
From Manikins to Virtual Reality: Understanding the Range of Medical Simulators



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INTRODUCTION

Simulation is an essential part of medical training. For centuries, the medical profession has used different types of simulators to help trainees practice and gain enough proficiency to perform surgeries and other procedures on real patients. As time has progressed, simulation tools have advanced not only in their technical capabilities but also in their overall appearance and user experience. The best simulators now immerse trainees in a controlled environment that closely resembles real life.

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

Broadly, medical simulators fall into three categories:

- **Manikins** - Sometimes called 'patient simulators', manikins are anatomical models that represent different parts of the human body, allowing trainees to prepare for working on real patients.
- **Task trainers** - These simulation tools are designed specifically for one commonly performed medical procedure, providing the trainee with predictable, repeatable practice.
- **Virtual Reality (VR)** - In the context of medical simulation, Virtual Reality simulators are powered by computer technology, and typically include instruments and displays to immerse a trainee in virtual medical environments.

This white paper will look at each of these simulation types, and provide some benefits, considerations, and examples for each one. We believe there is a place for each simulator type in medical training programs based on the goals of your training program.



MANIKINS

The first medical simulation tools nearly all featured inert reproductions of the human anatomy that facilitated practice and allowed trainees to learn their trade in a risk-free environment.

While some medical professionals still refer to these training devices as “mannequins”, the preferred term is actually manikin. Manikins allow for the repeated practice of simple to advanced tasks where the manikin responds to treatment, but they’re not always easy to come by, and some can only be used once. Using purpose-built manikins is more efficient and cost-effective, with full-body manikins or models of body parts affording limitless opportunity for practice.

Benefits:

- Modern manikins are lifelike and closely resemble human anatomy. High-end manikins can display realistic vital signs and respond to treatment such as CPR, adrenalin injections, oxygen, etc.
- They enable learners to develop their skills under close supervision in a low-pressure setting.
- Most can be used repeatedly by multiple trainees.
- They help trainees develop specific behaviors related to their healthcare roles (such as nurse/patient relationships).
- They are great for team training scenarios.



Things to consider:

- Top-end manikins can be expensive, and involve ongoing costs around maintenance, supplies and cleaning.
- Simple manikins are inert and do not typically provide trainers with feedback or data insights on the performance of each trainee.
- Even the most sophisticated manikins cannot perfectly replicate the complexity of the human anatomy.
- Manikins are not practical for learning all medical or surgical scenarios due to their limited specifications.
- Studies have shown that working with manikins can limit the learning experience as they don’t react or present like real patients.

Types of manikin simulators:

Low-Fidelity Manikins - The most basic manikins have minimal technical components and are typically used for repeated practice of clinical skills such as CPR, catheter placement or wound care. Low-fidelity manikins can also fall into the category of task trainers.

Mid-Fidelity Manikins - These are usually full-body patient simulators, though they may have minimal computer components and lack the complex functionality of high-fidelity manikins.

High-Fidelity Manikins - At the top end of the scale, high-fidelity manikins incorporate the latest in computer hardware technology to mimic human anatomy and physiology. They are commonly wireless and can be programmed to provide a very realistic full-body patient representation. Examples of high-fidelity manikins include expanding chests that 'breathe', have variable heart rates and tones, measurable blood pressure, pulses, and can even talk in some cases.



TASK TRAINERS

Task trainers are specialized simulators or lifelike models of human anatomy designed to help learners practice a specific skill.

Task Trainers help trainees break down a common, repeatable physical task into simple steps, helping to build proficiency and confidence when it comes to real-life applications.

By their very nature, task trainers are useful for perfecting competency-based and procedural skills such as suturing, airway management, lumbar and venous punctures, catheterization and more.

