

Current Issues in Pharmacy and Medical Sciences

Formerly ANNALES UNIVERSITATIS MARIAE CURIE-SKLODOWSKA, SECTIO DDD, PHARMACIA

journal homepage: <http://www.curipms.umlub.pl/>



Evaluation of parenteral injection skills of medical undergraduates on mannequins in a tertiary care teaching hospital in South India – A cross-sectional study

JERIN JAMES* , PORKODI A, JAMUNA RANI, SATHYANARAYANAN VARADARAJAN 

Department of Pharmacology, SRM Medical College Hospital & Research Centre, Kattankulathur, Tamilnadu, India

ARTICLE INFO

Received 15 February 2022
Accepted 10 August 2023

Keywords:

pharmacology,
parenteral injections,
OSPE,
mannequins.

ABSTRACT

Appropriate knowledge and expertise of parenteral injection is vital in the medical field. Hence we impart training on mannequins before the students practice on patients. This study was conducted to evaluate the skill exhibited by the students in parenteral injection skills, namely intravenous, intramuscular, intradermal and subcutaneous injections. The students were assessed for step based on the pre-validated check list created for Objective Structured Practical Examination. In this study, 16 % of the students failed to check the prescription order before starting the procedure. The name and the expiry date of the drug was not checked by 22 % of the students. Hundred percent of the students sterilized their hands. Loading of drug was done properly by 80 % of the students and 88 % of the students checked for air bubbles in the syringe and removed them properly. The site for injection was not sterilized by 26 percent of the students. Tourniquet was not applied by 19 percent of the students and 28 % of the students did not hold the bevel up during insertion for intravenous route. The steps where frequent faltering happened needs to be emphasized for them to perform better in a more efficient manner during the summative assessment as well as for future practice.

INTRODUCTION

The fundamental objective of introducing competitive-based medical education in India was to help students develop observable expertise in a learner-centered, time-dependent manner. This curriculum focuses on outcomes that are relevant to the everyday practise of medicine rather than facts [1,2]. With the ultimate goal of all students achieving skills satisfactorily regardless of when they do so, the student can learn at his or her own speed. The National Medical Council (NMC, India) has, over time, made substantial revisions to the instructional and training methodologies, syllabus and evaluation patterns for medical students in order to consistently attain excellence in the field. A paradigm change has taken place from an approach that is exam- and classroom-centered, to one that is student-centered. A lot of thought has gone into offering skill-based training [3].

In daily medical practise, using the right injection method is essential. Every undergraduate medical student who plans to practise medicine must be able to administer parenteral injections via intramuscular (IM), intravenous (IV),

subcutaneous (SC) and intradermal (ID) routes [4,5]. It is essential, however, to take the proper aseptic precautions. A bad injection might leave the patient with consequences such as bleeding, hematomas, vein punctures and infections at the injection site. Due to being pricked by a used and possibly contaminated needle, some diseases can spread. However, training trainees to administer injections directly to patients would cause anxiety and concern [6,7]. In order to improve their confidence and lower their worry about mastering the talent, we teach the skill by using mannequins. When students learn in this way, practical classes become more engaging and they look forward to picking up new abilities [8].

The Objective Structured Patterned Examination (OSPE), a valid tool for determining the competencies of specific pupils, was used in this paper to evaluate the students' performance. According to research [9,10], OSPE is a robust, valid, and objective assessment instrument that eliminates examiner bias.

Teachers will be able to evaluate the knowledge and skill outcomes that have been reached by second year medical undergraduates by looking at the injection technique skills they have learned on mannequins through the practical

* Corresponding author
e-mail: jerinj@srmist.edu.in

adoption of OSPE approaches. Based on assessor input, the OSPE stations and checklist will be modified as necessary in the future. In our work, we used OSPE as a formative assessment tool in pharmacology exams to measure injection technique skills.

MATERIAL AND METHODS

This was a cross sectional study conducted to evaluate the skill acquired for injection techniques based on a pre-validated OSPE check list by the department of pharmacology, at a tertiary care teaching hospital, in India, after approval from the Institutional Ethics Committee and after obtaining written informed consent from the study participants. A total of 104 second-year medical students took part in the study. During the practical sessions, the students received systematic demonstrations of the various parenteral injection techniques on mannequins prior to the evaluation.

