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REVIEW ARTICLES

SIMULATORS IN ANAESTHESIA AND HEALTHCARE

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Simulation is the imitation of a real entity, process or situation. It entails resurrection of even most miniature details of the real object, but in a more favorable or safe environment. Simulations have come to occupy an important position in aviation, traffic, computers, military training, disaster preparedness, video gaming and even the film industry. The field of medicine was not to be left behind, and perhaps the use of simulators in the field of healthcare is one of the finest uses of science and technology in the service of mankind. Simulators have been developed for laparoscopic surgery, trauma care, CPR, research in diagnosis and therapy.[1,2,3]

Simulation can be (a) Physical – in which artificial objects are substituted for the real objects, and (b) Interactive- in which artificial conditions are made to mimic real life situations. Training simulators can be (a) Live - ie real people use virtual equipment in real environment (b) Virtual - ie real people use virtual equipment in virtual environment, and (c) Constructive - ie virtual people use virtual equipment in a virtual environment. One of the greatest advantages of modern simulators is that they make you gain experience in decision making when faced with a difficult situation, besides making you practice the already known skills. Another advantage offered by simulators is that they allow assessment of skills of medical personnel without compromising the safety of patients.

History of simulation used in healthcare and anaesthesia:

The first medical simulators were simple models of human patients. These were representations in clay and stone to demonstrate clinical features of disease states and their effects on humans. Models helped students learn the anatomy of the musculoskeletal system and organ systems.[4]

Much of the impetus for the development of simulators in anaesthesia came from the observed parallels between the environment of anesthesiologist and that in the aviation industry. The aviation industry has a long history of using simulators for training and maintenance of skills, particularly in crisis management. The first aircraft simulator was built by Edwin Link in 1929. The current aircraft simulators are so realistic that pilots can be trained and certified to fly entirely on the aircraft simulator.[5] These simulators addressed the importance of repeated practice, in order for responses to become automatic in the event of an emergency.[6] Similar to the aviation environment, anaesthesia practice in the operating room involves multiple tasks requiring a high degree of vigilance, procedural, monitoring and decision-making skills in a dynamic, complex environment which is affected by the simultaneous interactions of the different members of the operative team. As in aviation, critical life-threatening incidents are rare, but when they do occur, they have potentially disastrous consequences unless the anaesthesiologist is able to quickly diagnose and correct the problem. Simulation technology provides a potential way of learning and practicing

all the skills involved in anaesthesia, including crisis management without harm to a real patient.[7]

The first anaesthesia simulator, SIM1, was described in 1969 by Denson and Abrahamson.[8] Its concepts and construction were ahead of its time. It was originally developed as an aid in learning to intubate as well as to induce anaesthesia. It consisted of a manikin comprising an intubatable airway and upper torso and arms. Despite its cutting-edge technology at the time, cost constraints greatly limited its practical use and further development was abandoned.[9] In 1986, a team at Stanford headed by Gaba and DeAnda developed a full scale simulator called the Comprehensive Anesthesia Simulation Environment (CASE) to specifically study decision-making processes of anaesthesiologists during critical events.[10]

Advantages of using simulators in medical field:

1 They closely mimic the real situation
2 There is absolutely no risk to the patients
3 The devices can generate customized scenarios
4 Repeated assessments are possible
5 A hands on experience of even clinically rare scenarios can be had
6 Recording of one's activity allows for assessment

Another aspect of simulation is that training can in many cases be performed not just for a fixed duration or number of cases, but rather to specific criterion levels of competency and skill. People retain in memory 20 % of what they see, 40% of what they see and hear and 70% of what they see, hear and do. Naturally, continuous training is highly substantial for effective learning. Using the Anaesthesia Simulators, one can even earn CME credit hours.

Type of simulation models

Active models: Active models that attempt to reproduce living anatomy or physiology such as Harvey's manikin are able to recreate many physical findings of the cardiology examination, including palpation, auscultation, and electrocardiography.

Interactive models: Interactive models have been developed responding to actions taken by a learner. Until recently, these simulations were two dimensional computer programs that substituted a textbook. Computer simulations have the advantage of allowing students and physicians to make judgments, and also to make and evaluate errors. This process of interactive learning through assessment, evaluation, decision making, and error correction is a much stronger learning experience than passive instruction.

Computer simulators

These have been proposed as an ideal tool for assessment of students for clinical skills.[11] Programmed patients and simulated clinical situations, including mock disaster drills, have been used extensively for education and evaluation. Immersive disease state simulations allow a doctor or health care provider to experience what a disease actually feels like. Using sensors and transducers symptomatic effects can be delivered to a participant allowing them to experience the patient's disease state.

