

# Use of simulation technology in Australian Defence Force resuscitation training

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## ABSTRACT

**Realistic training of health personnel for the resuscitation of military casualties is problematic. There are few opportunities for personnel to obtain the necessary experience unless working in a busy emergency or trauma environment. Even so, the specific nature of military trauma means that many aspects of casualty management may not be adequately covered in the civilian domain. This paper discusses the use of advanced simulation technology in the training of military resuscitation teams. Such training has been available to members of the Australian Defence Force (ADF) for two years.**

## Introduction

The smallest building block of health support within the ADF is the resuscitation team. Each resuscitation team consists of a medical officer, a nursing officer, an advanced medical assistant, a medical scribe and an orderly. The role of the resuscitation team is to work together and manage effectively the resuscitation of military casualties, using rapid diagnosis and treatment of life-threatening injury. Onward transfer to a surgical facility can then be considered after resuscitation and stabilisation of the casualty's condition. Such care is described as Level 2 (Table 1) and following this, casualties may proceed to a surgical facility where initial wound surgery is performed with an aim of treating life-threatening injury by surgical means.

The critical point to be made is that resuscitation of casualties is performed not by groups of individuals but by teams. In order to work effectively as a team, each

member must be certain as to his/her role, assured by the abilities of other team members, confident in the application of all available equipment and undaunted by the working environment. Understanding the importance of the team in the process of resuscitation, the ADF has developed a doctrinal environment that encourages teamwork by providing consistency. This allows all members to transfer between teams secure in the knowledge that equipment and protocols will be identical and that new team members will be assuming corresponding roles. (Figure. 1)



Fig 1. The manikin is moulaged to present a realistic injury. Note the resuscitation team has set up its equipment as detailed in the Resuscitation Standardisation Handbook.

Casualty Treatment Regimes (CTR) have been produced so that care may be delivered along specific management pathways appropriate to the level of health support being provided (1). The basis for these regimes is one derived from the Advanced Trauma Life Support (ATLS) program which was drawn up by the American College of Surgeons during the early 1980s, and designed to improve the level of trauma care that was delivered by physicians who were not regular trauma

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Table 1. Levels of casualty health support

Designation	Type of Care	Location of Care
Level 1	Location and removal from danger "Self", "buddy" and "first aid" Emergency life-saving measures	Site of wounding Aid post
Level 2*	Collection, sorting, treatment and evacuation Provision of resuscitation procedures	Medical company Immediate resuscitation team
Level 3*	Initial wound surgery Hospitalisation for medium and high intensity nursing	Forward surgical team Health Support Battalion
Level 4	Specialised surgery, rehabilitation and hospitalisation	Civilian base hospital
Level 5	Advanced specialised and sophisticated management and care. Research facilities. Regional and supraregional units	University teaching hospital

\*Location of resuscitation teams

care providers. In liaison with the Royal Australian College of Surgeons, this program is run as the Early Management of Severe Trauma (EMST) course and medical officers in the ADF combine this with an extra military module.

Having been provided with a basis for the management of trauma casualties, it is important that resuscitation teams are able to carry out the CTRs correctly. In order to do this the Resuscitation Standardisation Handbook (RSH) describes not only the composition of the resuscitation team but also the training requirements for membership (2)(Table 2). It also details the specific roles for team members in the form of duty statements, the composition and layout of equipment along with the process of documentation. It also recognises that training for members of the team should continue and that this should happen initially at unit level.

Table 2. *Qualifications for resuscitation team membership*

	Mandatory	Advantageous
Medical Officer	Medical qualification EMST + military module	Higher speciality training LS <sup>1</sup> courses
Nursing Officer	Nursing qualification FNC <sup>2</sup>	Higher specialty training TNCC <sup>3</sup>
Medical Assistant	AAMC <sup>4</sup>	Civilian/military experience Level 4 (paramedic) course
Scribe	AMC <sup>5</sup>	Civilian/military experience
Orderly	Basic first aid	Advanced first aid

<sup>1</sup> Advanced Life Support courses  
<sup>2</sup> Field Nursing course  
<sup>3</sup> Trauma Nursing Core Course  
<sup>4</sup> Advanced Assistant Medical course  
<sup>5</sup> Assistant Medical course

### Traditional Training

A significant amount of instruction occurs in the classroom. Training on “part task trainers” is important and skills such as intubation, cannulation and cardio-pulmonary resuscitation draw heavily on such resources. The value of field exercises using surrogate patients is substantial. Casualties on such exercises are often moulaged and may carry cards describing the mechanism of injury, often with photographic representation of genuine injury. Directing staff will advise the team on any changes in the state of the casualty’s condition and the efficacy of any treatments. Team members are encouraged to carry out their own further training and for some, this could include college-accredited courses (eg. emergency medicine, anaesthesia, surgery and nursing). For others the use of attachments to strategic alliance trauma hospitals enables both regular and reserve members of the ADF to experience civilian trauma; however, at medical assistant level this can be limited by restrictions on direct patient care associated with registration and professional issues.

