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SUSHURTA – THE PIONEER OF SIMULATION IN SURGICAL EDUCATION

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ABSTRACT

Introduction: Surgery is a medical speciality that uses operative manual and instrumental techniques on a patient to investigate or to treat a pathological conditions, disease or injury, to improve bodily function to repair unwanted ruptured area. It is a technical field which includes different tasks ranging from simple wound closure to highly complex diagnostic and therapeutic procedures. Achieving surgical competence is a complex process that involves the attainment of knowledge, judgement, professionalism and surgical skills. A surgeon needs repeated practice of the surgical procedures to acquire the surgical skills. In recent era, simulation has come into custom as a method of teaching the technical skills to surgical trainees. Simulation is a model of a real activity created for learning purpose and simulator is a machine designed to provide a realistic imitation for this purpose. The expectations that the surgical trainee will acquire all necessary skills in a purely clinical environment are no longer realistic. Simulation offers the benefits like safe environment for practice and error resulting in improved patient safety and learning efficiency. For simulation, a wide variety of models are available from animal or cadaveric models to virtual reality simulators. **Method:** Pubmed database is searched to write this article. **Results:** Although the modern era has developed many synthetic simulators to acquire surgical skills, the root of the concept lies 1000 BC in Ancient Indian system of medicine and surgery. **Discussion:** *Sushruta* was the first to introduce simulation in surgical education as *Yogya*. He is the inventor of simulators.

KEYWORDS: *Yogya*, *Seevan*, Computer simulators, Simulator models, Bench Top Models, Virtual reality.

INTRODUCTION

Simulation is an educational technique that allows the interactive performance of the trainee in an environment that creates imitation of real life scenario.

A critical role of simulator is to teach trainees a specific skill set. Simulators provide safe and realistic learning environments for repeated practice.[1] Simulation allows many ways to acquire skills within the limits of work hour restrictions and limited clinical exposure.

Simulation provides a means for surgeons in practice to acquire the necessary skills to incorporate new technologies.[2] Simulation training serves as a bridge between classroom learning and real life clinical experience. Using different simulators, surgeons can experience a range of events from physical examination to major trauma.[3]

In every field of medical science like surgery, obstetrics, gynaecology, orthopaedic etc. simulators are used to train the surgeons.

In ancient era Sushruta stated the "*Yogya*" karma which mimic with simulator in modern era. Sushruta mentioned various surgical procedures, para surgical procedures and wound dressings. He also mentioned various models on which these surgical and para surgical procedures were practiced before attaining the patient.

METHOD

PUBMED database searched with keyword Simulation in surgery. The search was limited to articles published from 2003 to till date. Total 12 articles were scrutinised out of which 3 were retried. Relevant articles were included for review. Systemic review studies were included in this review article.

Use of simulators in clinical practice

Various types of simulations are available including bench top models, animals and human cadavers, virtual reality simulators, computer simulators etc. Available simulation models rages from animal or cadaveric models to virtual reality simulators.[4]

Animal and Human Cadaver

Some models used to practice surgical skills are human cadaver and animals. The advantage, in using animals models are opportunities to mimic complications and realism. But these models are expensive, their anatomy differs from that of human and there are many ethical

issues in using animals for study. Cadavers are also expensive, limited availability and it is not possible to stimulate complication in cadavers like bleeding.[5]

Synthetic Bench Top Models and Tower Trainers

Synthetic models like bench top models are those designed to teach open surgical procedures and tower trainers are those use for teaching minimally invasive procedures. Bench top models are available for simulation variety of procedure like knot tying, suturing, facial closure. But they have limitations that they teach only one surgical technique rather than an entire operation.[6]

Tower trainers are models which simulate variety of techniques including laparoscopic suturing, knot tying, clips applying and co-ordination drills. It includes a box with slits on superior surface for trocar insertion. Real laparoscopic instruments are inserted through trochar in to box, where the procedure is simulated. A camera inside the box provides the video output to a monitor on which trainees can watch their own movements. [7]

Virtual Reality (VR) Simulation

VR simulation is the use of 3D objects and environment to create immersive learning experience. Its principle is to impart, practice and check user's knowledge using interactive scenario and environment to reflect real life situation. VR surgical simulation signals the beginning of an era of computer simulation for surgery. [8] Training by VR simulation encompasses systems designed to teach endoscopic, laparoscopic and per cutaneous interventions. [9]

The use of VR simulations does not need an expert like in bench models learning. These models allow practice at various levels of difficulty, it can stimulate complications and automatically provide objective measures of assessment.[10] VR models have been criticise for initial cost of system acquisition, limited force feedback with use of surgical instruments and lack of realism of graphics.[11]

Part Task Trainers

Training of specific skills such as airway management, arterial line and chest drain placements can be taught using part task trainers commonly available as manikins or animal models and are useful to understand the techniques and practice in low risk situations without any patient harm.

