistent with the lower percentage of hospitals with multiple showers. Fifty-two (68%) had no facility to control the runoff of water used in the decontamination process (Table 4).

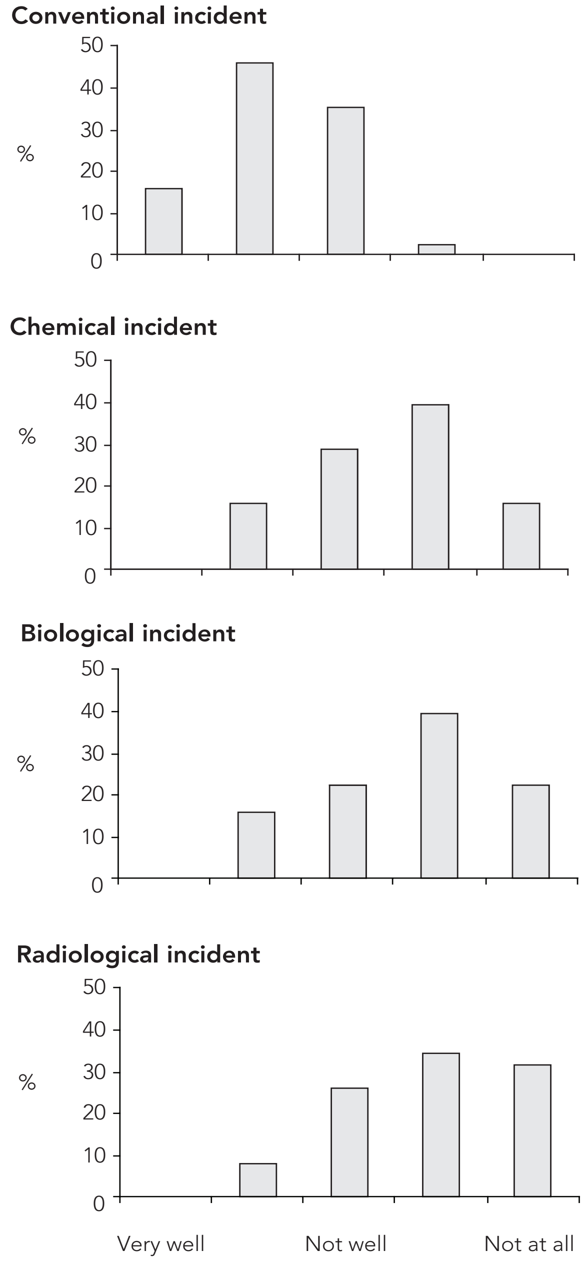
Thirty-three directors (43%) reported that their department's plan involved sending hospital staff outside to manage potentially contaminated patients. If more than 20 patients presented to their hospital after a CBR incident, respondents were asked who would be responsible for commencing their decontamination. Responses included the fire services alone (55%), hospital staff alone (32%), both of these (9%), or a combination of the fire and ambulance services and hospital staff (1%). One believed that decontamination was usually done before hospital, and two did not answer (Table 5). This survey did not examine whether formal arrangements, such as memoranda of understanding, had been developed with other agencies to provide this function.

Most emergency departments had supplies of general PPE, such as helmets, boots and gloves, but were less likely to have more sophisticated equipment (Table 4). The highest level of PPE to which they would have access was reported as Level A by five (7%), Level B by 11 (14%), Level C by 34 (45%), and Level D by 18 (24%). Four (5%) respondents did not know what was available to their staff, and a further four (5%) did not answer the question. It is worth noting that these levels were defined in the survey to

Table 7. "Significant difficulties" reported in conducting exercises ($n = 76$; more than one response permitted)

Difficulty	Tabletop exercise	Field exercise
Expense	20 (26%)	51 (67%)
Time	54 (71%)	60 (79%)
Staffing	43 (57%)	65 (86%)
Interference with normal patient care	33 (43%)	60 (79%)
Interagency collaboration problems	21 (28%)	27 (36%)
Exercise not required	0	0
Other	1 (1%)	1 (1%)

Figure 3. Respondents' perception of how well their emergency department would cope with a mass casualty incident ($n = 76$)



avoid confusion and to maximise accuracy of responses. Fewer than half the departments with access to Level C PPE or higher (22; 44%) reported a formal process of accreditation of training for staff in use of this equipment, with four (8%) being unsure. Although 38 (76%) of departments with these levels of PPE had practiced donning it (another four did not answer), 15 (30%) reported that this practice occurs less than once a year, with a further eight (16%) never practicing. Only four (8%) practiced at least every 6 months.

