



Ancient Concept of Simulation in Perspective of Ayurveda

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Ayurveda, the native healthcare system of India, is a rich resource of well-documented ancient medical knowledge. Although the roots of this knowledge date back to the *Vedic* and post-*Vedic* eras, it is generally believed that a dedicated branch for healthcare was gradually established approximately between 400 BC and 200 AD.

Objective of this review is to hint at preliminary understanding of ancient concept of simulation and to record the Ayurveda as trailblazer when reviewing the mile stone in the history of simulation. Literature regarding simulation were collected through various search engines like as PubMed, Medline, Google scholar. Classical text of Ayurveda Charak, Sushrut, Vagbhat and Chakrapani, Dalhan commentary were referred to collect ancient view of simulation. Literature available was analysed critically. It was found that preliminary concept of simulation hinted in Ayurveda as imblaze in establishing the basic concept of simulation.

Keywords: Ayurveda; bandh; shawavichedhan; simulation; yogya.

1. INTRODUCTION

Health education has gone through remarkable changes all over the world. Simulators are now extensively used in various high-risk occupations [1,2]. When accessing the discovery, medical simulation takes place in a cumulative fashion not creditable to a single discovery [3]. In 1956, Benjamin Bloom defines the aim of the education system. Bloom's create three domains cognitive, affective, and psychomotor [4]. Cognitive domain explains expertise relation to brain as knowledge. Affective domain focused on behaviour, attitude and valuing morals related with heart. psychomotor domain is related with skills of hand as imitation, manipulation, presion [5] *Sushruta* gives major directions for medical simulation before 200BC [6]. This is suggestive of the existence of the standard medical practice during ancient times, similar to the registration of a health worker of the present days [7]. There are many advantages of using simulation in training. Simulation tools serve as an alternative to real patients [8]. The extent of clinical exposure to certain basic procedures are not possible because of a lack of patients [9]. *Sushruta* gives a major direction for practical approach as he was a surgeon. For that purpose he gives valuable concept of *yogya*(practical training), *bandh*(bandage), *shawavichedhan*(dissection) to enhance student's practical and clinical skills [7][10]. However, upon careful consultation of the diverse sources of mainstream medical literature in the list of prominent contributions, one does not come across any of the contributions credited to *Ayurveda* literature. So with this review authors want to hint preliminary understanding of ancient concept of simulation, and to record the important contribution of Ayurveda in establishing the basic concept of simulation in medical field.

1.1 Objective

To hint and record preliminary understanding of ancient concept of simulation in perspective of Ayurveda.

2. MATERIALS AND METHODS

Classical texts of *Ayurveda* viz. *Sushruta*, *Charak*, *Vagbhat Samhita*, *Dalhan* commentary, *Chakrapani* commentary were studied for research references of *yogyavidhi*, *bandhvidhi*, and *anukatva*. Literature available regarding modern simulation methods through various

search engines as PubMed, Medline, Google Scholar was also collected. These references from both streams of knowledge were compared and analyzed critically.

3. DISCUSSION

Clinical skills and theoretical knowledge are two equally important parts of medical education. A crucial challenge for medical undergraduates is the implementation of their theoretical knowledge to manage the patients. Today's major issue is that medical students and graduate doctors have remarkable deficits in their clinical skills [11][12]. Healthcare simulation is a branch of simulation related to education and training in the medical fields of the various school. Healthcare simulation can be said to have four main purposes education, assessment, research, and healthy system integration in facilitating patient safety. In the past, its main purpose was to train medical professionals to reduce errors during surgery, prescription, crisis interventions, and general practice [13]. In the medical field, one can find its origins in antiquity, when models of human patients were built in clay and stone to demonstrate clinical features of diseases, and their effects on humans [14]. If we overlook the modern era of medical simulation In 1994, the Center for Medical Simulation (CMS) put the first commercially produced, full-featured mannequin simulator to help train clinicians in teamwork and crisis management.

For performing any clinical work knowledge, attitude and skills are very important factors. Benjamin Bloom created bloom's Taxonomy for categorizing levels of obstruction- thus providing a useful structure in which to describe lesson plan components. It defines three domains of learning as cognitive, affective, and psychomotor domains. The cognitive domain concern with knowledge, the affective domain related to attitude, feelings, and the psychomotor domain is about performing skills [15].

