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Demonstration of Ability to Teach and Assess Life Saving Skills by First Year Medical and Dental Students Using Peyton's Four Steps; A Randomized, Single Blind, Controlled Educational Trial in Skills' Lab

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ABSTRACT

Teaching of life saving skills by trained peer tutors in skill labs is an effective educational strategy. Demand for professionals trained in skills has led to an increase in need for trained clinical instructors. Peer tuition is expected to overcome this problem to some extent. Learning such skills on real patients poses several ethical dilemmas. Skill labs provide a safe and effective alternative to patients. Present study is aimed at studying the progress in learning and ability to teach and assess performance of selected life saving skills by peer tutors using Peyton's Four steps of skill acquisition. This is an experimental study with randomized, single blind, controlled educational intervention based protocol. 134 pre-clinical students were trained by the Skills Committee to become peer tutors according to Peyton's Four steps. Ability to teach and assess skill was compared between peer tutors and conventional teachers. Peer tutors' progress was also recorded over successive sessions. Finally, pre and post-test scores of 657 peer tutees were analysed. Peer tutors showed significant improvement in scores over successive sessions. Ability to teach and assess skills by peer tutors surpassed that of clinical instructors, as assessed by blinded assessors according to Peyton's Four steps. Peer tutees showed significant improvement in post-test scores over pretest. Clinical students did not show statistically significant improvement in Adult and pediatric BLS and Suturing skills. Peer tutors trained in Skills Labs according to Peyton's four steps are as effective or better than clinical instructors in teaching and assessing performance of selected life saving skills in peer tutees.

Keywords:
BLS, peer tuition, simulation based medical education, Peyton's four steps, skill lab

1. Introduction

"The metaphor for exemplary teaching changes from teaching as transmission to teaching as transformation [1]." Teaching of critical life and death issues, end of life care and performance of life

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saving skills in medical education is viewed as and expected to be transformational [2,3]. Quality teaching is a small part, compared with actual learning and performance of medical skills in real life. Medical teachers continue to innovate and test effective methods to teach and assess acquisition and performance ability of these skills. It is a complex task to teach the requisite knowledge and skills involved in handling life and death situations to medical students. Not only do they need to learn the skills, they have to learn them without jeopardizing actual patient care. Advent of simulated patients and scenarios has dramatically improved our ability to teach these topics in safety of skill labs[4]. Students report improved understanding and retention of knowledge after getting exposed to these topics in simulations [4,5]. As skill labs become popular and simulations evolve into more "life-like" situations, the search for accurate and unbiased techniques and methods to assess actual skill acquisition has also intensified [6].

Several studies have documented the superiority of deliberate practice in development and retention of skills when simulations are used [7]. In a meta-analysis of 14 studies, simulation with deliberate practice was better than conventional methods of clinical education in developing skills such as CPR, advanced cardiac life support, cardiac auscultation, and central venous line placement, among several other life-saving skills [7]. The boundary between, "knowing-what?" and "knowing-how?" fades when learning life-saving skills. The need for learning these skills in small groups through practice sessions in skills lab has led to increased demands in terms of trained faculty instructors in addition to resources. This has allowed peer tutoring to be tested in medical education. Available data supports peer tutoring in subject content related to life saving skills [8]. Medical students are known to perform well as tutors in simulation labs and scenarios. Relevance of year of training and level of knowledge of peer tutors in medicine is also well studied [8,9]. Studies comparing level of skill acquisition in peer tutored versus teaching staff tutored medical students support peer tutoring as a method of instruction that is as effective as teaching staff teaching in skill labs [9].

Skills' teaching in medicine is frequently designed around Peyton's four steps of skill teaching [10]. These steps are as follows:

- Step 1 – "Demonstrate": The tutor demonstrates the skill at a normal pace and without additional comments.
- Step 2 – "Talk the tutee through": The tutor demonstrates the respective skill while describing each procedure in detail.
- Step 3 – "Tutee talks tutor through": The tutor performs the skill for a third time, based on the sub-steps vocalized to him by the tutee.
- Step 4 – "Tutee does": The tutee performs the skill on his/her own.