A high fidelity simulator is full body computerised manikin that has realistic features such as blinking eyes with reacting pupils, chest that rise and fall with respiration, palpable pulses, various heart and lung sounds and ability to cry drool and bleed.[12]

Virtual Operating Rooms

Bench top models, virtual reality models, animal and cadaveric simulators are all focused on teaching the technical skill necessary to perform a wide range of surgical procedures. To teach and access both technical and non technical aspects of performance, virtual operating rooms have been developed.[13]

These rooms consist of an operating table, lights, suction equipment and an anaesthesia machine. They contain a simulator and a control room, which is separated from operating rooms by one way mirror. VR operating rooms are designed to take into account the technical skills required to perform an operation.

Simulation has been use to teach neonatal resuscitation, paediatric advanced life support, advanced airway management in paediatrics. In orthopaedic, methods to developed surgical skills include hands on training in a laboratory setting using synthetic bones or cadaver models as well as software tools and computerised simulators. In gynaecology simulators are like suture trainers, training devices for proper placement and positioning of barrier subcutaneous and intrauterine contraceptive and devices for practising placement of periurethral slings, simulators for examining female breast and pelvis.

Yogya Karma

Sushruta in *sutrasthana* mentioned the *yogya karma*. According to him the preceptor should see his disciple attends the practice of surgery even if he has already thoroughly mastered the several branches of science of medicine. A pupil otherwise well read but uninitiated in to the practice is not competent to take in hand the medical or surgical treatment of disease.[14] Sushruta describe various procedures in surgery and the objects on which these procedures to be practiced.

- *Chhedan Karma* – Specific forms of incision should be taught by making cuts in the body of *Pushpaphala* (A kind of jourd) *Alabu*, *Kalindak* (Watermelon), *Trapus* (Cucumber), *Ervaruk*. Making cuts either in the upward or downward direction should be similarly taught.

- *Bhedan Karma* –Excisions should be practically demonstrate by making opening in the body of full water bag, or in the bladder of dead animal or in the side of leather pouch full of slime.
- *Lekhan Karma* –Scrapping should be instructed on piece of skin with hairs.
- *Vedhan Karma* - Venesection should be taught on vein of dead animal or with help of lotus stem.
- *Eshan Karma* –Probing and stuffing should be taught on worm eaten wood or on reed of bamboo or on mouth of dried gourd.
- *Aharan Karma* –Extraction should be taught by withdrawing seeds from the kernel of *bimbi, bilwa* or jack fruit, extraction of teeth from the jaws of dead animal.
- *Vistravan Karma* – Secreting or evacuating should be taught on surface of *shalmali* plank covered with bees wax.
- *Seewan Karma* – Suturing on pieces of cloths and skin,
- *Bandh* - Bandaging learned on specific limbs of full sized dummies made by stuffed linen.
- *Agni Kshar Karma* – Cauterising or applying alkaline preparation should be demonstrated on soft flesh piece.
- *Karna sandhi bandha* –Plastic surgery of ear should be demonstrated on soft muscle or stem of lotus.
- *Netrapranidhan, Basti, Vran Basti* – The art inserting syringes, enema taught to insert tube in to lateral fissure of a pitcher full of water or in to mouth of gourd.[15]

According to Sushruta, an intelligent surgeon who has tried his practice hand in surgery will never lose his presence of mind in his professional practice.[16]

RESULT

The aim of implementing simulation based training in surgery is to provide a complimentary experience which help in accelerating the learning and enhancing the patient encounters. Although the literature supports both synthetic and virtual reality training in technical skill, there are some limitations for their use. Many simulator models are developed in modern era with taking into consideration the basic concept of Yogya as described by Sushruta, the father of surgery. Hence we must say that Sushruta is the pioneer of simulation in clinical and surgical education.

DISCUSSION

Recent technological advancement is centralized around the idea developing new skills. The introduction of minimally invasive surgery, computer assisted and image guided procedures demands familiarisation with technology and development of new skill by trainee and established experts to want to adapt the new technologies in there practice.

From the overall study it is clear that the Sushruta has already mentioned the so called simulators to train his student in surgical skill. In modern era the basic of principle of *Yogya* is taken as pillars for simulations. Many advanced technologies is continuously inventing in abroad to make simulators best and mimic to real life. In India there is need to develop this technology more.

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