Learning Injection Techniques With Simulators: Medical Students’ Perspectives

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ABSTRACT

Background: In the present scenario, the exposure of medical students to problem solving and clinical skills acquisition is limited. Administration of medication through parenteral routes is a vital aspect of medical practice. Simulators provide an environment that closely mimics reality, without actual risk to real patient. Objectives: The aim of this study is to obtain students’ perspectives of the educational value of simulation in learning parenteral injection techniques, and their views regarding the simulation modalities used. Materials and Methods: This observational, questionnaire based study to evaluate the educational role of simulation in learning injection techniques included II-year MBBS students (n=88) at BGSGIMS, Bangalore. Students were asked to respond to the survey elements using a 5-point Likert scale. Results: Majority of the students responded positively to simulation techniques in achieving learning outcomes such as improvement of psychomotor skills and knowledge of injection techniques, self-confidence, better understanding of pharmacology of drug administration and reduced fears of causing patient harm. Regarding the simulation modalities, most of the students highly rated the adequacy of training materials and the experience and approachability of the faculty trainers. However, 94% of students felt the need for repetitive sessions for confidence boosting. Conclusion: Learning injection techniques through simulation has been positively perceived by students as an educational tool that provides an opportunity for interactive learning without risk to a real patient.

KEYWORDS: Mannequins, Medical curriculum, Patient-safety, Simulation.

INTRODUCTION

Medical profession is a high stake job, with an obligation to provide optimal treatment and to ensure patients’ safety and well-being. Also, medicine is a discipline that is a science as well as an art and repeated exposures with enhanced experience will help improve skills and confidence [1]. Repeated practice is a key component of learning and maintenance of skills in the medical discipline, and this concept of deliberate practice for acquisition and retention of medical skills has been emphasized by Medical Education [2]. However, with increased intake of students each academic year, combined with pressure to augment tertiary hospital productivity, students have limited access to hospital patients [3]. Moreover, there has been a drastic drift in the status of our patient population, from predominantly in-patient to day-care in certain circumstances, thus limiting the exposure of medical students to problem solving and clinical skills acquisition [4]. Simulation-based learning has the potential to supplement the diminishing resources for practice of medical skills [2]. The use of simulation as a teaching strategy can contribute to optimize patient safety and treatment outcomes. The students are thus provided with opportunities to experience scenarios and intervene in clinical situations within a safe, supervised, controlled setting without posing a risk to a patient [5]. Simulation takes many forms, from simple skills training models to computerized full-body mannequins. Part-task trainers are models used for repeated practice of the technical components of a clinical task. Examples include “arms” for practicing intravenous cannulation and synthetic skin pads for practicing suturing [3].
Administration of medication via parenteral routes is a vital aspect of medical and nursing practice. Many of the medication errors occur due to inappropriate medication dosage, erroneous techniques and incorrect administration site. Injection technique is more than just a psychomotor or mathematical skill. It also requires critical thinking and clinical decision making. Mannequin simulations provide a safe environment for students to practice these important skills in a realistic situation, and the learners are benefitted by the immediate feedback that is provided by faculty facilitators. If needed, students can be allowed to repeat skills and procedures until proficiency is achieved [5].

The success of any simulation-based learning is a direct determinant of the effectiveness of faculty who are using it. The creativity, clinical knowledge, teaching expertise, and technological abilities of the faculty are highly influential in the effective use of patient simulation. Simulation is a learner-centered instructional strategy where faculty acts primarily as facilitators [5].

Mannequins of varied types are being used extensively in the education of health professionals. However, the usefulness of part-task trainers in the teaching of intramuscular and intravenous injection skills to undergraduate medical students has not been reported so far, to the best of our knowledge. Hence the present study was undertaken to obtain students’ perspectives of the educational value of simulation sessions, and their view about the simulation modalities used.

MATERIALS AND METHODS

Setting and Study design: This observational, questionnaire-based study was conducted at BGS Global Institute of Medical Sciences, Department of Pharmacology, Bangalore, in the academic year 2014–2015.

