An Introduction to Medical Simulation

How simulation tools can be used in medical training programs to improve learning outcomes and minimize patient risk.

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WHAT IS MEDICAL SIMULATION?

> Simulation (noun): A situation in which a particular set of conditions is created artificially in order to study or experience something that could exist in reality.

Simulation training involves the creation of artificial environments that imitate the real-world to achieve educational goals through experiential learning. In the context of medicine, simulation tools allow trainee medical professionals to develop their skills in a controlled environment, away from 'real' patients.

Simulation provides a safe, stress-free alternative where trainees can make mistakes and learn from them. It encourages individuals to study at their own pace and provides educators with vital performance data via continuous assessment and examination. It offers continuity across multiple procedures and medical specialties, and ensures all trainees reach a standard level of proficiency before coming into contact with a real patient.

In short, simulation delivers all the benefits of world-class medical training, without putting patients at risk.

THE HISTORY OF MEDICAL SIMULATION

Simulation turns *"See One, Do One, Teach One"* into *"See One, Practise Many, Do One."*

One of the earliest examples of medical simulation tools was the obstetrical manikins introduced around 1700 by Grégoire of Paris to train midwives. Since then, all manner of training aids have been manufactured or adapted to help trainees prepare for working on patients. From manikins and anatomical models to cadavers and animal parts, they are designed to facilitate practice and build confidence.

The problem with most historical simulation tools lays in how little they reflected the real-world surgical environment. Cadavers were the most effective, but they were hard to come by and, of course, you could only use them once. Most models, on the other hand, were rudimentary and unrepresentative of real human anatomy. For simulation to be truly effective, it had to match the 'live' experience as closely as possible.

In the 1980s, 'box trainers' started providing trainees with responsive instruments and display screens. From here, as the technology improved, so too did the simulators, with technological advances making it ever easier to replicate the intricacies of the human anatomy.

The 21st century saw the arrival of virtual reality (VR) and robotics which have driven simulation to the frontier of innovation in medical education, placing trainees at the center of immersive, virtual worlds where they feel like they are actually in the operating theatre working on a patient.

Mohr's obstetric simulator assembled and its components from Die gebährende Frau by Friedrich Börner

WHY MEDICAL SIMULATION?

Surgical error is the third biggest cause of death after cancer and heart disease[1]

Advocates for mandatory simulation within medical training programs point out many parallels with the aviation industry. Every day, millions of people all over the world place their lives in the hands of surgeons and pilots, but the industries have very different approaches to training.

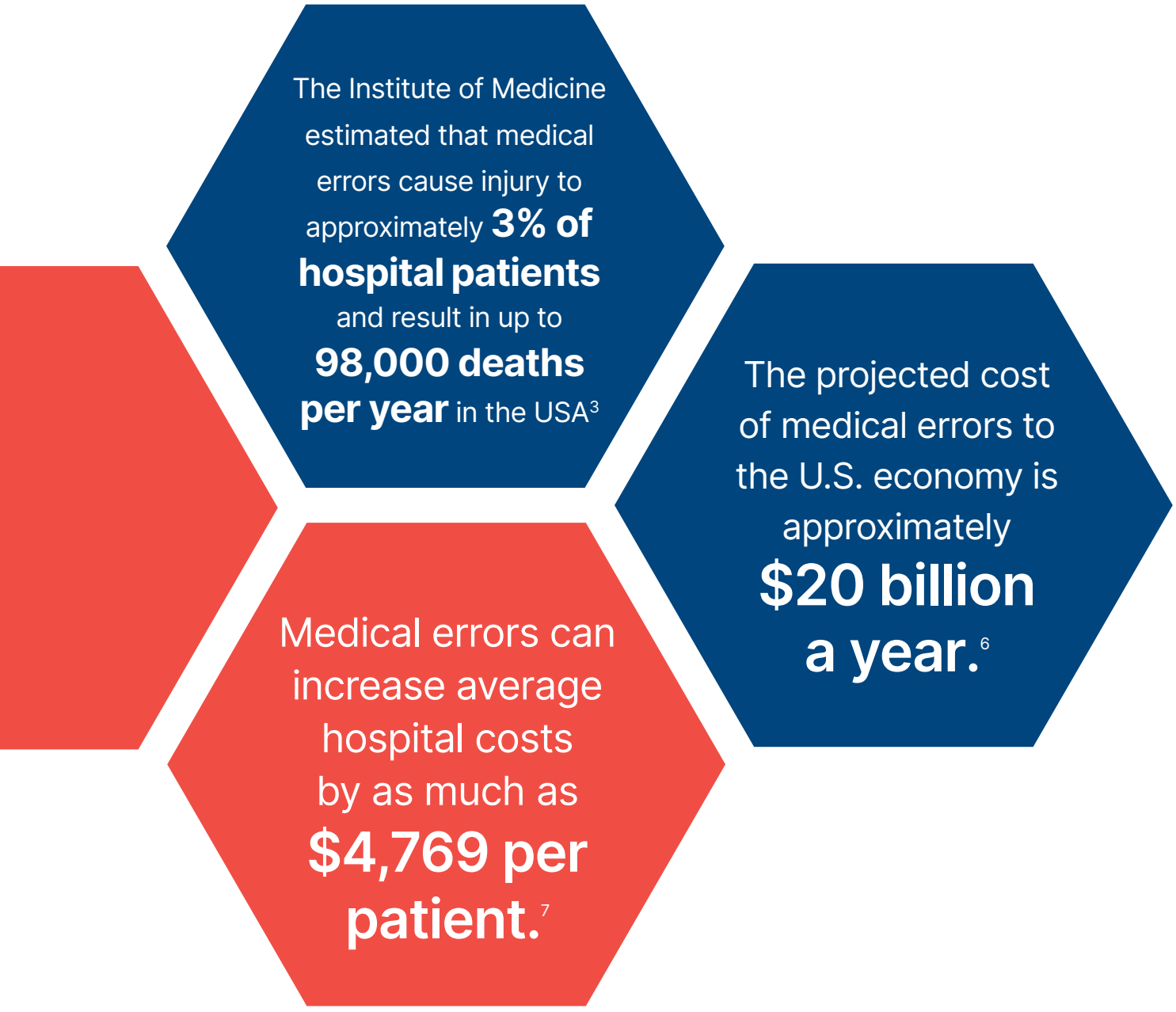
Diagnostic errors affect **more than 12 million Americans each year**[4] and may seriously harm **1/3 of these patients**[5] likely dwarfing all other causes of harm from medical errors combined.

