Review Article

# Simulation in pediatrics: Is it about time?

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## ABSTRACT

Pediatrics is a challenging field where "Time is Essence" and the interplay of time-bound dynamics has a huge influence on the outcomes, particularly in an acutely ill child. In this context, simulation based training appears to play a major role in training young Paediatricians to develop critical decision making skills and learning in a risk-free environment. In present times and in future, it is expected that simulation is used by practically every healthcare provider at some or multiple points in the training and certification process.

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## INTRODUCTION

Acute care delivery in pediatrics is a complex, expensive, error prone, medical specialty, and remains the focal point of major improvement efforts in healthcare delivery. We are now in a complex healthcare system where the stakes of accountability and responsibility are high it patients, health-care providers, administrators, or the law-makers. Acute care especially Emergency room (ER) or intensive care tops the list of time-bound dynamic complexities. There is a need to provide healthcare with the least harm to the patient.

Historically, acute care outcomes have been predominantly attributed to the patient's genetic predisposition, baseline dysfunction, and severity of the insult. Data have shed light on the importance of an additional factor: Human factor. Epidemiologic data suggest that delayed or overly aggressive treatments, poor team dynamics, and certain human factors are among the most important drivers of poor outcomes during critical illness.[1,2]

Simulation offers tremendous promise to improve healthcare delivery, especially in acute care areas. It can be an efficient mode to learn crisis resource management (CRM), unit risk assessment, check situation readiness, implement new protocols, test run new instruments, improve interdepartmental coordination, learn new concepts or procedural skills and also in establishing a new unit.

## WHAT IS SIMULATION-BASED TRAINING OR LEARNING?

Simulation is the creation of a real-life experience in an artificially controlled and interactive environment. Gaba[3] describes simulation more as a technique rather than technology. Although it is recent in medical environment, the concept is not a recent one. The origin dates back to medieval times when soldiers learnt the art of swordsmanship on dummy soldiers.

Simulation-based training involves creation of a real-life scenario: An acute environment such as ER/Pediatric Intensive Care Unit (PICU), common acute emergencies such as seizures,

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septic shock, acute team members such as nurses, doctors, paramedics, parents, and patient, and the dynamic interaction in real-time with real equipment.

Simulation thus allows the learner to experience a real-life scenario in a risk-free environment, reflect on the experience through feedback and structured debriefing, understand the concepts more clearly and experiment/practice in a safe environment at his/her pace. Simulation sessions may help the novice progress up the learning curve faster and acquire the essential technical and nontechnical skills in preparation for real-life.

Simulation, hence, has gained popularity as one of the promising techniques to facilitate learning amongst health-care providers, especially acute care without risking patient's safety.

## TYPES OF SIMULATORS

Simulation-based interventions can be conducted for many purposes: Education and training assessment, improvement in the quality of care, designing of new equipment, etc. These simulation exercises warrant some of simulator use. Types of simulators uses are summarized below.[4-8]

### Part-task trainers

Training of specific skills such as airway management, arterial line, central line, intraosseous line, and chest drain placements can be taught using part-task trainers. Commonly available as manikins or animal models and is useful for novice trainees to understand the techniques and practice in a low-risk situation without any patient harm. Part-task trainers are widely utilized in various skills-based workshops and life support courses.

### Role-play

This is an excellent way to train and assess communication skills. Role-play may be as child actors, parents, trauma victims, pregnant mothers, etc. Role-play sessions are particularly applicable for teaching breaking the bad news, explaining a procedure, taking consent, etc.

### Standardized patients

It is used to demonstrate specific clinical skills and elicit signs, discuss approach and practical management. This is part of the traditional examination popular among various undergraduate and postgraduate curriculum assessments.

### Computer-based simulators

It is categorized on the basis of fidelity. Fidelity is the common industry term used in simulation to describe the degree of realism and technical complexity of models. This is dictated by the needs of the application; more complex is the task, more is the fidelity of the model. Low-fidelity models can be developed and updated rapidly while high-fidelity models cost more to engineer and maintain but are more flexible when applied to different uses. However, not everything needs to be taught in a high-fidelity simulation. A screen text simulator and static mannequins are examples for low-fidelity simulators. Examples of medium fidelity simulators include virtual simulators like video games and mannequins with mechanical movements like AMBU Man (Ballerup, Denmark). A high-fidelity simulator [Figure 1] is a full body computerized manikin that has realistic features, such as blinking eyes with reacting pupils, chests that rise and fall with respirations, palpable pulses, various heart and lung sounds, and the ability to cry, drool, and bleed. They can respond physiologically to interventions, such as medication administration, intravenous fluid infusions, and application of oxygen. They have procedural features to allow chest tube and tracheotomy management, defibrillation, and urinary catheter insertion. Laerdal, CAE, and Gaumard are the most popular companies involved in pediatric simulation.

## SCOPE OF SIMULATION IN ACUTE CARE PEDIATRICS

- Improving patient outcomes
- Discovering system errors
- Improving the quality of education
- Credentialing and exams.

