IAP Journal of Medical Education and Research
Volume 3, Issue 1 - 2026, Pg. No. 20-26
Peer Reviewed & Open Access Journal

Research Article

Assessment of Competency Level of Intern Doctors For Intraosseous Insertion Skill on an Infant Intraosseous Leg Task Trainer After Introduction of a Simulation-Based Short Course Training Module

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How to cite this article:
Tandon K R, Desai V K, Tandon R, Vyas D. Assessment of Competency Level of Intern Doctors For Intraosseous Insertion Skill on an Infant Intraosseous Leg Task Trainer After Introduction of a Simulation-Based Short Course Training Module. IAP J. Med. Educ. Res. 2026;3(1):20-26.

Date of Submission: 2026-05-03
Date of Acceptance: 2026-05-15

ABSTRACT

Background: Since Simulation-Based Education (SBE) provides safe learning, as a part of skill development, future doctors also should learn to perform intraosseous (IO) insertion skill, which is one of the vital skills in emergency Pediatrics.

Objectives: To train and assess Indian Medical Graduates (IMG) for the acquirement of IO access skill through a short course module using an infant intraosseous leg task trainer in the later part of their internship year.

Materials and Methods: This quasi-experimental educational study was conducted in year 2025 on 53 volunteer interns after approval from the ethics committee and permission from the dean. After the introduction of simulation based short course module, the participants were assessed for achievement of competency. Feedback was also taken from them about their satisfaction and confidence level on a 1-10 Likert scale.

Result: All 53 participants successfully identified the anatomical site. Major components of IO skill: adherence to the correct insertion angle, bone marrow aspiration, and infusion of physiological solutions were achieved by 52(98.11%), 50(94.33%), and 48(90.56%) participants, respectively. Comparisons between pre- and post-tests indicated meaningful improvements in knowledge, satisfaction, and confidence. The median (Q1, Q3) time for overall procedure was 69 (57, 118) seconds. A total of 47(88.6%) participants achieved the passing score of ≥14 out of 20.

Conclusion: A simulation-based training module enhanced the intern doctors' competency with confidence in intraosseous insertion skill on task-trainer.

Keywords: Competency-Based Medical Education (Cbme), Mannequin, National Medical Commission, Pediatric Emergency, Simulation, Task-Trainer

Introduction

For children who are critically ill, the intraosseous route provides a rapid and reliable means of access, as it utilizes non-collapsible vascular channels.[1] Intraosseous access is warranted in emergencies such as shock, cardiac arrest, and significant dehydration.[1] Intraosseous access is increasingly recognized as an effective alternative for fluid administration following unsuccessful peripheral venous access.[2,3] Major resuscitation organizations advocate for the intraosseous (IO) route as the preferred method of infusion when quick and dependable intravenous (IV) access is not available.[1,3,4]Therefore, it is essential for all healthcare professionals involved in acute care or those responding to cardiovascular emergencies to receive training and maintain their skills in the placement and use of IO devices.[1-7]

Recently, in India, medical education emphasized the importance of innovative teaching approaches that connect theoretical knowledge with practical clinical application. So, Simulation-Based Education (SBE) has become a crucial resource within medical training institutions. By creating a safe learning environment, SBE enables students to engage in practical exercises, improving their clinical skills and decision-making capabilities. The importance of SBE in pediatric education, focusing on its contribution to developing clinical reasoning and procedural abilities in medical students, is well explained by Ramachandra G et al. in their article.[8] The National Medical Commission (NMC) of India acknowledged the necessity of incorporating SBE into the medical curriculum and introduced a Competency-Based-Medical-Education (CBME) since 2019. Integrating simulation in medical education has immense advantages particularly, it is a potential life saver, which can be achieved by the educational experience, repetitive practice and instant feedback with modest monetary investment.[8,9] Utilization of several manikins of varying fidelity or task trainers enables instructors to develop uniform scenarios and evaluate performance reliably among students.[10] Studies indicate that organized training programs that utilize simulation can result in notable enhancements in procedural success rates and a decrease in complication rates in actual applications.[9-11]

Intraosseous access is one of those skills that provides rapid and reliable access for administering fluids and medications in situations like cardiac arrest or shock when peripheral intravenous access is not possible for any reason. Looking at its importance in pediatric emergency management, this simulation-based study was undertaken to train and assess Indian Medical Graduates (IMGs) to acquire IO access skills through a short course module using an infant intraosseous leg task trainer in the later part of their internship year.

