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Review Article

A Review of Simulation Pedagogy Past and Present; and The Experiences at One Center During the COVID-19 Pandemic

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Abstract

Background: Simulation based education is defined as a series of structured activities that represent real or potential situations in real world practice. During the Covid-19 pandemic, teaching methods for MBBS students which have been developed for decades, but remained at the fringes of medical training, like teaching with simulators, suddenly came into the fore. Hence, this remains the right time to update ourselves with knowledge about simulator use in education, as we can foresee that this teaching modality will continue to play a large role in medicine pedagogy in the years to come. **Methods:** Published papers on the subject were reviewed from Pub Med, Scopus, Google Scholar, ResearchGate (range 2008 to 2023) sources. Feedback was obtained from both teachers and students using a simple questionnaire. While teachers gave a singularly positive feed of their simulation-based teaching experience during the pandemic years, student feedback was a little mixed. Almost all students felt that the simulation-based learning instructions were extremely helpful, but the degree of relevance they felt to their clinical years varied. **Conclusion:** Simulation based teaching has come a long way, especially over the past few decades. Present day tactics use computer screen-based scenarios with step-by-step history taking, clinical examination modules (integrated with hi-fidelity mannequins) and management methods which can lead to cure, complications or death. Students can learn through missteps and can correct their responses. As the healthcare industry rapidly evolves technologically, it will increasingly become dependent on simulation as a teaching method in all levels of medical training in the interests of patient safety and student proficiency.

Keywords: **-** COVID-19, medical teaching, pandemic, simulated clinical teaching, simulation for assessment, simulation pedagogy

Introduction

Over centuries, most practical medical, surgical and gynecological skills have been taught at the bedside of real patients, and these unfortunately exposed patients to risks as the new learners acquired new skills. However, it is only within the last few decades that many medical disciplines are developing simulation methods as a means of training students on not only clinical and procedural skills, but also teamwork and communication. Along with simulation development have come newer methods of training, education, competency, and practical skills (Bienstock & Heuer, 2022).

‘‘Simulator’’ refers to a physical object that may be a full or part of the task that is to be taught or replicated.

‘‘Simulation,” on the other hand, refers to created situations, or applications on simulators for education and training.

The spectrum of simulation may include one or more of the following actions:

1. Verbal (role play on created situations)
2. Standardised patients (actors trained to act as patients)

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3. Part-task trainers (physical simulators or virtual reality based)
4. Computer patient (computer screen based virtual world for communication skills, clinical training or procedural knowledge)
5. Electronic patient (replica of clinical situation which may be mannequin based or virtual reality) (Cooper & Taqueti, 2008)

Simulation based education is defined as a series of structured activities that represent real or potential situations in real world practice. These activities allow participants to analyse and act appropriately to different situations in a simulated environment and consequently, develop or enhance their knowledge, skills and attitudes towards the subject taught.

Rationale for the review:

The world shut down its doors in March 2020, when the WHO declared Covid-19 a pandemic. This threw all education into turmoil, since, apart from some niche courses, most teaching was done in classrooms, face to face. The teaching of healthcare professionals was especially affected as bedside clinical teaching has always formed a major part of medical training. At this point in history, methods which have been developed for decades, but remained at the fringes of medical training, like teaching with simulators, suddenly came into the fore. The rise in simulation-based education also created a need for training of educators, who had not previously been familiar with the advances in technology such teaching entails. Hence, this remains the right time to update ourselves with knowledge about simulator use in education, as we can foresee that this teaching modality will continue to play a large role in medicine pedagogy in the years to come.

Protocol: We used search engines and databases from Pub Med, Scopus, Google Scholar, ResearchGate (range 2008 to 2023) for the review.

A simple questionnaire was used to assess educators and student experiences (appendix 1 and 2)

History of Medical Simulation

One can find the origins of simulation in teaching even in ancient pre-history, when the art of healing was passed on from practitioners to apprentices. Models of human patients built in clay, or stone carvings detailing clinical features of diseases have been found in many ancient archeological sites throughout the world.

Animals have been used for the training of surgical skills since the middle ages, and through to modern times (Jones *et al.,* 2015).

