

# What a Disaster?! Assessing Utility of Simulated Disaster Exercise and Educational Process for Improving Hospital Preparedness

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## Abbreviations:

ANUM = Associate Nurse Unit Manager  
CI = confidence interval  
ED = emergency department  
HEWS = hospital early warning system  
IQ = inter-quartile  
JCAHO = Joint Commission on the  
Accreditation of Health Care  
Organizations  
NUM = Nurse Unit Manager

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## Abstract

**Introduction:** Recent events have brought disaster medicine into the public focus. Both the government and communities expect hospitals to be prepared to cope with all types of emergencies. Disaster simulations are the traditional method of testing hospital disaster plans, but a recent, comprehensive, literature review failed to find any substantial scientific data proving the benefit of these resource- and time-consuming exercises.

**Objectives:** The objective of this study was to test the hypothesis that an audiovisual presentation of the hospital disaster plans followed by a simulated disaster exercise and debriefing improved staff knowledge, confidence, and hospital preparedness for disasters.

**Methods:** A survey of 50 members of the medical, nursing, and administrative staff were chosen from a pool of approximately 170 people likely to be in a position of responsibility in the event of a disaster. The pre-intervention survey tested factual knowledge as well as perceptions about individual and departmental preparedness. Post-intervention, the same 50 staff members were asked to repeat the survey, which included additional questions establishing their involvement in the exercise.

**Results:** There were 50 pre-intervention tests and 42 post-intervention tests. The intervention resulted in a significant improvement in test pass rate: pre-intervention pass rate 9/50 (18%, 95% confidence interval ((CI) = 16.1–19.9%) versus post-intervention pass rate 21/42 (50%, 95% CI = 42.4–57.6%;  $\chi^2$  test,  $p = 0.002$ ). Emergency department (ED) staff had a stronger baseline knowledge than non-ED staff: ED pre-test mean value for scores = 12.1 versus non-ED scores of 6.2 (difference 5.9, 95% CI = 3.3–8.4);  $t$ -test,  $p < 0.001$ . Those that attended  $\geq 1$  component had a greater increase in mean scores: increase in mean attendees was 5.6, versus the scores of non-attendees of 2.7 (difference 2.9, 95% CI = 1.0–4.9);  $t$ -test,  $p = 0.004$ . There was no significant increase in the general perception of preparedness. However, the majority of those surveyed described the exercise of benefit to themselves (53.7%, 95% CI = 45.5–61.8%) and their department (63.2%, 95% CI = 53.5–72.8%).

**Conclusions:** The disaster exercise and educational process had the greatest benefit for individuals and departments involved directly. The intervention also prompted enterprise-wide review, and an upgrade of disaster plans at departmental levels. Pre-intervention knowledge scores were poor. Post-intervention knowledge base remained suboptimal, despite a statistically significant improvement. This study supports the widely held belief that disaster simulation is a worthwhile exercise, but more must be done. More time and resources must be dedicated to the increasingly important field of hospital disaster preparedness.

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## Introduction

Hospital disaster preparedness presents complex clinical, operational, and philosophical challenges. It is difficult to determine how much time, money, and effort should be spent on preparing for an event that may not occur. Nearly 40 years ago, Menczer noted that many communities either have become over-confident in their ability to manage disasters or are so uninterested that they ignore necessary training and skills.<sup>1</sup>

An *external disaster* is an event that generates a casualty profile that threatens to overwhelm existing hospital emergency services. Emergency departments (EDs) in the state of Victoria, Australia often are near disaster status on a daily basis. A number of healthcare networks in the state have introduced strategies to address this issue. The appointment of a dedicated Emergency Planning Officer<sup>2</sup> and the introduction of a hospital early warning system (HEWS)<sup>3</sup> for *near disaster* status (>90% of ED cubicles are occupied, and three patients are waiting for admission for >8 hours, and >5 patients are in the waiting room) are two such strategies.