Study subjects: All of the 88 MBBS students enrolled in the second year of Medical School were invited to participate in the injection technique practical sessions on part-task trainers, conducted in the Department of Pharmacology.

Study tools: Part-task trainers, also known as static task trainers, are designed to replicate only a portion of the body. Many of these represent selected anatomical areas of the human body and are used to teach basic psychomotor skills and procedures. The models used in our study included an injectable training arm model (XC-434) and electronic buttock injection simulator (XC-431A) for intravenous (IV) injection and intramuscular (IM) injection respectively.

Study Process: The students were divided into small groups and the techniques of intravenous and intramuscular injection was demonstrated on part-task trainers by faculty members. This was followed by repeated practice sessions and the students worked through each session as a team, with the faculty members facilitating the sessions.

The students were then briefed regarding the purpose of the study and were invited to participate and provide their response, after obtaining an informed consent. A self-administered questionnaire was prepared after thorough literature review. The questionnaire included sections to determine students’ viewpoint of the educational role of simulation in learning injection techniques and simulation modalities. The students were asked to respond to items using a 5-point Likert scale from 1 to 5, 1—strongly disagree, 5—strongly agree. The completed questionnaires were then collected, compiled and analyzed.

Ethical approval: An ethical approval of the study was obtained from the Institutional Ethics Committee, BGS GIMS.

Statistical Analysis: Descriptive analysis was used for individual questions and the results were expressed in terms of frequencies and percentages. The responses were then divided into ‘Accept’ category (strongly agree & agree) and ‘Reject’ category (strongly disagree & disagree) and neutral was considered as separate. Chi-square test and Fischer exact test (cell frequency <5) were then computed for statistical significance. All the statistical analysis was carried out with Statistical Package for Social Sciences, version 16.0 considering p < 0.05 as statistically significant.

RESULTS

Eighty four out of the 88 (95.5%) II-year medical students responded to the questionnaire. Of these 66.7% (n=56) were females and 33.3% (n=28) were males.

Table 1 represents the response of medical students towards the educational role of simulation in learning IV and IM injection techniques. Students’ responses to the first section of the questionnaire were highly positive. Majority of the students perceived an improvement in psychomotor skills (82.2%) and self-confidence (75%). 84.5% of students agreed that the simulation sessions contributed to better understanding of pharmacology of routes of drug administration. The responses demonstrated a statistically significant increase in terms of improvement of pre-existing knowledge of injection techniques (p=0.012) and reducing students’ anxiety of causing patient harm (p=0.005).

In the second section, 73.8% and 57.2% of respondents expressed a high level of satisfaction about the adequacy of training materials (mannequins, equipments and disposables) and the clarity of the objectives of simulation sessions, respectively. Statistically significant results were noted with the expertise (84.3%, p=0.02) and approachability of the faculty trainers (88.1%, p=0.002). Around 74% of students agreed that checklists provided for assessment was adequate (p=0.008). Overall, 29.8% of the participants stated that the amount of time allotted to practice was not satisfactory. A whopping 94% respondents felt the need for repetitive sessions for skill acquisition and confidence boosting (p=0.0001) as shown in Table 2.
### Table 1: Students responses towards the role of simulation in learning IV and IM injection techniques

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Strongly disagree n (%)</th>
<th>Disagree n (%)</th>
<th>Neutral n (%)</th>
<th>Agree n (%)</th>
<th>Strongly Agree n (%)</th>
<th>Mean score</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved my psychomotor skills</td>
<td>0</td>
<td>5 (5.9%)</td>
<td>10 (11.9%)</td>
<td>55 (65.5%)</td>
<td>14 (16.7%)</td>
<td>3.92</td>
<td>0.72</td>
<td>0.44</td>
</tr>
<tr>
<td>Improved my existing knowledge of injection techniques</td>
<td>0</td>
<td>2 (2.4%)</td>
<td>3 (3.6%)</td>
<td>54 (64.3%)</td>
<td>26 (31%)</td>
<td>4.25</td>
<td>0.57</td>
<td>0.012*</td>
</tr>
<tr>
<td>Contributed to my understanding of the pharmacology of routes of drug administration</td>
<td>0</td>
<td>3 (3.6%)</td>
<td>10 (11.9%)</td>
<td>52 (61.9%)</td>
<td>19 (22.6%)</td>
<td>4.03</td>
<td>0.7</td>
<td>0.08</td>
</tr>
<tr>
<td>Improved my self-confidence</td>
<td>0</td>
<td>7 (8.33%)</td>
<td>14 (16.7%)</td>
<td>48 (57.1%)</td>
<td>15 (17.9%)</td>
<td>3.84</td>
<td>0.81</td>
<td>0.84</td>
</tr>
<tr>
<td>Reduced my fears of causing patient harm</td>
<td>0</td>
<td>1 (1.2%)</td>
<td>10 (11.9%)</td>
<td>44 (52.4%)</td>
<td>29 (34.5%)</td>
<td>4.20</td>
<td>0.69</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