Present study is aimed at documenting and reporting the quantitative improvement in ability to teach selected life-saving skills by first year medical and dental students after undergoing training according to Peyton's four-step design. Study objectives were set as follows:

1. Teach selected life-saving skills, according to Peyton's method, to first year medical and dental students, in eight sessions, aided by simulations.
2. Track and compare results from assessments of peer tutors through direct observation of their ability to teach in comparison with conventional clinical instructors, over successive training sessions.
3. Compare pre and post test results for peer tutees exposed to teaching of life-saving skills by peer tutors.

2. Materials and Methods

2.1 Study Design

This is an experimental study. A randomized, single blind, controlled educational intervention based protocol was designed. Institutional Ethical Committee for Undergraduate Medical Research reviewed and cleared the study protocol in 2017. Six "Skill Stations" with learning outcomes, visual aids such as mounted photographs and flow charts, verbal cue cards and simulation material were designed. Table 1 gives the detail of each skill station.

Table 1
Detail of "Skill Stations" used to teach Peer Tutors

Skill Station	Learning Outcomes	Visual Aids	Verbal Cue Cards	Simulations/ Prop Material
Basic Life Support, (Adult), Single Rescuer, Two-Rescuer.	Identifies need for CPR Calls for help Clears airway Performs rescue breaths on adult victim Performs effective CPR on adult victim Performs Heimlich maneuver on adult choking victim	BLS algorithms from American Heart Association Illustrations of Heimlich maneuver Compression number and depth in Effective CPR	Single-rescuer CPR Two-rescuer CPR Heimlich required	Leardal Resusci-Anne QCPR with feedback device Full body & Torso Compression board
Basic Life Support, (Child), Single Rescuer, Two-Rescuer	Identifies need for CPR in a child Calls for help Clears airway while maintaining C-spine stability Performs rescue breaths Performs effective CPR Uses two-finger technique in infant Performs back blows and chest thrusts maneuver on child/infant choking victim	Pediatric BLS algorithms from American Heart Association and American Academy of Pediatrics Illustrations of choking in child and back blow maneuver Compression number and depth in Effective child CPR	5-year-old child found in a park. Needs single-rescuer CPR Child seized in school and found unconscious. Two-rescuer child CPR Choking 2-year old requiring back blows 4-year-old victim of drowning	Leardal Resusci-Baby QCPR and QCPR AW (airway model) Pediatric and Infant model with feedback device Compression board
ABCDE of Trauma Victim	Performs ABCDE assessment in acute trauma victim Clears airway while maintaining C-spine stability Performs rescue breaths Performs ambu-bagging upon indication Describes indications for endotracheal intubation Performs effective CPR on trauma victim Prioritizes IV sites Selects appropriate fluid for resuscitation Performs "Disability" survey	Illustration of trauma victim survey points C-spine collar Parts of ambu bag Endotracheal tube and laryngoscope Color coded IV cannulas Board for patient transport Patient Transport Kit	Motor vehicle accident victim requiring C-spine stabilization and fluids Bomb blast victim requiring IV fluids and disability survey with prevention of exposure Gun shot injury victim requiring endotracheal intubation and blood transfusion	Same as BLS