In the ancient system of medicine *adhyayan* (study), *adhyapan* (teaching), and *tadvidsambhasha* (healthy discussion) were the means for acquiring knowledge [16][17]. Near about 500 BC *Acharya* mentioned the qualities of a good physician in the form of *chatushpada* (quadruple) as *pariyavadata* (excellence in theoretical knowledge), *bahushodrushtakarmata* (extensive practical experience), *daksh*

(dexterity), and *shouch* (cleanliness) [18]. As Bloom's taxonomy defines the goals of the education system, likewise qualities of *bhishaka* among *chatushpada* could define the goals of the ancient education system. The psychomotor activity itself needs cognitive, and affective domains, so it is a higher-level domain. Because without having knowledge and attitude we cannot perform any skills individually. In *Ayurveda* third quality of *bhishak* is *bahushudrushtakarmata* means having extensive practical experience; the fourth quality is *daksh* means dexterity. *Acharya Sushruta* had given importance to the practical approach as he was a surgeon. He mentioned that to be fit in surgical practices one should acquire theoretical knowledge with practical experiences [19]. The psychomotor domain is an important area that mentioned the goals of the education system related to the skills of course. The level of a psychomotor domain involves perceiving, patterning, accommodating, refining, varying, improvising, and composing. All these steps are gathered under three headings imitation, control, and automatism. Imitation means pay attention and observe the procedure and tries to repeat it, control means perform under the guidance of a teacher and automatism means perform independently [5].

3.1 *Yogyasutriya*- the Major Contribution of *Ayurveda* in Simulation

Sushruta devoted a complete chapter *Yogyasutriyam* (practical training) to make a student fit for surgical work. In the view of *Sushruta*, though the student has understood the elements of the science fully. He must be made competent (*yogya*) because by acquiring only theoretical knowledge and no practical training, he becomes unfit and incompetent for surgical procedures. With this purpose, *Sushruta* explained and demonstrated different kinds of *yogyavidhi*. *Sushrut* does not only illustrate the chapter by name *Yogyasutriya* for making a student capable of surgical work but also explains different kinds of *karmabhyasa* (practical training). A different kind of *chedana* (excision) is one of the *shastrakarma*. Excision use for the treatment of various diseases, but we cannot perform it directly on the patient. First must need to practice *chedanakarma* on *puspaphala* (pumpkin), *alabu* (bitter gourd), *kalindaka* (watermelon), *trapusa* (cucumber), *ervaruka* (Eclipta prostrate), *karkaruka* (*Calotropis gigantea*), etc.; *Utkartana* (excess cutting) and *apakartana* (inadequate cutting) should be instructed practically. *Bhedana*

means spitting or dividing. We do not perform *bhedana* karma directly on the patient for that purpose we should use bellows, a urinary bladder of animals, a leather sack, and such others filled with water or slush. *Lekhana* means scraping or scarification. This karma is done by using a broad sheet of leather with hairs. *Vedhana* means puncturing done by using the veins of dead animals and stalk of the lily plant. *Eshana* means probing or exploring done by using the holes in a piece of wood eaten by moths, bamboo, *nala* (a kind of hollow reed), and *dryalabu* (bitter gourd). *Aharana* means extracting or pulling out done by using a fleshy portion of *panasa* (jackfruit), *bimbi* (red gourd), *bilvaphala* (wood apple), and teeth of dead animals. *Visravana* means draining fluids by using a plank of *shalmali* wood smeared with beeswax. *Sivana* means suturing, sewing, or joining by using thin *bandha* (bandaging) by using models of manikins prepared from mud, cloth, etc., and parts of the human body. Applications of fire (branding) and alkali (thermal and alkaline cauterise) on soft muscles. Fabricating the ear, joining the served ear, and bandaging by using soft skin, muscles, and hollow stalk of lily plant. Washing/bathing of eyes and wounds should be shown using a pot having a beak at its side containing water or by the mouth of the *alabu* (empty bitter gourd) [20]. *Sushruta* says that in this way the intelligent, who has made fit himself by using methods and techniques suitable for practical training described in the texts, does not falter in his actions. *Sushruta's* great effort to give utmost importance to practical training and make every student fit to perform surgical procedures [21] (Fig. 1).

3.2 *Bandha* (Bandaging)

Bandha means bandaging due to which wound healing, and stability of the bony joints is obtained [22]. There are some materials useful for bandaging; these are, cloth made from *ksauma* (flax), *karpasa* (cotton), *avika* (sheep wool), *dukulaka* (inner bark trees), *kauseya* (silk), *patorna* (wool of leaves), *cinapatta* (silk cloth), *charma* (hide), *antarvalkala* (inner layer of barks), *alabusakala* (pieces of bitter gourd), *rajju* (rope), *tulaphalasantanika* (pad made from the wool of silk cotton fruit) and metals (sheets of silver, copper, iron, etc.); these are to be used as material for bandaging. Fourteen patterns of bandaging viz, 1. *Kosa* 2. *Dama* 3. *Svastika* 4. *Anuvellita* 5. *Mutoli* (or *pratoli*) 6. *Mandala* 7. *Sthagika* 8. *Yamak* 9. *Khatva* 10. *Cina* 11. *Vibhandha* 12. *Vitana* 13. *Gophana* and 14.

