Introduction
The use of simulation in medical education has come to stay. Simulation is now accepted the world over as one of the important techniques for imparting knowledge, skills, and attitudes to all levels of health-care professionals in general, and to undergraduate health-care students in particular. Simulation has been defined by Gaba as "a technique-not a technology-to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner."[1] Maran and Glavin defined simulation as “an educational technique that allows interactive, and at times immersive, activity by recreating all or part of clinical experience without exposing patients to the associated risks.”[2] The key element in these definitions is that a) simulation is an educational activity, b) simulation is interactive and experiential, c) simulation is designed to mimic a real-life activity as realistically as possible, and d) simulation is used to avoid exposing patients to undue risks.

Types of Simulators
Simulators are commonly classified according to the tasks they perform and according to the technology involved. The types of simulators are:

Part-task trainers/task trainers
These are simulators designed for specific tasks. These can be of many types as follows:

Physical models
They usually represent body parts. Examples are intravenous injection training arms, rectal/vaginal examination mannequins, suturing training pads, etc., Full-body mannequins can also help in task training, for example, Resusci Anne for cardiopulmonary resuscitation training. Since these are manufactured for a specific task, they can be quite realistic in their representation of the relevant task. Simple everyday objects have also been used for this purpose, for example, the use of oranges for teaching intramuscular injections.

Computer-based models
These are usually programs written for a computer-based simulation and consist of case scenarios where students are presented with different management choices. Depending on their choice, further menu pages open up and take them through the scenario. The students are also provided with a feedback at the end indicating the appropriate choices and the reasons for these. Sometimes these models can also be graphical, pictorially representing, for example, a hospital ward in which the student can interact with people or objects by clicking on them.

Virtual reality simulators
These can be immersive or nonimmersive. These simulators are also computer-based screens, but differ from the previous category in that trainees can interact with instruments with virtual tips to perform various procedures with haptic feedback, that is, the feel of tissue resistance. They are available for minimally invasive surgical procedures, endoscopic procedures, and nowadays, even for open surgical procedures. In the immersive models, the trainees usually use a wearable device which creates an entire virtual environment around them like an operation theater, with which they can interact.

Mannequin-based simulation (full-mission simulation/cold simulators)
These are higher technology computer controlled full-body simulators which are capable of mimicking various physiological derangements, especially related to cardiovascular and respiratory physiology. Usually, these mannequins are used to play out a critical medical or surgical event or emergency scenario to enable the students to train as a team to diagnose and manage the simulated patient.

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Various interventions such as intravenous access, intercostal tube drainage, and urinary bladder catheterization can also be performed in these mannequins. They are best used for training in teamwork and soft (nontechnical) skills such as leadership, situational awareness, decision-making, and communication. However, in view of their expense, it is not advisable to use them as simple task trainers, which is what happens unfortunately in many centers. These mannequins require training of faculty both for technical aspects of usage and for proper educational methodology, particularly debrief.

**Standardized patients (SPs) (warm simulators)**

These are usually actors who are trained to respond in specific ways to medical students. They are used to depict illnesses or for practising communication skills. As they are actual people, there is a high degree of realism in these interactions. These SPs can also provide directed feedback and even evaluate students in an examination situation.

**Hybrid simulation**

This type of simulation is defined as one wherein two or more simulation modalities are combined to produce a more realistic simulation experience. Examples are the use of wearable devices by SPs, wherein students can perform procedures and interact with a real human being at the same time. For example, a SP may wear a suture pad on his arm on which the trainee can suture, while providing an opportunity for the trainee to obtain informed consent, explain the procedure, etc.

**Relevance of Simulation in the Present Day Undergraduate Curriculum**

The medical profession is usually resistant to changes. This has been seen time and again with the introduction of any new technology. To some extent, this resistance is justified; after all, one would not like to abandon tried and trusted methods for some new-fangled ideas which mean learning an entirely new skill with the associated learning curve, with possible risk of patient harm. On the other hand, unless there were innovations and innovators, medicine would never progress. We would not have laparoscopy, robotic surgery, new imaging modalities, and disruptive changes in existing treatment protocols, to name but a few. Simulation is a case in point. Modern-day simulation has been around since the early 1960s with the development of Resusci Anne for teaching resuscitation, but medical educators have been slow to adopt this method to impart education to our undergraduate students. Even today, most medical colleges use no simulation at all, or at the most a small percentage of total curricular time is devoted to this modality. Usually, even in the colleges where simulation is used, it is treated almost like a cocurricular activity which happens only occasionally depending on the mutual convenience of trainers and trainees. The usual refrain is that good doctors have been coming out of a tried and tested system, so there is no real need to change it.