All the training detailed above allows participants the opportunity to learn and practise skills before exposure to military casualties. Unfortunately the lack of realism associated with the traditional training environment detracts from the overall learning process. There is a gap between training and experience and this remains wide enough for those ADF personnel undergoing such training to report that they do not get a “feel” for the speciality of military trauma.

Recognising this, medical officers of the ADF approached the Medical Simulation Centre of the Department of Anaesthesia and Pain Management, the University of Sydney, and in collaboration developed courses for military simulation aimed at providing an experiential training environment of simulated battlefield injury reproduced with a high degree of fidelity.

### The Sydney Medical Simulation Centre

The Sydney Medical Simulation Centre is based at the Royal North Shore Hospital, St Leonards, New South Wales, Australia. The Simulation Centre opened in 1997 primarily to provide a simulated environment for anaesthesia training and subsequently has developed a number of courses in other fields, including trauma management. The Centre relies on an experienced faculty working in major trauma centres with anaesthetic and surgical backgrounds in both the civilian and military fields.

Within the Centre is a simulation suite that uses an advanced simulator manikin of a type manufactured by MedSim-Eagle Simulation Inc., Fort Lauderdale, Florida. This “full patient, high-fidelity simulator” is an adult-sized manikin fitted with a variety of electromechanical and pneumatic devices and connected to a computer and a variety of sensors. Complex software programs enable the manikin to operate automatically by controlling the vital functions. Sophisticated mathematical modelling of the manikin’s physiological and pharmacological responses to physical interventions, or drug administration, allows integration with the control systems so that realistic responses can occur in “real time”.

The manikin is constructed in such a way as to allow the full range of airway manipulations and instrumentation from basic head tilt and chin lift, through endotracheal intubation to the provision of a surgical airway. Chest trauma has been modelled to allow a variety of pathological states from simple pneumothoraces to cardiac tamponade to be simulated. The manikin can be cannulated and pulses can be palpated. The blood pressure is generated by the computer model and can

be supplied to monitoring equipment when appropriate. Sensors monitor interventions such as oxygen therapy, ventilation and drug administration, and the appropriate physiological responses are programmed to occur realistically. The manikin can be spoken to and questioned relying on a member of the directing staff to provide the appropriate response using a microphone linked to a loud speaker located by the head. Neurological signs and symptoms, including arm movement and pupillary reflexes are also exhibited by the manikin.

### Scenarios

Complex computer modelling associated with high-fidelity representation of the response to medical intervention allows elaborate injury scenarios to be developed (Tables 3 and 4).

The scenarios can be tailored individually to allow specific training aims to be

incorporated into cases. Teams using the Centre have included those from the Royal Australian Navy, who have simulated medical emergencies associated with diving and decompression illness, and Joint Service teams who have been tasked with providing medical support with chemical, biological and radiological capabilities to security forces at the Sydney Olympics. The level of difficulty of each scenario can be modified to take into account differences in the requirements of various teams allowing an almost endless permutation of available scenarios.

### Process of Simulation

Over the last two years more than 200 ADF personnel have been trained through the Centre, principally members of the Australian Army and Navy. Training has included the specific preparation of resuscitation teams for operational

Table 3. Training details of a typical scenario

Army Resuscitation Team Medical Simulation Training - Scenario B July 2000		
SUMMARY:		Mortar attack Young soldier with multiple fragment injuries Respiratory distress Hypoxia Tension pneumothorax
SET-UP:	Manikin	Moulaged multiple wounds to anterior head, chest and abdomen Supplemental oxygen in situ Lying on field stretcher with field medical report
	Settings	Spontaneous movements and painful stimuli Self-ventilating RR20 SpO <sub>2</sub> 85% on air Mild hypovolaemia BP 100/60, P110 low volume Trigger tension pneumothorax scenario
EXPECTED RESPONSES:		Initial assessment Follows CTR2 – needle thoracocentesis and tube drainage of chest. Venous access and fluid resuscitation Consider airway control if no improvement Assess priority and plan evacuation
DEBRIEFING POINTS:		Early recognition of respiratory distress Prompt treatment of life-threatening conditions before completion of initial assessment Timing of intubation