Rapid IV Access	Recognizes signs of impending shock Prioritizes IV sites in adults and children Selects appropriate IV fluid in shock resuscitation Performs IV cannulation with aseptic precautions Recognizes phlebitis	Color coded IV cannulas Phlebitis IV fluid charts Algorithm Management of Shock	Patient with early impending shock requiring rapid IV access and fluid infusion Checking patency of IV cannula in a child	Arm with anatomically correct veins and marked insertion sites
Basic Suturing Technique	Differentiates mono vs. poly filament suture material Selects appropriate suture material and needle for simple surgical wounds Describes indications for three common suture techniques Performs simple interrupted, simple continuous and mattress sutures on props	Illustrations: Monofilament sutures Polyfilament sutures Types of suture needles Simple interrupted sutures Simple continuous sutures Mattress sutures Non-suture materials for wound repair		Suture materials with different needles Foam pads with thin semi-porous covering, (mimicking skin) Suture scissors Toothed and non-toothed forceps Derma-bond material
Rapid Interpretation of ECG	Calculates heart rate and analyzes rhythm from ECG strip Calculates PR, RR, QRS duration Differentiates supraventricular from ventricular tachycardia Recognizes heart blocks Estimates axis of the heart from direction of QRS complex	Illustration ECG paper Formula for calculating heart rate and axis Abnormalities of rate, rhythm and axis	Cases describing: An athlete with sinus arrhythmia A child in pain A 60-year old on Beta blocker SVT, VT, VF, AF, Heart blocks LVH, RVH	ECG Strips with: Normal sinus rhythm Tachycardia Bradycardia Arrhythmias Chest x-rays and ECG strips with LVH & RVH

2.2 Development of Skill Stations

Teaching scenarios and assessment rubrics were vetted in three rounds among principal investigator and the "Skill Station Committee" comprising of one physician, one cardiologist, two surgeons and three final year medical students. Skill Stations Committee was blinded to the experimental protocol. Visual aids were inspected from varying visual angles and distances and in consort with the teaching scenarios by the same committee and approved after revision. Simulation materials, (see Table 1), were tested and approved as well. Dresses and linen around simulations was designed to resemble our teaching hospital. All intravenous fluids and medications were purchased from local companies. Stethoscopes, thermometers, BP apparatuses and other clinical gadgets were placed on practice stations, as and when required to make the simulated set up look like actual clinical practice, (see Table 1)

2.3 Peer Tutor Enrolment & Training

First year medical and dental students were asked to participate in training to become "Peer Tutors". Third year medical students, who were pre-trained in skills performance, were enrolled as supervisors for the junior tutors. Senior tutors were trained by the skill station committee members and made responsible to observe and assist juniors in learning and performing skills and in providing performance feedback to the instructor and the skill station committee members. Junior tutors were briefed about their responsibilities as tutors which involved undergoing an eight-hour training over four weeks to qualify as peer tutors in their respective skill station. Consenting students were enrolled as "Peer Tutors". They were assigned to specific skill station after random drawing of names. Each group of peer tutors were given pre-tests according to their skill station. They were taught by an AHA certified instructor for total of eight hours per skill station over one month. One session was thirty minutes and comprised of theoretical teaching, scenario based testing and demonstration of skill around props and simulations. Every alternate session was followed by practice and testing with cue cards and simulations/props. Remedial sessions were given for students not meeting required standards. A total of fifty hours of teaching were recorded over twenty-six days.

Table 2
Demographic and Educational Details of Peer Tutors, (Percentages given)

Skill Station	n	Male/Female %	Mean Age, (Yrs)	Major Ethnicity	Education % FSc/Cambridge	Peer Tuition Experience %
ECG	29	40.0/60.0	20+/- 2.3	Pushtoon	98.0/2.00	2.0
BLS, Adult	28	57.0/33.0	22+/- 2.1	Pushtoon	99.0/1.00	7.0
BLS, Child	18	30.0/60.0	21+/- 2.0	Pushtoon	99.0/1.0	3.0
ABCDE	22	20.0/80.0	21+/- 2.2	Pushtoon	100/0.0	4.0
Rapid IV	17	10.0/90.0	22+/-1.5	Pushtoon	100/0.0	2.0
Suturing	20	80.0/20.0	20+/-2.0	Pushtoon	95/5.0	5.0

Peer tutors were observed by the skill station committee members playing pre-assigned roles as tutors according to cue cards on simulations/prop materials. Score cards were designed according to Peyton's Four Steps. Table 3 shows the scoring scheme of each peer tutor. This scheme was used in all teaching sessions to score the peer tutor's ability to teach and finally, evaluate the assigned skill. Performance in pre-set attributes was recorded for each peer tutor in each session. Students were cleared as tutors after passing post-test and a practical exam by their instructor and the skill station committee. There were two re-takes on written exam and seven remedials given for skill performance.

