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Indian Journal of Physiology and Pharmacology

Opinion Article

Can technology in a multipronged approach be effectively utilized in implementing a competency-based undergraduate curriculum?

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Quick Response Code:

Long-awaited new MBBS curriculum titled 'Competency-based Medical Curriculum (CBME) for the Indian Medical Graduates' has been rolled out by the Medical Council of India and implemented from August 2019 across all the Medical Colleges of the country. The curriculum is designed for creating an Indian Medical Graduate with the required knowledge, skills, attitudes, values and responsiveness to function appropriately and effectively as a physician of first contact of the community while being globally relevant.[1]

In Phase 1, the physiology curriculum has 11 topics with alignment and integration, 137 outcomes having 495 hours of teaching that includes 160 lecture hours, 310 hours of small group teaching/tutorials/integrated learning/practical, 40 hours of self-directed learning, 149 integrated competencies and 13 certifiable skills. New teaching/learning elements such as 1 month of foundation course, early clinical exposure (30 hours in physiology), alignment and integration, professional development, including Attitude, Ethics, and Communication Module (AETCOM) and Electives have been introduced.[1] CBME focuses on greater flexibility, learner-centered approach, role of teacher as facilitator, use of well-defined outcomes, demonstration of required skills and utilization of different assessment tools with more weightage on the formative type.

To address all these teaching-learning modalities, physiology teaching faculty has many questions to ponder upon – Are we adequately trained and equipped in the backdrop of deficient faculty strength, time constraints, limited support and resources? In spite of all odds, the onus is on the medical teachers and institutions in the best interest of the students to implement CBME on par with the global standards.

CAN TECHNOLOGY ASSIST US IN THIS ENDEAVOR?

Yes. With increasing knowledge and advancement of information technology, this can play a pivotal role in assisting the faculty with varied options and freely available resources which when used appropriately and effectively can motivate and generate more interest among the tech-savvy students of the present generation.[2] In this context, we, the faculty from the physiology department of Yenepoya Medical College, Mangalore, Karnataka, have made an attempt to successfully utilize technology in our curricular transactions. We have a robust information and communication technology (ICT) department catering to the advanced needs of faculty and students with seamless and secure access to support teaching, learning, and research. All the students are trained to use ICT facilities and are provided with laptops with Wi-Fi in the campus.

TECHNOLOGY IN FOUNDATION COURSE

We used the Google classroom platform and enrolled 150 students with faculty as moderators. E-reflections on the sessions, movies, books, assignments, daily feedback, session feedback, YouTube links, study material and reference articles were shared. Short movies on different themes were prepared by the students which were judged by a panel of experts and prizes were distributed to the winning teams. Google doc and Google forms were used for collecting responses from the students on various questionnaires and documentation of all faculty coordinator reports. Whitecoat ceremony was conducted on the last day of the foundation course which was streamed live on social networking pages of our university.

USE OF TECHNOLOGY FOR EFFECTIVE TEACHING LEARNING EXPERIENCE

At the end of a set of competencies, crossword and image finder jigsaw puzzle activity using online smart tools are conducted for students. Students are then asked to present seminars on those topics. Similarly, students were trained and encouraged to create concept maps using free online software for an easy understanding of the concepts. An assessment and feedback collected at the end of the students are highly rewarding for the faculty which shows student satisfaction and active learning. In addition, pulse tracing, electrocardiogram, stethography, pulmonary function tests and autonomic function tests are being conducted using digitized instruments.

SIMULATION-BASED TEACHING

We have developed integrated simulation-based modules that have been validated by experts for early clinical exposure and skill development Advanced Comprehensive Clinical Training and Simulation Centre (ACTS-YEN), Yenepoya (Deemed to be University), Mangalore. Physiology competencies on the cardiovascular system, respiratory system, reproductive systems and nervous system are taught for 1st-year students using high fidelity and low fidelity simulators and task trainers.[3] Pretest, posttest assessment and feedback are obtained online.

E-PORTAL FOR SELF-DIRECTED LEARNING

Our institution has YENGAGE, an online learning portal of Yenepoya (Deemed to be University), which is created on the ILIAS platform, is being used for online discussion forums as part of self-directed learning where students discuss on a particular topic assigned to a designated group and faculty as a facilitator. Relevant articles, study material, web links of YouTube videos, virtual labs and online learning centres are shared with the students. Student activities and progress are monitored periodically.

AS AN ASSESSMENT TOOL

Continuous formative assessments in the form of E-tests, E-reflections on early clinical exposure and AETCOM sessions are conducted using an online platform. About 20% of internal assessment is allotted to this part. E-portal is used for maintaining student profile, marks obtained in the seminar presentations, professionalism, behaviour, attendance, teaching schedule, unit test marks and internal assessment marks. Documentation of skill certification is also carried out with Google spreadsheets linked to the drive with student details, number of attempts, feedback provided at every stage and faculty involved with the checklists.

FOR OUTCOME ANALYSIS

An important component which needs to be addressed as a next level of CBME is to know the level of achievement of students and institution. This can be effectively addressed by adapting the model of outcome-based education. Here, the competencies are assessed with relation to the course outcomes (at the end of physiology teaching) and program outcomes (at the end of MBBS). This requires step by step systematic approach of mapping of outcomes at different levels and involves multiple assessments and feedbacks from all stakeholders.[4] This has been addressed by us by incorporating a technology-assisted outcome-based educational framework for analysing the outcomes which are linked to the teaching-learning methods and assessment techniques. We have mapped all the competencies to course outcomes and course outcomes are mapped with program outcomes. We have now started analysing the outcomes. Examinations on tablets, E logbooks, apps to assist in certifying skills, etc., are in the process of development.

CONCLUSION

It is clear from our experience that by optimal utilization of technology as a curricular transaction tool, we could address the principles of adult learning such as active learning, being problem-centric, based on previous experience, being relevant, having emotional connection, based on self-learning and the principle of alignment.[5] Technology can never replace the role of a teacher, but can definitely assist the faculty to make the teaching-learning experience more interesting, motivating, effective and memorable.

Implementation of CBME is a challenge for the faculty, but it is said that '*Challenges are what makes life interesting, and overcoming them is what makes them meaningful... If it does not challenge you, it does not change you.*' *Josh J. Marine.*

Strong determination, clear planning, involving all stakeholders, liaisoning with likeminded individuals and strategic alignment with the institutional goals can build an ideal environment for implementing curricular reforms in any educational program.

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Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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ORIGINAL ARTICLE

Continuum of Surgical Skill Acquisition for the Postgraduate Residents During COVID Pandemic: Role of Advanced Simulators in a Multipronged Modular Approach

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Abstract
Skill acquisition with required competencies as defined by the National Medical Commission for the postgraduate surgical residents can happen in a step-wise manner from novice or advanced beginner to competent levels. This requires well-defined program-specific objectives, teaching-learning and assessment methods as per the competency-based medical education curriculum. Various modalities of teaching for the residents are adapted during the COVID pandemic to maintain the continuum of learning. In this study, we have attempted to develop, implement, and evaluate the effectiveness of acquiring laparoscopic surgical skills using advanced simulators and with large live animal in a real-life situation by a modular training approach. This skill-based program was developed and implemented for final year General Surgery postgraduate residents of Yenepoya Medical College for training laparoscopic surgical competencies. The training was conducted at Advanced Simulation Centres of Yenepoya (Deemed to be University), Mangalore, Karnataka, India. Three training modules were prepared based on the competency-based medical education curriculum for incremental training with advanced simulators and large live animals in a real-life situation which included the sessions on briefing, scenarios, simulations, hands-on activities, debriefing, feedback, and assessment methods. Assessment after the modular training showed statistically significant improvement in their scores, and they scaled up their skill acquisition ladder after each module. The residents and faculty felt that integration from different specialties has increased their confidence levels and communication skills, exploring team dynamics with 1:1 mentorship to make them competent emphasizing the effectiveness of simulation-based training even during the pandemic.

Keywords Competency · Laparoscopy · Module · Skill · Simulation

Background

Skill acquisition is an essential component for surgical residents' training during their post-graduation studies. They move across the ladder step by step from novice/advanced beginner to competent to proficient levels. Being at the postgraduate level, the residents need to demonstrate the "Shows How" and "Does" competencies as per the Miller's pyramid of clinical competence [1].

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The Medical Council of India in 2017 has rolled out a competency-based postgraduate curriculum across all the programs. Accordingly, 15 program outcomes/Subject Specific learning objectives and program-specific outcomes/subject-specific competencies in all 3 domains of learning; knowledge (cognitive domain), professionalism (affective domain), and skills (psychomotor domain) have been defined in the postgraduate training program for MS in General surgery [2]. This curricular framework stresses the importance of specialist postgraduate training in recent advances addressing the health needs of the community and competent enough to handle effectively medical/surgical problems with empathy and humane approach [3]. The advancement of information technology has largely assisted the training programs.

Simulation-based skill training is a newer modality which has various advantages for the trainees to enhance their clinical skills in real life like situation which is ethical and stress-free and occurs in a safe environment [4, 5]. High fidelity simulators, virtual reality task trainers, animal models, and simulated patients form the components of simulation-based training programs [6, 7]. This teaching and training strategy has been effectively adapted in the departments of anesthesia, emergency medicine, intensive care medicine, surgery, obstetrics, pediatrics, ophthalmology, and radiology in many institutions [8].

Skill training using simulation has been widely recognized, accepted, and implemented into the curriculum by various boards and committees across the globe [9, 10]. With the newer developments in all the areas of medicine including surgical specialties, one of the most common skills that are essential to be acquired by a surgical resident at the end of their training is the basic laparoscopic skill. According to the American Board of Surgery, individuals are required to complete successfully an educational program entitled "The Fundamentals of Laparoscopic Surgery" (FLS) developed by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), to be board certified in general surgery [11, 12].

COVID-19 pandemic has affected the teaching and training process of residents all programs and skill acquisition for them was a challenging task that was severely compromised and has come to a grinding halt due to the paucity of non-COVID cases admitting to the hospitals [13, 14]. For maintaining the continuum of the learning process, different modalities were adapted by the institutions like virtual case-based discussions, seminar presentations, video-based surgical skills interactive training, online learning modules, virtual rounding, reflection assignments, surgical skills simulation training, research education, and medical education learning and journal clubs in virtual mode [15].