Governments and communities expect hospitals to be well-prepared to deal with all levels of a disaster. This is an expectation reinforced by the impressive nationwide response in Australia to the Bali bombings of October 2002. The unique nature of this horrific event enabled hospitals involved to perform at their best: >2 days elapsed from the last explosion to the arrival of the first patient at the closest Australian hospital. The patient load from this event was shared throughout the country.

The aims of the study were to: (1) improve basic knowledge of the hospital disaster response plan in senior medical and nursing staff; and (2) to assess self-reported personal and departmental disaster preparedness pre- and post-intervention. It was thought that hospital-wide disaster preparedness was sub-optimal, and that the implementation of a training process would result in measurable improvements.

## Background

In Victoria, Australia, there has been a recent increase in statewide and regional forums and tabletop disaster exercises instigated by the state government and regional representatives. Emergency physicians and nurses have been represented heavily, with less involvement from intensive care and operating theater personnel.

The City of Greater Geelong is a seaport and an industrial city in Victoria. It is home to an oil refinery, an aluminium smelter, a large motor vehicle manufacturing plant, and many other heavy industries. It also is the capital city of a beach resort region that frequently hosts major sporting events and festivals. Prior to this study, the ED at Geelong Hospital was the only department with a dedicated Disaster Committee and a detailed departmental disaster plan. The impression from informal discussions with long-term senior medical and nursing staff was that there was limited knowledge of the hospital disaster plan and that disaster preparedness was a low priority, even among key stakeholder departments, such as the intensive care unit and the operative services department.

A Barwon South-West regional threat assessment revealed a number of hazards within close proximity. Unlike the receiving hospitals for the Bali bombings victims, Geelong Hospital is likely to receive notification of a mass-casualty incident upon arrival of the first self-presenting patient. It is a 360-bed hospital and houses the sole ED for a catchment population of 250,000 persons.

## Methods

The study was conducted as an anonymous pre- and post-intervention survey. A study population was identified consisting of approximately 170 members of Barwon Health staff from key stakeholder departments. These were senior medical, nursing, and administrative staff, who, because of their training and rank within the organization, were likely to be placed in a position of responsibility during a disaster. In the ED, this consisted of medical consultants and registrars, Associate Nurse Unit Managers (ANUM), and critical care-certificated nurses who potentially would be in charge during the onset of a disaster.

For non-ED staff (including intensive care and operative services), the department Director, consultants, and senior registrars, Nurse Unit Managers (NUMs), ANUMs, and shift-in-charge nurses were sought. Staff likely to be on the Emergency Control Team (ECT), such as the Director of Medical Services and the Director of Surgical Services, also were included.

A convenience sample of 50 surveys was obtained, ensuring a representative selection from the groups and subgroups outlined above. This was opportunistic and not randomized formally. A larger representation of ED staff was obtained for general comparison with staff from the rest of the hospital. Power and sample size calculations demonstrated that 40 surveys would give adequate power to test for a significant change in the pass/fail rate (allowing for a 15% failure of follow-up in the post-intervention survey).

The surveys were conducted in the two weeks prior to implementation of the first component of the intervention. Verbal consent was obtained from the individuals surveyed. To ensure high compliance rates, the surveys were completed at the time of consent, and although they were completed in privacy, they were returned to the investigators immediately. Then, the respondent was given an invitation to the first component of the intervention, the audiovisual presentation of the disaster plan, with the date and time of the presentation clearly stated. Nobody who was approached refused to consent or declined to participate. The same 50 respondents were asked to repeat the survey 4–6 months post-intervention. This project was performed in adherence with the Questionnaires Policy in the Barwon Health Policies and Procedures Manual and as a Quality Assurance exercise, the Quality Unit deemed Ethics Committee approval unnecessary.