Sixty-nine (91%) respondents reported that their hospital had been involved in an exercise to test their major incident plan. Standard multicasualty exercises were more likely to have been conducted in the previous 2 years than CBR exercises, with tabletop exercises more likely than field type exercises in both groups (Table 6). Thirty-three per cent of hospitals reported having a CBR tabletop exercise in the past year, with 17% having a CBR field exercise. Notably, 43% reported that their hospital had not been involved in a CBR tabletop exercise in the past 5 years, which increased to 66% for a CBR field exercise. The most common difficulties in conducting exercises were reported to be those related to the impact on service delivery — time, available staff and direct effect on patient care. Cost was also raised as a significant issue, particularly for field exercises (Table 7).

Sixteen per cent of respondents reported that their department stockpiled antibiotics, 42% atropine, and 32% oximes, specifically for a CBR incident.

Only 30% of emergency departments had direct funding for disaster preparedness, with most of this for PPE (91%) or decontamination facilities (48%). Further training in CBR and specific funding for CBR preparedness were both thought to be needed by 91%. The single main priority for further funding was identified as being for training (59%), followed by PPE (16%) and decontamination facilities (10%). Despite requesting only the main priority, 10 (14%) listed multiple options, including the only respondent to nominate stockpiling.

Preparedness

Respondents were asked to grade how well they believed their department would cope with different types of mass casualty incident, on a 5-point visual analogue scale (Figure

Table 8. Maximum number of patients with which emergency departments could cope in the first 2 hours after an incident* ($n = 76$)

Type of incident	Maximum number of patients				
	< 10	10–20	21–50	51–100	> 100
Conventional	9 (12%)	22 (29%)	33 (43%)	10 (13%)	2 (3%)
CBR	33 (43%)	22 (29%)	13 (17%)	5 (7%)	3 (4%)

CBR = chemical, biological or radiological.
* Assuming one significant injury for every five "walking wounded".

3). Most respondents believed their department would cope "well" or "very well" with patients from a conventional mass casualty incident. However, the reverse was true for a CBR incident, with 16% believing they would cope "not at all" with a chemical incident, increasing to 22% for a biological, and 32% for a radiological incident. Regarding how well they believed they would personally cope with the response to such an incident, 23 (30%) believed they would cope well or very well with a chemical incident, compared with 16 (21%) for a biological and 15 (20%) for a radiological incident. However, 21 (28%) believed they would cope from "not well" to "not at all" with a chemical incident, increasing to 29 (38%) for a biological, and 35 (46%) for a radiological incident.

Respondents were then asked what they considered the maximum number of patients with which their department and hospital could cope in the first 2 hours after an incident (assuming one significant injury for every five "walking wounded") (Table 8). Forty-one per cent believed they would be able to cope with 20 patients or fewer after a conventional incident, which increased to 72% for a CBR incident. Eight of the 76 respondents considered that their hospital could cope with over 50 patients from a CBR incident in the first 2 hours.

Discussion

The high response rate to this survey probably reflected the increased interest in terrorism and WMD when it was conducted in 2003. Although we recognised that such a survey carries significant potential for reporting bias, we considered it the only way at present to readily obtain such data. The surveys were addressed to the directors of the emergency departments, as it was envisaged that they would either know or have access to information on the resources and capabilities of their departments.

Nearly all the hospitals surveyed appear to have a major incident plan, with most having some type of CBR annexure to that plan. These figures are similar to those found by surveys of Australian hospitals in 2002.[10,11] However, nearly one in six respondents believed their hospital had been involved in incidents in which their plan should have been activated, but had not been. We did not ask the reasons, but they potentially include inadequate staff education, poorly defined criteria for activation, and concern over the political implications of activation of a major incident plan and the subsequent response.

