Part Two: Medical Simulation

"See one, do one, teach one... just not on my Mom"

How to build a successful and long-lasting program.

P.G. Brindley MD FRCPC,[1,2,3] G. I. Suen MD FRCPC,[2] J. Drummond RRT,[2]

Introduction

1. Regional Simulation Program, Capital Health, Edmonton
2. Division of Critical Care Medicine, University of Alberta, Edmonton.
3. Canadian Resuscitation Institute

Correspondence to:
Peter G. Brindley MD FRCPC
Assistant Professor, University of Alberta
Program Director Critical Care Medicine
Attending Physician, Critical Care Medicine
Medical Lead for Patient Simulation, Capital Health
Vice-President Canadian Resuscitation Institute
4H1.22 University of Alberta Hospital,
8840-112th St, Edmonton Alberta
Email peterbrindley@cha.ab.ca
Tel 780-407-8822
Fax 780-407-6018

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Background: This manuscript is part-two of a three-part series on Medical Simulation. Part-one addressed the "why" of Simulation, namely, why Medical Simulation offers novel opportunities to improve education, continuing-competency, and patient safety. Part-two focuses on the "how" of simulation, namely, how to design, implement, and maintain a viable program. Part-three will cover the "what", namely what the future directions are likely to be, what sort of programs are currently available, and what evidence supports their implementation.

Definitions: Our definition of "Medical Simulation" means any technique, "low-tech" or "high tech", that attempts to realistically recreate clinical situations and allow training with minimum patient risk. In this way it resembles the "war-games" of the military or "flight simulators" of aviation. Medical training has always involved graduated acceptance of decision-making and supervised practice. Equally, examinations have long included actors. As such, medical training has always incorporated a degree of simulation of real practice. What has changed is the explosion of available technology; the principles of adult education, the focus on patient safety, and the expectation of proof via research. Simulation is therefore a huge topic. We hope to offer a concise introduction.

Simulation Versus Simulators

It must be emphasized that the Simulator (i.e. the task-trainer, computer or mannequin) is only a small part of the Simulation (i.e. the full experience of immersion in a simulated environment). In other words, optimal simulation represents a technique, not a technology. Simulation requires a realistic setting (the area used to represent the clinical environment); candidates willing to suspend disbelief (see below); able facilitators (actors realistically portraying Doctors, Nurses, Respiratory Therapists and others) and skilled debriefers (experts in the clinical content; experts in principles of Crisis Resource Management (CRM); and experts in giving feedback.) In short, it is easy to understand the rationale for simulation. It is also comparatively easy to secure one time funding to purchase a simulator or even to build a centre. However, it is much harder to deliver and maintain effective Medical Simulation programs. Millions of dollars have been wasted assuming otherwise.

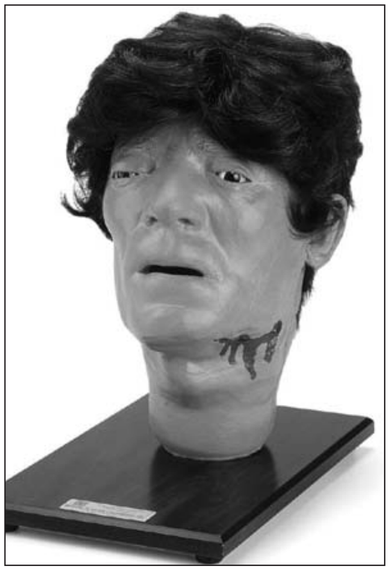
Hospitals and educators-alike must determine if they truly are committed to providing adequate long-term funds and resources and to listening to what learners want, and educators need. Otherwise programs traditionally last less than a year, or as long as people are prepared to give up their time without recognition or recompense. Good-will and enthusiasm are not simply enough. Instead of establishing and maintaining your own program, the option also exists to avoid capital and maintenance costs and instead contract out to recognized experts and regional simulation centres. For example, simple economics suggest that fifty thousand dollars (the cost of an average high-fidelity simulator) can either be invested in capital purchase or to paying others to provide numerous hours of education. With the first option no simulation has actually been delivered, in the second logistics are minimized.

Planning for Long Term Success

Numerous "champions" are also essential: whether as clinical experts; renowned teachers; enthusiastic administrators eager to innovate; or those passionate about Patient Safety. Simulation is potentially a large enough portfolio that it should not always be an additional task from an already busy clinician, educator or administrator. Again, without these insights, experience suggests that programs typically last about a year. Furthermore, lessons have been learnt by each centre that has started a program, and considerable expertise now exists in terms of matching the educational goal with the right simulation strategy. For example, initially, many programs wish to use a single simulator to teach all things. Unfortunately this prematurely wears-out the mannequin, and if the simulator is not the ideal platform it can actually distract from the educational goal. Without seeking the insights of others there is ever likelihood that the same mistakes will be repeated.