In recorded history, the first written evidence of simulation in healthcare education has been found in the ancient surgical texts of the Sushrut Samahita, which details the use of wooden blocks to train students in different methods of wound management (Owen & Harry, 2012).

In China, during the Song Dynasty (960–1279 CE), doctors used life-sized bronze statues to demonstrate acupuncture sites for students to practice on. These simulators also had the surface anatomy of internal organs drawn on it and holes for needle insertion (Bienstock & Heuer, 2022).

In France, in the 18th century, a midwife named Angélique Marguerite Le Boursier du Coudray developed a cloth model of a baby in the mother to demonstrate and teach both midwives and doctors how to deliver babies (Bienstock & Heuer, 2022).

From the above, we see that models and simulators have been used in medical education for millennia. However, modern medical simulation did not originate in medical schools, but was inspired by simulators in aviation.

The “blue box flight trainers” were a series of flight simulators used in the early 1930s to 1950s by Link Aviation Devices, founded by Edwin Albert Link. During World War II, they were used as the major pilot training aid for nearly all fighter pilots. This kind of simulation created a safe and controlled environment for training of pilots by enabling exposure to high-risk conditions without actually putting the life or limbs of the trainee pilots at risk. Another advantage was that the process could be standardized, as well as set at differing levels of complexity, allowing the trainee pilots to acquire flying skills gradually and improve their levels of expertise in a step-by-step manner (Jones *et al.,* 2015).

Taking their cue from aviation safety measures, in the early 1960s, Peter Safar wanted to find a safer way to teach cardiopulmonary resuscitation to his students. Collaborating with a plastic toy manufacturer named Ausmund Laerdal, he designed a realistic model to demonstrate mouth-to-mouth breathing and chest compressions that allowed his students to practice the technique without harming dying patients. He named this mannequin Resusci-Anne. This is the story of the origin of the most widely used CPR mannequin in medical education till date (Jones *et al.*, 2015).

The use of trained actors to simulate patient encounters was first recorded by Howard Barrows in 1964. These were called "standardized patients," and they simulate a clinical case in a standardized way (Jones *et al*., 2015).

With advancement of hardware and software technologies in the late 20th century, mannequins that could actually mimic pathological responses and provide feedback were produced. At Stanford University, a group led by David Gaba developed a comprehensive anesthesia simulation environment (CASE) mannequin in 1988 that incorporated the aviation model of "crew resource management," enabling teamwork training using scripted case scenarios. The use of CASE allowed for training of the anesthesia and surgical teams in the management of emergencies in "lifelike" real time (Jones *et al*., 2015).

Hence, we see that skills-based training on mannequins is one way to ensure that clinical skills are taught in a standardized way, and helps bridge gaps created by the pandemic due to non-availability of hospital training. In addition, during the covid pandemic, simulations have enable clinicians to develop the skills on proper infection control measures and management of Covid patients in prone position in the intensive care units, and stay in touch with newer clinical techniques (Bienstock & Heuer, 2022).

Simulation-based training is especially useful in the training of procedures that are infrequently seen in clinical practice and those procedures that have a learning curve which can be risky on a live patient when performed by a less skilled clinician (Wang *et al*., 2008).

Since the pandemic, even basic clinical teaching has begun to involve simulation training, and this is going to become more popular as time goes by.

With increased technological advancements, Virtual reality (VR) is becoming a new technology where the simulation of the clinical environment is created through a computer, and there is communication with a patient through a receiver. Virtual reality consists of a virtual environment's graphic system as well as information software output tools (vision, hearing, and tactile) and input devices (mouse, gloves, etc.). In a virtual environment, all the features of a clinical scenario can be reproduced based on the type of treatment and the student's level of learning. In addition, individuals can see the results of their intervention and correct them as required. VR is used for three-dimensional (3-D) visualization of anatomy for medical education, VR surgical simulators, and realistic surgical operating rooms.

Most studies on the use of virtual reality have obtained positive reviews with conclusions stating that it is better for clinicians to be trained by simulation before attempting any treatment on patients, especially while performing invasive interventions. However, a small number of studies also reported no significant difference of the virtual reality applications as compared to real world training, so further studies are required to confirm this method as a means of training. Also, the presence of a trained instructor is essential to develop positive effects of simulation-oriented syllabus on transferring skills to the operating rooms or intensive care units. Absence of a skilled instructor can lead to poor performance since proper clinical and operative skills need to be demonstrated as well as learned (Samadbeik *et al*., 2018).