Most respondents believed their emergency department would not cope well with an influx of patients from such an incident, with 15%–30% believing that it would not cope at all, depending on the type of agent. Of more concern was the proportion (41% for a conventional incident, and 72% for a CBR incident) who believed that their department could not cope with more than 20 patients in the first 2 hours after the incident. It is difficult to accurately predict the number of patients that a hospital could reasonably manage in a mass casualty incident, particularly as Australia has been relatively spared such events. However, this underlines the importance of conducting realistic exercises designed to reveal the strengths, weaknesses and capacity of hospital plans.[5] Previous surveys of hospital personnel have raised concerns that perceived preparedness of their institutions may be higher than actual preparedness.[10-12] Notably, of the five hospitals reported to be able to manage 51–100 patients after a CBR incident, all planned to send hospital staff outside, despite one having only Level D PPE, and a further three having fewer than 10 suits of Level C or higher (Table 9). Two had not been involved in a field exercise in the previous 5 years. Three respondents believed their hospitals could manage over 100 patients, although one hospital had not been involved in a field exercise in the previous 5 years.

Respondents generally perceived that they personally and their departments would cope better with a conventional major incident than with a CBR incident. They appeared more confident about dealing with contaminated patients

Table 9. Highest level of personal protective equipment (PPE) available to hospital staff at their institution

PPE level	Current study ($n = 76$)	Aitken (2002)[11] ($n = 61$)
Level A	5 (7%)	6 (10%)
Level B	11 (15%)	7 (12%)
Level C	34 (45%)	20 (33%)
Level D	18 (24%)	20 (33%)
Don't know	4 (5%)	5 (8%)
No answer	0	3 (4%)

from a chemical than a biological exposure, and less confident again for a radiological incident. This may reflect the perceived respective likelihood of an incident with each of these agents, and therefore the focus of any training or education that may have been conducted. It may also reflect prior experience with chemical (eg, industrial) and biological (eg, severe acute respiratory syndrome and "white powder") exposures, but little with radiological incidents.

Previous major incidents have repeatedly demonstrated that most people exposed to a chemical, biological or explosive attack bypass control measures such as triage and decontamination at the scene and self-present to hospitals.[13-16] Despite this, it is suggested that state disaster plans ensure that the more severely injured patients are directed to trauma centres by helicopter and ambulance, and the less injured be corralled or transferred by bus to smaller hospitals.[17] However, previous experience suggests that most of those injured leave the scene quickly, arriving at local hospitals by means other than ambulance, largely in the first 6 hours.[9] The US Centers for Disease Control and Prevention have warned that, in the event of an urban disaster, half of all casualties will arrive at hospital seeking medical care over a 1-hour period.[18] Two separate open-air terrorist bombings in Istanbul, Turkey, in November 2003 resulted in 33 deaths and injury to an estimated 450. One hundred and eighty-four patients presented to one hospital, all in the first hour after the incident, of whom 96 (52%) self-presented.[19] In the subway sarin attacks in Tokyo in 1995, fewer than 11% of those affected were transported by ambulance.[13] Studies of numerous disasters have also shown that most casualties are transported, by a variety of means, to the closest or most familiar hospitals, despite prior planning to distribute the patient load between centres.[14] Accordingly, hospitals cannot afford to rely on the controlled, orderly delivery of decontaminated patients from the scene by emergency services.[5,14] They also cannot assume that other emergency services or the military will be able to deploy resources to assist them, unless they have developed formal memoranda of understanding with them.