Table 3
Score Card for each Training Session to Assess Peer Tutor according to "Peyton's Four Steps"

Instructions: Kindly observe the peer tutor for one minute as he/she demonstrates the skill and score according to the following key	
Demonstrates the skill with two or more comments indicating recall	1.0
Demonstrates the skill at a normal pace without additional comments	2.0
Demonstrates the skill while describing the procedure steps, (cue card)	3.0
Demonstrates the skill based on steps vocalized by the tutee, (cue card)	4.0
Scores the tutee as he/she performs the skill taught by tutor, (score card)	5.0

The same skill station committee observed four clinical instructors teaching selected life saving skills to other students on same simulations/prop materials. These instructors were scored on the same cards according to Peyton's Four Steps, (Table 3) to score for ability to teach and evaluate the skill.

Peer tutors taught medical and dental students in a special two-day event. A total of 657 students were exposed to peer instruction in skill stations. Pre and post test scores were recorded for all the peer tutees.

2.4 Data Analysis

Data was entered in SPSS V-21 and MS Excel for analysis. Paired sample t-test was applied.

3. Results

200 first year medical and dental students were asked to participate. 127 medical and 10 dental students consented. 20 third year medical students, who were pre-trained in skills performance, were enrolled as supervisors for the junior tutors. 134 pre-clinical students finally consented to participate and signed up for training as "Peer Tutors". They were randomly assigned to each skill station, (see Table 1).

Demographic and Educational details of each group are given in Table 2. Table 3 shows mean scores achieved by peer tutors over one-month training period. Progressive increase was reported in peer tutor's ability to perform skill independently, as well as the ability to demonstrate the skill to a peer tutee, with each successive session. Figure 1 is a graphic representation of scores attained by Peer Tutors in Pre-Test, Post-test and Eight successive, hands-on training sessions.

Table 4 shows mean scores and results of paired sample t-test applied to mean scores achieved for performance of "Ability to Teach and Evaluate a Skill" by peer tutors versus clinical instructors for each skill tested. There is improvement in scores achieved by peer tutors compared with clinical instructors after session five. Peer tutors surpassed the scores for clinical instructors in session six-eight with significant difference in mean scores computed by paired sample t-test, (p-value - < 0.001).

Table 4
Results of paired Sample t-test for Mean Performance Scores achieved by Peer Tutors versus Clinical Instructors for all Skills tested in Eight Sessions

Session No.	Peer Tutors, (n=134)	Clinical Instructors, (n=4)	P-Value
First	12.91 ± 0.7911	31.43 ± 0.95811	<0.000
Second	13.50 ± 0.7162	33.55 ± 0.7491	<0.000
Third	16.71 ± 0.6325	33.20 ± 0.6284	<0.000
Fourth	20.425 ± 0.6655	33.725 ± 0.6975	<0.005
Fifth	30.56 ± 0.7695	34.463 ± 0.6923	<0.015
Sixth	39.92 ± 0.6558	34.95 ± 0.6679	<0.001
Seventh	44.50 ± 0.72511	34.83 ± 0.6543	<0.000
Eighth	45.67± 0.527	34.63 ± 0.6754	<0.000

Table 5 gives the mean scores for Pre and Post-test from the 657 peer tutees from clinical and pre-clinical levels of medical education. Both clinical as well as pre-clinical students showed significant improvement in Post-test scores after tutoring by the peer tutors, for most skills tested. P-values for mean pre and post-test scores was significant at <0.001 for skills except adult and

pediatric BLS and Suturing Skills for clinical medical and dental students with p-values 0.015, 0.005 and 0.005 respectively.

