Original Research

Simulation in Medicine: A Boone or a Bane?

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Abstract

Living through the pandemic years has enlarged our perspective on significance of technology and technologically driven services such as Artificial Intelligence, Virtual Reality, Augmented Reality, and the rest of the Internet of Things (IoT). Advances in AI and its employment in healthcare especially in the form of simulation technology, has made revolutionary changes in rendering effective medical training with many educational institutions modifying their conventional approaches in order to impart better clinical knowledge and practice to students in their pre-clinical years. The purpose of this study was to gain an insight into the student's viewpoints and preferences with respect to simulation technology over real-time clinical training. An online survey was conducted in February 2023 and data on perception towards simulation technology was collected using a self-administered questionnaire with responses in a 5-point Likert's scale. A reliability test was performed between the items of various variables using the SPSS program version 29.0.0.0 A poll from 200 participants was received and evaluated, and it demonstrated a favorable attitude towards the use of simulation in medical training, particularly in terms of practicing clinical skills, gaining confidence, and learning comfort. The effectiveness of this technology in dealing with infectious, urgent, or atypical patients however, remains unclear and disputed. Although simulation technology is seen as a beneficial supplementary aid for medical training, its advantages over traditional training remain debatable due to the limitations posed by it; thereby, emphasizing the importance of a multimodal approach in training.

Keywords: Artificial Intelligence, medical training, multidisciplinary approach, simulation technology, clinical experience, learning comfort.

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Introduction

Medicine is an ever-evolving field that demands up-to-the-minute interventions, ranging from laboratory work, diagnostics to surgical procedures. Despite the fact that all professional competencies have recently undergone a huge technological revolution, the application of technology, notably in medicine, has been exemplary. The pandemic years have helped us solidify our understanding of the importance of internet and its related services particularly, in accomplishing routine tasks in the most ingenious ways such as attending universities, hosting medical conferences, initiating research studies, and providing patient consultations, amongst many other things. The soaring potential of certain technologies like Virtual reality (VR), Augmented Reality (AR); Extended Reality (ER) and many more in medical science has compelled us to inculcate a bimodal mode of learning who aims at tackling certain inconveniences that are otherwise faced during conventional learning.[1] There is no clear demarcation of specific-technology associated advantages in educational settings as they can be interchangeably used with each other to aid in the training process.[2-3] Of all these technologies as for example, growing ethical concerns especially with respect to students and residents practicing on real patients as part of their training has lately prompted a call for an alternative that would fill the educational gap produced by these blunders.[4] Moreover, for elucidating the "Medical educators dilemma," a solution aimed not only at addressing ethical concerns of clinical

Practice but also at providing adequate clinical skills and precision was required, thereby introducing the use of simulators for not only undergraduate medical studies but also post-graduate specialty courses.[5]

Medical simulators strive to replicate real patients, physiological processes, or typical clinical events in pre-programmed environments to improve learning quality and comfort.[6] Its main accomplishment lies in overcoming general and ethical concerns about cadaveric dissections, patient safety and availability, recurring medical errors, exhaustive clinical trainings and so on. A simulator exposes professionals/students to pre-programmed clinical scenarios, allowing them to reflect on their theoretical knowledge and utilize it through means of practical demonstration, allowing them to make mistakes without endangering any patients or their professional identity.[7] It allows for the teaching of invasive procedures like intravenous drip placement, intubation, bronchoscopy, suturing, biopsies, and much more with ease, which in contrast; are exceedingly difficult, unrepeatable, and unpleasant if and when performed on real patients. It also exposes and familiarises the students/resident doctors to rare clinical scenarios which would be otherwise difficult to encounter on routine practice.[8-9] Furthermore, it ensures the provision of a risk-free

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environment for both; the patient as well as the physician thereby promoting maximum learning opportunities.[10] According to a recent study, residents practicing laparoscopic and resuscitation procedures on simulation dummies had greater surgical proficiency skills and were greatly benefitted in contrast to those educated through observational learning.[11-13] Simulation has widened our training scopes and has demonstrated a good, pragmatic impact in a multitude of medical training domains ranging from complex surgical competencies to nursing programs.[8] Their precision in delivering technical and practical skills has been appreciated in various field of medicine including internal medicine, Family medicine, critical care, rehabilitation and so on.[14] With further advancements, simulation is expected to be a reliable tool in the future for improving communication, teamwork, and other intrapersonal and interpersonal skills.