Materials and Methods

This quasi-experimental educational study was conducted at the "Simulation Center" of the private medical college of the western part of India between January 2025 and March 2025. Fifty-three volunteer interns out of a total of 138 from the first CBME batch were included in the study after obtaining approval from the institutional ethics committee, permission from the dean, and informed written consent from participants. All participants were assured of confidentiality, voluntary participation, and that no academic or professional disadvantage would result from non-participation. A short course training consisted of pre-watch video material, a pre-test, a mini-lecture, and a live demonstration of the steps of the IO procedure by a pediatric postgraduate student, followed by supervised hands-on practice and an individual assessment (a 2–3-minute video recording to be analyzed later) using an Infant Intraosseous Leg Task Trainer (I-IOL-TT). An intraosseous needle and all required consumables were provided to participants during assessment recording. This was followed by a post-test & feedback from them about their satisfaction and confidence level on a 1-10 Likert scale. Additionally, individual feedback was provided to each participant, highlighting their strengths and areas needing improvement. When they were performing this task, a video recording was made to record all the steps. Later, their performance was evaluated by analyzing recorded videos with the help of a predesigned structured IO insertion checklist based on a previous study,[12] ensuring uniformity and objective analysis. The primary end point of competency was achievement of a score of 14 or more out of 20 and functional IO access. Confidentiality and privacy of the participants were maintained at every level. Video recordings and evaluation forms were stored securely and anonymized during analysis.

Development of Module

The study duration spanned from September 2023 to March 2025. Between September 2023 and November 2024, the module was being developed, a research grant was approved, and a task trainer (I-IOL-TT) was purchased. From January 2025 to February 2025, training occurred alongside data collection for the assessment. Finally, from February 2025 to March 2025, the data was analyzed and interpreted.

I-IOL-TT

The Infant Intraosseous Leg Task Trainer (Laerdal® Intraosseous Trainer) is specifically developed for training IO access techniques in infants. The functional features facilitate the insertion of intraosseous needles and enable the aspiration of simulated bone marrow, along with having replaceable pads filled with simulated marrow fluid. It offers anatomically correct structure with a realistic feel during needle penetration and fluid withdrawal, helping interns understand the depth and angle of insertion, simulating actual clinical scenarios.

Statistical analysis

Descriptive statistics like median (Q1, Q3), frequency, and percentage were used for the continuous and categorical data.

Results

The current study involved 53 volunteers from the first CBME batch of a total of 138 interns, representing 38.41% participation; 27 (51.9%) were males. A total of 47 (88.6%) participants obtained a passing score (≥14 out of 20) for IO insertion skill on the task trainer. The median (Q1, Q3) (min., max.) checklist score was 17 (16, 17) (12, 19). The median (Q1, Q3) (Min., Max.) time of the total procedure was 69 (57, 118) (57, 269) seconds, where the median (Q1, Q3) (Min., Max.) preparation and placement times were 60 (53, 68) (33, 173) and 52 (46, 57) (26, 93) seconds, respectively. Comparison of correctness of knowledge (pre- and post-training) is shown in Table 1, whereas correctness attainment percentage of IO procedure at each step and total is as per Table 2. Among some vital steps like sudden reduction in resistance during insertion and upright steady position of IO needle achieved by 53 (100%) and 52 (98.11%), respectively, 50 (94.33%) of the participants successfully aspirated fluid from the marrow cavity, and 48 (90.56%) successfully infused saline. So, overall, 51 (96.22%) demonstrated a functional IO line. Post-training feedback from participants on the short course module is shown in Figures 1 to 3 on the Likert scale (Likert scale from 0 to 10, where 0 is very poor and 10 is excellent). Figure 1 feedback is for pre-read/pre-watch video material and PowerPoint presentation, whereas the Figure 2 feedback graph is for demonstration & practice time on task trainer. The feedback on confidence level in performing IO skills on task trainers and on patients as well as overall experience and satisfaction levels are as per Figure 3.

Table 1.Pre-and post-training comparison of study participants (n=53) for correct knowledge about Intraosseous Access Procedure

Questions Pertaining to Knowledge About Intraosseous Access Procedure	% of participants for correct knowledge		
	Pre-test	Post-test	Change
What is the primary indication for intraosseous access (IO) in paediatric patients?	96.2	100	+3.8
What is the preferred site for IO access in pediatric patients?	96.2	98.1	+1.9
True or False: Intraosseous lines can be used for blood transfusion.	58.5	81.1	+22.6
Which of the following fluids or medications can NOT be given through an intraosseous line?	49	81.1	+32.1
What is the maximum duration an IO line should remain in place?	73.6	98.1	+24.5
Which anatomical structure provides direct access to the vascular system via an IO line?	75.5	89.9	+14.4
What is the appropriate needle size for IO access in infants?	50.9	73.6	+22.7
What complication is most associated with prolonged use of IO lines?	79.2	92.5	+13.3
What is the most common method to confirm the correct placement of an intraosseous needle?	86.8	98.1	+11.3
In an infant less than 6 months age, which site can also be considered for intraosseous access?	50.9	77.4	+26.5