Table 5
Results of Paired Sample t-test for Mean Pre and Post-Test scores of Peer Tutees

Skill Station and Peer Tutee Group Description	"n"	Pretest (-/10)	Post-test (-/10)	p-value
Adult BLS, Pre-Clinical medical, dental students	112	4.4400 ± 1.1003	9.4420 ± 0.1731	< 0.000
Pediatric BLS, Pre-Clinical medical, dental students	112	3.734 ± 0.2721	9.3040 ± 0.2573	<0.000
Adult BLS, Clinical medical, dental students	78	5.4900 ± 1.6423	9.2434 ± 0.0982	< 0.015
Pediatric BLS, Clinical medical, dental students	78	6.667 ± 0.7890	9.0706 ± 0.4713	<0.005
ABCDE, Pre-Clinical medical, dental students	90	2.8760 ± 1.004	9.4386 ± 0.3190	< 0.000
ABCDE, Clinical medical, dental students	58	4.9810 ± 0.4800	9.2091 ± 0.4061	<0.000
ECG, Pre-Clinical medical, dental students	98	2.8950 ± 0.6463	8.9883 ± 1.0005	< 0.000
ECG, Clinical medical, dental students	84	3.6171 ± 0.7802	9.0080 ± 0.7902	<0.001
Rapid IV Access, Pre-Clinical medical, dental students	80	1.3021 ± 1.2849	9.1490 ± 0.6921	< 0.000
Rapid IV Access, Clinical medical, dental students	69	4.9901 ± 0.3870	9.0691 ± 0.8234	<0.000
Suturing, Pre-Clinical medical, dental students	94	0.8092 ± 0.6463	8.9673 ± 1.0045	< 0.000
Suturing, Clinical medical, dental students	80	4.9832 ± 1.6753	9.9980 ± 0.001s6	<0.005

4. Discussion

Our study shows that it is possible to train pre-clinical students to perform and teach life- saving skills, (Basic Life Support for Adults, Basic Life Support for Children, ABCDE of Initial Trauma Stabilization, Rapid Interpretation of ECG, Rapid IV Access and Basic Suturing Techniques), with help from vetted visual aids, short scenario based testing and simulated patients. A clear trend of improvement in ability to teach and evaluate the skills, being taught, is seen among our study participant peer tutors, (Figure 1).

We are presenting combined results for clinical skills' set listed in Table-1. Similar studies have been done utilizing Peyton's Four Steps for clinical skills' teaching to pre-clinical students. Lund *et al.*, [11] compared undergraduate medical students for acquisition and actual performance, on volunteer students, of IV cannulation. They randomized two groups of undergraduate students. Experimental group was taught IV cannulation in skills lab according to Peyton's four steps. Control group was taught this skill by clinical instructors on bedside. They concluded that the experimental group demonstrated success in IV cannulation on volunteer students in statistically significant shorter time required for actual skill performance on a patient. The experimental group also demonstrated statistically significant higher number of successful attempts of IV cannulation. Although they studied only one skill, however, their results confirm that learning a skill in safety of skills lab according to

Peyton's four steps is more effective that conventional bedside teaching in actual acquisition of that skill. We are preparing detailed manuscripts for each skill separately, for future submission.