Simulation-based training for the residents in few centers with advanced surgical skill infrastructure has led to active learning amidst challenging situations. There are no well-structured and validated training modules in this latest technology-assisted skill acquisition training program. Under these circumstances, we, at the Department of General Surgery of Yenepoya Medical College, under the Yenepoya (Deemed to be University) aimed to develop, implement, and evaluate a modular training program with an assessment blueprint on laparoscopic surgical skills for the final year MS General Surgery postgraduate residents at the skill training centers of the University.

Materials and Methods

This module was developed and implemented for final year MS General Surgery postgraduate residents (n=10) of Yenepoya Medical College of one cohort for training laparoscopic surgical skills. The simulation training was conducted at Advanced Surgical Skill Enhancement Division (ASSEND) and Advanced Comprehensive Clinical Training and Simulation Centre (ACTSYEN), Yenepoya (Deemed to be University), Mangalore, Karnataka, India, during October 2020 to March 2021. The animal ethics committee approval was obtained for the study (V-11011(13)/15/2 020-CPCSIA-DADF dated 9th October 2020).

ACTSYEN is the largest state-of-the-art simulation facility in the country equipped with a wide range of high fidelity mannequins, basic task trainers, three-dimensional virtual dissection table-Anatomage, and virtual reality simulators.

ASSEND is furnished with advanced equipment for surgical training like basic endo-trainers, electro-surgical devices, minimally invasive laparoscopic instruments, robotic setups, surgical microscope unit and a variety of open surgical instruments, animal model surgical training facilities, anesthesia equipment and monitors along with a team of trainers, veterinary surgeons, and technicians.

Development of Simulation-Based Skill Enhancement Module

The teaching faculty from the departments of General Surgery, Gastroenterology, Anesthesiology, and medical education brainstormed in developing the contents of the module which had learning objectives for each simulation session aligned with learning outcomes. The faculty involved from the Department of General Surgery had undergone laparoscopic training with an experience of 4 to 20 years and a surgical Gastroenterologist with advanced laparoscopy training.

All the 10 final year surgery postgraduate students of the 2018 batch were included in the training. The training modules were prepared following the guidelines for the competency-based medical education for raining in General Surgery after studying the basic training programs of professional bodies involved in the laparoscopy training with modifications as per the requirements of the trainees and available resources. A plan for the briefing, scenarios,

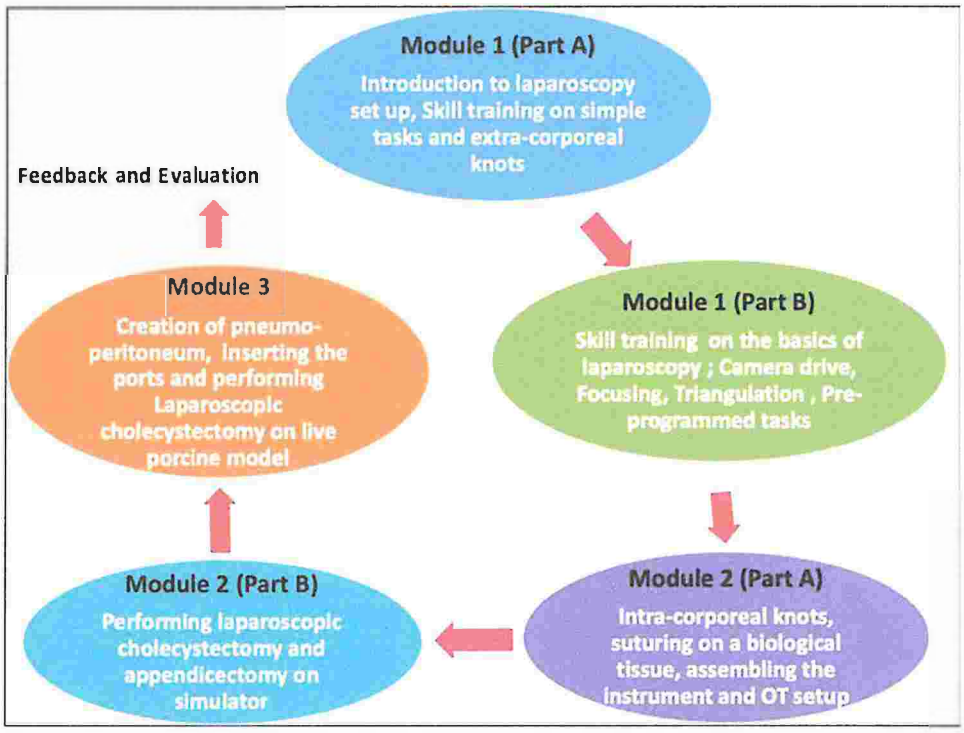

Fig. 1 Modular training process with simulation

simulations, teaching-learning methods, debriefing, and evaluation methods was discussed and developed for each module for the implementation (Fig. 1).

Module 1

The objectives of this module were to make the residents understand the basic principles of laparoscopic surgery including the history, indications, types of equipment used and their assembly, operation theater (OT) setup, sterilization methods, and complications of laparoscopy. Also to train them to perform the simple tasks of hand to eye cordination, camcera driving, focusing and extracorporeal knotting.

The competencies of module 1, teaching-learning methods used with duration, assessment, and levels of learning are depicted in Table 1.

Module2

The specific learning objectives of this module were to make the resident perform the simple laparoscopic steps such as setting up the equipment at OT for laparoscopic surgery, intra-corporeal knotting, and suturing on a biological tissue (chicken piece) and understand the individual steps, and perform diagnostic laparoscopy, laparoscopic cholecystectomy, and appendicectomy on a simulator.

The modular contents included are depicted in Table 2.

The residents were asked to practice all the tasks learned during the training workshop modules I and II for at least 10 h each. The assessment was conducted about 15 days after module II by the mentors on the knowledge of laparoscopic surgery and acquisition of sample tasks learnt. Viva and DOPS were used with a checklist for grading their performances. The laparoscopic tasks using endotrainer like building block exercise, putting the ring to the nail, putting a knot, suturing with silicon sheet, and peeling the grape and outside the endotrainer, extracorporeal knotting skills were used for training and assessment. All the students were assessed by the same expert involved in the process. Of the 10 students, 2 who underperformed were given additional training at the end of the assessment session.

Module3

The specific learning objectives are to make the resident create pneumo-peritoneum and insert primary and secondary ports safely, perform diagnostic laparoscopy, and perform all the steps of cholecystectomy correctly and safely with hands-on training on live anesthetized animal (porcine). The contents are shown in Table 3.

During module III which was held once a month, 2 trainees were trained per session and they were assisted by 2 other trainees who would be operating during the next session in the following month. Two animals per session were used; each session included two students and two mentors. Accordingly, each resident performed a full cholecystectomy (skin to skin) on a porcine model.

One to one mentor trainee ratio was maintained, with the mentor guiding the trainee throughout the procedure to make

Table 1 Contents of module 1

S. No.	Competency area	Teaching learning method/duration	Assessment method	Level of learning (Miller's)
1	• Introduction to laparoscopy (history, evolution, applications), • Ports, hand instruments and other equipment, their assembly • Sterilization techniques • Energy devices • Anesthesia in laparoscopic surgery, implications, modifications and complications • Creation of pneumoperitoneum, knotting techniques, • Diagnostic laparoscopy, appendicectomy and cholecystectomy at ACTSYEN using laparoscopic virtual reality simulator (CAE Co.)	Short lectures with demonstrations, illustrations, photographs and video clippings (4 h)	Pre-test and post-test	Knows how
2	• Skill training on simple tasks • Extra-corporeal knots at ASSEND	Small group, DOAP- on the endotrainer (40 min for each candidate)	Viva and Direct Observation of Procedural Skills (DOPS)	Shows
3	Skill training on the basics of laparoscopy such as • Camera drive, • Focusing, • Triangulation • Performing the pre-programmed tasks at ACTSYEN using laparoscopic virtual reality simulator (CAE Co.)	Small group, DOAP- on laparoscopic simulator (40 min for each candidate)		Shows

Table 2 Contents of module 2

S. No.	Competencies	Teaching learning method/duration	Assessment method	Level of learning (Miller's)
1	Intra-corporeal knots, suturing on a biological tissue (chicken piece), assembling the instrument and OT setup at ASSEND on endo-trainer	Small group, DOAP* (40 min for each candidate)	Viva and (DOPS)** using the checklist	Shows How
2	Performing diagnostic laparoscopy, laparoscopic cholecystectomy and appendicectomy at ACTSYEN using laparoscopic virtual reality simulator (CAE Co.)	Small group, DOAP (40 min for each candidate)		Shows How

DOAP Demonstration–Observation–Assistance–Performance

**DOPS* Direct Observation of Procedural Skills

sure that the procedure is done the same as it is done in human beings to give a real-life experience for the trainees from the start to finish of the surgery. The dignity of life of the animal was maintained throughout the training session. All the animals who underwent laparoscopic cholecystectomy recovered well from anesthesia without any mortality related to the training program.

Debriefing, feedback, and evaluation

After the residents completed the entire module, they were administered a questionnaire regarding their skill acquisition and learning experience with simulations and feedback was sought at each station. A retro-pre questionnaire, based on the Dreyfus model of skill acquisition, was administered. The feedback from faculty involved in the planning and implementation of this skill training module was also collected. Assessment using a validated checklist (Table 4) to assess the outcome of the training on endotrainer was conducted 2 months after the completion of basic skill training about the identification and knowledge about the use of laparoscopic instruments, extracorporeal knotting, performing simple laparoscopic tasks on endotrainer, intra-corporeal knotting and suturing. The checklist includes the questions

Table 3 Contents of module 3

S. No.	Competencies	Teaching learning method/duration	Assessment method	Level of learning (Miller's)
1	Creation of pneumo-peritoneum, inserting the ports, and performing all the steps of laparoscopic cholecystectomy	1:1 Hands-on training on live anesthetized animal (porcine) (2 h for each candidate)	Viva and DOPS with the checklist	Show How

related to higher order cognitive and psychomotor skills. More weightage (80%) was given to psychomotor component. The feedback from the residents and faculty along with assessment scores was analyzed. The assessment scores (pre- and post-test) were analyzed statistically using the paired *t*-test, with a *p*-value <0.05 taken as statistically significant (Statistical software IBM SPSS Version 23). MS Excel was used for data entry and generation of graphs. Google forms were used for assessment and feedback. Consensual validation of the whole module was done by 6 subject experts. There was 100% agreement among the experts.