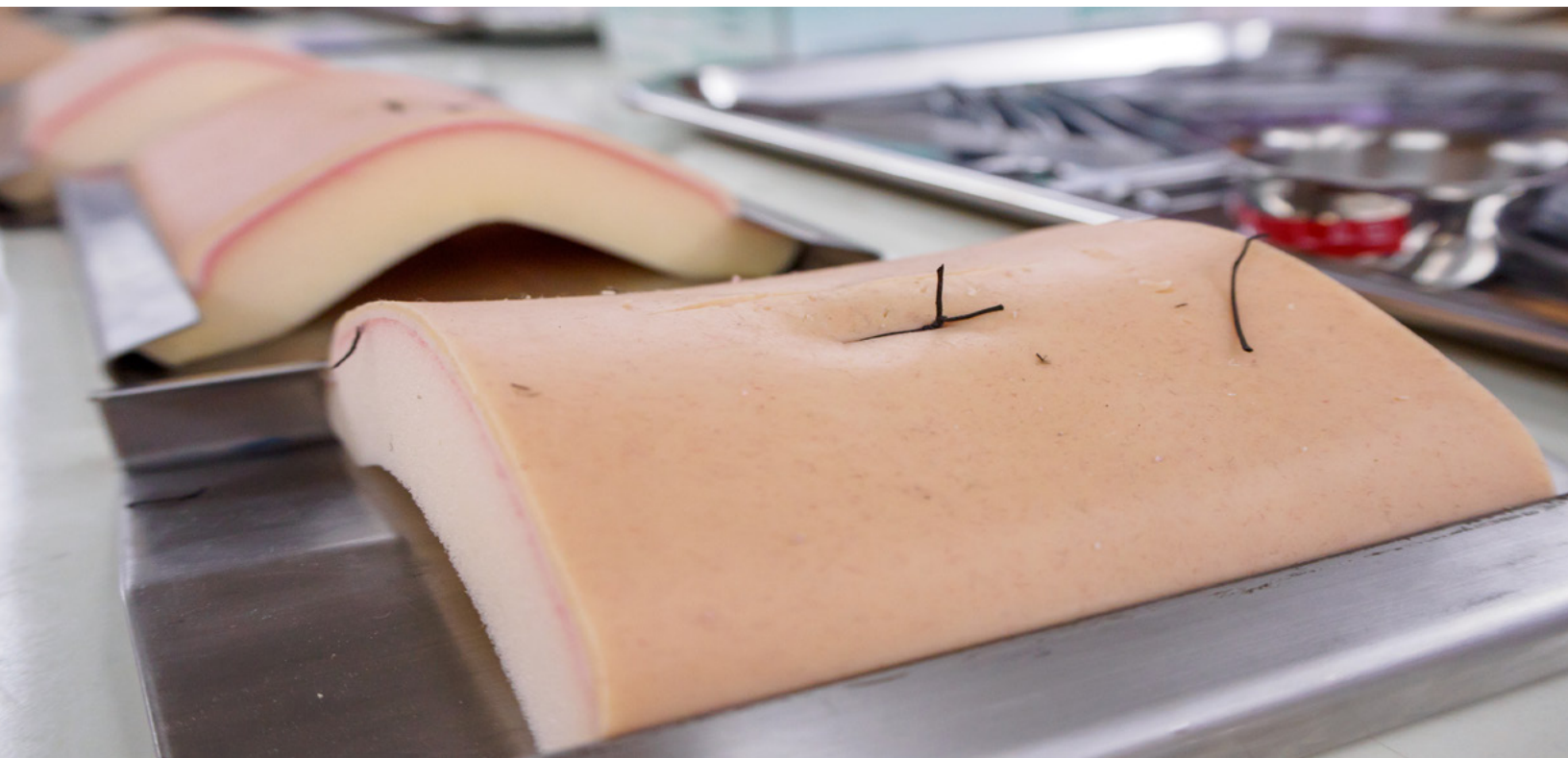
Task trainers may also be used in combination with real patients in a process called 'hybrid simulation'. Here, trainees can practice a task on the simulator while developing effective interpersonal skills with a patient at the same time.

Benefits:

- Repetition of a specific physical task allows the learner to develop both confidence and proficiency.
- Learners can practice invasive procedures without the risk of injury to a patient.
- Some task trainers can provide feedback and data insights that give an indication of a trainee's performance.
- 'Hybrid simulation' allows trainees to learn communication and patient relationship skills alongside practical tasks.

