J R Army Med Corps 2006; **152:** 132-135

Medium-Fidelity Medical Simulators: Use in a Pre-Hospital, Operational, Military Environment

Morrison JJ, Forbes K, Woolrich-Burt L, Russell R, Mahoney PF.

Capt JJ Morrison RAMC (V), E Squadron, 205 (Scottish) Field Hospital (V), Claverhouse Training Centre, 8 Granton Square, Edinburgh, EH5 1HA
Tel: 0131 552 2392
Fax: 0131 552 2397
E-mail: jonny_morrison@doctors.org.uk
currently

Registrar Gen Surg, Dept Gen Surg, Waikato Hospital, Hamilton, New Zealand
Tel: 646 7 839 8899
Fax: 646 7 858 0941

Capt K Forbes QARANC (V), A Squadron, 205 (Scottish) Field Hospital (V), Gordon Barracks, Bridge of Don, Aberdeen, Aberdeenshire, AB23 8DB

Lt Col L Woolrich-Burt RAMC, Consultant in Emergency Medicine, Dept Accident & Emergency, University Hospitals Coventry and Warwickshire NHS Trust, Walsgrave Hospital, Clifford Bridge Road, Walsgrave, Coventry, CV2 2DX

Lt Col R Russell RAMC, Senior Lecturer Emergency Medicine ADMEM RCDM Institute of Research and Development, University of Birmingham Research Park, Vincent Drive, Edgebaston Birmingham, B15 2SQ

Lt Col PF Mahoney RAMC, Senior Lecturer Military Critical Care ADMEM RCDM & SO1 Clinical Adviser 2 Med Bde.

ABSTRACT

On Operation Telic 6, the UK Med Group consisting of 3 Close Support Medical Regiment and 205 Field Hospital (Volunteers) deployed to provide medical support to coalition forces in Iraq. Personnel were drawn from Regular and Territorial Units, plus additional medical support from Armies of the Czech Republic and Denmark. The efficient delivery of operational emergency medical care hinged upon the successful integration of personnel from these units. We report on the use of a medium-fidelity simulator, in a pre-hospital and hospital environment over a three month period on an operational tour. In conducting 42 exercises (12 of which commenced in a pre-hospital environment), we have demonstrated the feasibility of the system in rehearsing the management of the major trauma patient. This training was used to enhance teamwork, identify system deficiencies and practise solutions in a safe environment. This paper discusses our experiences in relation to the current literature on this expanding area of trauma training.

Introduction

In May 2005, 3 Close Support UK Medical Group deployed to Iraq in support of Operation Telic 6. The Group consisted of a Regular Army unit, 12 Squadron, providing pre-hospital care and a Territorial Army unit, 205 Hospital Squadron manning a Field Hospital. In addition, the Danish Army provided a "Viper" pre-hospital unit and the Czech Army a General Surgical team.

In the Emergency Department (ED), most personnel had never worked together other than during pre-deployment training. They had previously been exposed to different working practices and guidelines and many were unfamiliar with ballistic injuries. Within the Field Hospital, there was a medium-fidelity medical simulator "Sim-Man" (Laerdal, Stavanger, Norway: cost of manikin, compressor and peripherals £27,965 (1)) which has an interactive airway, chest movements and palpable pulses driven by a pneumatic system (2). Compressed air is provided by a compressor requiring mains power and the system is controlled through a laptop.

For the period of August to November, it was used as a trauma simulator to enhance teamwork and test medical systems. The simulations rehearsed the management of the major trauma patient from a pre-hospital setting through to the resuscitation room. This programme built on simulation training delivered at Army Medical Service Training Centre (AMSTC), Strensall during pre-deployment training.

The training programme

Initially, Sim-Man was used in ED based scenarios to familiarize staff with the draft "Clinical Guidelines on Operations" (CGOs) (3). This was part of the evaluation and consultation process for the draft document, which provides a specific format for the running of a resuscitation room. When possible, a scenario was commenced by broadcasting an "Exercise Trauma Call" page to the relevant clinicians. The simulation scenarios enabled the team-leader to practise an initial briefing where specific roles were allocated to team members and any clinical information concerning the anticipated casualty (or casualties) was disseminated.

The Sim-Man would then be brought into the ED by the medical team responsible for pre-hospital care. This team could consist solely of combat medical technicians (CMT, essentially battlefield paramedics) or a mixture of CMTs, nurses and doctors. For this article, they are referred to collectively as the Pre-Hospital Medical Team (PHMT). The PHMT would handover to the Team Leader using a prescribed format under the headings mechanism, injury, signs and symptoms and treatments, (MIST format). The primary survey was then undertaken so that medical, nursing and paramedical staff could familiarize themselves with everything from team positions through to the location of equipment in the resuscitation bay. Any interventions performed were conducted as close to real time as possible. Appropriate radiographs and laboratory results were provided to enhance realism. At the end of the simulation, the participating team was immediately debriefed by the directing Consultant in Emergency Medicine. After 3 weeks, the program was expanded to include a more extensive pre-hospital phase,

Figure 1 A typical start position for a pre-hospital exercise. Sim-Man is located in the vehicle with the portability kit and laptop in the foreground.

conducted in an area adjacent to the field hospital.

