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Technical And Pedagogical Innovations For Training Students At ISPITS Of Tétouan: A Procedural Simulation Model

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Abstract:
Simulation plays a crucial role in nursing education, enabling students to apply the theoretical knowledge and skills they have acquired through the use of high- and low-fidelity procedural simulators. These simulators facilitate learning by allowing students to practice procedures—primarily technical ones—without any risk to patients. Mastery of therapeutic administration is one of the fundamental technical skills that nurses must develop. While there are commercially available intradermal injection simulators, they tend to be prohibitively expensive.
This study aims to integrate simulation-based learning into nursing education at the Higher Institute of Nursing Professions and Health Techniques of Tetouan (ISPITS-T) by utilizing alternative, cost-effective tools for teaching therapeutic administration. Specifically, we employed a sponge cuff, viscous gel, and chicken thighs as simulators. A total of 38 first-year general nursing students from ISPITS-T participated in the study. To evaluate the effectiveness of these proposed simulators in generating actionable knowledge in these students, we collected quantitative data through A self-administered pre- and post-test was developed to assess technical and non-technical skills related to administering drugs by injection (intradermal and subcutaneous). Pre- and post-tests were administered before and after the procedural simulation training sessions for subcutaneous and intradermal injections. They consisted of eight questions, formulated as statements reflecting the students' level of preparedness, confidence, stress level, technical accuracy, satisfaction, and perception of the educational value of the simulation activity. The Wilcoxon test was used to evaluate student performance. The results indicated statistically significant differences between pre-test and post-test scores for all evaluated items (Z values ranging from -3.569 to -5.031; $p < 0.001$). This demonstrates a significant improvement in student performance following the simulation sessions. Therefore, the sponge cuff, viscous gel, and chicken thighs prove to be effective and inexpensive simulators that enhance the technical skills required for therapeutic injections among nursing students.
Keywords: *Procedural simulation, therapeutic administration, simulators, impact*

1. INTRODUCTION

Simulation is a teaching method that, by imitating reality or being completely virtual, aims to help learners acquire the procedures, techniques, skills, critical thinking, etc. that they will need once they enter the professional world. Simulation currently has a useful place in the arsenal of teaching tools, combining learning through action, reflective analysis, and conceptualization (Boet et al., 2013), all within a safe and ethical framework that limits the impact of potential errors.
While simulation first appeared in the field of aeronautics, it is now widely used in nursing education, based on the principle and adage "never the first time on a patient." Simulation offers enormous benefits in the training process for healthcare professionals: risk-free learning for the patient (Ziv et al., 2013) in a safe and supportive environment. (Van Gele, 2014)
Given its importance and contribution to the training of healthcare professionals, the ISPITS of Tetouan has made simulation a pillar of training in order to help students achieve the objectives set by the training

standards. All the ISPITS in Morocco are committed to instilling in future healthcare professionals a set of organizational and professional values oriented towards respect for humanism and the development of a culture of safe, high-quality, and ethical nursing care. Given the current context, the lack of tutoring and support for students during clinical placements, and the recommendations to promote clinical scenarios for students, simulation would address both of these issues at the same time, while promoting the professionalization of nursing students. (Hoyelle-Pierre, 2023). The ISPITS of Tetouan has aligned itself with this perspective by using simulation as an essential support for the training of nursing students, specifically in the basic nursing modules, namely therapeutic administration 2, which is a fundamental module in the training program for versatile nurses and also essential in nursing practice. (Reference framework for the training of generalist nurses, 2018)

Parenteral therapeutic administration is an essential alternative when oral administration is contraindicated or inapplicable, particularly in serious or emergency situations. The use of the subcutaneous (SC) route is strictly governed by marketing authorization (MA) for certain common therapeutic indications (Renoud, 2023). The subcutaneous route is an extravascular parenteral route of administration. It consists of injecting medication or solution into the deep layer of the hypodermis (Renoud, 2023).

Intradermal injection is frequently used in dermatology, particularly for the injection of steroids in the treatment of keloids. Other departments, such as pediatrics, also require intradermal injection skills, particularly for BCG vaccination and tuberculin skin testing. Normally, immediately after intradermal injection, a papule appears on the skin, indicating that the injector has injected correctly (Techapichetvanich et al., 2018).