Variables impacting the use of simulators

One of the clearest examples of the value of technology driven education is the use of simulation in aviation training. Flight simulators are critical for educating the next generation of pilots and familiarizing them with their sophisticated gear.[19] Utilizing a similar concept, medicine too has modified its approach from "Conventional mentor/observational training" to "AI supported clinical training." Pre-programmed clinical setups, Currently, a wide range of simulators Have been developed, including a) Part-task trainers, b) Computer-enhanced mannequins (CEMs), c) Virtual reality (VR) simulators, and d) CAVE simulators (cave automatic virtual environment), with the former being relatively inexpensive and widely employed for the undergraduate training courses.[9,15] Regardless of their differences, the aforementioned tech-savvy interventions play an important part in developing students' capacities to deal with real-life emergency circumstances and aids in competency assessment.[16] Given the complexity and uncertainty of this profession, ofcourse, the experience provided by a simulator solely cannot and should not be considered sufficient in training future doctors;[17] however, other factors such as engineering limitations, cost, time constraints, and variable psychometric requirements also play a critical role in marking its limitations.[18]

according to a survey, considerably aid in student learning and, on a broader scale, Improve physicians' accuracy, confidence, management, and analytical skills when contrasted to chaotic unplanned conditions experienced in clinics.[20] As of now, the following are some of the pressing factors motivating us to advocate for simulation technology: a) a lack of physician availability (due to their own occupational commitments); b) significant time constraints, particularly when it comes

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to educating in emergency situations; c) patient safety; d) cost; e) unbefitting hospital affiliations; f) an increased likelihood of encountering medical errors and g) Certain ethical concerns as previously indica concerns as previously indicated.

Benefits and Flaws of Incorporating Simulation Technology

Simulation supports medical training in a variety of ways, with (Figure 1) illustrating some of the key benefits and drawbacks of this technology. Aside from ensuring patient safety, one of the most significant benefits is 3D visualization of the body's organ systems, which allows for better anatomical understanding and the development of newer surgical approaches when dealing with patients. Simulators can also be used to address patients' anxieties about surgeries or surgical procedures by allowing them to pre-witness the surgical experience using virtual technology.[21-22] Surgeons, particularly those who practice microsurgery, such as neurosurgeons, ophthalmic surgeons, orthopaedic susurgeons oncologists, laparoscopic laparos surgeons, and others, benefit greatly from simulators in terms of developing practice, estimating location, evaluating the content, and developing patient-centered treatment/surgical approaches.

In terms of students and medical and medical institutions, simulation effectively addresses challenges such as extended clinical training hours, lecturer unavailability, and handling extensive patient data, ethical concerns regarding repeated learning of clinical skills.[23-24]

Some institutions have also viewed this This technology as a "One-time heavy investment" due to the high set-up costs associated with implementation.[24]

However, as we move toward a bimoda learning trend, the future prospects offered by this technology appear profitable and convincing.[22]

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Figure 1: Discusses the advantages and disadvantages of simulation in medicine.