**Figure 1:** High-fidelity simulator

### Improving patient outcomes

CRM is a method of team training that focuses on behavioral skills, resource utilization, communication, leadership, and teamwork. These skills are essential for effective clinical care, yet few medical personnel is exposed to formal training in these areas. Team training has been found to decrease medical errors.[9] Simulation offers an ideal setting to practice methods of CRM in a safe learning environment. A systematic review of team training studies found that 85% of the studies utilized simulation.[10] A 2007 study evaluating the effectiveness of a mock code-based educational intervention on the leadership skills of pediatric residents[11] displayed significantly improved leadership skills compared with residents who did not undergo training. Andreatta *et al*.,[12] showed that conducting simulation-based mock codes significantly correlated with improved pediatric patient cardiopulmonary arrest survival rates.

### Discovering system errors

Communication failures account for many of the issues in patient safety. Simulation can be used to improve communication among team members and theoretically reduce patient errors. Interdisciplinary simulation can be used to identify institutional policies and practices that may be detrimental to patient care. For example, it can use to improve the transition between ER and PICU or between anesthetists and intensivists. Running such kind of simulation can find out situation readiness and the adequacy of handover. Over a 6-month period, the Andreatta *et al*. implemented an interdisciplinary team training and simulation program to improve the management of obstetric emergencies.[13] Transcripts from the debriefing sessions identified five main types of system-level and specialty-specific practices, policies, and procedures that could potentially cause conflict within the clinical team or adversely affect patient care. These included institutional policies that were impossible carry out, policies between departments that contradicted one another, policies that participants did not realize existed, and a variety of communications barriers between different departments and specialties. This study showed how interdisciplinary communications simulation training can be used to identify critical systems-based obstacles and issues that despite being endemic, might otherwise have gone unaddressed.

### Improving the quality of education

Curriculum-based training in PICU is primarily driven by textbooks and clinical experience gained with real patients under supervision by trainers. Errors are inevitable and not without repercussions. The trainers and learners have little opportunity to facilitate training without the added pressure of time and patient safety. Procedural skills such as line insertions and the competency required with dexterity and slickness for high-risk situations commonly encountered in PICU such as a patient in shock get undermined more frequently than not for novice trainees and hence more missed opportunities. Procedural skills may be learnt on simulated models or part-task trainers at the learner's pace with enough practice without causing patient harm. Learning in a nonrisk environment facilitates better reflection and retention. In fact, simulation offers a unique advantage for learning rarely performed procedures. Studies looking into the skill retention showed that a skill learnt in skill laboratories can sustain up to 1 year.[14] McGaghie *et al*.[15] looked into a specific question of whether simulation with deliberate practice yields better results than traditional education. They screened over 3000 articles published between 1990 and 2010 and demonstrated an improvement in the simulation with deliberate practice group over traditional education. Largest meta-analysis on simulation education was published by Cook *et al*. in JAMA,[16] also supported its superiority.

### Credentialing and exams

One more potential use of simulation is a tool to evaluate the competency and credentialing. It is a relatively new concept. Although computer-based scenario oriented exams are being conducted, there is not much experience using scenarios based on high fidelity simulators. Results of the Israeli study.[17] looking into usage simulation for board certification for anesthesiologists are promising. It might find more application in this regard as more studies look into their validity.

### How do I apply simulation in my acute care area?

Essential process for conducting a simulation-based training session is as below:

- Needs assessment and identifying target trainees or audience – based what has to be taught or assessed, location for the simulation exercise can be decided. For example, if the goal is to assess the team readiness for a code blue event, then point of care simulation (simulation at the work area) is ideal. If learning a new procedural skill is the goal, then it can be performed in a Skill Laboratory
- Set learning objectives – this is a very important step. Too many learning objectives might confuse

the learner. Hence, they should be clear and few
- Develop training scenario – scenario should be such that learner should be able to relate to it
- Determine performance measures – prepare a checklist so as to help with debriefing process
- Prepare the location and set-up of the equipment (location, manikins/part-task trainers, drugs and other props, video set-up for feedback and control of simulation equipment according to the flow of the scenario) – set-up should be as realistic as possible. Intense experience during simulation exercise is a very essential factor in effective learning
- Effective debriefing by faculty – it is the heart of simulation exercise. Effective debriefing converts experience into learning. Debriefing should take as much time as the scenario. Various debriefing models are taught in the instructor workshops.

### Why simulation does based education work?

Simulation-based learning largely involves Kolb's principles of adult learning. We learn through experience. This forms the basis for the concept behind experiential learning. Experience gained through whatever form, be it at work, in life, or during formal educational processes will play a central role in our learning. All experiences offer lessons for our learning. When experiencing a process or a phenomenon, we perceive it through our senses and associate with it thoughts and feelings to make sense of it. We either connect it with other events and experience from the past or project it onto our future plans. As a result experiential learning cannot be dissociated from our thoughts, feelings, and emotions.