Like in gaming scenarios, augmented reality (AR) is another technology that can create digitally generated 3-D representations of a patient or scenario which is integrated with the real environment via a headset-cum-eye-wear worn by the user. AR can enhance the way medical students interact with online or tablet-based images by enabling them to picturise the model in 3 dimensions as well as manipulate the image with their hands, allowing for a truly immersive experience (Dhar *et al*., 2021).

Screen-Based Simulation is positioned slightly lower than VR on the fidelity spectrum. These are conventional computer screen-based simulators, which represent less detail of the physical environment, but can still help in development of clinical judgment and cognitive skills that are required to manage a complex clinical situation in a reliable and predictable manner. They also offer significant flexibility of time and place for training exercises. One can record the training event as well, so that all correct or incorrect decisions or actions of the trainee are captured and tracked, and can be

used for re-training. In addition, this method does not require an instructor to be present while the trainee is learning the skill. And finally, computer screen-based simulations are significantly more cost effective, compared to mannequin simulation. Learners' feedback on this technology is also very favorable, especially in comparison to a lecture presenting the same material.

Screen-based simulation can be used for assessment purposes as well, especially to assess management decision making, although it is not useful in evaluating psychomotor skills (Ventre & Schwid, 2013).

Another important simulation tool is a standardized patient (SP). These are healthy volunteers who have been trained to act as patients by role-play activities in Objective Structured Clinical Examination (OSCE) training and assessments (Lay-Khim & Yee, 2019). By practicing with SPs, students can develop skills such as patient interviewing, history taking, team collaboration, professionalism, patient education, ethical decision making, patient safety, and general communication skills in a realistic, controlled and safe setting rather than learning directly on distressed and vulnerable patients in real life cases and scenarios. Hybrid simulation is a method that integrates SPs and mannequins to teach communication and practical skills in tandem (Lay-Khim & Yee, 2019).

Another important loophole in medical education has always been teaching medical students how to manage major incidents and disasters. This can be a truly daunting task since major incidents or disasters occur rarely, and are not the best situations for safe teaching and learning experiences, and also may be hazardous to the students and instructors as well. Therefore, simulation based medical education as the teaching tool for disaster management can be an excellent way to teach this difficult area of medical education.

Via simulation scenarios (either online or by VR), the students can learn to use psychomotor skills to elicit clinical findings and triage during an emergency, develop their cognitive domain for diagnosis and management, and affective domain to handle patients and their relatives in stressful situations. This exposure of students can increase confidence levels in handling major disasters as well as minor incidents (Saiboon *et al*., 2011).

Simulation training in Malaysia:

Simulation has been in use as a teaching tool in medical schools in Malaysia for more than 20 years. About three quarters of the teaching institutions have dedicated support staff to manage the simulations centres according to one study (Mohd Saiboon, 2019).

The 10 learning outcome domains of the Malaysian Qualifications Framework (MQF) correlate very well with the six core competencies recommended by the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties. These include medical knowledge, interpersonal skills, communication skills, patient care, system-based practice, and professionalism (Mahdy *et al*., 2020).

Through simulation based teaching and learning pedagogy, students can be taught the approach to a clinical problem, and teachers can guide and assess how they work together through the project. Nowadays, newer methods of teaching via simulation also include Problem Based Learning (PBL) with screen-based simulation, or augmented or VR simulation. Students can work together in groups to discuss how to best manage different clinical problems or scenarios. Especially during the COVID-19 pandemic, PBL through screen-based simulation has been used in many institutions to help instruct medical students (Mahdy *et al*., 2020).

The experience at AIMST University, Malaysia during the Covid-19 Pandemic

During the COVID-19 pandemic in 2021-2022 academic years, non-availability of public hospitals for undergraduate teaching had put a stop to face to face clinical teaching and learning for all medical students the world over, including Malaysia. At AIMST University, the teaching staff developed, implemented and assessed a simulated longitudinal clinical clerkship programme utilizing the Clinical Simulation Centre (CSC).