Results

The residents perceived that the simulation-based modular training 1:1 mentorship during training facilitated skill-building, and enhanced their hand-eye coordination skills; the scenario resembled a real-life situation enabling their integrated and incremental skill acquisition with confidence (Fig. 2).

Students also felt that the process followed benefitted them and believe that advanced simulation-based skill training improves quality care and communication skills and become competent even during the COVID pandemic (Table 5).

The students were asked to grade their perception before and after their training using a retro-pre questionnaire on a scale of 1 to 5 where 1 is the lowest and 5 the highest score. The mean scores were calculated which showed statistically significant results with incremental skill acquisition (paired *t*-test) as shown in Table 6. The assessment grades of residents following the overall modular skill training showed 40% of the residents achieving grade A and 60% grade B (Table 7).

Paired *t*-test

Faculty feedback on this simulation-based training revealed that this module benefits the residents in acquiring the relevant laparoscopic surgical skills (Table 8).

Discussion

In this study, we developed and evaluated the effectiveness of a simulation-based skill enhancement module for post-graduate surgical residents. Residents found that our modular skill-based training with 1:1 mentoring enhanced their competencies in a stepwise manner. According to Singh AG, simulation-based skill acquisitions are useful to teach a novice the basic psychomotor skills under the supervision with instant feedback which needs to be incorporated into the curriculum of the postgraduate program [16].

Any new psychomotor skill acquisition is based on the theory proposed by Fitts and Posner who have defined the step-by-step approach involved in this learning process. The first step is knowledge-based where the students gain the information on the background, basics involved, use of appropriate instruments for hand-eye coordination, precision, depth perception, dexterity, and spatial orientation which will be haphazard or not uniform. The next phase includes the application of cognitive components for perfomance-based training to know the synchronicity of movements. The trainee gains proficiency and smoothness in handling the setup with confidence for a given situation in the last phase [17, 18]. This is in line with the process followed in our modular training program.

Table4 Checklist for the post-training assessment of laparoscopic skills for MS General Surgery residents

S. No.	Skill assessed	Score (1–5)
1.	Ability to identify and describe the use of basic laparoscopic instruments (Knows how)	**1. Poor**
2.	Ability to perform simple tasks of hand-eye coordination on endotrainer (Shows how)	**2. Fair**
3.	Ability to make an extra-corporeal knot (Shows how)	**3. Good**
4.	Ability to perform intracorporeal knot on the endotrainer (Shows how)	**4. Very Good**
5.	Perform intracorporeal suturing (Shows how)	**5. Excellent**

Grading: A, above 21; B, 11 to 20; C, below 10

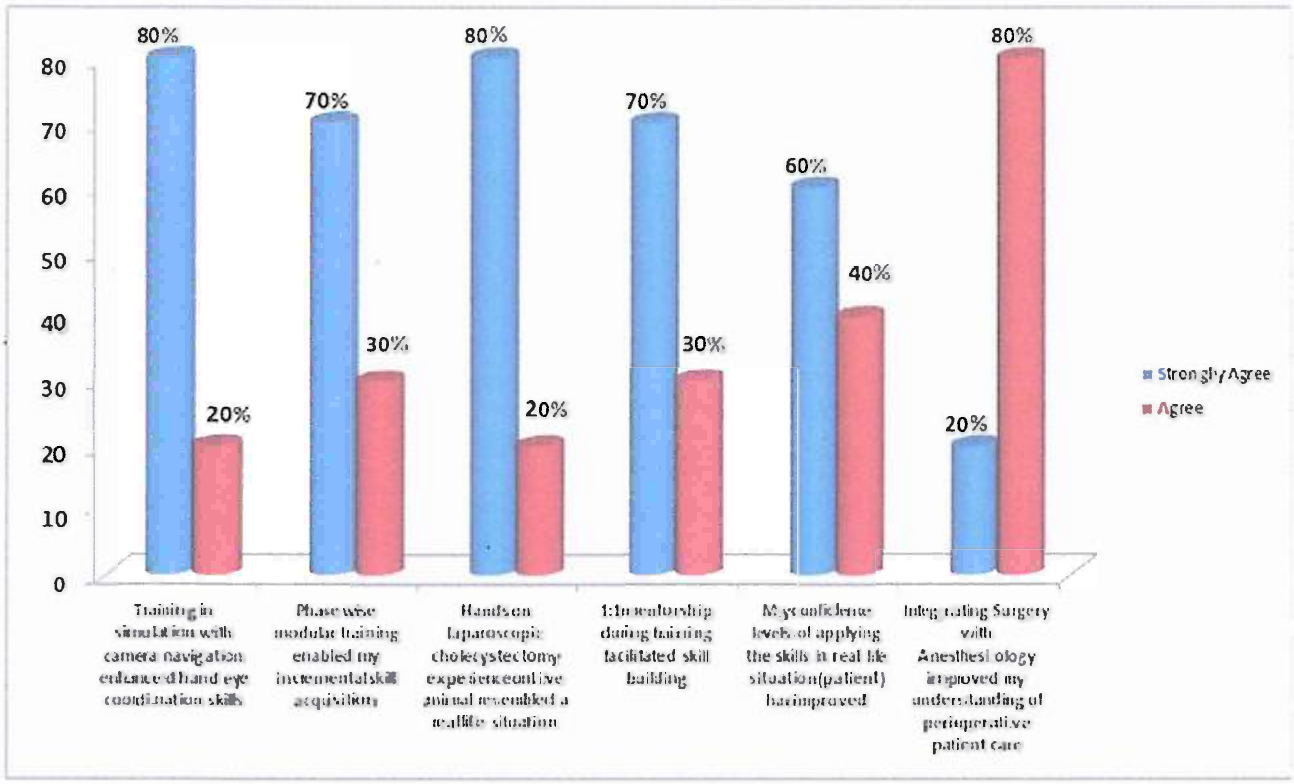

Fig. 2 Students' perception of simulation-based learning ($n=10$)

Table 5 Student perception on simulation-based training ($n=10$)

Question	Strongly agree (%)	Agree (%)	Neutral (%)
Initial briefing helped me to understand the history, evolution, application, present status, and future perspectives of simulation-based learning.	5 (50%)	5 (50%)	-
The debriefing session helped me in analyzing the challenges faced with probable solutions to overcome them.	6(60%)	4 (40%)	-
Simulation training can improve patient safety and quality of healthcare.	6 (60%)	2(20%)	2 (20%)
ASSEND provides a safe non-threatening learning environment during this COVID pandemic.	7 (70%)	2 (20%)	1 (10%)
Sophisticated equipment, infrastructure facilities, and technology provided at ASSEND assisted me in acquiring the clinical skills.	6 (60%)	4(40%)	-
Simulation can improve effective participation and communication skills	7 (70%)	3 (30%)	-
Simulation in health care has advantages for training and gaining the competencies for residents	6 (60%)	4(40)	-
I would like to have more simulation-based training sessions.	9 (90%)	1 (10%)	-

Table 6 Pre-test and post-test scores of skill assessment after module 1 ($n=10$)

	Pre-test score	Post-test score	
Mean	4.80	8.20	$P<0.0001$
Standard deviation	1.14	1.48	

Simulation-based virtual reality training has greater advantages in reducing the errors and operating time with more accuracy, providing quality health care according to the 23 randomized control trials from the Cochrane library with 622 participants according to a study conducted by Gurusamy et al. which is in accordance with the observations in our study [19].

Table 7 Assessment grades of residents following the modular skill training (n=10)

Post-training assessment grade of laparoscopic skills		No of residents	
Grade A (Above 21)		4 (40%)	
Grade B (11–20)		6 (60%)	
Student perception of skill acquisition in each module			
Novice (Stage 1) to advanced beginner (Stage 2)		4 (40%)	
Novice (Stage 1) to competent (Stage 3)		1 (10%)	
Advanced beginner (Stage 2) to Competent (Stage 3)		4(40%)	
Advanced beginner (Stage 2) to Proficient (Stage 4)		1 (10%)	
	Perceived skill levels before modular training	**Perceived skill levels after modular training**	P <0.0003*
Standard deviation	1.50	2.70	
Standard error of the mean	0.53	0.67	

*Paired t-test

Table 8 Faculty feedback on simulation-based modular skill training (n=7)

Question	Strongly agree (%)	Agree (%)	Neutral (%)
Initial briefing helped the trainee to understand the history, evolution, application, present status, and future perspectives of simulation-based learning.	4(57%)	3 (43%)	-
Training in simulation with camera navigation enhanced the trainee's hand-eye coordination skills.	5 (71%)	2(29%)	-
Hands-on laparoscopic cholecystectomy experience on live animals resembled a real-life situation.	2 (29%)	5 (71%)	-
1:1 mentorship during training facilitated skill-building.	6 (87%)	1 (13%)	-
Phase-wise modular training enabled incremental skill acquisition by the trainees.	5 (71%)	2(29%)	-
The trainee's confidence levels of applying the skills in a real-life situation (patient) have improved.	2 (29%)	4(57%)	1 (14%)
Integrating surgery with anesthesiology improved the trainee's understanding of perioperative patient care.	2 (29%)	4(57%)	1 (14%)
The debriefing session helped the trainees in analyzing the challenges faced with probable solutions to overcome them.	3 (43%)	4 (57%)	-
Simulation training can improve patient safety and quality of healthcare.	4(57%)	2 (29%)	1 (14%)
ASSEND provides a safe non-threatening learning environment during this COVID pandemic.	4 (57%)	3 (43%)	-
Sophisticated equipment, infrastructure facilities, and technology provided at AS SEND helped the trainees in acquiring the skill.	3 (43%)	4 (57%)	-
Simulation can improve effective participation and communication skills.	4(57%)	2 (29%)	1 (14%)
Simulation in health care has advantages for training and gaining the competencies for residents.	4(57%)	3 (43%)	-
Overall this module is beneficial to the residents.	6 (86%)	1 (14%)	-
An effective skill training happens with such a simulation module.	4(57%)	3 (43%)	-
The level of laparoscopic skills and confidence in performing the laparoscopic tasks by the trainees has improved *after* the basic laparoscopic skill training.	3 (43%)	3 (43%)	1 (14%)
Development and implementation of such simulation module requires a collaborative approach with other departments.	3 (43%)	4(57%)	-
The development and implementation of such a simulation module is time-consuming.	3 (43%)	3(43%)	1 (14%)
I would like to be a faculty during future simulation-based training sessions.	2(29%)	5 (71%)	-

Seymour et al. in 2002 demonstrated the transfer of virtual reality training skills to the operating room environment involving 16 surgical residents in a prospective, randomized, blinded study where they found that virtual reality surgical simulation training to reach specific target criteria significantly improved the performance of residents in an operating room in laparoscopic cholecystectomy [20].