Although there are different teaching models for imparting these skills, they differ in terms of cost and preparation time. Currently, several high-tech simulators are available on the market, but their high cost can be a barrier for many institutions. SimulSkin, for example, is designed to mimic the texture and resistance of human skin. Their price can reach several hundred euros, depending on the features. It is therefore essential to develop cost-effective solutions that guarantee effective training for all future healthcare professionals. (Khalil et al., 2009).

Given these prohibitive costs, it makes sense to offer less expensive simulators, such as chicken thighs and Slim gel for learning intradermal injections, or a sponge cuff for subcutaneous injections. This approach has several advantages in terms of accessibility, practicality (chicken thighs are readily available and can be prepared quickly), and authenticity.

Graber et al. demonstrated that patients are more willing to allow medical students to perform procedures such as venipuncture, lumbar puncture, or central line insertion on them after the students have undergone simulation training.(Graber, 2005)

Clinical skills, at their most basic level, are psychomotor abilities acquired through reinforcement and require direct instruction. In some respects, clinical skills may appear easier to master, as students tend to retain 90% of what they do compared to only 10% of what they read. However, clinical skills extend beyond mere motor memory. They demand the integration of problem-solving abilities, communication proficiency, and medical techniques within a complex context and necessitate consistent practice.(Okuda et al., 2009). As with intradermal and subcutaneous injections, this procedure requires constant vigilance, confidence in execution, and rigorous mastery of the technique.

The innovative aspect of our research is the proposal of an educational device incorporating simulators for teaching therapeutic administration, including intradermal and subcutaneous injections, which have never been tested before. Typically, individuals learn to administer these injections for the first time on a patient, which goes against the principle of simulation: 'Never the first time on a patient.' Our main objective is to demonstrate the effectiveness of simulators in teaching injection techniques through a system that includes practice on a simulator (procedural simulation). This device complies with the technical specifications for intradermal injection (it produces a raised wheal, indicating that the injection was successful). The same applies to Slim Gel. There is also a cuff that can be attached to the arm or thigh to learn how to give subcutaneous injections.

2. MATERIALS AND METHODS

This is a quantitative pre-test/post-test study that aims to introduce simulation-based learning using low-cost and accessible tools into the basic nursing training program, specifically within the “Therapeutic Administration 2” module focused on injection technique.

The study involved Group A, consisting of 38 multi-skilled nursing students enrolled in the second semester of their first year of basic nursing at ISPITS of Tetouan. After giving their consent to participate in the research, 38 novices in therapeutic administration 2, a course that presents the framework of basic nursing training. The study targeted all second-semester students in the first cycle at ISPITS of Tetouan who were enrolled in the "Therapeutic Administration 2" course. Participation in the study was voluntary and limited to students who agreed to be involved in the research. It is important to note that this course is a mandatory institutional requirement (core module) for all students in the second year. The implementation of the proposed simulation-based educational interventions was carried out outside the official hours allocated to the module.

Consent to participate in the research was sought from students at the first meeting. After explaining the purpose and objectives of the research, the participants were informed that they were free to decide whether or not to take part in the experiment. The expected benefits of participating in the research were also presented, in particular the contribution to advancing knowledge in this field.

In order to conduct a successful debriefing, it was helpful to take photos and make video recordings with administrative permission. Authorization to record the sessions was obtained.

Anonymity was respected for all tests distributed during the study. The Research Ethics Committee (REC) of the multidisciplinary faculty of Taroudant approved the study (02/REC/24).

2.1. Description of proposed simulators:

2.1.1 The arm simulator for subcutaneous injection (Figure 1):

This simulator represents an arm that allows for the correct and realistic practice of subcutaneous injection. The thin, natural-looking sponge gives the simulator an appearance very similar to real skin. The arm simulator is made from readily available and inexpensive materials (sponge, plastic belt, glue, etc.). This hybrid simulation device aims to integrate technical skills and position the learner in complex situations.

Figure 1: An arm simulator for practicing subcutaneous injections

2.1.2 Slime gel for intradermal injection (Figure 2) :

With its sticky, transparent gelatinous appearance, Slime gel (Little Monster Foam Gum, Uni-Fob sarl) makes it easy to form the intradermal injection papilla and clearly see the angle and level of needle insertion during intradermal injection.