Panchangi. Their shapes are generally implied in their names themselves [23]. *Kosa* means a cocoon-like sac, envelop, or scabbard. It is a kind of bandaging that should be used for the thumb, finger, and joints of the finger. *Dama* means wound round like a belt used for the painful part. *Svastika* means cruciform like plus mark. It is a kind of bandh used for the joints such as *kurcha* (area over metatarsals), between the brows, between the breasts, palms, soles, and ears. *Anuvellita* means bent underneath or twisted kind of bandh used for the extremities. *Mutolior Pratoli* is a broad winding for the neck and penis. *Mandala* means round disc-like, ring-like, or circular kind of bandh used for parts that are round/cylindrical. *Sthagikameansto* conceal or stump like used for the tips of the thumbs, fingers, and penis. *Yamaka* means twin, double, or with two folds/parts used for two wounds side by side. *Khatva* means swing or hammock-like used for the lower jaw, temples, and cheeks. *Cina* means threadlike, 'T' shaped used for the outer canthus of the eyes. *Vibandha* means obstructive, binding from both sides used for the

back, abdomen, and chest. *Vitana* means tent-like, canopy-like used for the head (scalp). *Gophana* means horns of the cow used for the chin, nose, lips, shoulders, and urinary bladder. *Panchang* having five parts, five tailed used for organs above the shoulders or that kind of bandage which gets well-placed (sitting tight) on the part may be selected and applied [24]. In addition to fourteen types of bandaging techniques (*bandhanakarma*) according to the site of application, three types of bandaging knots (*yantrana*) and dressing material from organic and inorganic sources have been described. The patient as a whole has been taken into consideration. Bandaging methods vary according to the psycho-somatic constitution of the patient (*prakriti*), the status of body dosha, site of the wound (*desha*), and seasonal variables (*kala* and *ritu*). He has described the conditions where bandaging should be avoided. The role of a diet and lifestyle regimen (*ahara* and *vihara*) has been emphasized in a separate chapter (Fig. 2).