We found that assessment of residents after this modular training showed statistically significant improvement in skill acquisition, team dynamics, and time management in a stress-free environment which follows the previous

studies that reemphasized the role of simulation in improving the learning process [21–23].

A 5-day workshop of 50 residents of 5 sessions with 10 residents in each small group conducted at All India Institute of Medical Sciences, New Delhi, in medical, surgical, trauma, and mixed cases scenarios showed that their confidence levels increased from 48 to 76%, communication aspects from 38% to 76%, the tendency to blame team members decreased from 58% to 36%, enhanced hand-eye coordination skills, 86% were ready to participate as a team, and effective learning outcome was achieved [24].

Some of the limitations of the modular training are:

- Anatomy of the model (porcine) though similar is different from that of the human beings. There are multiple lobes of liver in a porcine animal as compared to human beings (difficult), cystic duct is thin and elongated (easy), and cystic artery is very fine (easy). Hence, the training need not reflect the real life situation as there can be several anatomical variations in humans developmentally or due to disease or previous surgery.
- The skill training on the animal model was mainly on the basics of laparoscopy and laparoscopic cholecystectomy, but the other common procedural skills could not be imparted due to lack of appropriate models.

In this study, the training was conducted for the final year residents. Training the second year students could be considered the future scope as the students will continue their resident surgical training program for a longer period after their basic laparoscopic skill training and would be involved with surgeries on actual patients under supervision of the mentors. We feel that the skill training of the surgical residents on a live anesthetized animal, following all the steps and care exactly as an actual patient, gives a real-life experience as compared to training on a cadaver as it provides the experience of operating on a live tissue to the trainee.

Success of this modular program enabled us to conduct similar training for surgical oncology trainees in GI oncology and uro-oncology procedures. Here the focus was on advanced surgical skills as the trainees are qualified general surgeons having required surgical skills. They performed rectal mobilization, dissection of inferior mesenteric vessels, hysterectomy, omentectomy, wedge resection of liver, peritoneal biopsy, partial nephrectomy, and radical nephrectomy, on live porcine models.

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Medical Education

An integrated simulation-based early clinical exposure module in cardiovascular physiology

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ABSTRACT

Objectives: A good conceptual understanding of physiology is very important to build a strong foundation for medical students. It is a daunting job for teachers to emphasise the clinical relevance of basic science subjects as exposure to patients invariably starts after these subjects have been taught. With the introduction of early clinical exposure in the newly revised Indian undergraduate medical curriculum, this problem can be addressed to a certain extent. We developed an integrated simulation module for teaching cardiovascular physiology to pre-clinical students as a part of early clinical exposure.

Materials and Methods: We included 145 medical students of a Private Medical College of a Deemed to be University in Mangalore, Karnataka, India. The teaching module covered the topics of cardiovascular physiology such as functional anatomy, cardiac cycle, normal electrocardiogram (ECG), arrhythmia, arterial pulse examination, heart sounds and hands-on cardiovascular examination using a variety of simulators. The assessment was done by pre-test and post-test. A retro-pre questionnaire was used to assess their self-perceived knowledge gain and level of clinical skills. Feedback on overall experience was collected from the participants.

Results: The student feedback showed that learning experience was life-like (98.6%), effective, innovative and enjoyable (99.3%) and making the overall experience of learning easier (95.2%). It also improved participation, communication (93.8%), clinical skills and a better understanding of patient care (99.3%). The results of the retro-pre questionnaire to assess their self-perceived knowledge gain (95%) and level of clinical skills (96%) were highly satisfactory. The assessment of knowledge domain showed 100% of the students achieved pass percentage (>50%) with significant difference among pre- and post-test scores. Faculty (100%) opined that simulation-based teaching resulted in effected learning.

Conclusions: The use of simulation-based teaching in cardiovascular physiology as part of early clinical exposure leads to enhanced learning and clinical application. This will stimulate interest in subject and promote better learning.

Keywords: Cardiovascular, Manikins, Medical education, Simulation training

INTRODUCTION

Physiology is a foundation for health professional students which require a lucid understanding of the concept. It is a core and mandatory subject for students of medical, dental, nursing and allied health sciences, which is considered as a difficult yet interesting at multiple levels by the students.[1] At present, physiology is being taught to undergraduate pre-clinical medical students in India using didactic lectures, small group tutorials, web-based e-learning and project-based methods.[2] The purpose of these different teaching-learning methods is to make the students

understand the clinical application of physiology in interactive and innovative style.

Till 2018, early clinical exposure was not a norm in most Indian medical colleges, which has now become an integral component of a new competency-based medical education curriculum. Lack of direct patient encounter and knowledge regarding actual health-care setting, it is a daunting task for educators to find a bridge to fill this lacuna.[3] The traditional model of teaching is being supplemented with different innovative techniques, to link the pre-clinical and clinical topics. This has not been effectively implemented everywhere due to multiple constraints at various levels.[2] There is a need to find ways to make undergraduate physiology learning experience more interesting, stimulating and enthusiastic with 'in action' student engagement using simulators. The use of mannequins, especially High Fidelity patient simulators promotes active and experiential learning.

Simulations are defined as 'approximations to the reality that require trainees to react to problems or conditions as they would under genuine circumstances.'[4] The simulation-based learning has been accepted as an established method for honing clinical competencies of medical, dental, nursing and other health sciences students worldwide.[5] Training in a stress-free and no-risk environment enhances students' emergency response. This results in a confident health professional.[6] 'Shows how' level of Miller's assessment framework requires the learner to demonstrate the integration of knowledge and skills into successful clinical performance. Simulation-based assessment tests a student at this level and has attained an important educational value by profoundly enhancing the learning environment for undergraduate students.[7]

Due to all these benefits, high fidelity human patient simulators have expanded their horizons into high school and college levels too. Here, it aids the students in problem-solving and critical thinking.[8] This mode of training is equipment demanding, needs sophisticated technology and trained simulation educators.

Simulation-based teaching has been effectively adapted in clinical specialties such as anaesthesia, emergency medicine, intensive care medicine, surgery, obstetrics, paediatrics, ophthalmology and radiology.[9] The simulators can be used to teach basic anatomy and physiology integrating with clinical aspects, in close to real-life settings. However, effectively using the same for teaching the basic science concepts to undergraduate pre-clinical students is not yet an established practice. The reasons could be due to lack of pre-existing framework and adequately trained simulation educators.

Gordon *et al.* and Harris *et al.* have shown that human patient simulators when used for undergraduate medical students to teach physiology, improves their learning process and helps in the retention of concepts.[10,11] The feedback obtained from the students who have undergone this process showed a deep satisfaction as shown in Harvard Summer Preclinical Institute by Gordon *et al.*[12]

In a study by Agha *et al.* to evaluate medical students' satisfaction with simulation-based learning strategy at College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia, showed significant difference between the satisfaction scores among genders as female students' preference for simulation-based teaching was more compared to their counterparts.[13]

There are limited studies regarding the implementation and learning outcomes of simulation-based physiology teaching as part of early clinical exposure using High Fidelity simulators in the Indian setup. The needs assessment of students showed that they preferred simulation-based learning. Hence, we aimed to develop an integrated simulation-based module with assessment blueprint for teaching cardiovascular physiology to undergraduate pre-clinical medical students as part of early clinical exposure. We also evaluated the training process to assess whether it is beneficial for understanding the concepts and acquiring clinical skills. We studied any gender-wise preference in simulation-based learning among the students.

MATERIALS AND METHODS

This module was developed and implemented for 1st-year undergraduate pre-clinical medical students (n = 145) of Yenepoya Medical College of one cohort for teaching cardiovascular physiology. The simulation training was conducted at Advanced Comprehensive Clinical Training and Simulation Centre (ACTS-YEN), Yenepoya (Deemed to be University), Mangalore, Karnataka, India. The Institutional Ethics committee approval was obtained for the study.

The needs assessment was done in consultation with the stakeholders including the student fraternity before module development. The students were explained about different teaching-learning strategies which included large group interactive teaching, small group teaching, E-learning, simulation-based and project-based learning. These teaching-learning methods were discussed with the students highlighting the advantages and limitations of each. This was then followed by written feedback. The feedback was collected to determine the order of their preference for learning cardiovascular system. The analysis showed that 95% of them opted for simulation-based learning as their topmost preference.

Development of simulation-based module

Brainstorming sessions were conducted with the teaching faculty from physiology, department of internal medicine and

medical education unit. The module hence created consisted of the goals and learning objectives for each simulation sessions which were defined with learning outcomes and assessment methods [Figure 1].

A plan was prepared for the briefing, scenarios, simulations, debriefing and evaluation. A team of simulation educators was selected and trained for the implementation of plan. A pilot session was conducted on a group of 2nd-year students and their feedback was collected. Based on these results, few changes were made to the plan.

Students were introduced to the topics of cardiac cycle and electrocardiogram (ECG) by large group interactive method. An electronic pre-test that comprised 15 multiple choice questions from the topics of cardiovascular physiology was administered to the students.

The actual process at the simulation centre

The students (n = 145) were giving a briefing about the learning outcomes, the working of simulators and facilities available at the simulation centre for 20 min. This included hands-on experience with mannequins, techniques, scenarios and procedural skills. The students were then divided into five groups of 30 each having a team leader and timekeeper for smooth transition between the sessions. Students were rotated in an orderly pre-planned fashion across the four simulation stations. Each station was of 20 min duration. [Figure 1] Each station had one simulation educator to facilitate learning. A brief description of each station is as follows.

Station 1

This was a Virtual Dissection Table by Anatomage Inc. (California, USA, 2016.) This table provides a visualisation of human anatomy with high-level accuracy and dissectible in 3D format. Using this, students were shown the structural anatomy and relations of heart and major blood vessels. Students were encouraged to individually identify the structural relations of the heart.