## Intervention

The intervention had two components: (1) a one-hour lecture; and (2) a compressed-time disaster simulation (including a debriefing process). A widely advertised one-hour lecture entitled “Bombs, Bushfires and Big Bingles—Are

ED Staff <input type="checkbox"/> Non-ED Staff <input type="checkbox"/>		Yes	No	Don't Know
1.	An External Disaster is a Code Brown.			
2.	Geelong Hospital has a Disaster Plan.			
3.	There is a copy of this plan in my department. If Yes, where? _____			
4.	In the event of an External Disaster, the Emergency Control Team will assemble in a designated area. If Yes, where? _____			
5.	A dedicated back-up communication network exists in the hospital should landlines and mobile phones fail during a major incident.			
6.	The disaster plan contains a job card for various staff roles. If Yes, my role might be _____			
7.	I am well prepared for a disaster. <i>Strongly disagree / disagree / not sure / agree / strongly agree</i>			
8.	Disaster preparedness is a high priority in my department. <i>Strongly disagree / disagree / not sure / agree / strongly agree</i>			
9.	My department is well-prepared for a disaster. <i>Strongly disagree / disagree / not sure / agree / strongly agree</i>			
<b>Mark:</b> 1. 5; 2. 3; 3. 2; 4. 1; 5. 1; 6. 2; 7. 3; 8. 2; 9. 1				

**Figure 1**—Disaster preparedness survey (ED = emergency department)

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We Ready for the Next Big One?” was delivered at the weekly hospital-wide forum on 05 October 2004 by the chief investigator. On Sunday, 10 October 2004, Geelong hospital was the closest receiving hospital for casualties from a simulated mass-casualty incident “Exercise Kardinia Express” scripted by the local State Emergency Service officers. The exercise resulted in the delivery of 45 moulage patients (25 stretcher patients, 20 walking wounded) to the Geelong ED. Each patient underwent real-time triage and registration followed by compressed time treatment and disposition. Patient disposition and management beyond the ED was conducted as a tabletop exercise. A hot debriefing was conducted in the ED immediately after the disaster simulation had been terminated. A formal, enterprise-wide debriefing was conducted on 20 October 2004.

The funding for the intervention included money for three additional individual shifts (two nurses, one clerk) on the day of the simulation to mitigate an adverse impact on real-time patient care. Other agencies involved in the simulation donated their time and resources. Participation was voluntary.

The lecture was advertised through the usual process for hospital-wide presentations. The hot debriefing was conducted for those willing and able to attend on the day. All Barwon Health staff members were invited to the enterprise-wide debriefing (which was scheduled at a time deemed convenient for operating services staff) via the Barwon Health Intranet. There was also an invitation announced over the hospital public address system 30 minutes prior to commencement of the debriefing.

#### Survey

A pre- and post-intervention survey was developed to assess basic knowledge of the hospital disaster plan and allow self-assessment of personal and departmental disaster preparedness (Figure 1). The survey was deliberately brief and basic in an effort to facilitate a high rate of verbal consent. A predetermined scoring system was defined by the researchers. The basic factual knowledge component comprised six weighted questions, with the key first question worth five points, and the other five questions worth

		Mean	Difference	CI of difference	t-test
Pre-intervention Score/20	Mean score ED	12.1	5.9	3.3-8.4	$p < 0.001$
	Mean score Non-ED	6.2			
Post-intervention Score/20	Mean score ED	15.8	4.2	2.7-7.6	$p < 0.001$
	Mean score non-ED	10.6			
Mean Change	Mean change ED	3.4	1.3	-0.7-3.5	$p = 0.195$
	Mean Change non-ED	4.7			

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**Table 1**—Mean scores of pre- and post-intervention surveys (CI = confidence interval; ED = emergency department)

three points each. Medical representatives of the Geelong ED Disaster Committee agreed that a 70% score (14/20) would represent a “passing” score for the factual component of the survey. The self-assessment component was conducted using a five-point scale ranging from “strongly disagree” = 1 to “strongly agree” = 5, with a number of assertions regarding personal and departmental disaster preparedness. In the post-intervention survey, individuals were asked to report on their awareness of or involvement in each component of the intervention. In addition, they were questioned directly on the impact of the intervention on their personal and departmental disaster preparedness.