Things to consider:

- Task trainers offer limited scope for general training as they are confined to one task.
- Investing in multiple task trainers for multiple procedures can be costly.
- Most task trainers lack the functionality and versatility of high-fidelity manikins and VR simulators and do not present a variety of anatomies, pathologies, and patient scenarios.
- Performance feedback requires a proctor.



Types of task trainer simulators:

There are a huge variety of task trainers available, from basic models to highly specialized simulators that can replicate complex medical procedures extremely accurately. Examples of task trainer simulators include:

- **CPR trainers** - Among other features, these simulators are equipped with a CPR Rate Monitor with 'depth' clicker that allows for instant feedback to both instructor and student regarding the rate and depth of chest compressions.
- **Central line insertions** - Central Vascular Catheterization, using Subclavian, Supraclavicular, and Internal Jugular approaches. These trainers use ultrasound guidance during catheter placement.
- **Vascular Access** - An arm model used to practice ultrasound-guided access procedures of the upper extremity.
- **Ventrilo scopes** - Simulated stethoscopes used to teach pulmonary and cardiac auscultation by playing recorded physiological sounds.
- **Birthing simulators** - silicone pelvis with a standard fetus inside to teach delivery for midwives or OB/GYNs.



VIRTUAL REALITY (VR) SIMULATORS

Virtual Reality (VR) technology is driving the future of medical simulation. Unlike more straightforward, practical manikins and task trainers, VR tools create immersive experiences that place trainees into hyper-real scenarios. By combining optics, haptics, and graphics, the best VR simulators make trainees feel like they are really there in the operating room or clinical environment working with a live patient.

When most people think of Virtual Reality, they imagine goggles or headsets that place the user in computer generated surroundings. But, while some simulators only use VR goggles others combine multiple simulation tools - manikins, models, surgical instruments, and computer-generated displays - to create a multi-sensory, mixed-reality environment.

Benefits:

- VR simulators provide a truly immersive experience that is as close to the 'real thing' as it's possible to get.
- They allow for unlimited practice with no risk to patients.
- There is minimal need for single-use accessories, thus reducing the environmental footprint.
- Though initially expensive, incorporating VR simulators into medical training program can save costs in the longer term thanks to their versatility. By changing settings, trainees can explore multiple types of patients and scenarios on the same simulator, while learners at different stages of their education can adjust the task complexity accordingly.
- The sophistication of the technology means more opportunity to collect data, providing trainers with detailed feedback and insights into trainees' performance.
- By combining graphics, optics, and haptics, VR simulators not only 'show' trainees how to perform certain procedures, but they also help them to 'feel' what the real-world procedure will be like and gain muscle memory from repeatedly using them.
- VR adds an excitement to learning which makes students want to train and can often be used as a recruitment tool.



Things to consider:

- The cost for higher-end VR simulators may be prohibitive for some training facilities.
- Some training facilities lack the space or resources to use VR simulators effectively.

Types of VR simulators:

VR headsets or goggles - Some medical simulators use VR headsets or goggles to place the trainee in a virtual reality world. As with other non-medical applications, these devices typically include a stereoscopic display (providing separate images for each eye), stereo sound, and sensors. The main issue with these simulators is that they are mainly visual and are less reflective of real surgical environments.

Fully immersive VR simulators - The most effective VR simulators combine computer technology with a realistic set-up that prepares trainees for the real world. This might include the use of controllers designed to look and feel like real instruments, as well as tactile materials that provide haptic feedback, and displays that react in real-time to a trainee's actions.



SURGICAL SCIENCE: AT THE CUTTING EDGE OF MEDICAL SIMULATION TECHNOLOGY

Surgical Science simulators combine manikins, task training and VR technology to provide holistic solutions that not only help trainees become more confident and proficient, but also give educators valuable insights about individual performance.

With unmatched graphics, optics, and haptics, Surgical Science offers a realistic learning experience for simulation centers, hospitals, universities, and medical device partners across the world, helping medical professionals become more skilled and confident.