The British Medical Journal suggests that 'medical errors' is the **3rd largest cause of death** after cancer and heart disease'[1]

The WHO estimates there are **7 million** injuries/ complications and **1 million** deaths out of the 234 million major surgical procedures performed annually worldwide - around **half of which are preventable**[2]

1 https://www.bmj.com/content/353/bmj.i2139.long.
2 https://www.ncbi.nlm.nih.gov/books/NBK333498/.
3 https://pubmed.ncbi.nlm.nih.gov/25077248/.
4 https://pubmed.ncbi.nlm.nih.gov/24742777/ .
5 https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/1656540.
6 https://www.soa.org/globalassets/assets/files/research/projects/research-econ-measurement.pdf.
7 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2262792.

Commercial pilots are required to practice emergency procedures on a simulator every six months. They are not allowed to fly until they have reached an acceptable level of aptitude. But there are no such rules in place in the medical industry, despite statistics showing that human error is a major factor in negative patient outcomes:



GOALS OF MEDICAL SIMULATION

"There needs to be global standard to make healthcare safer"

One of the major benefits of simulation is that it can be used to create continuity across surgical disciplines, nursing practices, and even national healthcare systems. In most countries, trainees learn at different paces and have different exposure to live patient environments within their training programs. Simulation provides major opportunities to deliver a more considered approach.

Goals of a standardized approach to medical simulation include:

- **Improved patient care and safety -** The ultimate goal of simulation in medical training is to reduce risk from surgical interventions and to improve patient outcomes
- **Improved surgical and healthcare skills -** Simulation allows for unlimited practice in a safe environment, including the ability to experience different scenarios and complications
- **Improved confidence in a crisis or high-stress situation -** It is not just patients who are affected by high-pressure situations. Medical professionals have been shown to perform better when they feel prepared
- **Reduced healthcare costs -** Although the most sophisticated simulators are expensive, they are cheap compared to the cost burden on healthcare systems when caring for patients who have experienced surgical issues
- **Better team communication -** Simulation provides a collaborative environment where trainees can work together with colleagues and learn from one another without the pressure of the Operating Room

WHO CAN BE TRAINED USING MEDICAL SIMULATION?

Simulation can be effective in any healthcare setting

Medical simulation is not just beneficial to trainee surgeons but can be used across the healthcare industry and beyond. Simulation tools can help with practical applications, team-based communication, cognitive thinking, and many other elements of healthcare - as well as complex surgical procedures.

Everyone within a GP surgery, hospital, or critical care setting can benefit from medical simulation training, including:

- **Physicians**
- **Nurses**
- **Surgeons**
- **Medical students**
- **Paramedics**
- **Respiratory therapists**

Even veterinary physicians and surgeons can use simulation to improve patient outcomes, with many simulation tools, techniques, and training frameworks equally applicable to treating animals as humans.