The vast majority of hospitals reported having a major incident plan, with most having a CBR annexure to that plan. However, it is naive to believe that a plan fulfils its function merely because it exists.[9] The optimum method of exercising major incident plans remains debated, and is influenced by the objectives of the particular exercise. A study by Johns Hopkins University was unable to provide a definitive statement favouring either field or tabletop exercises.[20] Our study found that at least 28% of hospitals had not been involved in either a field or tabletop CBR exercise in the previous 5 years, with a further 20% not answering at least one of these questions. Nearly half had not been involved in a tabletop CBR exercise in the previous 5 years, which increased to two-thirds of hospitals for a CBR field exercise. An essential component of education and exercises is interagency cooperation,[21-23] which reflects the multidisciplinary skill-mix and integrated approach needed in disaster management.[24] It is important to note that ambulance, fire, police and state emergency services were involved in a significant proportion of the exercises with hospitals, although the survey did not assess the nature or degree of this involvement for each.

There are significant difficulties in conducting exercises at hospitals, particularly field exercises. These include time constraints, cost and impact on service delivery, which are likely to be compounded by access block and emergency department overcrowding.[25,26] A Japanese study found that 73% of public hospitals stated it would be impossible to conduct exercises.[27] These difficulties may partly explain why Australian hospitals have not been more involved in local or multijurisdictional exercises, but it seems that many valuable opportunities have been lost.[28] Large-scale exercises have been held in a number of centres, addressing issues such as smallpox,[29] bioterrorism[30] and influenza.[31] In 2003, the largest Australian hospital-based field exercise involving contaminated patients — Exercise Supreme Truth — was conducted in South Australia. Despite extensive planning, interagency meetings, and additional funding for resources, such as a permanent mass decontamination facility, a number of significant deficiencies were revealed which had not been evident even in tabletop exercises held beforehand. We believe this further emphasises the integral role of exercises in the ongoing cycle of improvement in disaster planning. A number of recommendations were made, some of which have been implemented.[5]

There has been much debate as to whether hospital staff should be equipped with PPE to allow them to venture safely outside the hospital to assist with functions such as crowd control, decontamination, triage and initial treatment. In our survey, 43% reported that hospital staff would be expected to manage contaminated patients outside the hospital. This represents a significant increase from the 14% reported in a 2002 study,[10] and coincides with only a small increase in the number of departments with access to Level C or more sophisticated PPE from the level reported by Aitken in 2002[11] (Table 9). Forty-five per cent of hospitals reported that the highest level of PPE to which their staff had access was Level C, which is likely to reflect the provision of 180 Level C kits to each Australian state in 2003, which were then distributed between emergency service agencies and hospitals. In addition, it is likely that some hospitals reporting access to Level A or B also had access to Level C. However, according to Emergency Management Australia, Level C is appropriate only under specific conditions, as outlined in Table 10.[32] This information will not immediately be available to hospitals receiving contaminated patients, if at all. Although the Emergency Management Australia guidelines were developed for personnel operating within the zone of release of an agent, and not for persons outside that zone managing contaminated patients, no other Australian guidelines or standards have been established for the latter.

Hick et al have suggested that Level C PPE is appropriate for hospital staff, although recognising that the US Occupational Safety and Health Authority and other major regulatory bodies in that country have declined to specify what they consider to be an appropriate level for the health care sector.[33] In comparison, Garner et al questioned the assumption that patients presenting to emergency departments will be minimally contaminated, and recommended that medical personnel have access to Level B PPE.[34] If Level C PPE is considered to provide inadequate protection for hospital staff in such an environment, only 21% of Australian hospitals surveyed appear to have access to a more appropriate level.