This belief, however, does not consider several factors. First, the present-day students are nothing like the students of the last century. Right from childhood, they are exposed to technology that was unheard of just 2–3 decades ago – the mobile phones today have more computing power than most of the mainframes of that period. Students have learned to harness this technology to further their learning. The internet has now become the primary source of most of their learning, with its advantages and pitfalls. This is only going to increase in the future, whether we as teachers like it or not.

Second, technology has progressed in leaps and bounds, not only in computing but also in material technology, allowing for the manufacture of increasingly realistic simulation equipment which in turn permits the practice of real situations in an artificial environment in a more immersive fashion. With increasing use of simulation, costs of these simulators can be expected to come down.

Third, learning theories are being better understood, especially with reference to andragogy, experiential learning, and relevant learning. The drawback of the traditional medical curriculum in India is that it is what I call “schizophrenic” with two distinct and unconnected phases; namely, for the first 4½ years, it is mainly rote learning with patient exposure limited to bedside teaching, and then in internship, house surgeons are expected to look after patients, write orders for them, order investigations, and perform many medical and surgical procedures. This sudden change in emphasis from theory to practice finds most new interns not ready and unsure of themselves.

The need for medical students to be exposed to various practical aspects of practice has been now recognized in most countries, including in India where the Medical Council of India has advocated outcome based experiential learning in their Vision 2015 document. The skills that are needed for medical students include communication skills, performance of practical procedures, decision-making, and teamwork skills. All these skills are best taught through the vehicle of simulation, to ensure patient safety and a standardized training exposure for all students and to allow for repeated practice to achieve skill mastery. The value of simulation-based medical education (SBME) has been elegantly elaborated by Ker and Bradley who have described the need for curricular integration, deliberate practice, and importance of debriefing in the process. They also talk about the simulation continuum, the concept of skill development in the simulation center and subsequent transfer and maintenance of the skill in the clinical area.

**Use of Simulation in the Undergraduate Medical Curriculum**

For effective SBME to occur, certain important prerequisites need to be fulfilled are as follows

**Incorporation into curriculum**

It is vitally important to incorporate SBME into the medical curriculum if it has to find permanence in the teaching schedule in a medical college. It has been clearly seen that if this is not done, simulation-based teaching takes place in an ad hoc manner
and not all students are exposed to it equally. Incorporation into the curriculum will ensure that SBME becomes mandatory just like the other teaching/learning methods. It will ensure faculty acceptance and student participation. This needs to be done by the curriculum committee of the institution concerned based on local needs while aligning with the overall curricular thrust of the entire program.

**Procurement of equipment**

Once curricular incorporation is achieved, finding the budget for buying equipment becomes a lot easier. There is a tendency for new simulation programs to go overboard in their purchase of simulation equipment, especially in newly established medical colleges where fund constraints are less because checks and balances are not yet in place, and because these colleges are looking to provide value addition to their teaching vis-a-vis other medical colleges in the region. This splurging on expensive and not always necessary equipment results in an expensive simulation center where much of the equipment is never used and eventually becomes unusable through prolonged storage and disuse. The way to avoid this is to plan the purchases depending on the needs of the curriculum in terms of the skills that are required to be taught.

**Training and buy-in of faculty**

The faculty is the backbone of any simulation program. Simulation is very workforce intensive, and one of the major issues with SBME is the difficulty in accommodating large student numbers given the limited number of simulation equipment and limited curricular time. It is important therefore not to be too ambitious at the beginning when planning a simulation program. Feasibility of the program within the institutional workforce, time, and equipment constraints must be a major consideration in the planning process. Faculty buy-in into the program is another area of difficulty faced by many simulation programs. First, experienced simulation faculty are hard to find. Second, most clinical faculties are reluctant to sacrifice clinical time to devote attention to simulation. Third, SBME requires faculty to learn new techniques, frequently requiring a conscious effort to unlearn some of the existing ingrained concepts and ideas.