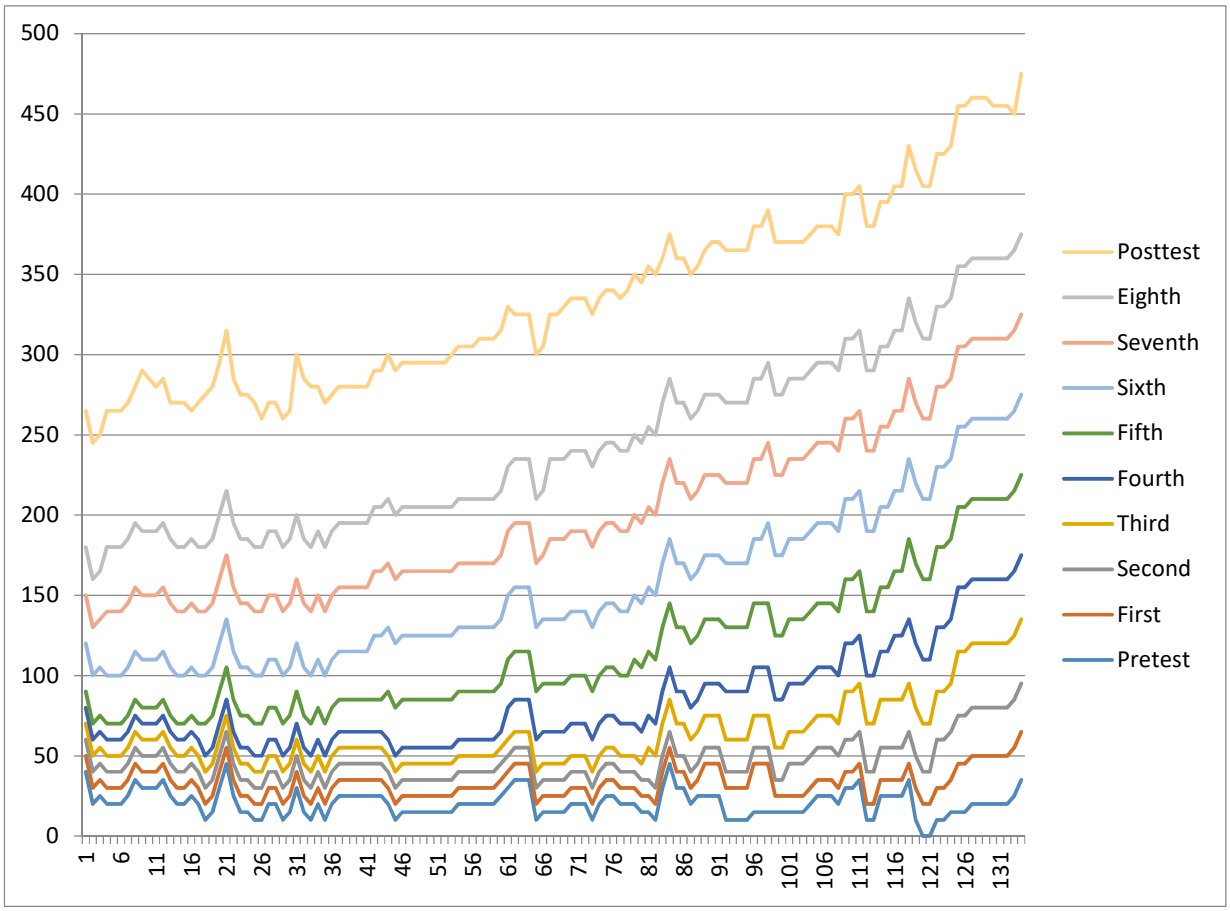

Fig. 1. Scores Attained by Peer Tutees in Pre-Test, Post-test and Eight Successive Training Sessions

The progressive improvement in skill performance scores and scores for ability to teach and evaluate the skills seen in our study is confirmed by several other studies. It is predictable that the more a subject is taught and practiced, the better a learning and performing level will be achieved. We were able to demonstrate better scores for "Ability to Teach and Evaluate" among peer tutors compared with conventional clinical instructors after five sessions. Peyton's four steps were used for all evaluations, (Table 3). All evaluations were done by assessors who were blind to the study protocol and to purpose of evaluations. Simulation based education and deliberate practice were assessed by McGaghie *et al*., [12] in 2012 in their exhaustive meta-analysis of literature spanning twenty years, (1990-2010). They concluded that Simulation Based Medical Education with Deliberate Practice is superior to conventional lecture and bedside sessions based medical education in acquisition of specific goals for selected clinical skill performance. We provided ample opportunities for Deliberate Practice of life saving skills to our study participant peer tutors. This may be a possible reason for better ability to teach and evaluate the skill compared with clinical instructors, who were educated in conventional systems. This finding is confirmed by Ericsson *et al*., [13,14] in their studies about achievement of mastery in skill performance in relation with Deliberate Practice. Utility and power of Deliberate Practice is well studied and proven beyond doubt in several educational and