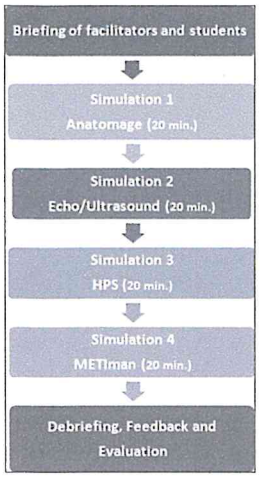

Figure 1: Steps involved in the implementation of the simulation module.

Station 2

This station had an ultrasound simulator-Vimedix (CAE Healthcare, Canada, 2016). The simulation educator explained the flow of blood through chambers of heart, cardiac cycle with pressure and volume changes. The production of the heart sounds was also explained.

Station 3

A clinical case scenario of ventricular fibrillation admitted in an intensive care unit was created on a High Fidelity Human Patient Simulator (HPS) (CAE Healthcare, Canada, 2014). The students were briefed regarding the working of HPS and the usage of various equipment, drugs and monitors connected to it. The learning objective of this station was to teach the electrical conduction system of the heart, its relation to ECG, normal ECG and identifying the abnormalities of rhythm in ECG.

Station 4

This station aimed at teaching clinical examination of the cardiovascular system using METIman (Medical Education Technologies Inc, CAE Healthcare, Canada, 2014), which is a High Fidelity patient simulator. With this simulator, arterial pulse examination including all peripheral pulses, heart sounds, apex beat, cardiac borders examination and breath sounds was demonstrated. The students were asked to practice individually on this mannequin.

The student doubts were addressed throughout the interactive sessions as well as at the end of the entire process.

Debriefing, feedback and evaluation

After the students completed the entire process, they were administered a questionnaire regarding their learning experience at the simulation centre [Table 1] and feedback was sought at each station [Figure 2]. An electronic post-test was conducted to evaluate the change in knowledge. A retro-pre questionnaire, based on the Dreyfus Model of skill acquisition was administered. They were asked to rate their self-perceived change in understanding of concepts in cardiovascular physiology. They also rated their confidence levels in clinical skills before and after the simulation training. The feedback from faculty involved in the planning and implementation of this integrated teaching module was also collected [Figure 3].

Table 1: Student perception of simulation-based learning (n=145).

Questions	Strongly agree (%)	Agree (%)	Undecided (%)	Disagree (%)	Strongly disagree (%)
The training session resembled a real-life situation	90 (62.1)	53 (36.6)	1 (0.7)	1 (0.7)	0
Cardiovascular physiology concepts were easily learnt by simulation	85 (58.6)	53 (36.6)	4 (2.8)	3 (2.1)	0
Initial briefing helped me to learn better	64 (44.1)	76 (52.4)	4 (2.8)	0	1 (0.7)
I feel that simulation is essential in understanding diseases of cardiovascular system	99 (68.3)	44 (30.3)	1 (0.7)	1 (0.7)	0
Small group teaching with simulation is a better way of teaching learning	105 (72.4)	34 (23.4)	4 (2.8)	1 (0.7)	1 (0.7)
Integrating anatomy with physiology facilitated my learning	93 (64.1)	50 (34.5)	2 (1.4)	0	0
Small group teaching with simulation keeps us to be more involved in learning	96 (66.2)	40 (27.6)	8 (5.5)	1 (0.7)	0
Simulation training can improve patient safety and quality of healthcare	95 (65.5)	49 (33.8)	0	1 (0.7)	0
Simulation can improve effective participation and communication	87 (60)	49 (33.8)	6 (4.1)	2 (1.4)	1 (0.7)
Simulation in healthcare has advantages for training and gaining the competencies for students	81 (55.9)	61 (42.1)	3 (2.1)	0	0
The training session was enjoyable	113 (77.9)	31 (21.4)	0	1 (0.7)	0
I would prefer to have more of simulation-based teaching in addition to traditional teaching methods in learning	124 (85.5)	21 (14.5)	0	0	0

(The top value is the number of students and in parentheses is the % of the total).

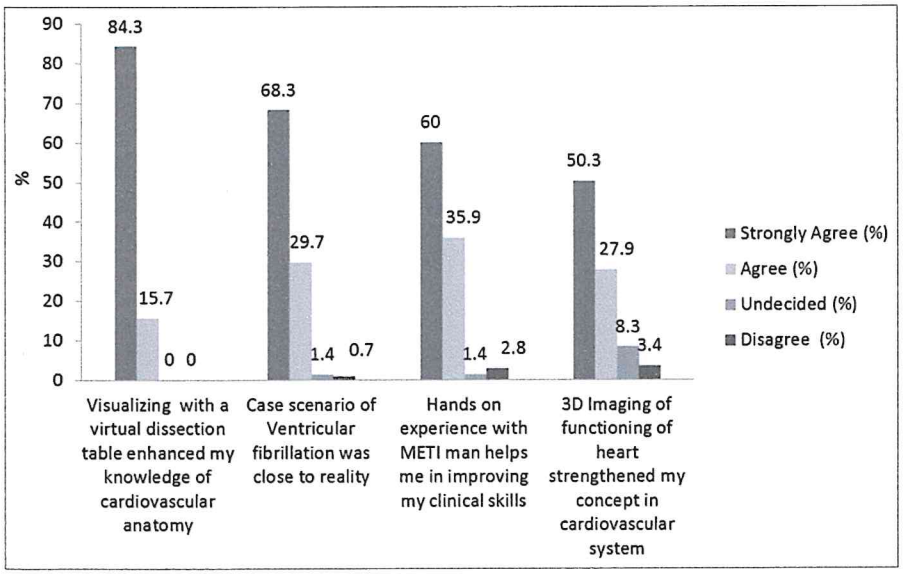

Figure 2: Student feedback on the utility of simulation stations.

The feedback from students and faculty along with assessment scores were analysed statistically using the Chi-square test, with $P < 0.05$ taken as statistically significant (Statistical software IBM SPSS Version 23). MS Excel was used for data entry and generation of graphs. Yengage, an online learning portal of Yenepoya (Deemed to be University), which is created on the ILIAS platform was used for assessment and feedback.

RESULTS

The student feedback on simulation-based learning shows that the cardiovascular physiology concepts and clinical skills were better understood in a near real-life situation (98.7%). Integrating anatomy, physiology with internal medicine in small groups was well appreciated. It made learning enjoyable for them (89.3%). The students' feedback was highly

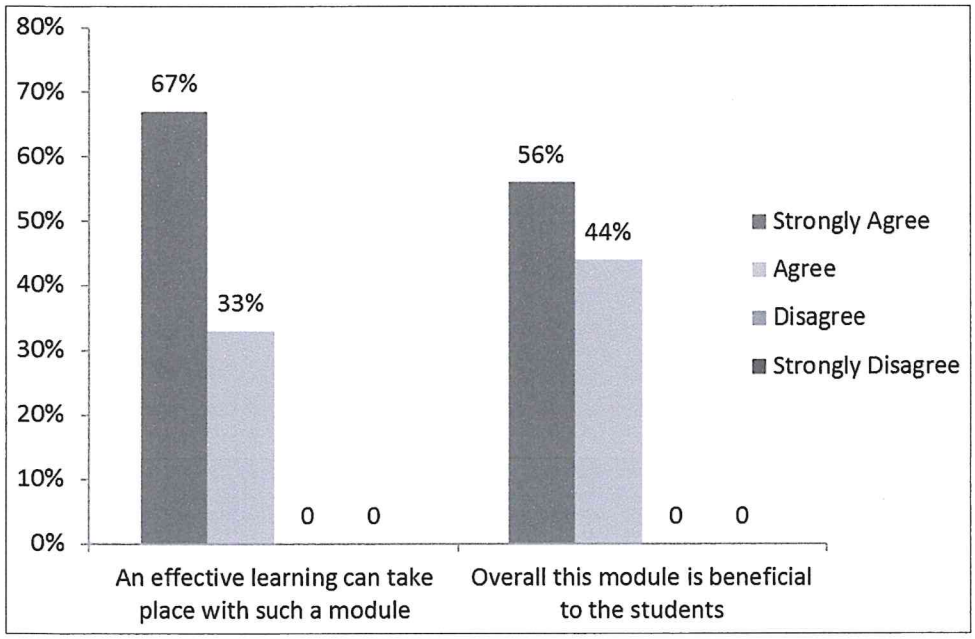

Figure 3: Faculty feedback on simulation-based teaching module (n=14).

Table 2: Gender-wise comparison of student feedback on simulation-based learning (n=145).

Questions	Strongly agree		Agree		Undecided		Disagree		Strongly disagree		*P*-value
M (n=65) F (n=80)	M	F	M	F	M	F	M	F	M	F	
Hands on experience with METIman helps me in improving my clinical skills	33 (51)	54 (67)	26 (40)	26 (33)	2 (3)		4 (6)	-	-	-	0.02
3D Imaging of functioning of heart strengthened my concept in cardiovascular system	26 (40)	47 (59)	30 (46)	25 (31)	8 (12)	4 (5)	1 (1)	4 (5)	-	-	0.04

(The top value is the number of students and in parentheses is the % of the total for the significant items only)

satisfactory for all the simulation stations. The majority of the students agreed that simulation sessions at every station addressed their need to integrate basic cardiovascular concepts with clinical applications effectively [Figure 2].

They also felt that it helped them in improving their communication skills (93.8%) and would prefer to have more simulation based teaching [Table 1].

On analysing for gender difference in learning preference, it was noted that the female students preferred hands-on experience with METIman in improving clinical skills and 3D imaging of functioning of heart when compared with the male students which were statistically significant [Table 2].

The faculty feedback revealed that 67% of the faculty strongly agreed and 37% agreed that effective learning takes place with a simulation-based integrated module. Similarly, 56% of the faculty strongly agreed and 44% agreed that this module is beneficial for student learning [Figure 3].

Table 3: Evaluation of simulated student learning.

Retro-pre questionnaire	Results	
Physiology concepts in cardiovascular system	95% advanced from beginner to proficient	
Confidence levels in clinical skills	96% advanced from beginner to proficient	
Electronic test results		
Number of students who took the tests (n)	145	*P*<0.0001
Average pre-test score	10.41/15	
Average post-test score	13.36/15	
Number of students who scored above 75% in post-test	91 (63%)	
Number of students who scored 65–75% in post-test	54 (37%)	

[Table 3] shows responses of the students to the retro-pre questionnaire to assess their self-perceived knowledge gain

and level of clinical skills before and after the integrated teaching session. Most of the students advanced from beginner to proficient in acquiring these skills (95% and 96%, respectively). Their summative assessment scores to test their actual gain in knowledge showed that all the students achieved the minimum pass percentage as desired.