Figure 2. A gel slime simulator (Little Monster Foam Gum, Uni-Fob sarl) designed for intradermal injection practice.

2.1.3 The chicken thigh used for intradermal injection (Figure 3):
This teaching model was chosen for two main reasons: its composition, which is very similar to human skin, and its ease of use.

Figure 3: Shows the chicken thigh used for the intradermal injection.

2.2 The pre-test/post-test questionnaire
To evaluate the impact of the simulation on students' competencies, each participant's responses were scored using a 4-point Likert scale, where 1 corresponded to -Strongly Disagree- and 4 to -Strongly Agree-. For both the pre-test and post-test, a global score was calculated by summing the responses to the eight items, yielding a total score ranging from 8 to 32. Higher scores reflected a higher level of technical and non-technical competency in medication administration, including readiness, confidence, precision, and emotional regulation. Each item was also analyzed individually to assess specific areas of improvement. The Wilcoxon signed-rank test was employed to compare pre- and post-test scores, as it is appropriate for ordinal data and matched samples. A statistically significant increase in the post-test scores would indicate a positive impact of the simulation session on the development of students' practical and behavioral competencies.

3. Statistical analysis
The data were analyzed using IBM SPSS Statistics software. For each questionnaire item, the mean and standard deviation (SD) were calculated for both the pre-test and post-test responses, providing an overview of the central tendency and variability of the students' scores. To evaluate the impact of the simulation, the Wilcoxon signed-rank test was applied to compare paired pre- and post-intervention scores. This non-parametric test was chosen due to the ordinal scale of measurement and the lack of assumption regarding the normal distribution of the differences. A p-value of less than 0.005 was considered statistically significant. A significant result was interpreted as evidence of a measurable impact of the simulation activity on the competencies assessed.

RESULTS
The results presented in the table indicate a clear improvement in all assessed items following the simulation-based intervention. Across all eight statements, the mean scores increased significantly from pre-test to post-test, demonstrating enhanced self-perceived readiness, confidence, and satisfaction among participants, for example: The item "I was ready to administer an injection for the first time" improved from a mean of 3.03 to 3.84, reflecting increased preparation.
Confidence-related items (Q3, Q4, Q5) show marked gains, particularly for "I was confident in identifying the correct insertion point", which rose from 2.89 to 3.76, and "My hand wasn't shaking during injection", which increased from 2.60 to 3.71.
Items assessing non-technical aspects such as satisfaction with the learning tool (Q6), the opportunity to reflect on errors (Q7), and willingness to repeat the simulation (Q8) also saw substantial increases in post-test means, all exceeding 3.75.
The low standard deviations in post-test scores suggest that responses were more homogeneous after the intervention, indicating consistent perceived benefits across the participant group.
These findings support the effectiveness of simulation as a pedagogical tool for enhancing both technical and non-technical competencies in nursing education.

Table 1: Descriptive Statistics of Students' Perceptions Before and After Simulation-Based Learning

Assessment of technical and non-technical knowledge		N	Minimum	Maximum	Mean	Standard déviation
I was ready to administer anintradermal/subcutaneous injection of medication for the first time	Q1pretest	38	2,00	4,00	3,0263	0,49248
	Q1posttest	38	1,00	4,00	3,8421	0,54655
I was nervous about giving a medication injection for the first time	Q2pretest	38	1,00	4,00	2,3947	0,78978
	Q2posttest	38	1,00	4,00	3,4474	0,72400
I was confident in administering the medication injection for the first time	Q3pretest	38	1,00	4,00	2,8947	0,79829
	Q3posttest	38	2,00	4,00	3,5526	0,68566
I was confident in identifying the correct insertion point for my needle	Q4pretest	38	1,00	4,00	2,8947	0,60580
	Q4posttest	38	3,00	4,00	3,7632	0,43085
I was sure my hand wasn't shaking when I gave the injection	Q5pretest	38	1,00	3,00	2,6053	0,59455
	Q5posttest	38	2,00	4,00	3,7105	0,51506
I am satisfied with this learning tool	Q6pretest	38	1,00	4,00	2,9474	0,76925
	Q6posttest	38	3,00	4,00	3,8158	0,39286
The simulation allowed me to come back and discuss the trivialization of mistakes	Q7pretest	38	1,00	4,00	2,9474	0,61281
	Q7posttest	38	3,00	4,00	3,7632	0,43085
I would love to have this simulation experience again in other modules	Q8pretest	38	2,00	4,00	3,0526	0,46192
	Q8posttest	38	3,00	4,00	3,8421	0,36954