performance domains including commerce, physical and mental sports, performing arts, biological sciences, and writing [15]. Multiple research studies have shown that Deliberate Practice is a significantly stronger predictor of professional accomplishment when compared with years of experience or academic aptitude [15].

Wayne *et al*., [16] studied simulations and deliberate practice on a group of post graduate trainees in learning Advanced Cardiac Life Support. They concluded, "A curriculum featuring deliberate practice dramatically increased the skills of residents in ACLS scenarios. Residents enjoy training, evaluation, and feedback in a simulated clinical environment."

Our peer tutors taught more than 600 peer tutees from pre-clinical and clinical years in medical and dental schools in a special event dedicated to "Skill Stations". This, in itself, is an unprecedented event in local arena of medical education. As seen from pre and post-test results achieved by the peer tutees, mean scores improved in all skills assessed in our study. We could not find a similar study with such a large sample size of peer tutees. A higher p-value for pre and post-test scores for clinical students in Adult BLS, Pediatric BLS and Suturing Skills can be explained by higher level of knowledge and exposure to these skills in clinical years. Although post-test scores appear to have improved in all skills tested, however clinical students performed consistently better than pre-clinical students and that is easily understandable.

Peer tuition has remained under investigation over past decade and there is ample evidence to support it as an equally effective, if not superior, technique in medical education. What makes it superior is its potential to reduce demands for trained faculty to teach small groups and to provide opportunity for training of undergraduates as future medical teachers. Peer tuition in skills labs is well studied and is being implemented in several medical schools at this time. Blohm *et al*., [17] documented working peer tuition programs in 33 out of 36 (91.7%), medical faculties in Germany.

One main aspect of our study was the ability of a peer tutor to evaluate or assess the competence of a peer tutee in performance of the skill being taught. While the benefits and potential of peer tuition is well studied, the ability of a peer tutor to actually assess and evaluate the skill acquisition by a peer tutee is relatively less studied. Bucknell *et al*., [18] documented that clinical students from senior years of healthcare education can make reliable assessments of their peers' performance during the exit test in basic life support. Study participants preferred peer assessment, and the peer assessment protocol was satisfactory for of peer tutees and peer assessors [18]. We did not compare the assessments made by our peer tutors with those of clinical instructors in this study. We plan to analyse the data from this viewpoint in future. Chenot *et al.,* [19] showed that peer tutors can act as examiners in summative OSCE, (Objectively Structured Clinical Exam) to evaluate basic medical skills. They observed slightly better grades being awarded by peer tutors, but their data analysis showed that this difference was of no practical concern.

We believe that our research is among the first few similar works in the area of peer tuition and simulation based medical education in our region. Further in-depth data analysis will be published after this initial work. Our results reflect other similar studies from medical educationists from other countries. We faced difficulties in terms of administrative cooperation and willingness. Our work, being an unprecedented experiment, was viewed negatively by our peers. This is entirely within the scope of difficulties faced by any scientist undertaking an unprecedented project and we hope for better understanding on part of peers and admin in future. We encountered a very healthy and encouraging change in our study participant peer tutors. Qualitative analysis of their experiences and ideas is being carried out and will be published later. We recommend close collaboration and combined effort to further elucidate the role of peer tuition in skills labs for better skill acquisition and performance.

5. Conclusion

Peer tutors trained in Skills Labs according to Peyton's four steps are as effective or better than clinical instructors in teaching and assessing performance of selected life-saving skills in peer tutees.

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