The level of PPE available to hospital staff is only one of the issues. It is questionable whether adequate numbers of hospital staff could be trained (and maintain proficiency) to a level at which they could safely operate in a contaminated environment. Fewer than half the departments with access to Level C or higher PPE reported a formal process of accreditation of training for staff in the use of this equipment. In addition, over half reported that staff practice donning PPE less often than once a year, or never. Sending hospital staff into a contaminated environment, with little understanding of HAZMAT (hazardous material) principles, wearing PPE they have donned perhaps once or twice previously, is an enormous occupational health and safety issue. In the United Kingdom, chemical PPE and a training package (Structured Approach to Chemical Casualties) were distributed to hospitals in 2001. Nevertheless, two subsequent exercises with simulated casualties contaminated with a chemical agent found substantial problems with the donning of PPE by staff, equipment failure, leakage of suits, efficacy of patient decontamination, staff decontamination and manual handling.[35] If Level C PPE is deemed appropriate in this context, there needs to be an absolute commitment to a rigorous and sustainable training and maintenance program. The US Occupational Safety and Health Standard on Personal Protective Equipment (Standard 29 CFR 1910.132) states that "the proper use of PPE requires considerable training by a competent person", and that "wearing PPE without proper training can be extremely dangerous and potentially fatal". "Medical personnel who will decontaminate victims must be trained to the First Responder Operations Level with emphasis on the use of PPE and decontamination procedures (29 CFR 1910.120(q)(6)). The employer must certify that personnel are trained to safely perform their job duties and responsibilities".[36] It has been suggested that such certification be linked to specialty training, board examination, hospital privileges, and continuing medical education requirements.[37] Of note, during the Gulf War, 6.5 million gas masks were distributed to the population in Israel, with at least 13 deaths caused by simple misuse of these masks.[38]

Only a third of emergency departments had ready access to stockpiles of antidotes. This is likely to be of more concern in the response to a chemical exposure, when treatments are likely to be required much faster than after a biological release. The location of stockpiles remains controversial, with debate on ready clinical availability versus cost, security and strategic positioning. In the US, strategic approaches, such as "chempack" (containing nerve agent antidotes), aim to supplement local supplies, which still need to be maintained. These Strategic National Stockpile

Table 10. Levels of personal protective equipment (PPE)[32]

Level	Option 1	Option 2	Notes
A	Fully encapsulated suit with SCBA	–	Unknown levels, or known level mandates
B	SCBA and chemical protective suit or charcoal suit	Airline and chemical protective suit or charcoal suit	Known level, or risk assessment performed if level not measurable Positive pressure system
C1	Powered air-purifying respirator and chemical protective suit	Powered air-purifying respirator and charcoal suit	Known level of risk, or risk assessment performed if level not measurable Positive pressure system
C2	Air-purifying respirator and chemical protective suit	Air-purifying respirator and charcoal suit	Known and measurable level Negative pressure system
D	Work clothes (uniforms or overalls)	–	No hazard present or detected May require access to PPE at short notice if near "warm zone"

SCBA = self-contained breathing apparatus.

assets are delivered to the site within 12 hours of a federal decision to deploy, so are unlikely to be immediately available.[39] In Australia, the National Emergency Medicines Stockpile was established in 2002 and includes antidotes, antibiotics, PPE and ventilators. Antidotes to chemical agents that form part of this stockpile need to be stored at hospitals to allow treating clinicians to have ready and rapid access if they are to be used to any effect. Our survey did not formally address the size of individual hospital stockpiles, but it is likely to be a significant issue.

Further concerns are evident on examining some of the functional and logistic components of CBR planning at some hospitals. The level of PPE available to staff often did not correlate with the expectation that they would manage contaminated patients outside the hospital. Of the 33 emergency departments that planned to send staff outside, five had Level D PPE only, which appears inadequate by any standards, potentially putting staff at significant risk. A further two respondents were unaware of the level of PPE available at their institution. In addition, seven of these hospitals had not conducted any exercises in the previous 5 years. Five hospitals reported that they would be able to manage between 50 and 100 patients in the first 2 hours after a CBR incident, but one had access only to Level D PPE, and the other four each had fewer than 10 protective suits (although of a higher level). Two had not been involved in a field exercise in the previous 5 years. Three hospitals believed they would be able to cope with over 100 patients in the same time frame, although one had fewer than 10 PPE suits, and one had not had a field exercise in the previous 5 years.

These data raises significant doubt as to whether some hospitals' resources and training would allow them to achieve their perceived capability. Of the 12 respondents who believed their department would cope "well" in a CBR disaster, two had Level D PPE only, with no CBR exercise in the previous 5 years. Accordingly, we strongly encourage hospitals to look at the feasibility of conducting realistic field exercises that are designed to reveal their strengths and weaknesses. It is only by truly testing our plans that we can more realistically appreciate what is likely to work in a major incident, and what issues and modifications need to be considered. To claim preparedness without doing so appears naive.