Table 4. A selection of successfully trialed military trauma scenarios

	Scenario	Mechanism	Injury	Specific Skills and Objectives
Battle	Blast	Car Bomb	Loss of consciousness Respiratory distress	Cervical spine protection Airway control
	GSW	GSW leg trapped by debris	# femur Hypovolaemic shock	Splint Haemorrhage control Volume resuscitation
	Fragmentation	Mortar attack	Multiple fragment injuries Respiratory distress Tension pneumothorax Hypovolaemic shock	Needle thoracocentesis Chest drainage Diagnostic peritoneal lavage
	CBR	Terrorist bomb	Nerve agent poisoning	Atropine and oxime therapy
Non-Battle	Medical	Collapse	Myocardial infarction	CPR Defibrillation
	Heat	Strenuous activity	Hyperthermia Hypovolaemic shock Compartment syndrome	Monitor temperature Volume resuscitation Cooling
	Envenomation	Snake bite	Respiratory distress	Pressure bandage/immobilisation Identification of snake Antivenom
	Diving	Emergency ascent from depth	Confusion Hypotensive shock	Positioning and preparation for transfer to decompression facility
	MVA	Pedestrian hit by vehicle	Head injury Spinal cord injury Hypovolaemic shock	Cervical & lumbar spine protection Volume resuscitation Nasogastric tube Urinary catheter

deployment overseas as well as the basic training of new teams and continuation training of experienced ones.

The process of training using the simulator is straightforward. Members usually train for a day or so in the unit environment, refreshing both individual and team skills prior to spending their time at the simulator.

It is then usual for two teams from a unit to attend, alternating as either active participants or observers in a variety of resuscitation scenarios, usually numbering between four and six, during the course of a day.

The process of simulator training involves six stages –

- a. orientation; objectives for training are set along with an introduction to the Centre
- b. familiarisation; the students are introduced to the simulation manikin, learn about its characteristics and are given the opportunity to practise appropriate skills such as intubation and cannulation prior to a full scenario-based simulation. (This is an important step in diffusing anxiety and recognising the strengths and limitations of the simulation environment).
- c. simulation; over a 20 minute period full scenario-based simulation occurs without interruption. The simulation is recorded on video and also broadcast in an adjacent viewing room where other members of the unit watch the resuscitation and prepare to participate in the debriefing.
- d. debriefing; this takes about 30 minutes and is a peer discussion process facilitated by the senior medical officer of the unit concerned and an instructor from the Simulation Centre. During the debriefing, the video is used as a framework for discussion. (All participants and observers get an opportunity to discuss a range of clinical and human factor issues). (Figure.2)



Fig 2. Debriefing session using the video recording. Note the overlay of vital signs on the screen.

- e. conclusion; the process of reviewing the day's events including a summary of lessons learned during the day.
- f. feedback; all participants are asked to fill out an anonymous course appraisal questionnaire.

## Discussion

The use of simulation as an aid to training is not new. For centuries, military forces have used drill and exercises to prepare both individual soldiers and units for war (3). Battlefield simulation is now an accepted form of military training, and many areas including aviation and armoured warfare employ simulator systems to improve the scope and range of training opportunities.

Large scale simulation training expanded during World War II when a lack of flying resources combined with a pressing need to produce trained pilots led to flight training being completed on ground trainers. Advances in technology during the ensuing years have seen the development of simulation capable of advanced skills training and emergency procedure practice.

The aviation industry continued with its interest in simulation work and expanded the scope to include whole crews rather than individual pilot training. It had become apparent after analysis of critical incident reports and accident investigations that mistakes occurred in spite of the high levels of individual training. Resources were often available which could have prevented the crises from developing and better teamwork might have averted the disasters. Work in medical fields has confirmed that the making of errors is a universal phenomenon across all levels of training although experience helps to prevent, reduce and rectify them (3,4,5).

This crisis resource management model of aviation simulation has been readily adapted into the field of anaesthesia (7). The same basic properties of crisis such as uncertainty, risk, rapid change and complexity are as apparent in anaesthesia as they are in aviation. The similarity of crisis exists within military trauma resuscitation and the benefits for simulated practice are quite apparent. Other high risk domains – space flight, ship handling, fire fighting, nuclear power – have accepted that simulation training has intrinsic value by both saving time and money and providing a safe opportunity for learning.