Wide-ranging support is also essential. For example, Simulation is not just relevant for those interested in education- you should also target those concerned with safety, staff-retention, rural-outreach, even research. The wider the interest group is, the greater the opportunities for collaboration and shared funding. Equally, it is very easy to unintentionally give the impression that those who teach traditionally, or were not trained using Simulation, that they are somehow out-of-date. Not only is that specious, it is also disastrous for your Simulation Program. Only following the above caveats is it appropriate to discuss the Simulators themselves.

Classification of Simulators: 1. Task trainers 2. Computer based systems 3. Full Mission Simulators



Example of a Task Trainer: Mr. Hurt Head Trauma Trainer™ www.laerdal.ca

Task Trainers

Task trainers reproduce only one aspect of the required skill.[1] By breaking down a larger task into its component subtasks, students learn even complex skills in a controlled and timely fashion.[2] Task trainers are commonly used to teach procedural skills such as central venous cannulation, endotracheal intubation, and aspiration of joints.[3] Beaubien and Baker suggest using "task trainers to train teamwork related skills to the point of over-learning."[2] Task trainers tend to be much less time-consuming than full mission simulators, thus allowing learners to repetitively practice certain skills until mastery occurs.[4] They are also less-expensive which permits purchase of multiple units,.The relative lack of mechanical parts means they typically require less maintenance, and are more robust and portable. This allows task trainers to be lent-out easier or be taken directly to the learner. Learners can often use these task trainers in a semi-independent fashion. This means trainees can learn at their own pace, and busy facilitators do not always need to be present.

Task trainers with haptic (touch) feedback are increasingly being used to teach procedural skills.[3,4] These systems "create the illusion that the operator is coming into physical contact with the model". For example, a colonoscopy simulator with haptic feedback actually provides the student with varying degrees of resistance while the endoscope is navigated through the colon depending on the simulated patient's anatomy. For example, when learning the lumbar puncture, a haptic system can simulate the "pop" that indicates successfully locating the spinal space.[3]

Computer Based Systems

Computer based systems focus more on individual decision-making and judgment as compared to the manual dexterity aspects of a task trainer. They typically involve watching a television screen, and as such, there is typically little need to simulate the whole clinical environment.[4] Psychologically, however, they can be useful if the scenarios are engaging. Multiple examples of web-based resuscitation scenarios exist and typically involve resuscitating a patient by applying principles taught in an advanced life support course.[5] Learners are given a variety of choices and are scored on appropriateness and speed of response. However, working alone, being seated behind a computer terminal, and merely clicking on a computer button which states, for example, "intubate patient" is far different than performing for real. However, computer based systems can be a cost-effective way to provide simulation to large groups. They can promote clinical judgment, and can address preliminary Crisis Resource Management (CRM) proficiencies such as the need for situational awareness and pre-emptive treatment. However, they really do not address CRM proficiencies such as communication or teamwork. As computer technology advances, this type of Simulation may become even more useful and more portable. For example, Issenberg et al. described the introduction of virtual reality (VR) simulators such as the "PreOp endoscopic simulator". This VR simulator combines a haptic feedback device with real-time 3D graphics on a personal computer.[3]

Example of a Computer-Based Simulator with Tactile (Haptic) Feedback: Xitact ITP — Instrument Tracking Port™ www.xitact.com

Full Mission Simulators

Full-mission simulators aim to achieve an immersive experience for the learner by ensuring that equipment, environmental, and psychological realism are maximized. The classic example is the multi-million dollar flight simulators used to train pilots[2] where cockpits are almost indistinguishable from reality and hydraulic machines simulate the physical characteristics of flight. Teamwork and CRM skills can be practiced in a fashion that is not feasible with task trainers or computer-based systems. Beaubin and Baker therefore recommend using full mission simulators to "hone teamwork related skills under conditions of ambiguity, time pressure, and stress".[2] The obvious use of full mission simulators in health care is to simulate the full resuscitation of critically ill patients, and to highlight CRM.

"Perfect is often the enemy of good"

The primary disadvantages of full mission simulators are their higher costs and lower portability. The more sophisticated the simulator, the easier they can malfunction, the greater the reluctance to allow them to leave the Simulation Centre, and the greater the need for dedicated facilities and trained personnel.[6] As such, expertise is needed to determine which platform offers the most blend of realism, portability and practicality, and cost-effectiveness. As such, Simulation Experts can be indispensable.