Kolb teaches that for this type of learning to be successful, the cyclical model requires four kinds of abilities [Figure 2]:
- Concrete experience (CE)
- Reflective observation (RO)
- Abstract conceptualization (AC)
- Active experimentation (AE).

First, the learner gets freely involved in new experiences (CE). The crisis simulation exercise directly provides this opportunity for him. Then time and space are made for him to reflect on his experience from different perspectives (RO). This is usually done as a debrief session immediately following the conclusion of the simulation activity. It is this reflective element in the learner's cycle that will be strongly influenced by feedback from his peers or assessors, making the debrief session so valuable for learning.

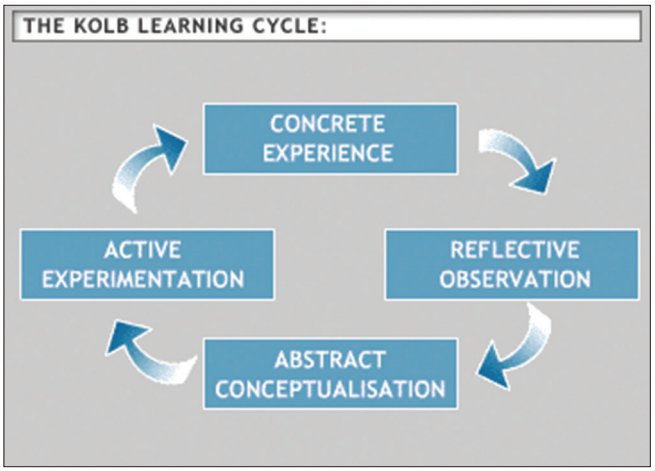


**Figure 2:** Components of Kolb's learning cycle

Next, the learner will be able to construct and reconstruct his ideas and process them into sound logical theories for future learning (AC). This moves him toward the last part of the cycle (AE) in which he now uses what he has understood to make clinical decisions and solve future crisis problems. By testing out implications in new situations, he will generate new learning content for the starting point of the next cycle, the CE again.

All four stages of the process are necessary for effective learning to be achieved. In simulation-based learning, the instructional designer needs to be able to use the operational model to create the training program learning opportunities that are sensitive to all these different stages of the cycle of learning.

### Advantages of simulation-based learning

Simulated practice environments are useful for reflection upon experience in clinical areas because it draws out learning points, develops clinical reasoning, and integrates theory with practice. Mistakes may be made, and learning can occur without risk to patients. Practical skills can be developed in a systematic supported manner. Furthermore, discussion of theoretical and ethical matters that are normally inappropriate in the presence of a patient can occur in parallel with the developing of practical skills.

One significant advantage of simulation is that it permits both the trainer and the learner to study patient treatment processes in ways that nature prohibits. The simulation can be run many times with the values of the parameters being modified between runs and the changes in outputs observed. It also offers unique advantage of learning procedural skills or management of clinical situations that are of rare incidence.

## FALLACIES

For simulation-based education to be effective, instructor needs to have a considerable experience in designing a realistic scenario. The instructor should be able to deliver an effective debriefing session tailoring to the needs of the trainee. As discussed above, if all the components of cycles of learning are not elicited during the simulation exercise, it might be underwhelming and might not lead to a desired learning experience.

## CHALLENGES AND FUTURE

As we stride forward this century as the second largest economy in the world, we also epitomize as one of the cost-effective models of healthcare. Simulation tools such as the high-fidelity simulators can be expensive and require trained personnel and specifically designed simulation labs equipped with the gadgets to facilitate simulation training. Few training institutions have already taken a leap in this direction and have set-up state of the art simulation laboratory. However, there is a gross under-utilization of these facilities due to lack of availability of simulation instructors. We need to create a bank of simulation instructors who can then inculcate effective training in our institutions.

The point of care or *in situ* simulation is a viable and more topical alternative to the expensive simulation laboratories in our set-up. We need to look at cost-effective models that can still work on the same principles of training and learning. We need a wider acceptance of a culture of quality and patient safety as a mandatory responsibility in our acute care areas and prepared to evaluate ourselves periodically of how well we can improve based on the regular simulation exercises. The investment in resources that improve the quality of care will eventually improve patient outcomes and hence become cost-effective.

Pediatric Simulation Training and Research Society of India (www.pedistarsindia.com) is working actively to deal with the challenges and bridge the gap in the availability of simulation expertise in pediatrics and acute care of children. One of the main goals of this society is to improve the outcomes of critically ill children using simulation-based interventions. It frequently conducts workshop or boot camps on different aspects of simulation in pediatrics.

## CONCLUSIONS

Simulation offers tremendous promise to improve the quality of care and education in acute care scenario. There is now a growing body of high-quality literature and evidence to support its growth. In the future, it can be expected that simulation will be used by practically aspect of pediatric acute care.

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### Conflicts of interest

There are no conflicts of interest.

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