

An introduction to medical simulation

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ABSTRACT

توفر المحاكاة الطبية استراتيجيات متعددة للتدريب الطبي الشامل، وذلك لتحسين سلامة المرضى ولتحسين توظيف العاملين والمحافظة عليهم. والمحاكاة الطبية هي تقنية تحفز التعليم التجريبي، وإستراتيجية أساسية لتعليم مهارات تدريب الأزمات. يمكن للمحاكاة أن تفيد المتدرب الواحد، الفريق المتدرب والمستشفى بأكملها. وتعتبر المحاكاة عنصراً أساسياً في سلامة المرضى لدرجة أنها وصفت بمختبر سلامة المرضى المستقبلي. ولا عجب في ذلك، حيث اعتمدها جمعيات مهنية عديدة في عدد من الدول. وعلى الرغم من وجود بعض التحديات فإن المحاكاة تمنح الكثير من الفرص للعاملين السريريين والإداريين والمتدربين على حد سواء.

While medical simulation is no panacea, it offers numerous potential strategies for comprehensive and practical training, safer patient care, and for those keen to attract and retain staff. It is a technique, rather than just a technology that promotes experiential and reflective learning. It is also a key strategy to teach Crisis Resource Management skills. Simulation can benefit the individual learner, the multidisciplinary team, and the hospital as a whole. It has been described as a key driver of patient safety, and even as the “patient safety laboratory” of the future. As such is endorsed by many professional societies in many nations. While challenges remain (and are outlined) there are great opportunities for clinicians, administrators, and educators alike.

Saudi Med J 2009; Vol. 30 (8): 991-994

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Medical simulation encompasses any technique that realistically recreates clinical situations and maximizes experiential learning, while minimizing risk.^{1,2} Medical training has always involved graduated acceptance of decision-making and supervised-practice. As such, formalized medical simulation is not a radical departure. However, what is novel is the focus on teaching, not just factual-knowledge and procedural dexterity, but also teamwork and crisis management; the focus on patient safety; and the willingness to learn from other professions. Simulation is therefore a huge topic. The purpose of this review is merely to offer a succinct introduction.

Simulation as a strategy to offer risk-free training. Traditionally, medical competence is gained through trial-and-error, and often by junior staff caring for sick patients with minimal supervision. While this may encourage self-reliance, it also means, the potential for increased patient-risk. However, it is difficult to create and maintain “experts” unless they are given the chance to practice, the chance to make decisions, and the chance to rectify mistakes. In short, while appropriate supervision should always be available to minimize risk, there was previously little choice but to rely upon the infamous “see-one, do-one, teach-one” approach.³ Medical simulation therefore, offers unique strategies, whether for initial training and maintenance of competence, but without patient-risk (Table 1).^{3,4}

Simulation as a strategy to offer comprehensive training. Factual knowledge can be delivered in lecture halls, and at bedsides. However, knowledge retention appears to be better after simulation than following passive or didactic methods.³⁻⁵ Factual knowledge also needs to be supplemented by procedural dexterity. Strategies are limited to using real patients, or simulators that range from task trainers to full-body computer mannequins. However, healthcare workers also need appropriate judgment, behaviors, and attitudes. It is here that simulation may provide its greatest gains.³⁻⁶

Medical errors and adverse outcomes are not usually merely due to inadequate factual knowledge or poor procedural dexterity. Instead, they frequently result from inadequate communication, poor teamwork, or inexperience managing evolving crises.⁶⁻⁸ These skills,

known collectively as crisis resource management (CRM), are a key determinant of patient outcome, but before simulation they were rarely taught.^{4,5} The CRM includes strategies that include how to recognize impending crises, mobilize assistance, and act preemptively (Table 2).^{4,5} Furthermore, licensing boards, such as the Royal College of Physicians and Surgeons of Canada, have determined that graduates become not just factual experts, but also communicators, collaborators, and advocates.⁷ These goals were not well addressed by traditional didactic education, but are ideally suited to simulation.

Simulation as a strategy to offer Crisis Management Training. The CRM skills include the ability to work in multidisciplinary (often multicultural) teams, to work under stress, to make decisions with limited information, to know how to advocate for patients, to know when to delegate, and to know when (and how) to exert control. Simulators also allow us to train in the same multidisciplinary teams that deliver actual care.^{2,4,8} In contrast, lecture-based education is usually delivered separately to the different medical professions.