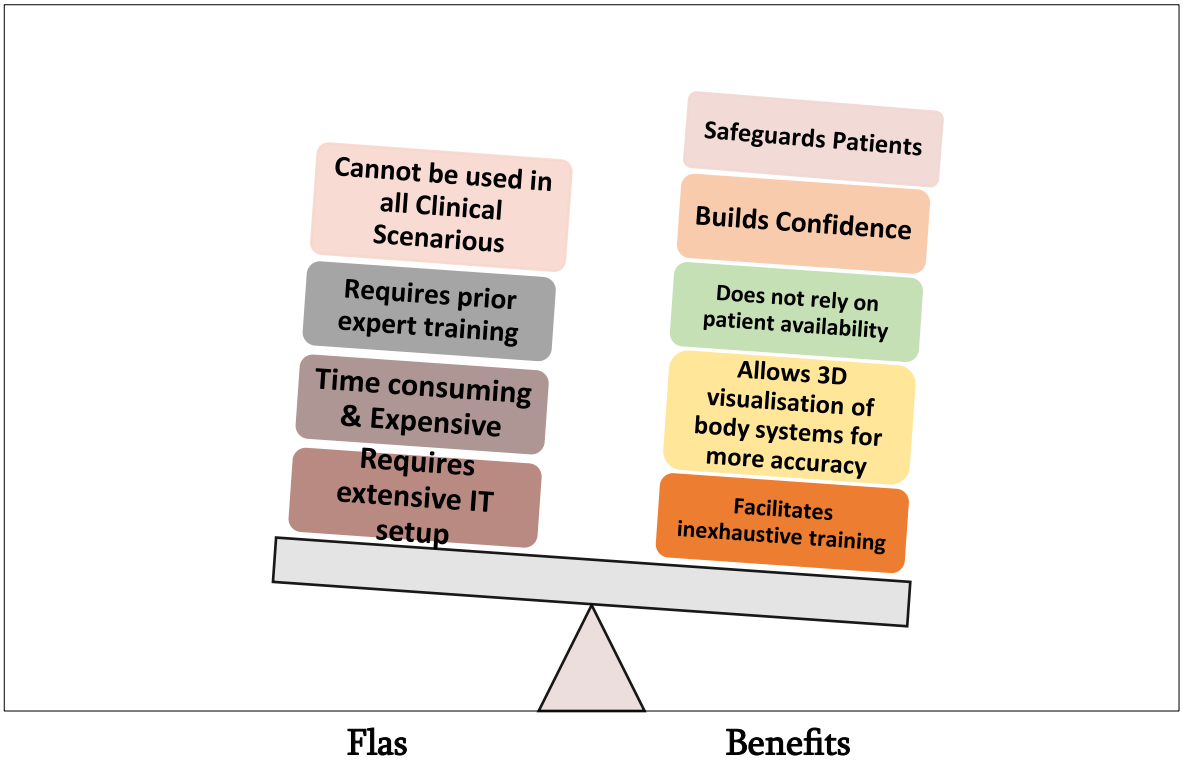

Figure 1: The following figure compares the benefits and flaws of implementing simulation technology in medical training. The benefits offered however, outweigh the flaws making it a reliable tool for educational training.

Materials and Methods

Assessing students' viewpoints and evaluating their acceptability of simulation technology was the primary purpose of our research. An online questionnaire-based survey supplemented our study. Our questionnaire included fifteen closed-ended items, where five each measured one of three variables: a) Students' Perceptions b) Perceived advantages of technology and c) Students' Preferences. The questionnaire was created using Google forms and distributed to students via email and other social networking sites. A four-point Likert scale was used to score responses to the questions, which varied from strongly agree, agree, disagree, to strongly disagree, with strongly agree assessed with a maximum of 4 points and strongly disagree graded with a minimum of point 1. A total of 200 responses were received from participants studying across various countries. The data was collected and a reliability test was performed between the variables using the SPSS program version 29.0.0.0; the rest of the analysis was carried out by reviewing the graphs obtained through the survey. The outcomes were produced, and conclusions were expressed.

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Table 1. Research Questions for the Study

Variable 1: Assessing Students' Perception

RQ1 Do you believe that training in real-world scenarios provides a professional/clinical benefit over training in controlled conditions (simulation labs)?

RQ2 The use of simulation models in certain medical specialties like infectious diseases is highly questionable

RQ3 Physicians trained in simulation clinics might not be able to handle stressful situations that regularly arise in the hospital settings

RQ4 You would rather trust in a physician who has completed the most of his physical OPD visits over one who has been training on simulation dummies

RQ5 One of the major drawbacks of employing AI over real-time exposure is the lack of development of interpersonal and communication skills

Variable 2: Assessing the perceived advantages of Simulation

RQ1 Practicing on simulation dummies gives same level of accuracy as practicing on a real patient

RQ2 Physicians establish confidence and sense of control over their practice when they perform clinical procedures using simulation models