DISCUSSION

The process of development and evaluation of an integrated simulation-based learning module as part of early clinical exposure to teach cardiovascular system physiology concepts to 1st-year undergraduate pre-clinical medical students was studied. Meticulous blueprinting the topics, using multiple modalities and integrating physiology knowledge with clinical application has helped in improving the students' academic and clinical performance. Proper understanding of physiology concepts in undergraduate teaching is the foundation basis for most disciplines/subjects in medical field. Learning clinical skills are one of the competencies expected to be attained by 1st-year undergraduate as per Medical Council of India's new competency-based medical education curriculum.[14] Hence, this module has helped students in improving both knowledge and clinical skills.

The stress-free environment has contributed to an enjoyable learning experience. Before the introduction of the new curriculum in the absence of early clinical exposure, real-life simulation sessions in undergraduate physiology helped the students to link theory to clinical aspects of cardiovascular system. The small group training sessions have the advantage of more interaction among the students which enhance their communication levels among themselves and the teachers. An integrated approach to teaching using simulations was beneficial to the students which gave them a comprehensive picture of learning medicine instead of compartmentalising anatomy and physiology as individual units.[11]

The virtual dissection table has the advantage of performing layer by layer dissection and visualising structures in various views in three dimensions. This has helped the students in integrating structural anatomy with functional physiology in our study. Similar results were found in a study conducted on 1st-year medical students in Canada who perceived enhanced learning with virtual dissection. This proved that virtual dissection augmented cadaveric dissection in medical education.[15]

The students could visualise the chambers of heart, valves, blood flow inside the heart, contraction of cardiac muscle and valvular movements using 3D imaging. Bell FE 3rd *et al.* have studied the effect of using ultrasound simulation to teach cardiac physiology to 1st-year medical students at the University Of South Carolina School Of Medicine. The post-test scores showed improvement in knowledge and the feedback from them was very positive as a valuable teaching tool for learning.[16] According to educational psychologists, the instructional methods that emphasise guidance with practical approaches are more effective than minimally guided approaches.[17] The use of trained simulation educators to facilitate learning at station could also be a factor contributing to improved student satisfaction.

The students were able to appreciate the intensive care unit set up which was created to monitor and manage a case of ventricular fibrillation in the simulation sessions using HPS in our study. They understood the diagnosis of the disease using symptoms and electrocardiogram. The students in small groups were able to feel the emergency situation, the behaviour of the staff handling the simulated patient and how he was treated. The web-based and mannequin simulations for learning shock physiology were conducted for 40 students at University of Central Florida, Orlando and Florida, where students rated the mannequin simulation as more effective in teaching shock and its treatment aspects which are in accordance with our observed results.[18] To teach undergraduate pre-clinical medical students in physiology, High Fidelity simulators have been used in the previous studies to teach basic neuroscience concepts,[19] respiratory physiology,[20] hypovolemic shock[21] and renal failure[22] only at selected centres worldwide. By appropriate design of the scenarios, proper training with simulators, drafting specific learning objectives with an assessment component, the desired goal can be attained effectively.[23]

METIman has an advantage of examination of precordium, arterial pulses, peripheral pulses, respiratory sounds and heart sound on a simulator without any discomfort to the subject or a patient. Females preferred hands-on experience with METIman in improving clinical skills while examining cardiovascular system. This might be due to overcoming the inhibition of practicing examination on male colleagues, which is observed in the Indian setup. This gender-wise difference of student feedback on simulation-based learning with different simulators is similar to the studies done in Saudi Arabia.[13]

The previous studies using HPS and METIman at different places have revealed that student satisfaction and learning are maximum with simulation-based teaching.[24] It has resulted in better understanding of the physiological aspects which are directly linked with the pathological conditions which are mimicked using Low and High Fidelity simulators.[25] In addition to the traditional didactic lectures, small group teaching, an integrated simulation-based teaching which includes hands-on experience for real-life-like situations increases the retention of learned knowledge as it involves the concept of 'learning by doing.' It has been proposed that in all health specialties, patient simulation with virtual reality blended with e-learning will enable medical students to learn effectively in a greater way.[26]

We found most of the students felt that their self-perceived knowledge and level of clinical skills have increased along with 100% of the students achieving a minimum pass percentage in their assessment. Similar results were seen in a study conducted in Chennai, India with simulation-based teaching. Their results showed that this mode of teaching had a significant impact on the knowledge and skills of both the gender group.[27]

The students in our study enjoyed the whole process of simulation-based learning as it is different from the traditional model of curricular transactions. All the students would like to have more simulation-based teaching programs for other topics in physiology. This innovative method of student teaching-learning strategy is being implemented across the health-care institutions worldwide.[28] In spite of such innovations in teaching-learning strategies, most of the medical colleges in India are following traditional teaching-learning methods.[29] The High Fidelity simulators with a functional physiological model are yet to be effectively utilised and incorporated into our curriculum. The reason for not using simulators may be related to the high operational cost involved. Simulation-based teaching integrated with other traditional methods in basic science education can definitely improve student learning.[30] Simulation-based learning implemented in curriculum helps the students to effectively practice patient care away from the bedside, enhance their theoretical and clinical skill knowledge.[31]

We are in the process of developing simulation-based integrated modules in other topics to cater to the needs of the student community. Such module needs to be incorporated into health medical curriculum to produce competent health-care professionals.

CONCLUSION

An integrated approach to early clinical exposure using simulation is useful for understanding the complex physiological mechanisms of the cardiovascular system. With sufficient infrastructure and clear planning, the learning process of the students can be made more effective and interesting.

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Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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End of Paediatric Posting Assessment of Medical Interns at a Teaching hospital from Coastal Karnataka

Sahana KS[1], Qadiri GJ[2], Saldanha PRM[3]

Abstract

Introduction: Internship is very a critical period of a medical undergraduate education during which student evolves into a doctor. The objectives of this study were to assess the interns at the end of their paediatric postings. **Materials and Methods.** Interns knowledge and skills were assessed at the end of their postings in the must know areas. Assessment was conducted by the trained faculty and interns were given the orientation about it. Method of assessment included OSCE, simulation based using standardized patients and computer based model driven simulators.Feedback was given to the students immediately at the end of their exam **Results:** Total 202 interns participated in the exam over the period of two years. New-borns assessment was done more frequently (22.7%) and interpretation of investigations was less frequently assessed (7.9%). Rest of other stations was assessed almost at the equal proportion. Highest score was observed in vaccines section (7.5) and lowest score was seen in procedures assessment (5.5). **Conclusion.** Interns were found to be weaker in procedural, communication and clinical scenario judgement skills which will help us in planning future training of the Interns.

Key words: Clinical rotatory internship, paediatrics, assessment

Introduction

Medical internship is the period where students are expected to learn additional skills, recognize emergency situations and enable them to become practice as primary care doctors. But there is a gradual decline in the overall competency level of interns[1].

Given the vast diversity of medical institutions in the country offering medical education of variable standards, one common exam national exit exam (NEXT) is being proposed for undergraduates, which is opined to bring the quality and maintain the standard[2]. Though the guidelines are not very clear yet, the practical component is being planned to conduct after the internship which can significantly change the outlook towards practical learning during internship.

In our institute we initiated the clinical skill assessment examinations for interns to encourage them to learn the essential

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clinical skills including communication and procedural skills along with the knowledge component during the internship period. Though there are many studies focusing on improvement of clinical competencies, at the post graduate trainee levels in paediatrics[3] limited literature is available on effective internship learning and assessment. So this study is being undertaken to know the performance of interns in the must know areas at the end of their postings.

Material and Methods

This was a Cross sectional study. Clinical skill assessment exam was started for interns in our Institute of Yenepoya Medical College affiliated to Yenepoya deemed to be University as per the norms of our university from April 2015. At the end of the paediatric posting, that is at the end of one month, interns were assessed for their skills and knowledge. Students were given prior information regarding the date of examination. Interns were given orientation in the beginning of the postings about the essential skills and the basic knowledge that they are supposed to learn during their rotation. Method of assessment included OSCE, simulation based using standardized patients and computer based model driven simulators [4]. Even the faculty were trained for the OSCE exam through basic medical education workshop and through separate training sessions for simulation lab usage. The MEU members and subject experts (by the senior faculties within the department) performed design and content validation of the stations. Examination stations with the structured check lists were designed by the one person who was in charge of the intern's clinical skill assessment examinations and the other faculty were briefed about it for the objective assessments. It was both a formative and summative assessment which was done both at the end of the paediatric postings and at the end of their internship. Students were given the extension if they failed in the assessment.

The skills assessed for Interns were as per the recommendations of the MCI regulations for graduate medical education[5]. These included:-New-born Resuscitation, Paediatric Emergency (Case Scenario), Vaccine administration, Drug Administration, Common diagnostic/therapeutic Procedures, Interpretation of Common Investigations, Clinical examination skills and Communication skills.

The procedures assessed included nebulisation, insertion of naso-gastric tube, Monteux test. Skills and knowledge related to method of administration, storage and common side effects of certain vaccines like BCG, Hepatitis B, OPV, IPV, DPT and MMR were assessed. Similar line of assessment was done for commonly used drugs like adrenaline, paracetamol, ORS, frusemide and certain antibiotics for their dose, route and use in the paediatric clinical scenarios.

Clinical scenarios included the assessment of dehydration, shock and its management, calculation of maintenance IV fluids, snake bite and identification of SAM. Due to the availability of simulation lab, it was easy for us to mimic the scenarios.

Examination skills included blood pressure measurement, systemic examination and anthropometric measurements. Counselling skills included counselling the mother with febrile seizures child, breast feeding and counselling the mother for phototherapy. New-born stations concentrated on basic new-born care, neonatal resuscitation and assessment and management of common neonatal problems

Feedback was given to the students immediately at the end of their assessment. Feedback was taken from the faculty members based on 5 point Likert scale (level of agreement). The data was entered in the excel sheet and analysed with SPSS software version 22. Approval from the institutional ethical committee was obtained which granted us the waiver of informed consent from the study participants.

Results

Total 202 interns participated in the exit exam. It was started in the year April 2015 and continued for more than of two years till date. Those interns who could not attend on the date were given rescheduled date.