The mannequins used in the study were Advance venepuncture and injection arm and Buttock injection model (Laerdal Medical, Gatesville, Texas) and ID and SC injection model (Limbs & Things Ltd, Bristol, UK). During the training sessions, all of the students were permitted to practise alone, and there was also instruction on how to practise the skills. Prior to the summative evaluation, the study was carried out during the last revision sessions. Subject matter experts created an OSPE checklist, which was pre-validated for its content and applicability. Training was given to the students in accordance with the check list. Faculty members who were evaluating student performance during the study were given the OSPE checklist and asked to fill it out with scores for each step. Using SPSSV 21.0, the data from the OSPE checklist were analysed, and the results were tabulated and presented as descriptive statistics.

RESULTS

The study included 104 second-year medical students in total. The study's objective was to evaluate the parenteral injection competencies (IV, IM, ID, and SC) that second-year medical students had learned on mannequins during the session leading up to their OSPE summative exam. Under the new competency-based curriculum India, students are required to demonstrate this competency. They had to administer parenteral medication via one of four different routes: IM, IV, ID and SC.

As found in our study, 16% of the enrolled students failed to double-check the medication order before beginning the procedure, while 22% of the students failed to check the drug's name and expiration date. However, 90% of the students sanitised their hands before handling anything. In addition, 80% of the students correctly loaded the medicine, while 88% of the students correctly identified and eliminated any air bubbles from the syringe. Still, 26 percent of the students failed to sanitise the injection site, while 19% of the students failed to apply a tourniquet, and 28% of the students failed to hold the bevel up during IV insertion.

DISCUSSION

Two essential components of education are teaching and student evaluation. Producing doctors of the highest calibre will be made easier by teaching the right skills and appropriately evaluating them in medical education. Since each subject in the new competency-based medical education curriculum requires the acquisition of a specific set of skills, it is the educators' duty to provide their departments with the materials needed for such trainings. The divide between theory and practise has been closed owing to this innovative approach to skill-based education.

For the purpose of our study, we trained students in parenteral injection procedures using mannequins in the skill lab, and we also offered enough review for skill practise. The quality of the skills the pupils had learned was evaluated as the next phase. OSPE was utilised as the evaluation technique for this competency in order to remove bias from the evaluation process. The department's subject matter experts validated the OSPE checklist, which they judged to be satisfactory and acceptable.

The pupils' performance in our study has been extremely strong due to their ongoing practise and training. Even though there were failures at every stage, just a few regular faults were made. One such mistake was failing to verify the drug's name and expiration date. Failure to pull back the plunger to confirm injection into vein in the case of an IV and to avoid any vascular entry in the case of an IM injection was another error that was frequently made. Overall, the students gave satisfactory performance, albeit they could have done better with more practise, which would have helped with their summative evaluation.

Inappropriate medicine, dose, delivery route, frequency or length of therapy are all examples of errors brought on by inadequate training. Before giving an injection, it is crucial to read the prescription sequence. We noted that 15% of the students in our study neglected to verify the medication order before administering the shot. Beyond the aforementioned, aseptic conditions must be maintained by practising good hand hygiene. In our study, 10% of individuals failed to properly sanitise their hands before the operation.

According to Shenoy *et al.* and Malhotra *et al.*, OSPE is a workable and trustworthy method of evaluation in the undergraduate pharmacology curriculum [11,12]. Jain *et al.* also concurred that OSPE, as opposed to traditional practical examinations, helped students learn and acquire practical skills more effectively. Additionally, OPSE has been suggested by Vishwakarma *et al.* as a workable and skill-improving instrument for pharmacology exams [14]. Other non-clinical areas have also seen widespread adoption of OSPE in terms of training and evaluation [15,16].

In the second year, practising parenteral medication administration using mannequins will help students feel less anxious when practising on actual patients. A step-by-step OSPE checklist can help students learn each procedure and emphasise the areas where they are most prone to make mistakes. Students can use the OSPE checklist as a helpful formative evaluation tool during their practical test.

Table 1. OSPE checklist for IM, IV, ID, SC injection techniques on mannequins

| Sl no. | Evaluation criteria | IV | | IM | | ID | | SC | | Average | |
|---|--|------------|-----------|------------|-----------|------------|-----------|------------|-----------|----------|---------|
| | | Yes; n (%) | No; n (%) | Yes; n (%) | No; n (%) | Yes; n (%) | No; n (%) | Yes; n (%) | No; n (%) | Yes; (%) | No; (%) |
| 1 | Whether the student checked the prescription order before injection | 88 (84.7) | 16 (15.3) | 90 (86.5) | 14 (13.5) | 90 (86.5) | 14 (13.5) | 91 (87.5) | 13 (12.5) | 86.3 | 13.7 |
| 2 | Whether the name and expiry date of the drug was checked | 81 (77.9) | 23 (22.1) | 82 (78.8) | 22 (21.2) | 80 (76.9) | 24 (23.1) | 81 (77.9) | 23 (22.1) | 77.9 | 22.1 |
| 3 | Did the student sterilize his hands before injection | 94 (90.4) | 10 (9.6) | 98 (94.2) | 6 (5.8) | 90 (86.5) | 14 (13.5) | 92 (88.5) | 12 (11.5) | 81.7 | 18.3 |
| 4 | Was the loading of drug into the syringe done properly | 85 (81.7) | 19 (18.3) | 86 (82.7) | 18 (17.3) | 85 (81.7) | 19 (18.3) | 84 (80.8) | 20 (19.2) | 81.7 | 18.3 |
| 5 | Did the student check for air-bubble in syringe before injection | 92 (88.5) | 12 (11.5) | 95 (91.3) | 09 (8.7) | 94 (90.4) | 10 (9.6) | 94 (90.4) | 10 (9.6) | 90.1 | 9.9 |
| 6 | Was the site of injection sterilized prior to injection | 101 (97.1) | 03 (2.9) | 100 (96.2) | 04 (3.8) | 86 (82.7) | 18 (17.3) | 82 (78.8) | 22 (21.2) | 88.7 | 11.3 |
| 7 | In case of IV injection | 82 (78.8) | 22 (21.2) | NA | | NA | | NA | | 78.8 | 21.2 |
| | a) whether tourniquet was applied | | | NA | | NA | | NA | | | |
| | b) Needle bevel up while inserting into vein | 75 (72.1) | 29 (27.9) | NA | | NA | | NA | | 72.1 | 27.9 |
| | c) Whether angle of insertion reduced to < 25° | 77 (74.0) | 27 (26.0) | NA | | NA | | NA | | 74.0 | 26.0 |
| | d) Before injecting the medication to the vein was the plunger pulled back to see blood aspirate | 66 (63.5) | 38 (36.5) | NA | | NA | | NA | | 63.5 | 36.5 |
| e) Was the cotton dipped in spirit placed at the site after withdrawing the syringe | 90 (86.6) | 14 (13.5) | NA | | NA | | NA | | 86.6 | 13.5 | |
| 8 | In case of IM injection | NA | | 98 (94.2) | 6 (5.8) | NA | | NA | | 94.2 | 5.8 |
| | a) Whether the needle inserted at 90° | NA | | | | NA | | NA | | | |
| | b) Before injecting the medication to the muscle was the plunger pulled back to see any blood aspirate | NA | | 71 (68.3) | 33 (31.7) | NA | | NA | | 68.3 | 31.7 |
| c) Was the cotton dipped in spirit placed at the site after withdrawing the syringe | NA | | 92 (88.5) | 12 (11.5) | NA | | NA | | 88.5 | 11.5 | |
| 9 | In case of ID injection | NA | | NA | | 84 (80.8) | 20 (19.2) | NA | | 80.8 | 19.2 |
| | a) Whether the needle was inserted at 10-15° angle | NA | | NA | | | | NA | | | |
| | b) Whether needle bevel up during insertion | NA | | NA | | 78 (75.0) | 26 (25.0) | NA | | 75.0 | 25.0 |
| | c) Whether the formation of bleb was appreciated in ID Injection | NA | | NA | | 74 (71.2) | 30 (28.9) | NA | | 71.2 | 28.9 |
| d) Whether area was demarcated with pen | NA | | NA | | 70 (67.3) | 34 (32.7) | NA | | 67.3 | 32.7 | |
| 10 | In case of SC injection | NA | | NA | | NA | | 73 (70.2) | 31 (29.8) | 70.2 | 29.8 |
| | a) whether the skin was grasped properly before injection | NA | | NA | | NA | | | | | |
| b) Was the needle inserted at 90° | NA | | NA | | NA | | 97 (93.3) | 7 (6.8) | 93.3 | 6.8 | |
| 11 | After the injection, was the syringe, cotton swab and medication disposed | 80 (76.9) | 24 (23.1) | 80 (76.9) | 24 (23.1) | 82 (78.8) | 22 (21.2) | 84 (80.8) | 20 (19.2) | 78.4 | 21.6 |

IV – intravenous, IM – intramuscular, SC – subcutaneous, ID – intradermal, NA – Not Applicable, n – frequency, % – percentage

CONCLUSION

This was the first group of students at our medical college to engage in OSPE through the employment of mannequins to practise parenteral injection techniques. We found that the students had developed their skills in a methodical manner. For them to perform better and more effectively during the summative evaluation, as well as for future practise, the steps where frequent failing occurred need to be highlighted. Making the evaluation process simpler for the assessor is another benefit of using this OSPE checklist.

ORCID iDs

Jerin James <https://orcid.org/0000-0002-5534-9299>
 Sathyanarayanan Varadarajan <https://orcid.org/0000-0003-0713-5576>

REFERENCES

- Shah N, Desai C, Jorwekar G, Badyal D, Singh T. Competency-based medical education: An overview and application in pharmacology. *Indian J Pharmacol.* 2016;48(Suppl 1):S5-S9.
- Basheer A. Competency-based medical education in India: Are we ready? *J Curr Res Sci Med.* 2019;5:1-3.

- Medical Council of India. *Competency Based Undergraduate Curriculum for the Indian Medical Graduate.* 2018:1-3. [https://www.mciindia.org/CMS/information-desk/for-colleges/ug-curriculum]
- Katz LM, Finch A, McKinnish T, Gilliland K, Tolleson-Rinehart S, Marks BL. Teaching procedural skills to medical students: A pilot procedural skills lab. *Educ Health (Abingdon).* 2017;30(1):79-83.
- Huo B, MacNevin W, Smyth M, Miller SG. Medical student comfort with procedural skills performance based on elective experience and career interest. *Cureus.* 2020;12(12):e12374.
- King KC, Strony R. Needlestick. In: *StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.* [https://www.ncbi.nlm.nih.gov/books/NBK493147/]
- Denault D, Gardner H. OSHA Bloodborne Pathogen Standards. In: *StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.*
- Makmor-Bakry M, Azmi N, Ali AM. Mannequin-simulator as a new teaching and learning method in performance-based pharmacotherapy. *Indian J Pharm Edu Res.* 2013;47(3):1-5.
- Shaifali I, Ahsan M, Khurram Mallick A, Professor A. A study on objective structured practical examination (OSPE) as a tool for assessment of medical students. *IJBAMR.* 2016;(5):784-90.
- Prasad HLK, Prasad HVK, Sajitha K, Bhat S, Shetty KJ. Comparison of Objective Structured Practical Examination (OSPE) versus conventional pathology practical examination methods among the second-year medical students-a cross-sectional study. *Med Sci Educ.* 2020;30(3):1131-5.
- Shenoy PJ, Kamath P, Sayeli V, Pai S. Standardization and validation of objective structured practical examination in pharmacology: Our experience and lessons learned. *Indian J Pharmacol.* 2017;49(4):270-4.

12. Malhotra SD, Shah KN, Patel VJ. Objective structured practical examination as a tool for the formative assessment of practical skills of undergraduate students in pharmacology. *J Educ Health Promot.* 2013;2:53.
13. Shipra J, Ruchika K, Pushkar M, Prerna G. Introduction and evaluation of objective structured practical examination as an assessment tool in pharmacology for second year medical students. *JCDR.* 2021;15(3):FC01-FC04.
14. Vishwakarma K, Sharma M, Matreja PS, Giri VP. Introducing objective structured practical examination as a method of learning and evaluation for undergraduate pharmacology. *Indian J Pharmacol.* 2016;48(Suppl 1):S47-S51.
15. Feroze M, Jacob AJ. OSPE in pathology. *Indian J Pathol Microbiol.* 2002;45(1):53-7.
16. Singh G, Singh R. Objective structured practical examination: A tool design to gauge the perception and performance of the undergraduate medical students for Gram stain. *J Med Sci Health.* 2020;6(2):19-24.