Learning takes place at a number of levels. At the simplest, it requires the acquisition and comprehension of new knowledge and associated skills (declarative knowledge). At more advanced levels the correct application of such knowledge is developed (procedural knowledge) along with an ability to utilise it to problem solve (experience). The highest levels involve the use of experience both successful and unsuccessful to provide potential solutions to new problems whilst performing in unfamiliar environments or distracting circumstances.

Simulation training helps in the learning process. It enhances the acquisition of knowledge and skills and by providing a

realistic environment for training it facilitates learning by setting it in a relevant clinical context (experiential learning) (6,8,9). By basing it in a Centre, expert opinions and advice can be readily available for training sessions so enabling the reinforcement of key points and the clarification of uncertain ones during the simulation process. Rather than using whatever becomes available in “real life”, simulation training can be planned in advance to include rare or difficult events (10). It has been shown that in anaesthesia some trainees have preferred training in the simulator to training in the operating or emergency room for these reasons (11).



Fig 3. The resuscitation team in action. A sense of realism is rapidly attained.

Simulation training for resuscitation teams works in two ways. Individuals are able to obtain new knowledge and can experiment with “cause-and-effect” relationships observing realistic responses to treatments given or interventions performed. (Figure. 3). They can learn how to use new equipment or protocols and they can do so in stages or at their own pace. Team training is especially suited to the use of video debriefing. Resuscitation is a crisis event and memory of such events is often inaccurate (12). Individual members of a team often perform in relative isolation and a video recording of the scenario provides an opportunity for all to observe their own work and that of others. Human factors become apparent during video debriefing. Team function is a combination of individual and team skills (Figure 4). Leadership, communication, situational awareness and resource utilisation are often issues that are not readily brought to mind when assessing performance, but aviation work showed how deficiencies in these areas could diminish team effectiveness. Observers can view the video recording and can assess clinical and behavioural skills, although it maybe difficult to accurately correlate the performance in the simulator with that in ‘real-life’ (13,14).

Experience with significant numbers of military teams being trained through the simulation centre has shown that time spent in the simulator is perceived as excellent training. In general, advanced patient

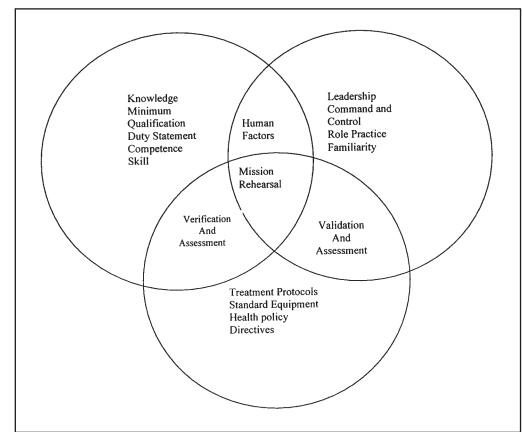


Fig 4. A Venn diagram showing the overlapping training uses of simulation where the focus is on realistic mission rehearsal.

simulator training is highly rated, as is the teaching style, particularly in the use of video debriefing (15,16). The simulated environment is felt to be challenging, realistic and practical and is beneficial with respect to aspects of teamwork in a way rarely seen in the peacetime environment. The environment is felt to be stressful because of the video scrutiny and personal performance by many is felt to be sub-optimal presumably because of this factor. Others, however, felt that performance was enhanced by the extra anxiety.

Some aspects of the simulation training were felt to lack realism. The manikin, although advanced, is unable to model some physiological signs such as sweating, colour and temperature change and the participants report that these extra signs would be useful for fine-tuning performance. The whole experience is theatrical and a degree of “belief” is required to maximally utilise this training resource but most teams seemed to be able to take this step. Advanced high-fidelity simulation is an expensive adjunct to training. Unfortunately it is relatively Centre-dependent although efforts are being made to improve the ability to make it more portable and therefore allow other teaching establishments the opportunity to utilise its training potential.

## Conclusion

High quality, prompt resuscitation can reduce the mortality and morbidity of battlefield casualties (17). Severely injured but salvageable casualties make up approximately 15% of the total casualty figures and the percentage of casualties who would succumb to either an ‘early death’ (hours) or a ‘late death’ (days) could be reduced if resuscitation were to be performed well (18).

Simulator training is an ideal environment for mission rehearsal as pre-training has been shown to improve subsequent performance (19,20,21). It is important to provide resuscitation teams on operational deployments who are as well trained as they

can possibly be as there is no place for 'on the job training'. The so-called 'learning curve' can only exist at some poor unfortunate's expense.

Experience with military trauma simulation at the Sydney Medical Simulation Centre has confirmed its role as an invaluable tool in the preparation of ADF resuscitation teams for operational deployment.

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