Duration of the each session was about 5 min. Table 1 gives the details of the assessment.

Table 1: Details of the Examinations (n=202)

Focus area assessed	Number (percentage)
Vaccines	24 (11.8%)
Drugs	21 (10.3%)
Communication skills	25 (12.3%)
Procedures	24 (11.8%)
Examination skills	21 (10.3%)
Clinical scenarios and judgement	25 (12.3%)
Newborn	46 (22.7%)
Investigations	16 (7.9%)

New-borns section was assessed maximum and interpretation of investigations was less frequently assessed. Rest of other stations were assessed almost at the equal proportion.

Table 2: Details of Scoring in Exit Exam (Out Of 10)

Focus Area	Mean Score	Range
Vaccines	7.5	4-10
Drugs	6.25	3-10
Communication skills	6	2-9
Procedures	5.5	2-9
Examination skill	7	5-10
Clinical scenarios and judgement	6	1-10
New born	6.5	2-9
Investigations	6.5	3.5-8

Highest score was observed in vaccines section and lowest score was seen in procedures assessment.

Feedback was taken from all the faculty members regarding clinical posting assessment of interns and the details are given below (Table 3). Overall agreement percentage observed was 74.9% (score 4 or above on 5 point likert scale on level of agreement). Highest level of agreement was seen for the assessment of communication skills which was found to be satisfactory.

Table 3: Feedback taken from the faculty regarding the end posting evaluation of interns (n=9)

Feedback	Agree (%)
Assessment should be done for all the interns. Compulsory	77.7%
This exam is helping them to improve their knowledge and skills.	66.6%
Conduction of exam was smooth	66.6%
Communication skills assessment is satisfactory.	88.8%

Discussion

Research continues to document serious deficiencies in clinical skill among students and interns of medical colleges. Traditionally log book recording and monitoring has been used as tool but level of scrutiny varies. Newer methods of assessment have been developed focusing on various skills among which we used OSCE and simulation based assessment. Objective Structured Clinical Examinations (OSCEs) have been used by medical schools as it is a precise, objective, and reproducible allowing uniform testing of students for a wide range of clinical skill[6].

Study done by Short et al, on 106 interns where they found out that OSCE exam resulted in statistically significant improvement in all core competencies like patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice[7]. In our study 66.6% of our faculty agreed that clinical assessment is helping them to improve their knowledge and skills.

In a study done by Ben et al, noted that the implementation of the modified-OSCEs at their institution has been one of the tools responsible for paediatrics residents performance improvement and students also stated that experiences was very much educational[8] though in our study feedback from the students was not taken.

Pelly et al identified the important gaps in the knowledge and skills of graduating medical students in Canada regarding vaccines indications, contraindications, adverse events, safety and patient interaction[9]. But in our study highest scoring was observed in the vaccine section. Doing the reassessment regarding vaccination at the internship makes it obligatory for the students to learn the more practical and technical aspects like method of administration and storage.

In a study done Gloria et al, they opined that the feasibility of the continuous implementation of a system should be taken into account from the beginning of the project since the resources available such as human and material may be limited[10]. We also agree with the same as it requires lot of efforts and time to prepare the stations and coordination among faculty members.

In a study done by Sharma et al, it was found that almost 50% of the interns practiced and learned skills because of the assessment and whatever the interns practice or learns, the skill must be assessed based on their learning objectives as defined in the log book[11].

Undergraduate medical education in India is lacking in doctor–patient communication skills[12]. So assessing the communication skill during internship will also help us to give them the constructive feedback and gives scope for improvement.

Different methods of assessment have also been used like Mini- clinical evaluation exercise (mini-CEX examination) by Balamurugan et al for interns and concluded that there is a lot of potential for improvement of students with respect to clinical skills[13]. Morris et. al., systematically reviewed the literature to identify and grade tools used for the end point assessment of procedural skills (e.g., phlebotomy, IV cannulation, suturing) competence in medical students prior to certification and they concluded that there is a need to develop standardized tools with proven reliability and validity for assessment of procedural skills competence at the end of medical training. Medicine graduates must

have comparable levels of procedural skills acquisition entering the clinical workforce irrespective of the country of training[14].

So, intern's examination at the end of their postings helped in skill orientation training during their postings and which in turn led to the improved performance of students in overall clinical care of the patients.

Conclusion

Interns were found to be weaker in procedural, communication and clinical scenario judgement skills which will help us in planning future training of the Interns.

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Outcome of triage results between two groups of interns subjected to different model of simulation

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ABSTRACT

Background: In the emergency department, triaging is a very important for mass casualties and should not lead to any errors while doing so. In spite of subjecting interns to triaging theory classes in their final year of MBBS, they are not confident in triaging when need comes. To address this, we designed this study which aims at understanding the efficacy and type of triage based simulation education for medical interns during their 1 year internship programme.
Methods: A cross sectional study with 186 intern students of a Yenepoya Medical College Hospital of Karnataka was selected for the triage simulation. The interns who could attend the entire programme were randomly divided into 2 groups of n=91 each. One group underwent desktop based triage simulation (n1=91) and the other group faced enacted patient based triage simulation training followed by test. Evaluation comprised of tests to 2 groups of interns. The first group were subjected to test following desktop triage simulation and the second group were subjected to test following enacted patient simulation based triaging.
Results: The test result showed that there was significant improvement in the result obtained from the group that underwent high fidelity simulation ($p<0.05$).
Conclusions: Simulation based training which is closed to reality leads to a significant increase in learning and recalling output compared to the traditional method.

Keywords: Triage, Simulation, Emergency, Interns

INTRODUCTION

'Good judgement comes from experience and experience comes from bad judgement', one among the pinnacle concepts in the journey of a medical student. The aviation industry was one of the first to implement simulation as an educational tool to reduce the mishaps due to human error. This experience provided insights to how simulation based education are successfully incorporated into medicine. Simulation-based educational methods are recognized as an established component of medical training for medical students, residents, and fellows.[1] for applying theoretical knowledge in a better way reducing the human errors. Triage is defined as the initial clinical sorting process in hospital Emergency department. Especially in high risk scenarios such as triaging. The patient has to be sorted out to the right code without any delay for the appropriate treatment to begin.

Hence proper coding in the shortest available time is of prime importance. A watershed study in the simulation fidelity realm specifically identified studies that compared performance outcomes associated with low- and high-fidelity simulators vs. No intervention controls.[2]

Alessi's foundational paper addressed not whether high fidelity is a critical, but whether for particular levels or categories of learners or instructional goals, different levels of fidelity might be more or less appropriate and beneficial.[3]

Many studies showed no significant advantage of high fidelity simulation over low fidelity simulation, with average difference ranging from 1% to 2%.[2] Practically it is difficult and dangerous to subject the interns to triaging in real scenarios. Although simulation is identified for its contribution to learning, critics claim this doesn't portray the complexities of the actual pre hospital environment and question how effective assessment is when undertaken in a controlled setting. Hence the objectives of this study were to subject medical interns of tertiary care hospital to two models of (low fidelity– desktop and high fidelity enacting subjects) simulation on triaging to compare the outcome. Also, to understand the efficacy of such teaching methodologies to integrate it with the curriculum, and to modify it periodically for achieving the best possible outcome.

METHODS

A cross sectional study using complete enumeration sampling method, the interns of Yenepoya Medical College Hospital, Mangalore, Karnataka, India (n=186) were selected who were randomly allocated into two groups of desktop based triage simulation (Group 1, n=91) and enacted patient based triage simulation training (Group 2, n=91) during October 2018 to January 2019. Interns who could participate in both pre and post-test of triage simulation were included in the study. Four interns were excluded as they could not participate in both the simulation and the test. To avoid inconvenience to the operation of the emergency department and interns postings, this intervention was done over the span of 2 weeks. The Institutional Ethics committee approval was obtained for the study. There were no health risks, discomforts, or inconveniences reported due to participation. Both groups underwent a simulation pretest to compare the differences between the two groups. The first group simulation was conducted at Advanced Comprehensive Clinical Training and Simulation Centre (ACTS-YEN), Yenepoya Deemed to be University, Mangalore, Karnataka.

The second group simulation was conducted in the emergency department of hospital. Moulage was applied to each patient actor to create lifelike injuries. They were wheeled/brought on stretchers into the emergency department from the ambulances (Figure 1 and 2). They had their vitals and injury details mentioned on a placard which was tagged in the front of their clothes. The interns who were able to attend the both scenario and the test were included in the study. Paediatric triaging was excluded. Each participant read and noted his/her response according to instructions in the self-administered questionnaire. The collected data was compiled and kept under safe custody of the principal investigator in our simulation centre and confidentially was maintained.

Figure 1: Multiple lacerated wounds with tachycardia on left and unresponsive person on the stretcher on the right.

Figure 2: (a) Pregnant lady being wheeled into casualty, (b) unconscious girl with vitals in normal limits.

Both the groups were subjected randomly coded specific question paper set before and after simulation. Same set of questions were repeated to the candidates in the pre- and post-test amongst both the groups. There were a total of six question papers each having 5 set of questions about triage, with two separate columns for answering. First column to specify the triage code and the second column to justify the code based on vitals/conscious status.

Simple triage and rapid treatment (START) is currently the most widely used triage system in the United States for mass casualty incidents.[4-7] It was developed in 1983 by staff at Hoag Hospital and Newport Beach Fire and Marine Department in California for rescuers with basic first-aid skills.[8] First, responders delegate the movement of injured victims to a designated collection point as directed by using four main categories based on injury severity:

Black: (Deceased/expectant) injuries incompatible with life or without spontaneous respiration; should not be moved forward to the collection point.

Red: (Immediate) severe injuries but high potential for survival with treatment; taken to collection point first.

Yellow: (Delayed) serious injuries but not immediately life-threatening.

Green: (Walking wounded) minor injuries.