During this time, "fusion teaching methods" using a multimodal approach of online and simulation based teaching in the clinical skills centre at AIMST University seemed the most appropriate option. Fusion teaching for effective curricular delivery was especially used to deliver clinical teaching to year 5 medical students since they were missing out on direct clinical encounters (Sethuraman, 2021).

Structured, simulation-based clinical teaching using a hybrid model combining simulated patients, normal volunteers, high-fidelity mannequins and other simulation devices were used to teach clinical

medical skills and knowledge. All parameters of learning were taught and assessed via simulation based methods, and communication skills, perceptual skills (auscultation), psychomotor skills (physical examination) and cognitive skills (management) showed statistically significant improvement. All students in a small pilot study found this simulated programme beneficial. This adaptation of longitudinal clinical clerkship in simulation mode has been an original and successful pedagogy effort during the pandemic years at year 5 MBBS level (Singh *et al.,* 2021).

Teacher/instructor experience:

"As a medical simulation instructor during the Covid-19 pandemic, I have worked with undergraduate medical students to help them develop their clinical skills and prepare for real-world patient care. I have personally learned a great deal about the value of experiential learning in medical education."

"The task trainer manikins provided a highly realistic and interactive learning experience, allowing students to practice a range of skills such as suturing, airway management, and catheterization. We also used video recordings of the simulations to review and analyses their performance, allowing for continuous learning and improvement."

"Structure of CSC clinical teaching module has to be carefully planned and executed."

All the instructors and lecturers involved in clinical teaching during the pandemic gave very positive feedback on their experience with simulation based education.

Student experience:

A simple feedback form was created to ask the students who were taught during the pandemic by using entirely simulation based clinical encounters. The questionnaire (see appendix 1) asked the students their opinion on the relevance of their clinical skills training as relates to their real world bed side clinical teaching now; and whether the training they received has made them more confident to face their present clinical years.

A total of 36 students were surveyed (Year 5 MBBS). Student feedback was somewhat more ambivalent; 55 to 60% agreed that their clinical skills centre based simulated teaching was useful in training them to face real world experiences, but only 25-35% felt they strongly agreed with the relevance of simulated training to their medical education.

However, most respondents of the feedback strongly agreed that their simulated teaching gave them the opportunity of a safe environment to practice clinical skills before facing their clinical encounters.

