Virtual patient simulation for prevention of medical error: beyond just technical upskilling

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Abstract

Virtual patient simulation is a well established mode of medical education for many technically oriented clinical skills. Resuscitation Annie has been used for teaching cardiopulmonary resuscitation for many years and other similar simulation has been used extensively for teaching colonoscopy, delivering babies, suturing, and a variety of surgical techniques and procedures. There are very few medical schools that would not routinely use such simulation as a standard part of their curriculum. This is not because they are cost effective (although they are) but rather because they have been shown to reduce human error in performing these clinical skills and provide a safe environment for doctors to learn such procedures without endangering real patients. Simulation has taken many forms in Medicine including: (1) Computer-based simulations; (2) Standardised patients widely used in OSCE training and examination; (3) Virtual environments; (4) mannequins such as Resuscitation Annie, and (5) so-called "high fidelity" simulations resembling as much as possible the actual clinical situations. These forms of simulation have been used to teach the important skill of clinical decision-making as well as technical procedures (Owen, 2008).

Simulation has been adopted for training in many industries where the consequences of getting it wrong expose people to unnecessary risk or the cost (in human or financial terms) of committing such error is high. Aerospace, the Military and Nuclear power plants are three such examples. Medicine also represents an industry where the financial and human cost of error is unacceptably high and where human factors are the number one cause of such error. In this article we will look at the role of using simulation ion medical education for the prevention of medical error not from the procedural or technical side, but with a focus on the human side of the equation. Errors in communication, critical assessment and clinical judgement skills are very common causes of medical error in hospitals. Like more technical procedures, these essential clinical skills can also be taught effectively using patient simulation, providing a safe environment for physicians to commit such errors and to learn from mistakes without endangering patients.

The aviation and medical professions share many similarities in terms of the complex environments in which pilots and doctors work. Both professions require high stress decision making abilities, as the wrong choice by either a pilot or doctor often leads to injury or death. In the aviation industry however human errors can cause massive losses of life, which result in widespread public attention and scrutiny, whereas medical errors result in the loss of individual life and seldom attract national publicity (Helmrich, 2000). Nevertheless, the death toll attributed to human error in the medical profession is much higher per year than in aviation. The US Institute of Medicine report in 1999 estimated that each year between 44,000 and 98,000 people die as a result of medical errors (www.iom.edu). This has been updated with a study in 2004 by Healthgrades demonstrating an average of 195,000 people in the US died due to potentially preventable, in-hospital medical errors in each of the years 2000, 2001 and 2002. This study was based on a study of 37 million patient records. These numbers represent the equivalent of 390 jumbo jets crashing per year. It is estimated that the financial costs of

these errors represented US$ 19 billion per year (www.healthgrades.com).

In contrasting the approaches in medicine and aviation, what becomes apparent is the need to discover how the aviation industry is reducing human error and the necessity of finding a means to repurpose these methods in the medical context. One of the most effective methods of training in aviation is of course simulation. But in aviation this does not merely focus on technical ability, as many may presume, but on the communication, and decision making process of pilots in the cockpit. Sophisticated simulators have been introduced to allow full crews to practice dealing with error inducing situations without jeopardizing passengers (Helmrich, 2000). Once a mock simulation has been completed, assessments can be made on individual performances to see who is making the errors and why. Team performance will also be assessed to uncover if the error could have been prevented by the intervention of a team member, and what role, if any, the team has played in precipitating the mistake. In this instance, team communications becomes central in error prevention and individual evaluations paramount in pinpointing who is making mistakes and how they can be corrected. This method can be similarly adapted in the medical context.

To date, simulation in medical education has largely centered on the technical development of doctors, rather than team dynamics and communications. Similarly simulation in medical education needs to shift the focus of training to go beyond technical skills and teach communications, leadership training and relationship building skills. Behaviours found to precipitate medical errors include:

- Communication e.g. Failure to inform team of patient's problems for example, surgeon fails to inform anesthetist of use of drug before blood pressure is seriously affected e.g. Failure to discuss alternative procedures.
- Leadership: eg Failure to establish leadership for operating room team.
- Interpersonal relations, conflict, e.g. overt hostility and frustration for example, patient deteriorates while surgeon and anesthetist are in conflict over whether to terminate surgery after pneumothorax.

This clear need to supplement medical education programmes with training in communications, leadership and team dynamics can be achieved by simulation as evidenced in the aviation industry. The subsequent paragraphs will therefore describe current cutting edge medical simulation techniques that have been developed to meet this demand.

Some platforms using simulation to teach clinical reasoning and communication in medicine

Here we will take a brief look at some different approaches to the use of simulation to teach clinical thinking, medical decision making, communication with colleagues and patients, leadership and team dynamics and interpersonal relationships in medical practice.

The Interactive Case based Online Network (ICON)

Harvard University has developed a system called the Interactive Case Based Online Network (ICON), that focuses on fostering an interdisciplinary relationship between students and faculty geared towards developing a new mindset in future physicians. The engaging nature of the patient simulated programme permits students to interact with experienced faculty, specialists from different disciplines, and other students via a virtual environment. In each ICON case, the scenario progress in real-time, much the same way that a real problem would present itself. As the patient's situation unfolds, students are responsible for the application of the science. They act in small groups of 8-10 as a multidisciplinary team would do and must decide as a group how to direct the patient's care. In doing so they need to communicate directly with the patient, request consults, and coordinate the medical team's activities. Students are able to communicate with each other and other medical consultants embodying the case characters via online learning modules, instant messaging, and electronic pagers. These communication methods facilitate both asynchronous and synchronous interactions between the students, staff and the patient. The overall product is a student-driven educational environment that simulates the decision making processes in hospitals.