*P value <0.05 is considered statistically significant

### Table 2: Students opinion regarding the simulation modalities (Includes the training methods, the materials used and the faculty trainers)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Strongly disagree n (%)</th>
<th>Disagree n (%)</th>
<th>Neutral n (%)</th>
<th>Agree n (%)</th>
<th>Strongly Agree n (%)</th>
<th>Mean score</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mannequins, equipments &amp; disposables were satisfactory</td>
<td>0</td>
<td>6 (7.1%)</td>
<td>16 (19%)</td>
<td>48 (57.1%)</td>
<td>14 (16.7%)</td>
<td>3.83</td>
<td>0.78</td>
<td>0.3</td>
</tr>
<tr>
<td>The objectives of the simulation sessions were well defined</td>
<td>0</td>
<td>4 (4.8%)</td>
<td>32 (38.1%)</td>
<td>33 (39.3%)</td>
<td>15 (17.9%)</td>
<td>3.84</td>
<td>0.66</td>
<td>0.27</td>
</tr>
<tr>
<td>The check-list provided for assessment was adequate</td>
<td>0</td>
<td>2 (2.4%)</td>
<td>20 (23.8%)</td>
<td>51 (60.7%)</td>
<td>11 (13.1%)</td>
<td>3.7</td>
<td>0.81</td>
<td>0.008*</td>
</tr>
<tr>
<td>Demonstration of the techniques by staff was adequate</td>
<td>0</td>
<td>2 (2.4%)</td>
<td>12 (14.3%)</td>
<td>43 (51.2%)</td>
<td>27 (32.1%)</td>
<td>4.13</td>
<td>0.74</td>
<td>0.002*</td>
</tr>
<tr>
<td>Staff members were communicative, approachable and confident</td>
<td>0</td>
<td>1 (1.2%)</td>
<td>7 (8.33%)</td>
<td>52 (61.9%)</td>
<td>22 (26.2%)</td>
<td>4.17</td>
<td>0.62</td>
<td>0.0002*</td>
</tr>
<tr>
<td>Time allotted for practice was sufficient</td>
<td>3</td>
<td>22 (26.2%)</td>
<td>17 (20.2)</td>
<td>31 (36.9%)</td>
<td>5 (5.9%)</td>
<td>3.04</td>
<td>1.12</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Repetitive practice sessions are required for confidence improvement</td>
<td>0</td>
<td>1 (1.2%)</td>
<td>4 (4.8%)</td>
<td>37 (44%)</td>
<td>42 (50%)</td>
<td>4.42</td>
<td>0.64</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

*P value <0.05 is considered statistically significant
†Adapted from Bagnasco et al. BMC Medical Education 2014, 14:106 [13].
DISCUSSION
Limited patient encounters, increased demands on training hours and a focus on patient safety have necessitated the use of innovative ways in medical education to provide optimal health care. Simulation-based medical education provides an excellent opportunity to students for deliberate practice and acquisition of problem solving and psychomotor skills, without risk to an actual patient [6].

Learning the techniques of intravenous and intramuscular injections using simulation models offers several benefits to students, such as exposure to the reality in an emergent situation, and the importance of providing the right medication in the right dosage at the right time by the right route. Repeated practice under faculty supervision helps students acquire psychomotor skills, reinforce existing knowledge, as well as to practice the application of new knowledge safely until mastery is achieved. This in turn boosts their self-confidence and competence when they enter the clinical setting [5]. The results of our study showed that the participating students perceived a significant improvement in their existing knowledge of injection techniques. Majority of the students positively responded about improvements in psychomotor skills and self-confidence. These findings are in congruence with studies conducted on simulation models by Nuzhat A, et al and Halm BM, et al [7,8].

Simulation allows students to apply their theoretical knowledge of pharmacology to practice [4]. Practicing the injection maneuvers on mannequins allows students to integrate the concepts of routes of administration learnt in theory classes with clinical practice. The same thoughts were echoed by around 85% of our students.

The fear of making mistakes is the highest anxiety-producing situation for students. High student anxiety can lead to decreased learning, which may negatively influence decision making and clinical judgment [9]. Numerous studies by Pugh CM, et al have shown that use of mannequin-based simulation can potentially minimize student anxiety in the clinical setting [10,11]. As such, students can make mistakes, without fear of harming a live person, learn from those mistakes and achieve proficiency by attaining predefined benchmarks in a safe environment, which may have a potential impact upon patient safety [12]. In our study, student responses were overwhelmingly positive with 86.9% of them concurring that this exercise allayed their fears of causing patient harm.

Simulation is merely a tool for training, and the success of simulation as an exercise is dependent on how effectively it is used by the trainee and the trainer [12]. The optimal execution of the simulation procedures also depends on the quality of the training materials (mannequins, equipments and disposables). Findings from our study indicate that most of the students were highly satisfied with the training methodology, check-lists and training materials. The expertise of the faculty is crucial in achieving high quality and clear simulation sessions. They are in control of the events and timing of the scenario for reflection or correction [5]. Our students’ ratings of staff expertise, approachability and communicativeness were significantly high. These findings were similar to study conducted by Bagnasco A, et al [13].

Restriction of time allotted for simulation techniques in curriculum is one of the commonly cited barriers for effective learning [14]. The results from our study demonstrated that around 50% of students were not satisfied about allotted practice time. However, this value was less than the observations by Bagnasco A, et al, where >48% of students reported dissatisfaction over time allotted [13].

Deliberate and repetitive practice in an environment where it is permissible to make mistakes, will improve training outcomes. An enormous 94% of our students urged for repetitive practice sessions. By constant practice, students may attain proficiency that is likely to enable them to perform their first case on a real patient in an acceptable manner [12].

CONCLUSION
In the recent years, the use of simulators in the field of health care has grown exponentially and their use has tremendous proven value. Simulation can be used as a tool to aid teaching and learning across a wide range of cognitive, behavioral and psychomotor competencies. Simple, relatively inexpensive, but effective part-task trainers used in learning injection techniques provide a realistic approach to medication administration in a safe setting. Repetitive practice combined with faculty supervision and feedback, can boost students’ self-confidence and help reduce anxiety in the actual patient care setting. In our study, simulation has been positively perceived by students as an educational tool that provides an opportunity for interactive learning without risk to a real patient. This overwhelmingly positive student feedback calls for research to explore simulation technology in understanding intricate concepts of pharmacology. Further studies may be required to determine if medical students actually perform better in the clinical setting after simulation training.

LIMITATIONS
The study included a single institution and therefore the findings may not be generalized. A questionnaire-based study mainly depends on the information provided by the respondents. Responses obtained in this manner may be subject to social desirability that may bias answers toward more acceptable norms. Since 5-point Likert scale was implied to assess the response, there may be individual subjectivity as well (Cummins RA, 2000) [15].

ACKNOWLEDGEMENTS
The authors would like acknowledge the II year medical students of BGS GIMS for their voluntary participation in this study. The authors are indebted to the management of BGS GIMS for providing the infrastructure, equipments and simulators required for the study. Our sincere thanks to the Staff, Department of Pharmacology for their unconditional support.
support and to the Staff of Community Medicine, BGSGIMS for their expert guidance in statistical analysis.

**Conflicts of interest:** None.

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