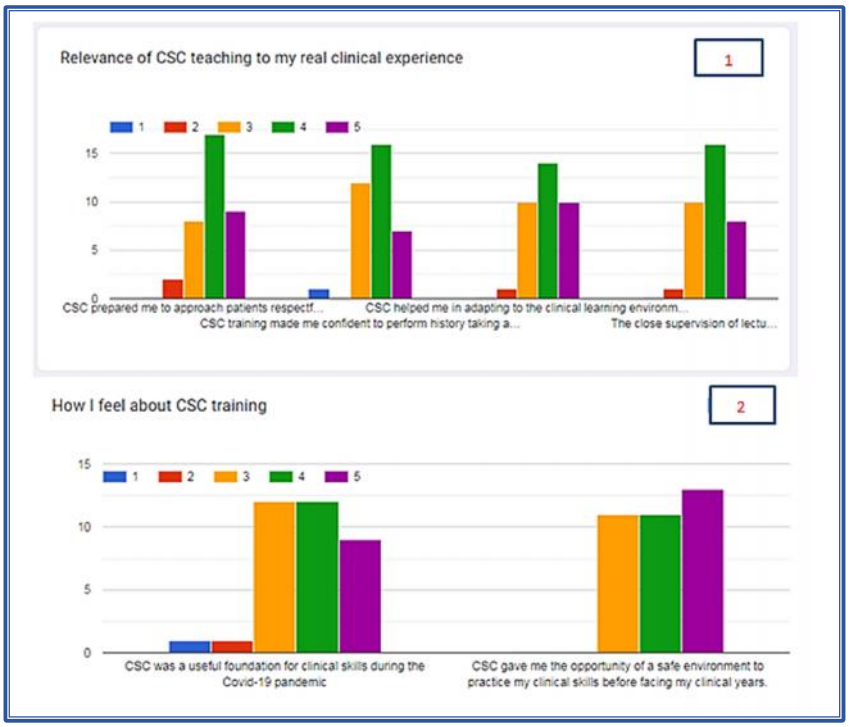

Fig1: Bar chart analysis of student feedback

Advantages and Disadvantages of simulation - based teaching and learning

Advantages

1. Enables standardized evaluation for each student
2. Training can be recorded and reviewed and feedback can be generated
3. Can be paused for correction or re-learning
4. Complex environment and problems can be created to assess meta-cognitive skills
5. Interactive learning
6. Communication skills can be assessed
7. Psychomotor skills can be taught, practiced and assessed
8. Being trained and assessed by using simulation before real patient encounters reduces a patient's risk of harm.

Disadvantages

1. Expensive to buy and maintain simulators
2. Only small groups of students can be taught at a time
3. Performance anxiety may hinder assessment
4. Trainers need to be trained to maintain competency (Levine *et al*., 2012)

Conclusion:

The future of simulation

Simulation based teaching has come a long way, especially over the past few decades. Present day tactics use computer screen based scenarios with step by step history taking, clinical examination modules (integrated with hi-fidelity mannequins) and management methods which can lead to cure/complications/death. VR and AR based teaching with the aid of interactive virtual environments can create immersive experiences for the students to work alone or in a team. All these scenarios progress based on student choices made during the simulated encounter. Students can learn through missteps and correct their responses the second time around.

As the healthcare industry rapidly evolves technologically, it will increasingly become dependent on simulation as a teaching method at all levels of medical training in the interests of patient safety and student proficiency.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix 1 (Student feedback)

We are performing a study on student experiences regarding simulation education during the covid pandemic. Your objective feedback would be greatly appreciated.

Please answer all the statements according to the following 1 to 5 scale:
1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree

Please **circle a number** between 1 and 5 to indicate which response best fits your experience with CSC teaching and its relevance to your performance in the ward now. Do you feel your CSC learning was helpful in preparing you for your clinical experience?

Relevance of CSC* teaching to my real clinical experience					
CSC prepared me to approach patients respectfully and confidently	1	2	3	4	5
CSC training made me confident to perform history taking and examination of a real patient	1	2	3	4	5
CSC helped me in adapting to the clinical learning environment	1	2	3	4	5
The close supervision of lecturers enabled me to develop quality clinical procedural skills and perform them with confidence	1	2	3	4	5
How I feel about CSC* training					
CSC was a useful foundation for clinical skills during the Covid-19 pandemic	1	2	3	4	5
CSC gave me the opportunity of a safe environment to practice my clinical skills before facing my clinical years.	1	2	3	4	5

*Clinical Skills Centre

Declaration: I understand that the above data may be analysed for publication purposes and I agree to let the data be used for this purpose. It has been explained to me that no personal details will be revealed in any publication.

Initials: Date:

Appendix 2 (Trainer feedback)

We are performing a study on educator experiences regarding simulation education during the covid pandemic. Your objective feedback would be greatly appreciated.

Please answer all the statements according to the following 1 to 5 scale:
1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree

Please **circle a number** between 1 and 5 to indicate which response best fits your experience with CSC teaching and its relevance to clinical performance of students.

Relevance of CSC* teaching to real clinical experience					
CSC is a good substitute when correctly adapted to the clinical learning environment	1	2	3	4	5
The close supervision of students helps them to develop quality clinical as well as procedural skills and perform them with confidence	1	2	3	4	5
CSC gave the opportunity of a safe environment for students to practice clinical skills before facing their clinical years.	1	2	3	4	5
How I feel about CSC* training					
CSC was a useful foundation for clinical knowledge, skills and attitudes during the Covid-19 pandemic	1	2	3	4	5
Simulation training is a reasonable substitute for bedside teaching of clinical skills, communication and teamwork.	1	2	3	4	5

*Clinical Skills Centre

Any personal observation you would like to share?

Declaration: I understand that the above data may be analysed for publication purposes and I agree to let the data be used for this purpose. It has been explained to me that no personal details will be revealed in any publication.

Initials: Date: