Simulation in Healthcare - the technological perspective

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No Astronaut would leave the planet without hundreds of hours spend in the simulator to train all tasks he needs for his mission. No Pilot would get his license without passing a lot of simulated scenarios. No bridge would be built without having simulated all thinkable influences. Simulation is used in many domains and in many different ways to minimize all risks or to prepare all professionals in the best way. In all high risk industries, such as military, aviation, space flight, and nuclear power industries, this technique is well known and used very intensive. To get a highly reliable system many tests, proofs and checks are an absolute must. Is this the case in healthcare?

Simulation refers to the artificial replication of sufficient elements of a real-world domain to achieve a stated goal and it can help users understand and model real life systems. Simulation should be used when it is expensive or dangerous to run the real systems. We can gain better understanding of a system and identify problems. Moreover we can test the potential effects of changes. Most technical disciplines use simulation to optimize product development processes. Planning and development is much easier and less expensive with using different methods of simulation. A very common and useful tool is for example the finite elements method (FEM). The finite element method is a numerical technique to find approximate solutions in many mechanical engineering disciplines. FEM is nowadays a pure computer simulation.
Simulation has many faces, her some examples to get an overview:

- **Mathematical Simulation** is the formal modeling of systems has been via a mathematical model, which attempts to find analytical solutions to problems which enables the prediction of the behavior of the system from a set of parameters and initial conditions
- **Computer Simulation** has become a useful part of modeling many natural systems in physics, chemistry and biology, and human systems in economics and social science
- **Physical simulation** substitutes the real thing by similar or physically comparable objects; most of them are smaller models of the real thing.
- **Interactive simulation** or "**Human-In-The-Loop Simulation**" means the human interaction with a System, or Humans as part of a physical simulation. Flight Simulators are probably the most well-known representatives of this type of simulation, the Patient Simulation is one too.

It is more and more common to hear simulations of many kinds referred to as synthetic environments or virtual reality. This label has been adopted to broaden the definition of simulation. The big field of virtual reality is getting a more and more important part in the simulation field or as part of interactive simulation.

Simulation in healthcare

Use of part task trainers is a very old method to train healthcare professionals or medical students. In the 1700s Madame du Coudray created "the machine" to train midwifes in the court of King Louis XV. In healthcare we know a lot of computer simulation tools, so called medical microsimulators. They were developed to satisfy the medical student's needs to focus

on the conceptual understanding of medical procedures and to train them to identify and understand medical cases and the treatment. To train procedures, tasks or skills the so called basic simulators find their application. Examples for basic simulators are resuscitation manikins to train chest compressions. There is a big variety of part task trainers for nearly every medical skill available. Beside all skill trainer and low fidelity training manikins there are just a few high fidelity simulators available. The three big manufacturers follow two different concepts. Model driven simulators and free "on the fly" programmable simulators. There is still an ongoing discussion which concept is the best. From the technical perspective the model driven simulators are real computer simulation with a manikin as interface. But if we have a more psychological look on it, simulation is not even the manikin and it inputs, outputs and mathematical behavior. It is more the whole training room in which the real clinician has to treat a virtual patient. David Gaba wrote in 2004 "simulation is a technique, not a technology".

Discussion

How can clinicians experience the difficulties of patient care without putting patients at undue risk? How can we assess the abilities of clinicians as individuals and teams when each patient is unique? These are questions that have challenged medicine for years. In recent years, these and related questions have begun to be answered in health care by the application of approaches new to medicine, but borrowed from years of successful service in other industries facing similar problems. We should concentrate on which tool fits best to our educational needs. The big question is, how can technology help simulation instructors to fulfill all educational needs? Some goals can be achieved with minimal fidelity, others require very high fidelity. Some degree of simulator and simulation fidelity is required to engage participants in a learning or evaluation activity. It needs a physical fidelity, a conceptual and an emotional fidelity. It has to look, feel and behave like a real patient, and it should have the ability to draw the participant into the situation. In one word the simulation and the instructor has to create a relevant experience for Simulation participants.

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Weblinks
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