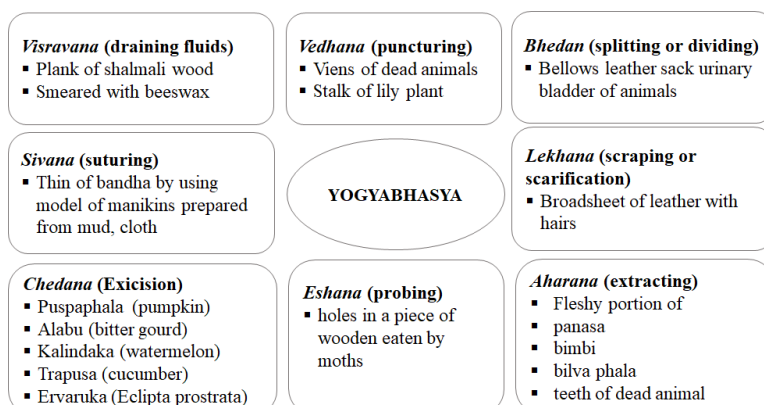


Fig. 1. Different methods of Yogyabhasya mentioned in Ayurveda

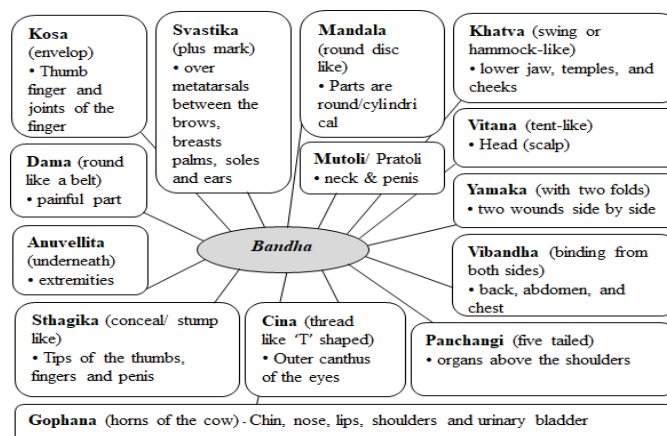


Fig. 2. Different types of Band mentioned in Ayurveda

3.3 Mrutshodhan (Dissection)

Good knowledge of anatomy is a prerequisite for the practice of surgery. *Sushruta* was the first to evolve the concept of anatomical dissection on dead bodies (*shavavichhedanakarma*) and the concept of experimental and practical training (*yogya*) by making use of experimental modules like a dummy, parts of dead bodies, and different natural objects; to gain proficiency in operative surgery. 'Practice leads to perfection is a universal principle advocated by him for all the surgeons of all the time. Hence, a dead body of a man, having all its parts, not dead by either poison or chronic disease, not of hundred years of age should be obtained; faeces present in the intestine should be removed; then the body is wrapped either with *munja* grass, *valkala* (inner bark of trees), *kusa* grass, *sana* (hemp) or any such as material, tied well and placed inside a cage, which is kept in a slow running stream, at a hidden place and allowed to undergo putrefaction. After knowing that it has become properly putrefied, it should be taken out, removed of its banding, and investigated for seven days, scrubbing it slowly (carefully) with brushes made from *usira* grass, *vala* (hairs of the tail of animals), *venu* (bamboo), *balvaja* (a kind of grass) or any other similar material and observe with his eye, all the major and minor parts like the skin, bones, joints, ligaments, and organs, etc [25].

3.4 Anukatva - Animals as Simulator

In the present era there are so many advanced techniques that come in simulation still there are some technical difficulties also come in simulation technique such as physical findings like skin colour, eye color, mental behaviour, etc. cannot be taught in simulators. But before 200BC *Sushruta* describes animals as a simulator to describe skin colour, hairs, nails, eyes colour, voice, body structure, etc. [10] There are three types of body constituents such as *vata*, *pitta*, and *kapha*. The person of *vata prakriti* is described as imitating goat, goyal ox, rabbit, rat, camel, dog, vulture, cow, donkey, etc. in their physical findings and mental behaviour. The person of *pitta prakriti* imitates in their activities, animals such as snake, owl, cat, monkey, tiger, bear, and mongoose. The person of *kapha prakriti* imitates in their activities and mental behaviour in animals such as lion, horse, elephant, cow, bull, red eagle, and swan. For example, The person of *vata prakriti* is very talkative, quick in a walk, wanders

too much and unsteady in mind, and is imitating animals like rabbit, dog, donkey, and crow. In the person of *pitta prakriti* body parts are yellowish and flabby, nails, eyes, palate, tongue, lips, palms and soles are coppery in colour and are imitating a tiger. The person of *kapha prakriti* is beautiful to look at, has white eyes, has a loud voice, and imitating like animals such as swan, lion [26].

simulation: Simulation based medical education is defined as any educational activity that utilizes simulation aides to replicate clinical scenarios. Medical simulation allows the acquisition of clinical skills through deliberate practice rather than an apprentice style of learning [27]. Commonly three types of simulations used live, virtual and Constructive. It is one of the useful method which can easily tested, transferred, and understood the deep practical knowledge of the subject. In medical disciplines, simulation modeling provides valuable solutions to solve the critical problems.

3.5 Limitation of Simulation

Generation to generation technology changes and advanced technology in the field of simulation comes. 21st century brought real breakthroughs due to the sudden development of technology. As a result of recent years of innovative development and accepted innovative solutions, the modeling of complex medical procedures turned more realistic. Though the current state of science finds that simulation usually leads to improved knowledge and skills, learners and instructors express high levels of satisfaction with the method that was already told in ancient science, but several types of simulations are not affordable to many teaching hospitals. There are some disadvantages of simulation because human systems are very complex and diverse. Sometimes models and instruments can never match humans completely. Poorly designed simulations can encourage negative learning. Even if the simulation is done in a realistic setup, it still isn't real, because these students get a freeze during real clinical situations [28]. Simulation is not a low-cost effort in training. Hence they are not affordable to many teaching hospitals. When the software and hardware of the simulation break down, the money will again be shelled out to repair or replace them. Technical difficulties also come in simulation techniques such as physical findings like skin colour cannot be taught in simulators [29,30].

4. CONCLUSION

Technical skills are very important in clinical practice. The above review reveals that *Ayurveda* places great emphasis on simulation in the form of *yogyavidhi*, *bandhvidhi*, *anukatva*. *Ayurvedic* simulation has come a long way from the basic task trainers used for the rehearsal of basic skills to the high fidelity human patient simulators. Adaptation of the above tools can provide easily available, cost-effective simulators. As *Ayurveda* is a competency-based science should be recognized as a pioneer in the foundation of simulation.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

RESEARCH SIGNIFICANCE

The study highlights the efficacy of "Ayurveda" which is an ancient tradition, used in some parts of India. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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