Table 2.Post-training Attainment of Psychomotor Skill (Step-wise & overall) of Intraosseous (IO) Access on An Infant Intraosseous Leg Task Trainer

S.No	Steps of the IO Procedure	Interpretation of each step & its score	No of participants (n=53) (%)
1	Position of the Knee while Inserting the IO Needle	Correct	53(100)
		Incorrect	00(0.00)
2	Usage of Topical Antiseptics	Yes	52(98.11)
		No	01(1.8)

3	Usage of Gloves	Yes	53(100)
		No	00(0.00)
4	Usage of Local Anaesthetics	Yes	42(79.2)
		No	11(20.75)
5	Score for Safety Guard Usage	Score 2	51(96.22)
		Score 0	2(3.77)
6	Score for the Insertion Technique of IO	Score 3	42(79.24)
		Score 1	10(18.86)
		Score 0	01(1.8)
7	Fluid Aspiration from the Marrow cavity	Yes	50(94.33)
		No	03(5.60)
8	Infusion of Saline via IO needle	Yes	48(90.56)
		No	05(9.43)
9	Securing the line	Yes	01(1.8)
		No	52(98.11)
10	Stability of the IO needle	Yes	24(45.28)
		No	29(54.71)
11	Location of Puncture Site	Correct	53(100)
		Incorrect	00(0.00)
12	Angle of IO Insertion	Correct	52(98.11)
		Incorrect	01(1.8)
13	Sudden Loss of Resistance After IO Insertion	Yes	53(100)
		No	00(0.00)
14	Needle Stayed Upright	Yes	52(98.11)
		No	01(1.8)
15	Withdrawal of Blood	Yes	50(94.33)
		No	03(5.60)
16	Absence of Swelling at Puncture Site	Yes	51(96.22)
		No	02(3.77)
17	Resistance while Infusion	Yes	03(5.60)
		No	50(94.33)
	Is IO functional? (≥3 out of 5) means any three or more from items or Sr.No.13-17	Yes	51(96.22)
		No	02(3.77)

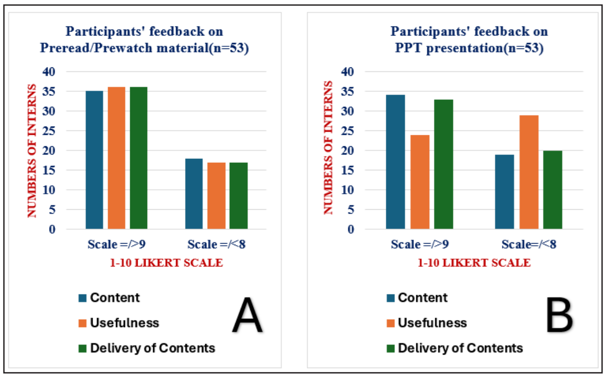

Figure 1.(A &B): Post-Training Participants' Feedback on Pre-Watch Material & PPT Presentation for Their Content, Usefulness &Content of Delivery on 1-10 Likert Scale

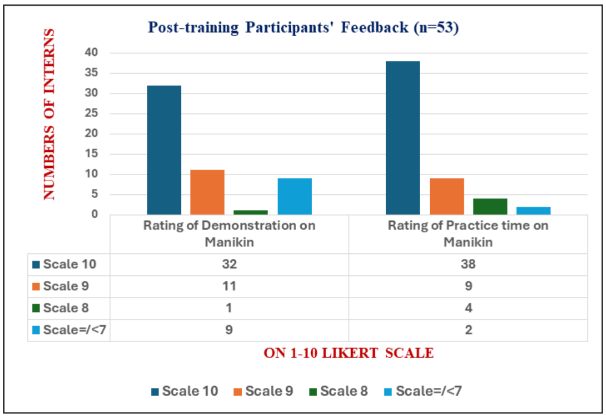

Figure 2.Post-Training Participants' Feedback About Demonstration and Practice Time on Manikin on 1-10 Likert Scale (1-Lowest…10-Highest)