RQ3 AI clinics facilitate better learning comfort and customization in contrast to real-time training

RQ4 Working with simulators offers you the ability to make mistakes without endangering patient safety

RQ5 A doctor trained in simulated clinics can possess comparable clinical judgement skills as those trained in hospitals

Variable 3: Assessing Students' Preferences

RQ1 Simulation clinics are an essential part of medical training

RQ2 Adding a dual teaching method (RT exposure + simulation) would improve academic performance in medical training

RQ3 The usage of cutting-edge 3D tables is substantially preferable over traditional dissection for learning fundamental courses like anatomy and surgery?

RQ4 Mark best suited preference for following scenarios - Symptom based learning

RQ5 Mark best suited preference for the following scenario – Developing interpersonal skills

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Results

Realibility is a measure of internal consistency of the constructs in the study. A construct is reliable if the Alpha (α) value is greater than 0.70. Construct reliability was asessed using Cronbach's Alpha. The results revealed that the Students' Perceptions scale with five items (α = .721) and Perceived Benefits of Technology with five items (α = .749) were found reliable. Similarly, student's preferences scale with five items was also found reliable (α = .756). Reliability tests are summarised in table below.

Table 2: Shows the Cronbach's Alpha of the items in various constructs. Items with α values of .70 or higher are considered reliable. The items in the aforementioned structures have an alpha value greater than 0.70 and are hence reliable.

Constructs	No. of Items	Alpha (α)
Student Perceptions' (SP)	5	.721
Perceived Benefits (PB)	5	.749
Students' Preferences	5	.756

Graphical Analysis

For Variable 1

The results obtained in this section revealed opposing views on real-time training versus simulation training. Numerous responses were seen supporting RT training for its effectiveness in handling emergency Situations, atypical clinical scenarios, and infectious outbreaks, underlining the importance of a physical approach in clinics. However, participants were also seen upvoting the usage of simulation, stressing the need for a blended training strategy.

Table 3a: Highlights the results obtained by graphical analysis for Variable 1.

Questions	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
RQ1	56.3	39.7	4	-
RQ2	25.6	58.3	14.6	1.5
RQ3	39.7	44.2	15.6	.5
RQ4	37.2	52.3	10.6	-
RQ5	39.2	50.8	8.5	1.5

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For Variable 2

The perceived advantages of employing simulation technology were examined by variable 2. When it came to learning on simulators, students overwhelmingly preferred aspects like building confidence, learning comfort, customization, and patient safety. However, there were some differences regarding having equal clinical judgement skills when comparing the two modalities, considering the practical experience aspect when it came to clinical decision-making.

Table 3b: Highlights the results obtained by graphical analysis for Variable 2.

Questions	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
RQ1	7	20.6	49.7	22.6
RQ2	17.1	51.8	23.1	8
RQ3	16.6	46.2	28.6	8.5
RQ4	33.2	57.3	8.5	1
RQ5	12.6	46.7	30.7	10.1

For Variable 3

This component evaluated students' learning preferences, with the majority of Participants preferring a dual mode of education that comprised both modalities (RT training+ simulation technologies).

Table 3c: Highlights the results obtained by graphical analysis for Variable 1.

Questions	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
RQ1	61.3	36.7	1.5	.5
RQ2	63.8	33.7	2.5	-
RQ3	34.7	35.2	24.6	5.5
RQ4	RT Training (163) and Simulation (36)			
RQ5	RT Training (173) and Simulation (26)			

Incorporation of VR Technology in Educational Curriculum

In July 2024, University Geomedi officially integrated VR Technology into their educational program for MD Faculty of Medicine students thereby, contributing to cutting-edge academic accomplishment. Multiple VR sets were procured and installed in the simulation lab, assisting in the delivery of high-end academic Competency in the areas of anatomikal study, surgical skills, intensive care unit simulation, laboratory work, and OSCEs. With the cooperation of the university faculty and students, a de novo teaching and learning technique has been implemented with the goal of not only meeting higher academic standards but also developing better practitioners of tomorrow.[25]