A typical exercise would consist of briefing the appropriate personnel followed by placing Sim-Man at his start location (such as trapped in a car, see figure 1). The PHMT would then be alerted to the location, deploying their assets appropriately. To enhance realism, pyrotechnics would often be employed to simulate a tactical environment, similar to the Care Under Fire and Tactical Field Care scenarios of Battlefield Advanced Trauma Life Support (BATLS) 2005 (4). The casualty would be extricated, often with the use of cutting equipment, and the resuscitation commenced as per BATLS protocols (4). The casualty would then be transported to the ED where the resuscitation would continue involving ED, radiology, surgical and laboratory staff. All personnel (including the Prehospital team) would be debriefed.

Training Programme Outcome

The ED alternated around three nursing teams, which when joined by medical and radiology staff, constituted the trauma team. This "unit" was rotated through the training programme when clinical duties permitted. A number of procedural issues were highlighted during the simulations. Solutions could be tested by further simulations before being adopted as departmental policy. For example, weapons were not allowed in the hospital, yet members of the PHMT needed to accompany their patients into the ED. A procedure was developed to enable rapid disarmament without delaying patient handover.

Several specific issues were also addressed. One issue was the practicality of transferring a casualty from a stretcher onto the ED trolley. Sim-Man provided a helpful training platform to rehearse this seemingly straightforward movement in a simulated emergency. Removal of Combat Body Armour (CBA) in battlefield casualties has been described previously (5), "Enhanced Combat Body Armour" (E-CBA) posed additional challenges in maintaining cervical spine protection during removal. The Sim-Man mannequin allowed various removal and cutting techniques to be explored. These guidelines have subsequently been incorporated into CGOs (3).

The exercises also provided opportunities to "pause" activity and refine clinical performance. This lead to the rehearsal of various set-piece procedures such as rapid sequence induction of anaesthesia and log rolls off spinal boards. Overall, it was apparent that the exercises provided an educational and enjoyable way to increase individual and team confidence.

Discussion

Simulation has become a prominent feature of medical training in the course of the past few decades. The idea was initially derived from aviation, where flight simulators have been used for many years to train novice pilots in the basic principles but also experienced crews in managing rare but critical incidents (6). Within the area of medical simulation, 'fidelity' refers to the level of realism achieved by the system (7). This can be considered in two categories: physical and psychological fidelity.

'Physical fidelity'

'Physical fidelity' refers to the level of complexity of the hardware and software driving the simulator. A medium-fidelity simulator offers a system with a human-sized mannequin capable of replicating a range of physiological and pathological signs (e.g. blood pressure and pulse oximetry). It also permits a number of realistic interventions (e.g intravenous access, endotracheal intubation, cricothyroidotomy and chest drainage). The computer "driving" the simulation provides an interface allowing the instructor either to program trends into the simulator or to effect minute to minute parameter changes. The computer itself cannot model clinical situations making the system reliant on the instructor understanding the clinical aspects of the scenario.

A high-fidelity system simulator (e.g. Medical Education Technology Inc., Human Patient Simulator, Florida, USA, cost of simulator £125,287.36 (8)) offers an additional level of hardware sophistication. For example, it incorporates realistic airway pressures and respiratory gas concentrations; however, these generally require more maintenance and permanent facilities (9). These types of systems are valuable when rapidly changing physiology (e.g. in anaesthesia and critical care simulations) needs to be modeled. The software uses mathematical algorithms to model cardiovascular and respiratory function. These are able to change in response to either a default pre-programmed deterioration or an intervention instituted by the trainee "sensed" by the mannequin. Following the initial set-up, these systems are designed to be "self-sufficient" once the scenario has commenced.

'Psychological-fidelity'

'Psychological-fidelity' refers to the level of learning actually attained by the trainee undergoing the simulated scenario. High-fidelity simulation is not always necessary when training cognitive tasks and procedures (10). For example, a trainee learning the sequence of steps in central line insertion does not require a speaking mannequin with light-reactive pupils. Such systems are best utilized for higher level trainees who benefit from more complex scenarios, rather than training novices. Morgan *et al* (11) could not demonstrate a difference in undergraduate basic anaesthetic skill level when comparing simulator-taught students to those who had watched a video. This is in contrast to advanced post-graduate level anaesthesia where simulation is used extensively to train doctors in airway skills, anaesthetic delivery and as a general assessment tool.

Additionally, simulation can improve performance (12, 13). Recently, with the increased accessibility and availability of whole patient simulators, training programs begun to involve complete multidisciplinary teams. Trauma training is a specific example (14) where training can help integrate departmental functioning by enhancing team working (15, 16). This is a feature that military training has explored (17). A number of armed forces use simulation as an adjunct to pre-deployment or peace-time training. It offers a safe environment in which to rehearse and assess responses to a variety of military medical challenges (18, 19, 20). All reports have involved high-fidelity simulators in a fixed environment. Leadership, communication, situational awareness and resource utilization were considered to have improved through the use of simulation.