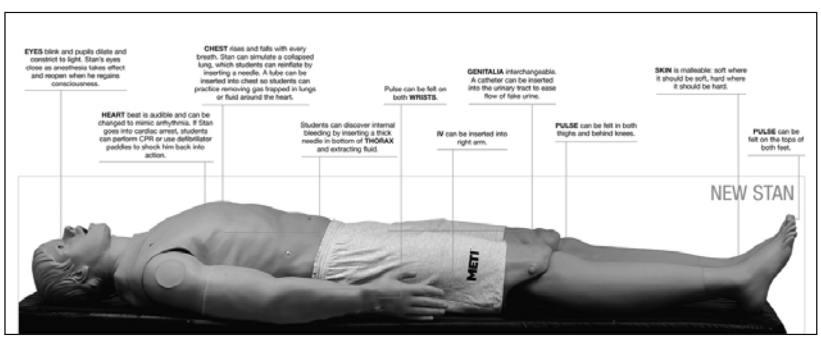
A full-body, high-fidelity simulator might be wasted on students who are learning routine tasks e.g. arterial line insertion. In contrast, healthcare workers may wish a highly realistic setting incorporating the latest simulator technology to learn how to function in an evolving crisis.[2] Full-mission medical simulators, such as the Laerdal SimMan® and METI ECS® offer the advantages of increased anatomic and physiologic reality with the ability to be packaged in a crate. As such, these two models are the most common for teaching acute care resuscitation.

Portability is extremely important. For example, whenever possible the simulator should be taken to the learner rather than expecting learners to come to a central teaching site. With busy schedules it is often impractical to expect healthcare workers to travel across town, let alone devote several days and invest the cost of travel and hotels. With this in mind the classrooms of the future should be flexible enough to be simulation-compatible. Furthermore, portable simulators, appropriately, dominate the market even if this means occasionally sacrificing realism.

Simulation Fidelity

Fidelity refers to "the degree to which the simulator replicates reality".[2] Studies have shown that with higher fidelity simulators are associated with higher percentages of students having a favorable response to the simulation experience.[7] Many trainees' first impressions and willingness to undergo Simulation training depend upon how realistic the simulator looks as compared with a real patient.

Other tools in the room such as a laryngoscope or realistically packaged medications also help to ensure a high-fidelity situation. These types of considerations are known as equipment fidelity.[2] Environmental fidelity is also an important consideration as simulations performed in a classroom may be quite different when performed in the middle of a busy emergency department trauma bay, or the tight confines of a patient room. In fact, this is one way in which "dry-runs" using simulators can actually help with the design of optimal medical treatment areas. It is also how Simulators can be used to train healthcare workers to deliver care in suboptimal environments. It is, again, why simulators should ideally be portable enough to be taken to the same area where the trainees will ultimately deliver care.



Example of a Full Mission Simulator: the METI Human Patient Simulator™ www.meti.com

Interestingly, however, the most important type of fidelity may be psychological fidelity.[4] Students must "temporarily suspend disbelief and interact much as they would in the real world".[2,4] Without psychological fidelity, equipment and environmental fidelity appear to be of limited utility. Again, it argues that simulation experts can offer unique insights.

Program Development

Several examples of successful simulation programs will be outlined in part-three of this series. However, in the most comprehensive systemic review to date of this topic, Issenberg *et al.* reviewed 670 articles found ten key features of high fidelity simulations associated with effective learning. These were 1. providing feedback, 2. repetitive practice, 3. curriculum integration, 4. range of difficulty level, 5. multiple learning strategies, 6. capturing clinical variation, 7. a controlled environment, 8. individualized learning, 9. defined outcomes, and 10. simulator validity.[3] In-depth discussion of each factor is beyond the scope of this paper, but their work clearly illustrates the presence of a large body of literature devoted to the theoretical principles and features of successful simulation. Those committed to simulation delivery need to follow this literature.

Instructors can be responsible for keeping lists of clinical events which can include "high-risk situations", "near misses" and "unfortunate outcomes". Educational experts and clinical content experts can readily turn these into simulation scenarios. However, it should be emphasized that education should also be about practicing when things go right. Good outcomes are, after all, our ultimate clinical goal. This approach also helps decrease the common misconception that Simulation is merely punitive.[8]

Summary

Initial purchase of a simulator is a minor part of establishing a simulation program. Viable programs require widespread support, ongoing funding, and champions in the clinical, educational and administrative sphere. Simulators are typically divided into task-trainers, computer-based systems, and full mission simulators. An appreciation of simulator fidelity includes not only assessing which simulator is most appropriate, but how to arrange the environment, and encourage the participants. Unfortunately, failure to recognize these many factors has been both widespread and costly. This manuscript is intended to offer constructive solutions and to promote the effectiveness and longevity of Medical Simulation programs.

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Example of a Full Mission Simulator: The Laderal SimMan™ www.laerdal.com

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