Most respondents considered staff training to be their department's main funding priority, whereas funding already provided was most likely to have been for PPE or decontamination equipment. A single funding strategy for the provision of equipment to hospitals is relatively simple, but needs to be followed with ongoing commitment to maintenance and training as, without this, equipment is likely to be of little value.[40] Training of hospital staff needs to be urgently addressed, with a firm commitment from governments to support, resource and finance appropriate training programs. It has recently been suggested that the Australian health care system consider including a mandatory component of disaster management training for all health care workers, medical students and student nurses.[20] Similar calls have been made internationally,[41] including calls for the development of integrated multidisciplinary curricula based on core competencies.[42,43]

We believe our data highlight the need to further develop national standards in disaster planning and preparedness. The Australian Council on Healthcare Standards found that the emergency management systems in 26% of facilities surveyed in 2003 and 2004 required attention to ensure they adequately protected staff and patients.[44] The US Joint Commission on Accreditation of Healthcare Organisations (JCAHO) requires hospitals that offer emergency services to be involved in two exercises per year, at least one of which includes an influx of volunteer or simulated individuals. They must also participate in at least one community-wide practice drill annually, relevant to the priority emergencies identified by the organisation's hazard vulnerability analysis, which assesses communication, coordination and effectiveness of the organisation's and community's command structures.[45] In the UK, the chief executive of each healthcare trust is required to ensure that arrangements are in place to enable adequate training, planning, exercising and testing of emergency planning arrangements. The National Health Service Emergency Planning Guidance (2005.40) states that each trust is required to undertake a minimum of a live field exercise every 3 years, a tabletop exercise every year, and a test of communication cascades every 6 months. There are no such stringent regulations in Australia.

Criteria have been proposed for minimum preparedness for hospital emergency departments to evaluate and treat victims of a biological or chemical agent.[46] At present in Australia, there are no minimum standards of preparedness of hospitals for dealing with mass casualties from a terrorist incident involving either conventional or CBR weapons. The Australian Standard *Planning for emergencies — health care facilities* was approved by the Council of Standards Australia in 1997,[47] but has not been updated. It provides an overview of aspects of preparedness, particularly to internal emergencies, but little specific detail, and at no point refers to acts of terrorism or CBR incidents. The Australian Council on Healthcare Standards has developed a series of accreditation standards for health care facilities, one component of which looks at emergency management systems. It states that each organisation "needs to identify potential emergency situations that may arise either internally or externally in terms of consequence, exposure, probability and preventative actions and develop and imple-

Table 11. Suggested minimum standards for hospitals reasonably expected to receive and manage patients after a chemical, biological or radiological incident[50]

- Written policies on the evaluation and treatment of patients involved in a chemical, biological or radiological incident.
- Written memoranda of understanding with external agencies that, as part of their plan, are expected to provide support to the hospital in a CBR incident.
- Ability to decontaminate at least 10 ambulant and five stretcher patients per hour.
- An accredited program of training for staff in the use of an appropriate level of personal protective equipment if they are expected to manage contaminated patients as part of their hospital's plan. This needs to be supported by an ongoing process of regular credentialling.
- At least 25% of emergency department staff (medical and nursing) must have completed an accredited training course recognised by their state's department of health as being appropriate.
- All new full-time medical and nursing appointees to the emergency department must have completed an accredited training course recognised by their state's department of health as being appropriate, within the first 12 months of that appointment.
- All hospital administrators who may reasonably be expected to perform a significant role in their hospital's response to a mass casualty incident must have completed an accredited training course recognised by their state's department of health as being appropriate.
- Two exercises within each 2-year period, at least one of which includes an influx of volunteers or simulated individuals. Written reports from each must be provided to that state's department of health.

ment an appropriate emergency response system in consultation with relevant external emergency response organisations".[48] Again, it provides minimal practical detail, although it notes that it was released in 2002, with a new edition due in 2007.