Studies also suggest that trainees perceive simulations to be useful, highly realistic, and that errors committed during simulations are similar to those in real practice.^{4,6} Participants also appreciate the opportunity of repeated practice and immediate feedback. Furthermore, medical simulation allows training in rare conditions that demand proficiency, but do not occur frequently enough to allow regular experience, such as difficult airways, mass casualty, even terrorist attacks, or pandemics.

Over a hundred years ago, Dr. William Osler famously stated: "He who studies medicine without books sails an uncharted sea, but he who studies medicine without patients does not go to sea at all."² In other words, health care workers cannot be created solely through books and lectures. Simulation offers a chance for a comprehensive, and reassuringly practical, education. It also offers a chance to reduce the alarming rates of medical error.⁹

Simulation as a strategy to decrease medical error. Studies report that 98,000 Americans die annually

following medical errors.⁶ Although precise numbers are debated, few deny that errors greatly affect patient outcome or contribute to sky rocketing costs. Experts highlight that most errors results from systemic causes, and rarely from lack of dedication, intelligence, or effort from healthcare workers.¹⁰ As a result, national agencies have called for "simulations of high risk health-care interventions", and examination boards are now incorporating simulation.¹⁰ Overall, simulation is becoming an expectation, not a luxury. It is also likely to become a significant draw as the best trainees and graduates look for the best (and safest) places to train and work. Early adopters have the chance to lead this field. Others may be forced to catch-up.

A major criticism of medical simulation is that it has not been shown to directly save lives. Another is its associated cost, and the current lack of high-level research. However, considerable evidence has shown its unique ability to create safer patient environments, and to address the human factors that greatly affect clinical outcomes.²⁻⁶ For example, simulation has been shown to increase adherence to clinical guidelines, decrease time to competence, enhance team performance, and increase knowledge and skill retention when compared to didactic instruction.³⁻⁷

Simulation as a strategy to design safer health care environments. Health systems are some of the most complex institutions in society. In addition, inexperience, human fallibility, and imperfect work environments mean that errors occur in all medical settings.⁶⁻⁸ However, the need to make decisions quickly, under stress, and with limited information, can compound the likelihood of error precisely where consequences are most serious. It is therefore not surprising, that a "care-gap" exists in medicine, namely the difference between what we know and what we do, or between what we ought to do and what is actually carried out. Regardless, we need practical strategies to bridge this "care-gap". Simulation demands real-time demonstration of actual healthcare delivery. In contrast, most examinations currently focus on regurgitating factual knowledge and traditional curricula do not include training in

Table 1 - Benefits of medical simulation.

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- No risk to patients.
 - Practice actual healthcare delivery.
 - Allows wide variety of scenarios including high-risk, low-frequency diseases.
 - Errors are allowed to be played out.
 - May be repeated as often as required to achieve proficiency.
 - Recording of performance allows for objective assessment, and feedback.
 - Educators can control material - rather than rely on random clinical presentations.
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Table 2 - Aspects of crisis resource management training.

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- Anticipation and planning.
 - Communication strategies.
 - Leadership and assertiveness.
 - Use of all available resources.
 - Distribution of workload.
 - Mobilization of help.
 - Frequent re-evaluation.
 - Challenge assumptions.
 - Concurrent not sequential management of multisystem illness.
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leadership, problem-solving, situational awareness, resource utilization, or communication.

Simulation and CRM are also not unique to medicine. Indeed, many CRM insights are from aviation, aerospace, and nuclear power. As in medicine, errors in these professions carry disastrous consequences. Unlike medicine, these professions readily adopted simulation, and insist on regular simulation as a function of continued employment.^{2,10} It becomes difficult to justify why our families and patients are not afforded the same concern when they enter high-risk environments, like the modern hospital. In fact, it has been argued that nowadays the most dangerous part of a pilot's day is the drive to the airport. Sadly, the same cannot be said for patients entering hospitals. This raises the issue of patient trust, and patient advocacy.