Table2: Wilcoxon Test Analysis of Technical and Non-Technical Skills Before and After Simulation

	Q1posttest - Q1pretest	Q2posttest - Q2pretest	Q3posttest - Q3pretest	Q4posttest - Q4pretest	Q5posttest - Q5pretest	Q6posttest - Q6pretest	Q7posttest - Q7pretest	Q8posttest - Q8pretest
Z	-4,446[b]	-4,028[b]	-3,569[b]	-4,638[b]	-5,031[b]	-4,402[b]	-4,360[b]	-4,845[b]
Asymptotic significance (two-tailed)	,000	,000	,000	,000	,000	,000	,000	,000

The results of the Wilcoxon test for paired samples revealed statistically significant differences between pre-test and post-test scores for all items assessed (Z between -3.569 and -5.031; $p < 0.001$). These data confirm a considerable improvement in student performance following the procedural simulation sessions.

4. DISCUSSION

Advances in medical education and healthcare have significantly expanded the scope of knowledge that students must master, while raising questions about patient safety. Simulator-based training is an effective way to improve the learning environment and promote cognitive processes by reducing the stress and anxiety associated with the clinical setting. It provides a safe environment where students can assess, make mistakes, and hone their skills before encountering a real patient. (Friedell, 2010)

The objective of this study was to investigate student satisfaction after the implementation of simulation-based learning in the basic nursing module for versatile nursing students in semester 2 at the Higher Institute of Nursing and Health Techniques of Tetouan (ISPITS-T).

Planning the simulation in this course, for the first time, poses an additional challenge in maintaining the quality of the course, achieving learning objectives, and conducting successful simulation sessions.

According to the study conducted on the class profile of first-year IP students, it appears that this is a heterogeneous group in terms of gender, age, educational level, and geographical origin, among other factors. The use of a low-fidelity mannequin allows students to enrich their knowledge and put their theoretical knowledge into practice in order to improve the technical skills required to perform an intramuscular injection correctly. (Hoyelle-Pierre, 2023)

For subcutaneous injections, we have developed a sponge cuff (see Materials) that is suitable and easy to use for learning this type of injection. The sponge cuff could help students improve their learning and enrich their knowledge, thereby increasing their self-confidence. Grynberg and his colleagues (2012) recently reported the results of an educational program similar to ours among students who were mainly in their second year of medical school (87%), with an analysis of the perceived benefits of using video compared to simple mannequin examinations. Their results were similar to ours in terms of the positive impact on student learning at the end of the educational session.

These positive results on student learning are consistent with the study by Techapichetvanich et al. (2018), who expressed the usefulness of artificial skin as a simple and effective model for learning intradermal injection. Concerns about patient safety have increased, which is why simulator training improves the learning environment and cognition by reducing anxiety and stress related to clinical situations. It provides a safe environment where students can assess, fail, and practice their skills so that the second time will be on a real patient. Other studies corroborate the same result, such as the one conducted by Young et al. (2007). After evaluating the cognitive performance of surgical and emergency medicine residents during an intensive care simulation, these researchers examined the residents' experience during 10 weeks of extensive simulation-based training and found that it was the amount of intensive care experience, rather than the length of residency training, that had the greatest impact on their performance.

Similarly, in our study, first-year IP students have a positive perception of their learning of injections, which is consistent with the observation by Young et al. that more training leads to better performance. This progress in simulation-based learning has helped students assimilate the course content in a short period of time, which also explains their high level of satisfaction with the training.

5. CONCLUSION

In summary, this study shows that students generally feel well prepared, confident, and capable of performing the professional tasks necessary for adequate patient care. Procedural simulation, integrated into their training, is widely considered an effective teaching tool, enabling them to acquire skills in a progressive and sustainable manner through repetition guided and supervised by teachers whose goal is to identify areas for improvement in learners.

This research highlights the growing interest in simulation devices in nursing education. These devices may be less expensive and more basic, but they meet the various training objectives, while emphasizing the importance of further exploring the most appropriate teaching methods and formats. These results pave the way for future comparative studies aimed at improving simulation approaches in clinical training.

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