In this article, the authors will discuss the general history of simulation-based medical education (SBME) including what simulation is, why simulation should be used and clinical simulation lab evaluation. With simulation labs emerging internationally and across multiple disciplines, the article will shed light on the positive impact of simulation in education and the high return on the investment that simulation requires to be most effective. Additionally, the article will address the question of whether or not the use of simulation as an education technique is a “passing trend”.

As early as 1910, simulation was used in aviation as a training method and skills improvement of pilots in World War I. The standard training for pilots developed simultaneously with pilot simulation training. Aviation continues to remain on the forefront of simulation use and development into the 21st century. Simulation has played a key role in the advancement of aviation training over the last hundred years.

Though aviation was on the cutting edge of simulation during WWII, troopers were also utilizing simulation for learning horse riding. Mechanical horses aided in training members of the military who had no previous experience riding horses and mechanical horses are still used in training today. The military continues to be one of the leading users of simulation for multitude of training objectives, evaluation, and improvements. Although simulation in the military involves a long history of gaming to predict outcomes and prepare for battle, contemporary military simulation includes medical training along with combat training.

A wide variety of disciplines are also utilizing simulation training. These disciplines include but are not limited to:

- Aerospace industry: a natural extension of the aviation industry, utilizing simulation in similar ways.
- Nuclear Industry: has achieved reasonably safe records over the second half of the twentieth century due to an intensive use of simulation training.
- Law Enforcement: use of simulations to prepare officers for nearly any scenario they might face on the streets.

The medical profession has been a relatively recent newcomer to the use of high-fidelity simulation. One author referred to the growth of simulation in medicine as a “prolonged gestation”. Medicine has long used low-tech mannequins for CPR training. By the end of the 20th century, hi-fidelity simulation mannequins and dedicated laboratories were becoming the new standard for medical schools, hospitals and nursing and allied health training programs. Medical simulation mannequins are now available in 3D for advanced medical training in trauma, anesthesia, obstetrics, neonatology, respiratory care and numerous other specialties. The first use of a computerized simulator for SBME was established at the University of Miami Medical School in the 1960’s. Medical students and residents were trained in cardiology using the simulator nicknamed “Harvey”.

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and those practitioners outperformed their traditionally trained peers. Ziv referred to SBME as an ethical imperative suggesting that simulation is an essential component of the medical training curriculum.

The rationale for simulation use in medicine has long been based on improving patient outcomes. The number that continues to drive the use of simulation for medical training in the United States is the widely quoted 98,000 accidental hospital deaths annually. This alarming number has remained constant for over a decade. The actual number of accidental hospital deaths may be higher and closer to 400,000 deaths. To provide some perspective, these numbers exceed the total sum of deaths in the United States from automobile accidents, breast cancer and AIDS. Two studies looked at the adverse effects in hospitalized patients and the percentage of adverse effects that lead to death. One study reported that in Colorado and Utah adverse events occurred in 2.9 percent of patients and that death was the outcome in 6.6 percent of those adverse events. Another study in New York reported adverse events in 3.7% of hospitalizations with death as the outcome in 13.6% of those cases.

The question that naturally follows the simulation conversation in medicine is “does simulation increase patient safety”? There appears to be no definitive statistical link at this time between simulation use and positive outcomes though further studies are encouraged. Over the last decade, research from around the world indicates that simulation helps in improving safety by training users on high-end technologies associated with anesthesia and surgical procedures. SBME has been linked to clinical improvement in laparoscopic surgery outcomes and adherence to ACLS protocol. As a stand-alone training method with direct impact to patient safety, the data on use of medical simulation is still lacking though supporters maintain that it is better to train on simulators and move to live patients than to train directly on live patients. McGaghie claimed that SBME with deliberate practice was superior in achieving clinical skills to the traditional medical education of “see one, do one, teach one.” More studies are needed to confirm a permanent role for medical simulation training in improving patient safety.

In 2005 the position of the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) on simulation use in medicine was supportive. JCAHO issued a statement that recommends the adoption of simulation technology and the establishment of evidenced-based research to prove impact on patient safety. JCAHO went on to propose that those seeking to implement simulation technology pursue proposals to offset the cost of constructing SIM-Center labs.