The follow-up survey asked what impact an individual’s involvement had on personal and departmental preparedness. This was assessed on a 4-point scale; 0 = no change, 1 = mild improvement, 2 = moderate improvement, 3 = major improvement.

## Results

Fifty senior medical and nursing staff members were surveyed pre-intervention. Of these, 21 (42%) were ED staff and 29 (58%) were non-ED staff. Four to six months after the intervention, 42/50 (84%) completed the same survey. Twenty-two of them (52.4%) attended at least one component of the exercise, and only 6/42 (14.3%) attended both the lecture and the simulated disaster. Thirty-one of 42 (73.8%) acknowledged awareness that the lecture had occurred.

### Factual Knowledge

The pass rate in the pre-intervention survey was 18% (9/50, 95% confidence interval (CI) = 16.1–19.9%). There was a statistically significant increase in pass rate to 50% (21/42, 95% CI = 42.4%–57.6%) post-intervention ( $\chi^2$  test  $p = 0.002$ ).

The ED staff obtained a higher mean value for the scores than did the non-ED staff on both the pre- and post- inter-

vention surveys. Both groups improved to a similar extent, albeit the non-ED staff started at a lower baseline (Table 1).

Individuals that attended at least one component of the intervention showed greater improvement in mean score compared with non-attendees (mean value of the increase in score; attendees = +5.6; non-attendees = +2.6; difference = 2.9 (95% CI = 1.0–4.9;  $t$ -test,  $p = 0.004$ )).

A score of 20 (100%) was achieved by one person (2%, 95% CI = 1.9–2.1%) on the pre-intervention survey and five people (11.9%, 95% CI = 10.7–13.1%) in the post-intervention survey; all were ED staff.

### Self-Assessment

In the self-assessment component of the survey, the most common pre-intervention survey response to the statement, “I am personally prepared” was “disagree” (16/50, 32%, 95% CI = 27.9–36.1%). The most common post-intervention survey response, was “agree” (19/42, 45.2%, 95% CI = 38.4–52.0%). With regard to departmental preparedness (“My department is prepared”), the most common pre-intervention survey response was “disagree” (22/50, 44%, 95% CI = 37.9–50.1%). This remained the most common post-intervention survey response with an equal number uncertain as to whether their department was prepared 13/42 (31%, 95% CI = 26.6–35.3%).

For personal preparedness, the median change was from “not sure” to “agree”, (before the interventions, median = 3; 25–75% inter quartile (IQ) range 2–3; after intervention) median = 4, 25–75% IQ range 2–4, Wilcoxon signed-rank test  $p = 0.066$ ).

For departmental preparedness, the median change was from “disagree” to “not sure”. The pre-intervention median = 2, 25–75% IQ range 2–3, with a median value post-intervention = 3, 25–75% IQ range 2–4, Wilcoxon signed rank-test,  $p = 0.092$

Question	Department	Median	25%-75% IQ Range	Mann-Whitney Test	Median Answer
Personal preparedness before	ED	3	2-4	$p = 0.022$	Not sure
	Non-ED	2	2-3		Disagree
Personal preparedness after	ED	4	4-4	$p = 0.003$	Agree
	Non-ED	2	2-3.75		Disagree
Departmental preparedness before	ED	3	2-4	$p = 0.02$	Not sure
	Non-ED	2	2-3		Disagree
Departmental preparedness after	ED	4	3-4	$p < 0.001$	Agree
	Non-ED	2	2-3		Disagree
Departmental preparedness priority before	ED	4	3-5	$p < 0.001$	Agree
	Non-ED	2	2-3		Disagree
Departmental preparedness priority after	ED	4	4-4.75	$p = 0.001$	Agree
	Non-ED	3	2-3.75		Not sure

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**Table 2**—Preparedness and priority before and after  
1 = Strongly disagree; 2 = Disagree; 3 = Unsure; 4 = Agree; 5 = Strongly agree  
(ED = emergency department; IQ = inter-quartile)

Regarding the third question, “Disaster preparedness is a high priority in my department”, the most common pre-intervention survey answer was “disagree”; 18/50 (36%, 95% CI = 31.2–40.8%). The most common post-intervention survey answer was “agree”; 15/42 (35.7% 95% CI = 30.5–40.9%). In regards to the median change from “not sure” to “agree”, the pre-intervention median was 3, with 25–75% IQ range 2–4 and after, the median was 4 with 25–75% IQ range 2–4, Wilcoxon signed rank-test,  $p = 0.09$ .