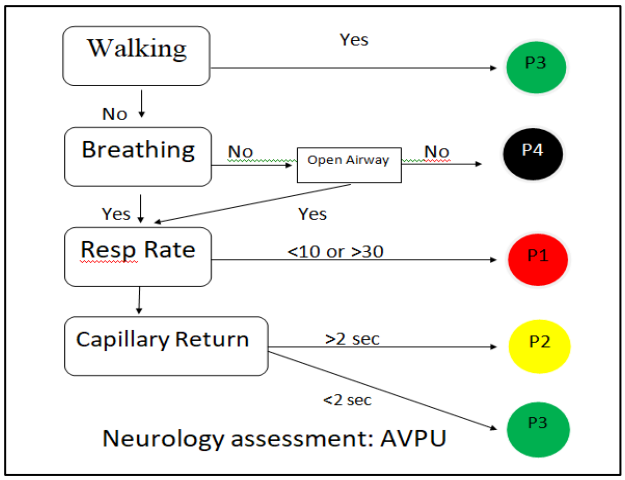

Figure 3: Table for sorting out the patients into different designed areas.

The triage colours were assigned by giving triage tags to patients or simply by physically sorting patients into different designated areas (Figure 3). "Green" patients were assigned by asking all victims who can walk to a designated area. All non-ambulatory patients were then assessed. Black tags were assigned to victims who are not breathing even after attempts are made to open airway. Red tags were assigned to any victim with respiratory rate greater than 30, absent radial pulse or cap refill greater than 2 sec and unable to follow simple commands. Yellow tags were then assigned to all others.

Neurological assessment was done using the mnemonic AVPU (Alert, responds to verbal stimuli, responds to painful stimuli, and unresponsive).

The interns were given a list of victims of different types of injury, assuming that all walking wounded have moved away from the area and that the findings are after they have repositioned the airway of any non-breathing patients. They were asked to categorise them with appropriate reason based on vital parameters and AVPU (Table 1).[8]

Table 1: Questionnaire items selected for all 6 sets for simulation.

Victim	Type of injury	Pertinent information
#1	Compound fracture, left femur	Respiratory rate over 30/minute; radial pulse absent; awake
#2	Sudden onset of chest pain with shortness of breath	Respiratory rate under 30/minute; capillary refill under 2 seconds; awake
#3	90% second degree burns	Respiratory rate none on arrival, spontaneous after repositioning; radial pulse present; unconscious
#4	Facial Injury	Respiratory rate over 30/minute; capillary refill under 2 seconds; awake
#5	Unable to move legs	Respiratory rate <30/min; radial pulse present; awake
#6	No apparent injuries	Respiratory rate normal; capillary refill <2 seconds; awake
#7	Sucking chest wound	Respiratory rate >30/min; radial pulse present; unconscious
#8	Dislocated right shoulder	Respiratory rate <30/min; radial pulse present; awake
#9	No visible wounds	Respiratory rate none; radial pulse absent; unconscious
#10	Scalp wound, estimated blood loss 500 cc	Respiratory rate >30/min; capillary refill <2 seconds; awake
#11	Massive head injury	Respiratory rate <30/min; radial pulse absent; unconscious
#12	Bruising over abdomen, complaining of abdominal pain	Respiratory rate >30/min; capillary refill <2 seconds; awake
#13	Impaled, 1 foot piece of shrapnel in right eye	Respiratory rate <30/min; radial pulse present; awake
#14	Female six months pregnant; broken left, lower leg	Respiratory rate <30/min; capillary refill <2 seconds; awake
#15	Severe difficulty breathing, chest sinks in on inspiration	Respiratory rate >30/min; radial pulse present; awake
#16	Unable to move, no verbal response	Respiratory rate <30/min; radial pulse present; awake and staring
#17	Amputated left arm, bleeding controlled	Respiratory rate <30/min; capillary refill <2 seconds; awake
#18	Large head wound, brain matter showing	Respiratory rate absent; radial absent; unconscious
#19	Minor abrasions	Respiratory rate <30/min; capillary refill <2 seconds; awake
#20	Bruise on forehead, blood in ears and nose	Respiratory rate <30/min; radial pulse present; unconscious
#21	Third degree burns over front of both legs	Respiratory rate <30/min; capillary refill <2 seconds; awake
#22	Compound fracture, left arm	Respiratory rate <30/min; radial pulse present; awake
#23	Impaled stick in right chest	Respiratory rate <30/min; capillary refill <2 seconds; awake

Continued.

Victim	Type of injury	Pertinent information
#24	Second degree burns, legs	Respiratory rate >30/min; radial pulse present; awake
#25	Blood in right eye	Respiratory rate <30/min; capillary refill <2 seconds; awake
#26	Eighteen year old adolescent, no visible injury	Respiratory rate absent; radial pulse absent; unconscious
#27	Impaled object, RUQ abdomen; difficulty breathing	Respiratory rate >30/min; radial pulse present; awake
#28	Patient saying same words over and over, "what happened?	Respiratory rate <30/min; capillary refill <2 seconds; awake
#29	Spurting blood from neck injury	Respiratory rate >30/min; radial pulse present; awake
#30	Patient states she is a diabetic; skin, moist and clammy; feels shaky	Respiratory rate <30/min; capillary refill >2 seconds; awake

The study was assessed based on the comparison of post test results between both the groups. The data of tests were collected and tabulated in excel sheet. Statistical analysis was done using independent t-test with IBM SPSS software ver.23. Data were represented as Mean±Standard deviation. P<0.05 was considered statistically significant. The final results were graphically represented and conclusions were drawn.

RESULTS

About 186 interns were selected for this study amongst 2 groups of interns over 2 weeks' time span. There was significant difference noted in the post test results of the second group (Group 2, n=91) who were subjected to high fidelity simulation than the first group (Group 1, n=91) (Table 2). There was no statistical significant difference in pre-test scores of these two groups.

Table 2: Pre-test and post-test results following simulation sessions.

	Group 1 (n=91)	Group 2 (n=91)	t
Pre-test (Mean±SD)	4.160±2.111	4.000±2.057	0.53800 p=0.591 ns
Post simulation test (Mean±SD)	7.022±2.108	7.637±1.710	2.163 p=0.032

Table 3: Feedback from the interns following simulation sessions.

Item	N (%)	Strongly agree	Agree	Undecided	Disagree
I feel the simulation session was realistic	N1 (%)	5 (5.5)	15 (16.5)	40 (43.9)	31 (34.1)
	N2 (%)	68 (74.7)	21 (23.1)	2 (2.2)	
The simulation session was an interesting learning experience	N1 (%)	4 (4.4)	20 (21.9)	52 (57.1)	15 (16.5)
	N2 (%)	60 (65.9)	25 (27.5)	6 (6.6)	-
I feel it was easier to recollect following the simulation	N1 (%)	68 (74.7)	14 (15.4)	9 (9.9)	-
	N2 (%)	80 (87.9)	11 (12.1)	-	-
I feel that I am confident in executing decisions post simulation	N1 (%)	45 (49.4)	25 (27.5)	21 (23.1)	-
	N2 (%)	59 (64.8)	28 (30.8)	4 (4.4)	
I would like to have similar simulation sessions in future	N1 (%)	5 (5.5)	23 (25.3)	40 (43.9)	23 (25.3)
	N2 (%)	79 (86.8)	8 (8.8)	4 (4.4)	
I would like to suggest the next batch of interns to actively participate in simulation sessions	N1 (%)	20 (21.9)	25 (27.5)	11 (12.1)	35 (38.5)
	N2 (%)	88 (96.7)	3 (3.3)	-	-

N1=numbers in group 1, N2=numbers in group 2.

Feedback was collected from both the group participants which showed that, interns liked the high fidelity simulation session in terms of experience, reality, recollection of the steps, confident levels and they preferred this mode of training to them (Table 3).

DISCUSSION

Simulation in medical education is gaining more importance in the backdrop of competency based medical education curriculum by the Medical Council of India. It has been proved by earlier studies the effectiveness of students gaining skills and cognitive enrichment in simulated environment. We had subjected our previous batch interns to desktop simulation with a positive feedback and results. We introduced the present batch of interns to the high fidelity simulation and wanted to know the outcome in comparison with the desktop simulation. Our study was designed to subject the medical interns to two different models of simulation on triaging to compare the outcome. The results showed that students exposed to high fidelity simulation scored better compared to the

second group who had low fidelity desktop simulation sessions.

Experiential learning theory serves as the endoskeleton of simulation-based education.[9]

Advanced comprehensive clinical training and simulation centre (ACTS-YEN) of our university is equipped with the state of the art high and low fidelity simulators with task trainers for undergraduate and post graduate training for health sciences students.

Kolb characterize learning as a four-stage cycle. A learner engages in a "concrete experience," in our context, a simulated medical procedure or patient encounter, and the components of that experience form the basis for the second step of the cycle, "observation and reflection."[9-11] As a result of this second step, learners develop their internalized operational model for working through a procedure or encounter. In the third step, learners test their operational model in a new situation (another simulation or actual clinical encounter), resulting in additional concrete experience, and the cycle repeats itself, until if and when a learner achieves mastery.[12-14] According to Iputo et al, the introduction of the problem-based learning/community-based education (PBL/CBE) curriculum coincided with improved academic performance.[15]

In this study we found that, simulation close to reality leads to a significant increase in learning and recalling output compared to the desktop simulation. There was significant statistical improvement in the results following simulation. High-fidelity patient simulation is already integrated into medical training in couple of centres and their results are in accordance with ours.[16-18] The solution to the dilemma lies in "ascertaining the correct level of fidelity based on the student's current instructional level. As a student progresses, the appropriate level of fidelity should increase." Then, as now, this guidance is derived from cognitive-load theory.[19,20] Early learning should occur in relatively low-fidelity environments to reduce cognitive load.[20] Later learning can involve increased fidelity and resultant load, while approaching clinical practice.

In our study both the groups were not from same fidelity which forms the limitation of the study. Future scope of this study would be to compare high fidelity mannequins and human actors than using desktop simulation.

CONCLUSION

Simulation based training gives better results than compared to traditional teachings. High fidelity simulation is readily acceptable by the students for the close to reality experience and visual and audio remembrance. It's an advantageous educational tool with the potential to influence a student's feelings, beliefs and behaviours in relation to patient care. Although there are challenges surrounding the management of student anxiety, assessment and cost, careful preparation and planning for these issues are manageable.

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Scientific Educational Research Publications

Sl. No.	Scientific Educational Research Publications
1.	Manavalan V, Dutt RA, Harishchandra B, Nirgude A. Continuum of Surgical Skill Acquisition for the Postgraduate Residents During COVID Pandemic: Role of Advanced Simulators in a Multipronged Modular Approach. Indian J SurgOncol. 2021 Nov 9 ;1-9. https://doi.org/10.1007/s13193-021-01472-9
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