And it is also valuable for medical professionals working in diverse areas such as:

- **Anaesthesiology**
- **Emergency medicine and trauma care**
- **Intensive care medicine**
- **Cardiology**
- **Endoscopic Surgery**
- **General Surgery**
- **Gynaecology**
- **Neurosurgery**
- **Orthopaedics**
- **Pain Medicine**
- **Pulmonology**
- **Pediatrics**
- **Radiology**
- **Robotic Surgery**
- **Vascular Surgery**
- **Veterinary Medicine**

THE BENEFITS OF MEDICAL SIMULATION

"I Hear And I Forget.
I See And I Remember.
I Do And I Understand."
Confucius

Today's simulation tools have comprehensively overcome the technical barriers of the past. Complex procedures like laparoscopies, endoscopies, and robotic surgeries can be practiced repeatedly on purpose-built simulators that replicate the surgical environment to the very last detail.

Trainees can:

- Practice basic skills and full procedures in a controlled, risk-free environment
- Be exposed to clinically challenging procedures and complication management
- Learn from mistakes and fix them
- Learn how internal organs and tissue behave thanks to hyper-realistic haptics and graphics
- Alter the degree of difficulty depending on how advanced they are in their training
- Retain knowledge and transfer it into the live surgical environment
- Reduce overall training time thanks to unlimited access to training tools

Trainers, educators, and healthcare providers can:

- Use simulation in all undergraduate and postgraduate training programs
- Tailor individualized or team-based learning activities
- Improve teamwork and knowledge sharing
- Gain data insights that help them provide individual support for those who need it
- Provide continuous assessment leading to a standardized curriculum and proficiency thresholds
- Shorten learning curves and prepare trainees for the live environment faster
- Reduce training costs by allowing self-management
- Lower overall operating costs by minimizing human error

THE BARRIERS TO IMPLEMENTATION

> *"Healthcare is an industry where it is notoriously difficult to make significant changes to processes that have always been done 'the old way' "*
> ***Lars Konge, Head of Research, CAMES***

The benefits of simulation are almost universally acknowledged but agreeing upon a global framework of change that transcends medical disciplines and international borders is daunting to say the least. Broadly, the main barriers to wholescale adoption of mandatory simulation practices fall into three categories:

- **Tradition** - There will always be those who are resistant to change, and feel that traditional training methods are the most effective
- **Cost** - The cost barrier is not merely about finding money for new equipment, it is tied to the overall complexities of healthcare budgets, and the difficulties in securing sign-off across multiple departments
- **Legislation** - While certain countries have made great strides in introducing national training guidelines featuring simulation, others have struggled to overcome legal red tape

TYPES OF MEDICAL SIMULATORS OUT THERE

Task Trainers

Manikins

Virtual Reality

MAKING SIMULATION WORK FOR YOU

Which simulation tools fit your budget, and which will deliver the best results?

Bringing simulation tools into your education centre or laboratory can be quite costly. A single high-fidelity simulator with its monitoring system and other necessary equipment may cost up to $200,000. In addition, synthetic body fluids, replacement skins, bandages, syringes, and other supplies are necessary to simulate the experience of treating real patients in a real hospital. Picking the right simulator is therefore essential in delivering the maximum return on investment. Simulators can vary greatly in their specifications and sophistication. Here is what to look for when choosing a simulator:

- **Realism -** The recreation of “reality” or “fidelity” is important, as it helps to engage the trainees emotionally, thus providing a unique learning experience
- **Independent learning and team training -** There are many situations where training as an OR team is imperative, but not all solutions have these capabilities
- **Metrics -** The best simulators provide measurable metrics for learning and improving in a structured training environment
- **Feedback -** Does the simulator provide standardized, objective, data-driven feedback?
- **Hardware + software -** For an authentic, hands-on training experience, a simulator should integrate hardware and software elements, with haptics and graphics combined to create an immersive environment
- **Validation -** Has the simulator been validated by recognised medical associations?

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Surgical Science has over 20 years of experience in creating the most realistic virtual reality medical simulators with advanced graphics and haptics and the ability to train teams. It is one of the only simulator companies that develops simulators in a wide range of medical specialties, with modules for training in over 150 procedures. Currently there are over 8,000 simulators being used in 91 countries around the globe. Included with all Surgical Science simulators is MentorLearn, a unique cloud-based simulator management system that provides performance reports and proficiency-based training. Developed in collaboration with medical professionals and associations worldwide, Surgical Science simulators are supported by over 400 validation studies.

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