For all three questions pre- and post-test, ED staff were significantly more confident with personal and departmental preparedness and rated it as a higher departmental priority (Table 2). There was a statistically significant difference between the median change in personal preparedness between those who attended  $\geq 1$  component of the exercise and those who did not attend; The median change in attendees was +1 on the scale (IQ range 0–2) compared with non-attendees having a median change of 0 (25–75% IQ range 0.25–0) Mann-Whitney rank sum test,  $p = 0.019$ . There was no significant difference in the median change in departmental preparedness (the median change of attendees = 0, IQ range 0.00–0.25 versus median change of non-attendees = 0, IQ range 0–1, Mann-Whitney rank sum test,  $p = 0.332$ ).

#### *Impressions of Improvement*

In regard to personal improvement, 41/50 (82%, 95% CI = 73.390.7%) completed this component; the majority (22/41) 53.7% (95% CI = 45.5–61.8%) reported some

degree of personal improvement (minor, moderate, or major). For the departmental improvement question, 38/50 (76%, 95% CI = 67.0–85.0%) replied; the majority (24/38) 63.2% (95% CI = 53.5–72.8%) reported some degree of departmental improvement.

Those who attended one or more component were compared with those who did not attend. For personal improvement, median rank for attendees was 2 (25–75% IQ range 1.75–2.00), compared with the non-attendees, median = 0 (25–75% IQ range 0–0) Mann-Whitney rank sum test,  $p = < 0.001$ .

For departmental improvement, the median rank for attendees was 2 (25–75% IQ range 1–2.5), versus the non-attendees median = 0 (25–75% IQ range 0–1). Mann-Whitney rank sum test,  $p = 0.005$ . On the four-point scale, this equates to a moderate sense of personal and departmental improvement for the attendees versus no sense of improvement reported by the non-attendees.

#### **Discussion**

Historically, generating interest and involvement in hospital disaster preparedness is a worldwide problem.<sup>1,4,5</sup> Hospitals in Israel are a notable exception; they invest considerable time and efforts into preparing for the threat of an imminent mass-casualty incident.<sup>6–8</sup> In the US, the Joint Commission on the Accreditation of Health Care Organizations (JCAHO)<sup>9</sup> has issued standards that require hospitals to test their emergency management plan twice each year, including at least one community-wide

practice drill to assess communications, coordination, and the effectiveness of the command structures.<sup>10</sup> The relevant Australian Standard approved by the Council of Standards-Australia recommends that the frequency of emergency management training should be such as to ensure “appropriate” levels of preparedness and response are maintained.<sup>11</sup> There are no specific requirements regarding the frequency or nature of training.

A comprehensive literature review by Hsu *et al* found that the effectiveness of hospital disaster drills is difficult to determine, as there are little objective data in the literature, such as pre- and post-test knowledge scores or statistics showing significant improvement of patient throughout time.<sup>10</sup> Limited knowledge of the hospital disaster plan often has been described.<sup>4,12,13</sup>

The most notable Australian disaster on record is the Ash Wednesday Bushfires of 1983, when many of the regions satellite cities were incinerated and 72 people died. Rutherford remarked that “even after involvement in a disaster, one forgets later”.<sup>13</sup> The most recent simulated disaster drill at Geelong Hospital was >10 years ago. Some of those surveyed remarked that in the event of a disaster, they would report to the ED and seek instruction.