Telehealth Outreach for Unified Community Health (TOUCH)

The TOUCH programme, created by the Universities of New Mexico and Hawaii, is similar to ICON because of its virtual patient centred base. However TOUCH differs slightly in its project design and objectives. TOUCH uses 3-D to create a virtual environment where the students can interact as in a hospital setting to perform procedures and to learn clinical reasoning. The TOUCH project is designed to facilitate student directed learning and connect individuals located in remote areas with up to date medical education. TOUCH uses an internet based conferencing system that supports real time, multipoint, and group communication and interaction and an environment called Flatland. Flatland is a "virtual reality application development environment" created by the University of New Mexico (http:www.ahpcc.unm.edu/ homunculus/). Unlike the ICON system, flatland combines sight and sound, and allows students to use virtual controls to interact with different learning scenarios based on various cases of disease or injury.

When combined together the AG and Flatland applications make up the TOUCH programme. In this setting students in remote areas are able to work out medical cases with specialists from Universities located at a distance, and are able to use a variety of multisensory applications to learn about drug interactions in the body, patient responses to treatment and the appropriate usage of medical testing without causing harm to a physical person.

Simulation Platform	Host	Type of Environment	URL
Interactive Case Based Online Network	Harvard University	Text based interaction with case based scenarios	http://icon.fas.harvard.edu/
TOUCH/ Flatlands	University of New Mexico/ University of Hawaii	Simulation with 3D effects and audio/video as well as multipoint conferencing	http://hsc.unm.edu/som/projects/touch/
Medical Readiness Trainer	University of Michigan	Virtual reality medical simulation environment	http://www-vrl.umich.edu/mrt
Web SP	Karolinska Institute	Case based interactive patient simulation	http://websp.lime.ki.se/
Second Life	Linden Research	Online virtual community	www.secondlife.com
Simplay	Fablusi	Online role play	www.fablusi.com

Figure 1: Simulation platforms

Web SP

The Karolinska Institute's Web SP structure differs from the other two systems in the way that it is ordered. The Web SP project is based on experiences gained from other simulation projects and is structured to create a generic platform design for web based patient cases. It provides an authoring tool to facilitate its use within faculty. The goals are: to move beyond the reliance of technology savvy instructors, to implement a rigorous evaluation protocol and to create tools that facilitate the exchange of patient cases between teachers Web SP technology facilitates these objectives by providing an easy to use Web browser functionality that is low cost and easily sustainable. They target three clinical elements in learning and training within their programme:

- testing students' existing knowledge and identify any gaps by discussing cases, and accessing online resources and texts;
- promoting higher level aspects of the thinking process requiring the students to interpret their findings, generate differential diagnoses and explain their decisions and;
- providing feedback through the process.

Second Life

Second Life is an extremely popular online 3D virtual world. A free downloadable client enables its users, called "Residents", to interact with each other through the use of avatars, providing a social network service. There have been several medical applications of this online service for education purposes including learning cardiac mummers, a virtual hospital, a virtual neurological centre, a medical library, an environment for people with disabilities, a medical imaging centre, a place to experience virtual hallucinations and the Centre for Disease Control (CDC) (cf Mesko 2007).

Fablusi/SimPlay Role Play Simulations

Fabulusi stands for "Fabulous Illusions." It is a web-based software that provides a template for designing and moderating simulations through role play used in a variety of educational situations with applications using a problem based learning approach in health e.g. managing difficult behaviours. It has an authoring tool and provides a virtual environment for role play.

Medical Readiness Trainer

This is based at the University of Michigan but is unique in that it can be used anywhere in the world regardless of internet connectivity (ie can use POTS, Internet or Internet 2), geography or language. It provides a modeling environment that can be used at any level (and independently of the native language of the trainee) to any health care provider on Earth. The process involves a fusion of remotely controlled Human Patient Simulators, semi-immersive Virtual reality, advanced agent-based computer modeling recreating physiologically and anatomically correct models of human disease.

Conclusion

Medicine must follow the example of the airline industry which has made travel safe by the use of simulation not only for teaching technical skills but also for teaching communication and critical reasoning which are main causes of error. It also must change the culture of hiding medical error and of the "blame game" so prevalent in hospitals around the world. There are many available platforms and successful early attempts at using simulation environments to teach clinical reasoning and essential clinical skills. At Griffith University we are currently developing a hybrid technique using multiple types of simulation to teach essential clinical reasoning and skills. This will include the use of an interactive online platform, a traditional eLearning platform (a modified version of Blackboard), onsite small group problem based scenarios, the used of professional actors as simulated patients, the use of mannequins for simulation, and onsite small group tutorials with and without faculty input. Our experience with simulation to date has shown it to be well accept by students and staff and we look forward to expanding its use in clinical reasoning and the prevention of medical error. ❑

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