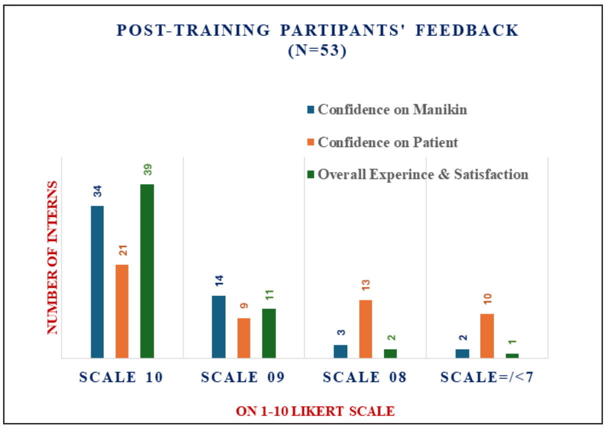

Figure 3.Post-Training Participants' Feedback About Confidence and Satisfaction Level on 1-10 Likert Scale (1-Lowest…10-Highest) in Performing Io Skill

Discussion

The overall experience received a full 10 on the Likert scale from 39 (73.5%) participants. The very good confidence level (≥8 on Likert scale) in performing IO skills on task trainers was reported by 51 (96.1%) participants, whereas on live patients, it was from 43 (81%) participants, which was somewhat lesser. The performance in simulation may not directly translate to clinical proficiency. The study was having limited training sessions, and without follow-up assessment, it is difficult to comment on long-term knowledge retention or sustained procedural competency. Also, a simulation environment cannot perfectly replicate the complexity and unpredictability of real-life clinical scenarios. While task trainers or manikins offer a safe and controlled setting to practice skills, they lack the anatomical variability, patient movement, and physiological responses found in live pediatric patients.

However, existing literature supports that this type of modality of training can be used. One of the systematic reviews showed that simulation has tremendous potential as a teaching and assessment tool for pediatric acute care providers.[13] Luck Raemma P. noted that IO access remains a vital emergency skill where venous access is difficult, especially in pediatric shock patients.[7] IO insertion skills need only low-fidelity manikin/task trainer as skill acquisition rather than a high-fidelity manikin, as here decision-making is not the primary goal. Issenberg et al. emphasized that simulation, when integrated with feedback and repetitive practice, significantly enhances learning outcomes and skill retention in medical trainees.[9] In the studies by Ahluwalia and Nancy M. Tofil, pediatric residents after simulation-based training showed a significant confidence level.[14,15] The use of blended educational tools such as video links, PowerPoint presentations, demonstrations on task trainers, pre- & post-tests, feedback, etc proved effective even for intern doctors. The hands-on component of this study was found to be the most beneficial and well-received by trainees, which is consistent with the pedagogical model proposed by Sawyer T et al.[16,17] Their "Learn, See, Practice, Prove, Do, Maintain" framework supports a progressive skill acquisition model where simulation forms the backbone of experiential learning, ensuring sustained competence in clinical practice.[16,17] Sawyer T et al. also highlighted that multimodal instructional strategies improve cognitive load management and procedural clarity, which enhances learning and retention.[16,17] It is also known that reinforcement for certain procedures through repeated exposure and targeted feedback from masters, procedural nuances, can be achieved as described by Nishisaki et al., who noted that repeated simulation cycles improve muscle memory and procedural precision over time.[11] The confidence in performing procedures is a really critical outcome metric. According to Ericsson, expert performance is largely achieved through deliberate practice and repetitive exposure, which simulation provides in a safe environment.[18] However, relatively lower confidence in patient-based scenarios pointed out the need for a structured transition from simulation to supervised clinical practice. The review study by Datta R. stated that for simulation-based education tools to be successful, an interdisciplinary approach, the appointment of a program director, provision of necessary equipment, a dedicated budget, and adequate office space are essential.[19] This trend is increasingly observed in private medical colleges where patient scarcity is more common due to high treatment costs and limited training time during the three years of residency. A meta-analysis by William C. McGaghie indicates that simulation-based medical education (SBME) combined with deliberate practice is more effective than traditional clinical medical education in achieving specific goals for clinical skill acquisition. However, SBME is a multifaceted educational intervention that requires careful implementation and thorough evaluation at training sites.[20]

In conclusion, structured simulation-based training in medical education during internship becomes a vital component of training for clinical preparedness. It prepares future clinicians ready to work in an acute paediatric care setting, especially equipped with IO insertion skills.

Acknowledgement

Study participants, Supporting Staffs of Simulation Center, Bhaikaka University

Sources of Funding: Intraosseous Infant Leg Task-Trainer and Consumables received from own Institution under PG thesis research grant. (BU/2024/R&D/28/1637 dated 23/07/2024)

Conflict of Interest: None

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