These problems require a concerted effort by the management for faculty training. Protected time needs to be provided to allow these facilitators to be able to participate in simulation teaching activities. Incentives in the form of research grants for SBME research, better promotional avenues, etc., will help in attracting faculty to this stream of medical education.

**Management support**

For any simulation program to be successful, management support is a must. This support is in the form of finance, space, and academic support by the Deanery. A management-driven program is much more likely to succeed than one where the management is a silent onlooker. Targets must be set for the simulation center by mutual discussion, and these targets are reviewed in periodic meetings to remove bottlenecks and provide new direction to the program. Senior management representation in the supervising committee of the simulation center is a must to show their commitment. Management support is made easier by educating senior management on the benefits of simulation. Of interest to them would be the impact on patient care and safety, improvement in the overall quality of medical graduates passing out from the institution and the natural knock-on effect of raising the standards of the institution among its peers, making it more attractive for new students in the highly competitive milieu of medical admissions. The simulation center staff has the responsibility to ensure full use of the available equipment in cooperation with the different departments and supporting research and patient care activities through simulation to prove the usefulness of the program.

**Legislation**

It is only a matter of time before countrywide legislation makes SBME mandatory. This is already the case in many developed countries and India is likely to follow suit sooner or later. More and more institutions in this country are recognizing this and setting up stand-alone simulation centers, and providing their staff opportunity to obtain further qualification and experience in this area. Such legislation, of course, will be a huge fillip to SBME in this country.

**Does Simulation Work?**

Many instructors who use simulation are satisfied with its face validity. However, there is enough data based on research which suggests that skills learned in the simulation center are transferable to the real clinical environment. These include both technical skills such as suturing as well as nontechnical skills such as communication, decision-making, leadership, etc. It has even been shown that simulation can help not only psychomotor but also cognitive skills.[4] The authors argue that simulation may lead to “deeper learning,” greater student satisfaction, and address different learning styles. Simulation has also been used innovatively in many other ways, for example, it has been used to train undergraduate medical students in the field with limited clinical supplies to conduct complicated deliveries.[5] Simulation can also be used in a classroom setting to demonstrate and practice patient management skills.[6] It is thus seen that there are many opportunities to use simulation in the medical curriculum. The usage of simulation opens up new vistas for learning which are limited only by one’s imagination.

Simulation is increasingly being used in the assessment. Most centers are reluctant to use it in summative high stakes assessment as the reliability and validity of all types of simulators for assessment are not yet established, and there is also the issue of variation in the feel and response of simulators made for the same task by different manufacturers.[7] Boulet[8] has defined the criteria that need to be fulfilled if simulation is to be used in the summative assessment. These include defining the skills to be taught, developing reliable and valid measurement tools, and demonstrating that the assessment scores are both valid and reliable.
Low-Cost Simulation

For a developing country like India, many institutions may find the simulators available on the market very expensive, especially if they have to develop a full-fledged simulation center with a good range of simulation equipment to cater to their training needs. However, simulation equipment need not be always expensive. Low-cost solutions are readily available in existing literature, and the author has personal knowledge of simulation educators who have developed their own low-cost solutions. The PROMPT program (Practical Obstetric Multi-Professional Training) is an initiative to reduce maternal mortality in developing nations which uses low-cost birthing simulators to train rural midwives and doctors in normal ad complicated childbirth. A number of low-cost simulators and simulator substitutes have been developed[9,10] The author has worked with arterial line trainer made from a thermocol hand model, BP apparatus bulb and tubing, and simple defibrillator simulators with a window in which laminated printed rhythm strips can be introduces to show different shockable and nonshockable rhythms. In fact, using clementine fruits for laparoscopic training has been shown to be a reliable and valid tool to teach laparoscopic skills.[11]

Conclusion

SBME is now here to stay. It can be argued that the use of this modality is no longer a matter of choice, but is obligatory, based on the increasing body of evidence that is accumulating in its favor. Several low-cost solutions are available or can be improvised by thinking out of the box, to reduce the cost associated with setting up a simulation center. It must be kept in mind that simulation is not a game or a fancy way of doing something new. It is an educational tool and should be based on the same educational principles that guide other educational methods. If used properly, and with adherence to educational principles, it will open up an entirely new world of learning to the medical student of the 21st century.

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Conflicts of interest

There are no conflicts of interest.

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