Within current literature, there has been limited reporting of the use of medium fidelity human patient simulators in a pre-hospital training environment. This has probably been due to the previous lack of portable systems and concern about exposing expensive equipment to the elements. Pre-hospital training has mainly concentrated on didactic programmes and tutorials for providers (21, 22). Depending on country and the aims of the program, it may incorporate some field skills (23).

While simulation-based training shows good promise (24), it is unclear precisely what type of programme and frequency of exposure will yield best results. High value training in the ED requires realistic scenarios supported by suitable material (such as radiographs and laboratory results). Realism hinges on instructors being sufficiently 'clinically aware' and adequately trained in the use of the simulator. Participants also have to be aware of system capacity and limitations. For example, the left arm of the Sim-Man deployed at the Field Hospital should not be cannulated as there is a speaker in the antecubital fossa. Poorly briefed or inadequately supervised participants may attempt canulation potentially causing costly damage.

Conclusion

In multinational military operations, medical personnel can be derived from many diverse units and countries. Simulation provides a way of team building, identifying system deficiencies and testing new ideas. Our experience demonstrates a use of simulation in an operational Field Hospital. Specifically, further study is indicated to assess more fully the impact of this training platform on clinical outcome.

Acknowledgements

The authors thank Surg Lt Cdr Hayton (RN) and L/Cpl Steadman (RAMC (V)) for their help and expertise with the Sim-Man training program.

References

1 http://www.laerdal.co.uk/, accessed 26/03/06.
2 Grenvik A, Schaefer J. From Resusci-Anne to Sim-Man: The evolution of simulators in medicine. *Crit Care Med* 2004;**32**(suppl 2):S56-S57.
3 JWP 4-03.1 Clinical Guidelines for Operations (2005) DRAFT DOCUMENT.
4 BATLS 2005. JSP 570
5 Ryan JM, Ballie R, Diak G *et al.* Safe removal of Combat Body Armour Lightweight following battlefield wounding – a timely reminder. *J R Med Corps* 1994;**140**:26-28.
6 Helmreich RL. Managing human error in aviation. *Sci Am* 1997;**267**:62-67.
7 Maran NJ, Glavin RJ. Low- to high-fidelity simulation – a continuum of medical education? *Medical Education* 2003;**37**(suppl. 1):22-28.
8 Medical Education Technologies, Incorporated. Personal correspondence. 19/04/06
9 Boffard KD, Tai NRM. Training to manage ballistic trauma. In: Mahoney PF, Ryan JM, Brooks AJ, Schwab CW, eds. *Ballistic trauma*. London: Springer 2005:486-513.
10 Patrick J. Training: research and practice, London, UK: Academic Press; 1992.
11 Morgan P, Cleave-Hogg D, McIlroy J *et al.* Simulation technology: a comparison of experimental and visual learning for undergraduate medical students. *Anesthesiology* 2002;**96**:10-16.
12 Weller JM, Bloch M, Young S *et al.* Evaluation of high fidelity patient simulator in assessment of performance of anaesthetists. *B J Anaes* 2003;**90**:43-47.
13 Chopra V, Gesink BJ, De Jong J *et al.* Does training on an anaesthesia simulator lead to improvement in performance? *B J Anaes* 1994;**73**:293-297.
14 Lee SK, Pardo M, Gaba D *et al.* Trauma assessment

training with a patient simulator: A prospective, randomized study. *J Trauma* 2003;**55**:651-657.
15 Shapiro MJ, Morey JC, Small SD *et al*. Simulation based teamwork training for emergency department staff: does it improve clinical team performance when added to an existing didactic teamwork curriculum? *Qual Saf Health Care* 2004;**13**:417-421.
16 Small SD, Wuerz RC, Simon R *et al*. Demonstration of high-fidelity simulation team training for emergency medicine. *Acad Emerg Med* 1999;**6**:312-323.
17 Leitch RA, Moses GR, Magee H. Simulation and the future of military medicine. *Mil Med* 2002;**167**: 350-354.
18 Hendrickse AD, Ellis AM, Morris RW. Use of simulation technology in Australian Defence Force resuscitation training. *J R Army Med Corps* 2001; **147**:173-178.
19 Holcomb JB, Dumire RD, Crommett JW *et al*. Evaluation of trauma team performance using an advanced human patient simulator for resuscitation training. *J Trauma* 2002;**52**:1078-1086.
20 Bruce S, Bridges EJ, Holcomb JB. Preparing to respond: Joint Trauma Training Center and USAF Nursing Warskills Simulation Laboratory. Crit *Care Nurs Clin N Am* 2003;**15**:149-162.
21 Johnson DR, Macias D, Dunlap A *et al*. A new approach to teaching pre-hospital trauma care to paramedic students. *Ann Emerg Med* 1999;**33**:51-55.
22 Tiska MA, Adu-Ampofo M, Boakye G *et al*. A model of prehospital trauma training for lay persons devised in Africa. *Emerg Med J* 2004;**21**:237-239.
23 Cowan ML, Cloutier MG. Medical simulation for disaster casualty management training. *J Trauma* 1988; **28**(suppl. 1):178-182.
24 Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. *Med Education* 2004;**38**:32-38.