In this study, concerns regarding factual knowledge of the hospital disaster plan and the level of personal and departmental disaster preparedness are described. Although a significant improvement in the pass rate was achieved (18 to 50%), limited comfort can be derived from a post-intervention pass rate of 50% among senior nursing and medical staff. The knowledge tested was basic and fundamental to the generic hospital disaster plan. Correct answers to “An External Disaster is a Code Brown” and “Geelong Hospital has a disaster plan” could have scored 8 points, and yet, the pre-intervention mean score was 8.7.

When directly asked to comment on disaster preparedness in the post-intervention survey, there was a clear impression of moderate improvement among individuals who attended at least one component of the intervention. Despite exhaustive efforts to achieve attendance at the lecture and involvement in the debriefing, nearly one-half of the surveyed population did not attend either forum. This is not a unique experience; Gray found when attempting to educate staff on a new hospital disaster plan that “because of lack of interest or other priorities, very few read the plan or attended the well-advertised teaching sessions.”<sup>4</sup> The poor attendance partly resulted in the overall failure to demonstrate improved, self-assessed personal and departmental preparedness.

Despite low attendance levels, the profile of hospital disaster preparedness rose, and a number of positive steps have been taken. The HEWS response to a *near disaster* has been re-launched with strong executive support for hospital-wide involvement. Key stakeholder departments have taken action; most notably, the senior members of the Operative Services Department have drafted a discussion paper and nursing administrators have reviewed the role of the hospital nurse coordinator in an external disaster as a matter of urgency.

A mass-casualty incident is an important risk and a real threat to the quality of care. Enthusiastic ED staff special-

ists, whose clinical duties take precedence over a range of non-clinical duties, cannot address these issues adequately. There must be a full-time, strategic Emergency Management Officer to maintain and sustain these initiatives enterprise-wide. Such a role would help develop department-level ownership of disaster preparedness in all relevant specialties, and has gained support from the Barwon Health Deputy Chief Executive Officer as chair of the Emergency Planning Committee. The recent bombings of the London transport services highlight the worldwide necessity for disaster preparedness and may result in increased interest in disaster planning in the Australian community and public health services.

Unfortunately, resources do not exist to conduct the described, labor-intensive education program every 6–12 months. A funded, enterprise-wide, simulated disaster has been recommended to coincide with the opening of a new ED in December 2007. The sub-optimal level of disaster preparedness demonstrated in long-term senior staff raises concerns regarding the knowledge of hospital registrars, many of whom stay for only 6–12 months, and, currently, receive little or no formal instruction in disaster medicine. An educational video (funded by Barwon Health) has been produced from footage taken during Exercise Kardinia Express, and a study assessing the utility of this tool to achieve rapid competency in the in-patient and ED registrars is in progress.

#### Limitations

The opportunistic selection process used is open to bias. The study group did not include junior-grade staff and must be interpreted in this light. The relatively small numbers of participants resulted in reduced power in the subgroup analyses. The follow-up survey response rate was high, and reflects a captive population within the hospital staff group. Overall attendance to the interventions was poor, and likely reflects the voluntary basis of these sessions. Compulsory attendance would not have been attainable, and is unlikely to be achieved in other institutions. Advertisement of the disaster simulation may have improved the turnout, but would have subverted the aim of testing preparedness. The formal post-exercise debriefing was advertised extensively and considered a vital component of the intervention, but also suffered from poor attendance.

#### Conclusion

“What a Disaster?!” describes a labor-intensive educational process made possible through the involvement of a number of willing enthusiasts. It successfully achieved its unambitious, short-term aims. Further cost-effective strategies are required to adequately improve and sustain hospital disaster preparedness. The following strategies currently either are in progress or under consideration: (1) development of effective and affordable education tools for permanent and transient medical and nursing staff; (2) mandatory hospital-wide involvement in the HEWS tiered response to a *near disaster* and acknowledgement of Code Brown as an extension of the HEWS; and (3) employment of a full-time, Emergency Management Officer with jurisdiction enterprise-wide and specific government endorsed requirements for conducting hospital-wide disaster exercises.

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