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Conclusion

With the progressive technological advancements, simulators have become an integral part of medical training making it necessary for the educational model to modernize. The change from observational learning to practical training supported by AI has improved the performance capabilities of students giving them the correct exposure in their preclinical years. Although the use of simulators in dealing with certain medical competencies or clinical circumstances is still debatable, it plays a crucial role in safeguarding patient's safety, which is frequently compromised in unsupervised settings. Simulations are Moving closer to being fundamental instruments for instructing and assessing students, and in no more time, they may surpass their technical constraints to support the teaching of other interpersonal and social skills. However prime, they still may never completely replace conventional clinical training considering the occult nature of the human body and uncertainty of this profession. Given that "Medicine is a field beyond mathematics," the use of real-time physical training and simulators is equally crucial for enabling the physician to handle any type of clinical scenarios under any given circumstances thereby, providing the patient with the best possible healthcare services and treatment.

სიმულაცია მედიცინაში: სარგებელი თუ ზიანი?

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აბსტრაქტი

პანდემიის წლების პერიოდში, ცხოვრებამ გააუმჯობესა ჩვენი პერსპექტივა ტექნოლოგიებისა და ტექნოლოგიურად ორიენტირებულ ისეთ სერვისებთან დაკავშირებით, როგორიცაა ხელოვნური ინტელექტი, ვირტუალური რეალობა, გაძლიერებული რეალობა და სხვა ინტერნეტმანიპულაციები. ხელოვნური ინტელექტის განვითარებამ და მისმა გამოყენებამ ჯანდაცვაში, განსაკუთრებით სიმულაციური ტექნოლოგიის სახით, რევოლუციური ცვლილებები მოახდინა შედეგიანი სამედიცინო ტრენინგების ჩატარებაზე. მრავალმა საგანმანათლებლო დაწესებულებამ შეცვალა მოძველებული ტრადიციული მიდგომები, რათა უკეთესი

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კლინიკური ცოდნა და პრაქტიკა გადაეცათ სტუდენტებისათვის წინაკლინიკურ წლებში.

კვლევის მიზანს წარმოადგენდა სტუდენტის შეხედულებებისა და პრეფერენციების გააზრება სიმულაციურ ტექნოლოგიებთან მიმართებაში, თანამედროვე რეალობაში, კლინიკური ტრენინგების მიმდინარეობისას. ონლაინ გამოკითხვა ჩატარდა 2023 წლის თებერვალში და მონაცემები სიმულაციური ტექნოლოგიების აღქმის შესახებ შეგროვდა თვითადმინისტრირებული კითხვარის გამოყენებით, 5-ბალიანი ლიკერტის შკალის პასუხებით. ჩატარდა სანდოობის ტესტი სხვადასხვა ცვლად ერთეულებს შორის SPSS პროგრამის 29.0.0.0 ვერსიის გამოყენებით. მიღებული და შეფასებული იქნა 200 მონაწილის გამოკითხვა, რამაც აჩვენა დადებითი დამოკიდებულება სამედიცინო ტრენინგში სიმულაციის გამოყენების მიმართ, განსაკუთრებით, კლინიკურ პრაქტიკაში, უნარები, თავდაჯერებულობის მოპოვება და სწავლის კომფორტი. თუმცა, ამ ტექნოლოგიის ეფექტურობა ინფექციურ, გადაუდებელ ან ატიპიურ პაციენტებთან ურთიერთობისას, გაურკვეველი და სადავოა. მიუხედავად იმისა, რომ სიმულაციური ტექნოლოგია განიხილება, როგორც სასარგებლო დამატებითი დახმარება სამედიცინო ტრენინგისთვის, მისი უპირატესობები ტრადიციულ ტრენინგებთან შედარებით, სადებატო რჩება, გამოთქმული შეზღუდვების გამო, რაც ხაზს უსვამს სწავლების მულტიმოდალური მიდგომის მნიშვნელობას.

საკვანძო სიტყვები: ხელოვნური ინტელექტი, სამედიცინო ტრენინგი, მულტიდისციპლინური მიდგომა, სიმულაციური ტექნოლოგია, კლინიკური გამოცდილება, სწავლის კომფორტი.

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