Detailed standards need to be developed to enable hospitals to assess their levels of preparedness more accurately and to provide guidance on improvement. However, a 1996 study analysing the major incident plans of 142 hospitals in the UK found that only 4% actually complied fully with National Health Service guidelines.[49] Accordingly, we believe that these need to be linked to a formal process of hospital accreditation tailored to the likely role a given hospital would play in the response to a mass casualty incident. A key component would be the development of an accredited training program for hospital staff, which is relevant to their particular roles and environment and could train significant numbers annually. This needs to include hospital administrators, who may be expected to provide leadership and coordination in a mass casualty incident.[28] The standards should also include statements on decontamination facilities, PPE (including training of staff expected to manage contaminated patients) and exercises (such as those used by the JCAHO[45]).

In our survey, 72% of respondents believed their hospital would not be able to cope with more than 20 patients in the first 2 hours after a CBR event. We, as clinicians, administrators and community members, need to decide whether this is acceptable, while also considering the likelihood of such an event, potential outcomes and competing demands for funding. In line with this, we propose a set of standards for hospitals that could reasonably be expected to receive patients after a CBR incident (Table 11).[50] We recognise that different standards may need to be devised for different hospitals, depending on their likely role in any response. Once developed, the standards would need to be administered and enforced by a body such as the Australian Council on Healthcare Standards.

Limitations of this study include the self-reporting of data, with its inherent bias, and an inability to fully review functional aspects of the plans. There are a large number of aspects to disaster preparedness, and it was impossible to cover all in the detail we would have liked. The survey therefore concentrated on hospital planning and resourcing for mass casualty incidents, and the acute response to an incident involving the presentation of contaminated patients. We did not specifically assess the surge capacity of Australian hospitals, although a recent study has raised significant concerns in that area, and found that Australian hospitals did not meet US Department of Health and Human Services benchmarks for mass casualty incidents.[51,52] We also did not examine broader issues, such as the longer-term capability to manage patients, particularly after a biological exposure, and its related public health issues. We also did not assess the resources (eg, Geiger counters) available for managing patients exposed to a radiological incident, such as a "dirty bomb"; this needs to be further examined. In addition, it is likely that the capabilities of some hospitals have changed significantly since the survey was conducted. For example, erectable mass decontamination facilities (TVI Corporation, Md, USA) and ventilators have subsequently been distributed to a number of Australian hospitals. However, it is too easy to claim that our data are not representative of a particular state or hospital, or that they are outdated. If that is believed to be the case, then the onus should be on that body, and indeed the Federal Government, to openly and transparently prove it to be so. The potential ramifications of inadequate planning and preparedness, or that based on false assumptions, must not be underestimated.

Conclusions

The Royal Australasian College of Surgeons has warned that "as long as we continue to tackle planning response and recovery from disaster in an ad hoc fashion the greater the chances will be of bigger and more catastrophic outcomes. If there are massive casualties, our hospitals would easily be overwhelmed and swamped".[53] Hospitals will almost certainly play a significant role in the response to a mass casualty incident. It is clear that, at least in the initial stages after such an event, they will need to be largely self-sufficient. We believe that some of the results presented here raise concerns about the level of response that Australian hospitals would be able to provide. Accordingly, we need accurate information about the capacity of our hospitals to manage patients from mass casualty incidents.

A superficial assessment of CBR plans may give a false sense of preparedness, and a detailed and critical review is needed to truly determine the functionality of these plans. We found that the vast majority of Australian emergency departments considered further funding to be needed to improve CBR disaster preparedness, with training regarded as the major funding priority. A set of agreed national standards would help remove uncertainty over what can reasonably be expected of hospitals, and allow more appropriate and efficient planning, training and allocation of resources. An open process with honest debate among all interested groups is needed for this to move forward.

Our findings should not be regarded as criticism of the efforts of individuals and departments to improve disaster preparedness in Australia, but rather as an aid to recognising current strengths and deficiencies, and a guide for future strategies. Just as administrators need to support this process, clinicians need to be involved in the development of plans and guidelines, and to be aware of their role in a system-based approach to preparedness. Without this, not only our patients, but also the health care system and its staff, may suffer when a mass casualty incident occurs.

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