Medical simulation training uses manikins, computers, virtual reality or actors posing as patients to teach doctors, nurses and other clinicians. While simulation training has been used in medicine for nearly 40 years, it has until recently been limited primarily to teaching standard techniques like chest compressions in cardiopulmonary resuscitation or pelvic examinations. But over the last few years, as the technology and training techniques have advanced, experts in the field have begun to broaden the scope of training. No longer confined to isolated procedures, simulation can now recreate entire clinical situations, giving clinicians the opportunity to develop skills in what is often identified as one of the major causes of error and quality issues in health care i.e poor teamwork and communication.[12]

Simulation can help develop decision-making, teamwork and team management skills.

Another advantage is that a user can practice over and over again on a rare clinical situation which would in reality occur very rarely but can be fatal

due to lack of recognition or failure of prompt intervention.

Anaesthesia residents at Stanford, have to go through an extensive simulated situation in which the patient, ie a specialized manikin, develops a severe, unexpected allergic reaction and then dies.[13]

Anaesthesia is a critical area in which adverse events may be frequent and severe. Iatrogenic errors can harm severely even young and healthy people during elective procedures. Physician's errors, that cause adverse events, are considered active errors and are often consequences of one or more system failures. Latent failures remain concealed until a human error happens overcoming the defensive barriers that are usually drawn up in health activities.

Medical simulators introduced in the early 1960s were widely used in anaesthesia fields, mainly in teaching basic and advanced life support techniques. Simulators were employed worldwide to train operating room teams to acquire and strengthen technical skills related to medical knowledge and technical procedures.[14,15] More recently simulation was adopted to train anaesthetists in non technical skills that are recognized the principal determinants of successful anaesthesia crisis management.[16] Research on simulation for nontechnical skills has become a recent area of interest. Referring to experiences of simulations for non technical procedure training, the Regional Education Institute has employed simulation in a course for the implementation of anaesthesiological check list. Rather than the participant's skills and knowledge assessment, the aim of the course was to demonstrate to the trainees the missing of some controls in the operating room even for caregivers with skill in anaesthesia. Prospective memory failures could be relevant errors in medicine particularly in a complex environment like the surgical theatre where it is particularly important to detect the system failures in advance of intervention.

Lack of understanding of the rationale for the individual tests in an anaesthesia machine pre-use check may contribute to its incorrect execution or total omission. Failure to properly check the anaesthesia machine continues to be a recurring problem. It is also one of the predisposing factors to critical incidents that may be most preventable through education and training.[17] Anaesthesia residents must be trained in their formative years about the importance of understanding, performing and interpreting the anesthesia machine pre-use check correctly and efficiently.

Utility of simulators

Anatomic models and phantoms imitating a structure of various body organs and systems (for example, a heart model simulating its external and internal structure, human brain, an eye etc.) are quite useful.

Another type of simulators includes full-size dummies of a human used for training first aid teams, and also paramedical personnel (firemen, rescuers, civil defence services). A set of special overlays even allows to imitate various damages (wounds, thermal and chemical burns, fractures and amputations of extremities etc.), to train methods of rendering emergency first aid (putting up bandages, bleeding arrest tourniquets, immobilisation of fractures, and others). Moreover, with sufficient number of similar dummies the simulation of mass catastrophes to train principles of triage, first medical aid and transportation is possible.

One more group constitutes simulators widely used for training techniques of heavy therapy and reanimation. There are many models of simulators for training methods of breath and heart reanimation in case of clinical death and other dangerous conditions (loss of consciousness, drowning, blockage of respiratory channels by alien matters etc.). Depending on complexity of models they may be adequately used for training of various categories of students: doctors, nurses, paramedical services and community population. It is possible with their help to train techniques of recovery of respiratory channels, artificial breathing, indirect heart massage, and the modern modifications of simulators allow the instructor to evaluate the pupils with the help of connected personal computer.

With more sophisticated models of simulators the imitation of specific disturbances of cordial activity and their correction by input in the learner's computer of the adequate treatment schemes is possible. Similar simulators make possible learning techniques as intravenous administration of medicines, setting up drips, cricothyrectomy, intubation, introduction of the gastric probe, realization of electrical defibrillation etc. etc.

Scope of Simulators in anaesthesia:

Simulators may mimic dozens of anaesthetic emergencies, including air embolism, anaphylaxis, bronchospasm, ketoacidosis, difficult airway, hyperkalemia, malignant hyperthermia, venous air embolism etc. Even simulators representing sedation and its many complications are available. The use of simulators in medical field thus has a bright future in training budding doctors by improving their skill and reactiveness, at the same time reducing risks for the patients.

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