Simulation as a strategy to increase public trust and decrease malpractice claims. The public is less tolerant of care from the inexperienced or fatigued, and the tradition of extended hours to ensure clinical experience is no longer deemed acceptable. However, trainees are not eager to endure further years of training to make up for the decreased experience, and the shortage of frontline staff means that many supervisors are not eager to demand it. As such, simulation offers a way to make better use of the limited time available, especially if curricula focus on core competencies, and gaps in clinical exposure.⁴

Society also has increasing expectations from its health care workers, and is increasingly litigious following bad outcomes. Combined, these factors could further dilute experience in direct patient care, and this might further decrease the competence of the next generation. Social justice concerns also means that it is inappropriate to learn disproportionately on patients, disadvantaged by income, or illness. When there was no alternative, this was regrettable, but perhaps unavoidable. When simulators exist it becomes hard to justify.^{4,10} Notably some United States jurisdictions have even offered reduced malpractice premiums for those that take simulation courses. While nobody is lobbying

for simulation to wholly replace didactic education or actual clinical experience, it becomes increasingly clear that simulation offers an exciting tool.¹⁰ However, as with any tool, the end result is only as good as the person using it. This requires an understanding of the science of simulation, and what is required from both administration and healthcare workers to achieve a viable Simulation program (Table 3).

How to build a simulation program: first steps. It is worth emphasizing that the Simulator (namely, the task-trainer, or mannequin) is a small part of the total simulation (such as, the experience of immersion in a simulated environment). Simulation is a technique, not a technology, and not just a machine. Optimal simulation requires realistic settings (the area used to represent the clinical environment), able facilitators (for example: actors portraying doctors, nurses, and others), and skilled debriefers (experts in the clinical content, and experts in CRM). In short, it is easy to understand the rationale from simulation.^{3,4} It may also not be difficult to secure one time funding to purchase a simulator, or even build a simulation center. However, it is much harder to maintain a viable medical simulation program. Huge sums have been wasted assuming otherwise.

Hospitals should determine if they are committed to providing adequate long-term funds, and dedicated resources. Otherwise, programs traditionally last approximately one year, or as long as people give up their time without recognition, or recompense. Goodwill and enthusiasm are rarely enough. Alternatively, instead of establishing and maintaining your own program, options exist to avoid capital and maintenance costs, and instead contract out to regional centers. For example, simple economics suggest that US\$50000 (the cost of an average full-body simulator) can be used either for one-time capital purchase, or to pay others to provide many hours of education. With the first option, no simulation has actually been delivered, and in the second, logistics are minimized.

Obstacles to participation must also be appreciated. These include lack of time, and lost income. However, another significant barrier is "performance anxiety".⁹ Medical educators must therefore ensure that all participants feel safe to learn, and safe to learn from mistakes. It is also easy for simulation champions to unintentionally give the impression that those who teach traditionally, or were not trained using simulation, are somehow "out-of-date". This must be avoided, given that the goal is to engage, and excite others on the full potential of simulation.

How to build a simulation program: additional steps. Due to cost and time constraints, many hospitals only employ simulation sessions once or twice a year. However, for simulation to be accepted and lead to

Table 3 - Requirements for a successful simulation program.

From the administration

- Identification of simulation as a priority.
- Adequate and predictable funding.
- Operating budget, not just capital budget.
- Support staff.
- Long term commitment.

For the healthcare workers

- Dedicated time and repeat exposure.
 - Non-punitive environment.
 - Eagerness to learn from mistakes/others.
 - Structured debriefing.
 - Deliberate curriculum.
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systemic change, sessions should be routine.¹⁰ The more that simulation becomes integrated into everyday life in the hospital, the greater the support it is likely to garner, and the more participants will see this as a normal (non-punitive) activity.

As simulation programs mature, education becomes more deliberate. As such, rather than relying upon the randomness of whatever patients present to the hospital, simulation centers plan training experiences, and incorporate well-established principles borrowed from Process Engineering.¹ For example, it starts with identifying major problem areas (such as an audit, or needs assessment). Next input is required from all relevant experts (namely, experts in both clinical content and simulation) in order to draft a curriculum (typically using a modified-Delphi approach). The curriculum is then “alpha-tested”, and finessing based upon the lessons learnt. Following the exercise, a structured debrief should explore what went well (and what did not), as well as a determination of what ongoing simulation is required.¹ In short, medical simulation is more than just a novel educational technique. It may even offer a unique “patient-safety laboratory” for the modern hospital.¹ It is therefore understandable that medical simulation has been described as a “revolution in healthcare”.¹ Whether it will be truly realized remains to be seen.

Acknowledgment. *The authors gratefully acknowledge Dr. Rafat Taber for his review of this manuscript, and his assistance in its preparation.*

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Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.