Medical simulation has become state of the art and extremely valuable in the early phases of all medical training. For instance, simulation training has become a routine part of training for respiratory therapists in the United States. Respiratory therapists are frequently involved in resuscitations, trauma, and ventilator care as a daily part of their duties. Low-tech simulation laboratories have become less common in respiratory training programs and high-tech simulation laboratories are slowly becoming more common. In colleges that share space with registered nurse training programs the cost may be more justifiable. High-Fidelity simulators are available in the form of SIM-Man, SIM-Baby, SIM-Mom, and various a la carte add-ons for trauma and respiratory diseases. The cost of one high-fidelity simulator with associated equipment can reach $US200,000.00. The cost of building a high-tech simulation lab, or converting space, can be in excess of $US1,000,000.00 and prohibitive for some budgets.

The development of medical education, at any level, fits into a general framework of clinical assessment using a simple pyramid model from bottom-to-top: knowledge, competencies, performance, and action. All levels of simulation facilitate critical thinking skills needed in the learning process. In terms of evidenced-based research that lends legitimacy to the claims that patient safety is improved by use of simulation the literature is slowly piling up. Berkenstadt called SBME a “mistake-forgiving” environment. There are numerous other benefits from the use of simulation in medical education and they all fit into the universal mission of improving patient outcomes. Teamwork within disciplines and interdisciplinary teams is established through the use of simulation as well as collaborative strategies. Bearman referred to SBME as linked to a “new professionalism” that supports a patient-centered and team-based approach to healthcare.
Learning By Simulation

Range of technologies are available via simulation and frequent practice assists users in developing a wide range of skills. For instance, simulation allows for the development of clinical judgment and the process of acclimation to accountability for patient outcomes.

The most valuable phase of simulation may take place during the evaluation process that is often associated with a debriefing session. Debriefing sessions are held immediately after a simulation experience with participants and evaluators sitting around a table. These sessions are designed to be a time when participants can speak freely about the simulation, watch video of the simulation, and generally and specifically discuss what went well and what needed improvement. The Debriefing Assessment for Simulation in Healthcare (DASH) program at Harvard Medical Simulation Center is a fine example of how debriefing can be utilized to enhance medical training. A trained debriefing guide sets a friendly tone but typically does little of the talking unless problems arise. A common technique is to write down on a board lists of how the participants critique themselves (what went well and what did not go well). Debriefing guides withhold their view of what transpired during the simulation until the conclusion and only state minimal, objective facts shared in a positive light.

The simulation experience is enhanced when participants have had a live set of clinical experiences to create a framework. Often students will say that they appreciated their simulation experience more after they went to a live clinical experience. Students are allowed to make errors in the simulation environment both minor and major without fear of a penalty and they are pre-briefed about this criterion ahead of time. The simulation experience becomes more rich and valuable when students understand the philosophy of simulation and feel free to fully immerse themselves in the role-playing model. At the conclusion of the simulation and debrief there should be a positive feeling of satisfaction among students, mentors, and faculty. There is an axiom in simulation that strongly discourages anyone leaving the simulation and debriefing session with negative feelings.

Simulation always provides hands-on training that students universally desire and that builds skills and confidence. From measuring a blood pressure to placing ECG leads, interpreting cardiac rhythms to manipulating mechanical ventilators, auscultating breath sounds to physical assessment, simulations allow students to develop through role playing as respiratory therapists, doctors, nurses and even family members of the patient. Students will often receive clinical contact hours for their experience in the simulation lab.

Simulation is not always expensive, offering less costly options such as the use of “standardized patients”. A standardized patient is a real person who volunteers or is paid to play the role of a hospital patient. Cases and scripts are selected and developed ahead of time and the standardized patient stays in character through the simulation. Some patients with actual disease processes such as pulmonary or cardiac volunteer can be members of a standardized patient pool available to some simulation programs. The added value of having simulation training with a live person able to interact authentically with participants is one way to substitute a high-value simulation experience without having a high-fidelity simulation lab. Often the value-added phase of standardized patient use occurs during debriefing when the actor provides detailed feedback about their perception of the event. Obvious limitations with standardized patients exist such as inability to simulate trauma and resuscitation scenarios and that some receive reimbursement.

Summary

The future appears bright for the use of simulation in medical education. Medical, nursing, and allied healthcare students trained through simulation have opportunities to practice hands-on techniques, teamwork, and communication through trial and error in a safe environment before working with live patients. The cost of high-fidelity simulation will continue to make its use prohibitive and challenging for some programs though the use of low-fidelity simulation, standardized patients, and role-playing continues to have measureable qualitative value. Cost center sharing is one way for programs on a tight budget who desire high-fidelity simulation to access this valuable skills-building, outcome-improving medical education adjunct tool.
References

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† Train-of-four
‡ Post-tetanic count
³ Second twitch

**REFERENCES:**
1. BRIDION Summary of Product Characteristics (SPC)

Please see summary of product characteristics for full prescribing information.

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References: