

Effect of Low Fidelity Simulation Training Program on Knowledge and Practices of Pediatric Nursing Students regarding Intravenous Cannulation

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Abstract

Background: In recent decades, nursing instructors have tended to use simulation rather than traditional methods due to benefits such as increased self – confidence. **Aim of this study:** Was to evaluate the effect of low fidelity simulation training program on knowledge and practices of pediatric nursing students regarding intravenous cannulation. **Research design:** A quasi-experimental design was utilized in the current study. **Setting:** This study was conducted at clinical pediatric laboratory skills in Benha Faculty of Nursing affiliated to Benha University. **Subjects:** Systematic random sample of 100 pediatric nursing students (pre-test and post- test) from pediatric nursing department, third year, first semester. **Tools of data collection:** Two tools were used, **I:** A Structured interviewing questionnaire sheet and **II:** Observational checklists to assess pediatric nursing students’ practices regarding intravenous using low fidelity simulation. **Results:** More than half of pediatric nursing students had unsatisfactory level of total knowledge score in pre training program implementation. While the majority of them had satisfactory level of total knowledge score in the post training program implementation phase. More than two fifths of pediatric nursing students had incompetent level of total practices score in the pre training program implementation phase, while the majority of them had competent level of total practices score in post training program. **Conclusion:** The low fidelity simulation training program had a significant positive effect in improving pediatric nursing student’s knowledge and practices towards intravenous cannulation. **Recommendations:** Simulation based learning should be introduced in nursing curriculum development to enhance student acquisition of knowledge with better performance

Key words: Intravenous Cannulation, Knowledge, Low Fidelity Simulation, Pediatric Nursing Students, Practices, Training Program.

Introduction

Simulation training is the creation of a true-to-life learning environment that mirrors real-life work and scenarios. Trainees can put real knowledge and skills into practice not just by reading books on theory or listening to lectures, but through physical, hands-on activity. This type of training is so effective as it takes into account several of the learning styles

preferred by different learners. Not everyone learns visually, or through auditory materials, and simulation-based training also considers the needs of kinesthetic learners who flourish through practical exercises (Cooper, 2017).

Simulation is a technique for practice and learning that can be applied to many different disciplines and trainees. It is a technique (not a technology) to replace and amplify real experiences with guided ones,

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often “immersive” in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. Simulation-based learning can be the way to develop health professionals’ knowledge, skills, and attitudes, whilst protecting patients from unnecessary risks **(Shapiro et al., 2016)**.

Each year, millions of pediatric patients admitted in the hospitals require some form of vascular access as a critical component of their medical care. The insertion and daily use of these vascular access devices is associated with risks and complications that can have impact on the clinical status and outcome of the patient **(Banrihunshisha & Jahrin, 2019)**.

Intravenous therapy is probably the most common invasive acute care procedure. It is estimated that 90% of hospital stays involve the use of infusion therapy and that 1.8 million peripheral IV catheterizations are performed in pediatric patients annually. Especially in pediatric patients, skillful procedure is essential because the vascular structures are not yet adequately developed and the extremities move excessively **(Buyukilmaz et al., 2019)**.

Thrombophlebitis and infection are common complications of peripheral venous catheter and their use should be discontinued because of occlusion or leakage. Insertion, monitoring and assessing peripheral venous catheter site is a common nursing activity. The guidelines recommend that peripheral intravenous catheter should be removed or replaced every (12-72) hour according to type of treatment, to avoid complication such as Thrombophlebitis **(Alataa, 2016)**.

The smallest necessary peripheral venous catheter should be well documented with date, time, size and location in the

patient’s chart. A primary goal of intravenous cannula therapy is to maintain patents, comfortable intravenous cannula access that can be used to administer the prescribed therapy reliably and safely **(Buyukilmaz et al., 2019)**.

Pediatric peripheral intravenous cannulation are difficult even for skilled practitioners. Peripheral IV success rates in children have been shown to be around 50 % on the first attempt and 90% after 4 attempts, young age is a known predictor for difficult IV access related to differences in physical characteristics of veins such as size and depth, may impact success rates. However, successful intravenous cannulation absolutely required for pediatric clinical risk management **(Kafil et al ., 2019)**.

Nurses need to undergo training (cognitive and psychomotor) and supervised practice to be proficient in the skill of intravenous cannulation. The skill of intravenous cannulation must be practiced regularly to maintain a high level of competency. This is important to gain quick and efficient intravenous access in pediatric populations when required. Children may have small sized and fragile veins and may not cooperate during cannulation due to fear - making it more difficult than in adults **(Morgaonkar et al., 2017)**.

Nurse practicing vascular access care require the knowledge ,skill and judgment to manage vascular access devices .As they play a vital role in delivery of care which start from selection of the optimal device and site for cannula insertion; proper site preparation ,management and good removal of vascular access which help in prevention of peripheral vascular access complications .Nursing management should be done on a regular

basis to improve overall practice and pediatric patient outcomes (Abo-Seif et al., 2021).

Significance of the study

Intravenous cannulation considers the most difficult, stressful, and time-consuming for health-care professionals. The insertion of needle in the vein and maintain the IV patency for pediatric patients is very stressful, because the veins of children are more fragile and covered with a thicker subcutaneous tissues. Failures of peripheral IV injections and complaints about pain at the IV injection sites cause both nurses and physicians to feel concerned and anxious. The high cost and time-consuming nature of inserting and maintaining an IV needle in the vein has prompted attempts to develop various ways to decrease the frequency of IV insertion and reinsertion and minimize complications related to peripheral IV injections (Hwang et al., 2019).

Moreover, simulation considers an effective way to teach skills through simulation-based training. Simulation involves immersion of a learner in a realistic situation (scenario) created within a physical space (simulator) that replicates the real environment. Simulation – based learning having many advantage as; Increase frequency of clinical experience without training on real children, meaningful feedback, repetitive practice and the ability to presentation of clinical symptomatology to meet learners needs. Also Benefits of using simulation for nursing students includes; the provisions of practice and feedback of trainer, higher level of engagement and enjoyment, learning as much from mistakes and reduced learning time and tasks (Dame & Hoebke, 2016). Hence, the researcher found the urgent to conduct study to evaluate the effect of educational intervention program for pediatric

nursing students regarding intravenous cannulation by using low fidelity simulation.

Aim of the Study

The aim of this study was to evaluate the effect of low fidelity simulation training program on knowledge and practices of pediatric nursing students regarding intravenous cannulation.

Research Hypothesis:

The low fidelity simulation was improved pediatric nursing students knowledge and enhances practices regarding intravenous cannulation.

Subjects and methods

Research Design:

A quasi-experimental design was utilized to conduct this study.

Setting of the study:

The study was conducted at clinical pediatric skill in Benha Faculty of Nursing affiliated to Benha University. These pediatric laboratory skills located on the fourth floor and contained simulation equipment's and supplies such as training arm simulation, IV catheter with different size, cotton, tourniquet, syringe, intravenous medication, infusion, adhesive tab, blood bottles, needle, sharps bin, cleaning wipes.

Subjects:

Systematic random sample of 100 pediatric nursing students (pre-test and post-test) from pediatric nursing department, third year, first semester academic year 2020-2021 includes 72 females and 28 males. The total number of pediatric nursing students 215. The first number random selection and then took one student and leave one student.

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Tools of data collection:

Data was collected through using the following two tools:

Tool I- A Structured Interviewing Questionnaire Sheet: It was developed by the researcher based on the recent literature as **Hockenberry and Wilson, (2018)** to assess nursing students' knowledge regarding intravenous cannulation. It was prepared in English language and composed of two parts:

Part I: Personal data of the studied students such as age, gender and previous training courses on intravenous cannula skills in pediatric nursing students using low fidelity simulation (three questions).

Part II:

- A) Pediatric nursing students' knowledge about intravenous cannulation in children, it was adapted from **Hockenberry and Wilson, (2018)** and modified by researcher to suit the study, it was consists of close-ended questions in form multiple choice, it consist of 15 questions.
- B) Pediatric nursing students' knowledge about simulation it was adapted from **Martins et al., (2018)** and modified by researcher to suit the study, it was consists of close-ended questions in form multiple choice, it consist of 7 questions.

Scoring system for pediatric nursing students' knowledge:

Scoring system for pediatric nursing student's answers was compared with model key answer; were scored as complete correct answer had scored two (2). Correct answer had scored one (1), unknown or wrong answer had scored zero (0). In this respect the level of student knowledge was categorized as if total knowledge scored less than 19 points it considered unsatisfactory knowledge and if

more than or equal 19 points was considered satisfactory knowledge.

Satisfactory 85% or more

Unsatisfactory less than 85%

Tool (II): Observational checklists regarding intravenous procedure:

It was adapted from **Greenberg, (2016)** it used to assess pediatric nursing student's practices regarding intravenous cannulation using low fidelity simulation. This tool contained seventy five (75) items divided into four main procedures are insertion of intravenous cannulation (20), removal of cannula (11) items, administering intravenous medications (23) items and withdrawal of blood sample (21) items.

Scoring system for observational checklists:

The scoring system consisted of two points: give a score of one (1) for done and zero (0) for not done; if pediatric nursing students done 64 steps correctly or more it considered competent level of practices , and if less than 64 steps it considered incompetent level of practices.

- **Competent level of practice** 85% or more

- **Incompetent level of practices** less than 85%

Tool Validity:

Tools of data collection were investigated for their content validity by panel of three experts in Pediatric Nursing specialty from the Faculty of Nursing Benha University and Beni Suef University, who are selected to test contents for clarity, relevance, comprehensiveness, understanding and applicability. The opinion was elicited regarding the format, layout, and relevancy of tools and all of their remarks were taken into

considerations, and the tools were regarded as a valid from the experts' point of view.

Reliability:

Internal consistency reliability of all items of the tools was assessed using Cronbach's alpha coefficient. It was (0.81) for knowledge questionnaire sheet, (0.91) for observational checklists. This indicates a high degree of reliability for the study tools.

Ethical Considerations:

Approval of the study was obtained from ethical committee Dean, Vice Dean for education & students affairs and head of department of pediatric nursing department in the faculty of nursing at Benha University before starting the study. Explain the aim of the study to the subjects to take their permission to do the study and ensure each participant approved to be involved in the study. Oral consent was obtained from pediatric nursing students. The researcher was informed the students that all the gathered data were used for research purpose only and not for any evaluations, the study was harmless and the studied students had the right to withdraw from the study at any time freely without any rationales.

Pilot Study:

A Pilot study was conducted to test the clearness and applicability of the study tools and to estimate the time needed for each tool, it was done on 10% of the total pediatric nursing students (10 students). Pediatric nursing students under pilot study were excluded from the present study to avoid sample bias and contamination. Few modifications were done, and the final form was developed. This phase took two weeks 3rd and 4th week of October 2020.

Filed Work:

The process of data collection was carried out through ten weeks which extent from beginning of November 2020 up to the second week of January 2021 for third year pediatric nursing students. The students divided into ten groups each group contain ten students. The total number of students 100 students. The low fidelity simulation training program was implemented to achieve aim of the current study by these phases; assessment, planning, implementation and evaluation phase.

The study was conducted through the following phases:

Assessment phase:

Assessment phase involved interviews with students to collect baseline data. The researcher was visited the Pediatric nursing students at faculty of nursing in Benha University three days/ weeks according to their academic schedule by rotation from 9:00 AM and extended to 3:00 PM. At beginning of interview; the researcher welcomed available students, explained the purpose, duration, activity of the study and take their oral approval to participate in the study prior to data collection. Then the researcher assessed the pediatric nursing students' level of knowledge and practice. The process of data collection carried out from 2nd week of the first academic semester 2020 (November 2020). The researcher collected the data by using previous tools four to six hours daily, starting at 9:00 Am till 3:00 PM, three days weekly according to their academic schedule. Ten to fifteen (10-15) students were assessed daily. The researcher assessed the pediatric nursing students knowledge and practice level regarding intravenous cannulation by using low fidelity

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simulation by using the same questionnaires sheet and observational checklists as the following:

Firstly, the researcher did the explanation the questionnaire sheet to the pediatric nursing students to assess their level of knowledge toward intravenous cannulation and they finished answering within 15-20 minutes at the beginning of the day.

Secondly, the researcher observed the pediatric nursing students administering intravenous medications and withdrawal of blood sample using observational checklists using low fidelity simulation at clinical pediatric laboratory skills. The average time needed for observational completion of each student was between 15-20 minutes, this period of pretest (knowledge and practices) took place three week.

Planning phase:

Based on baseline data obtained from assessment phase and relevant review of literatures, the low fidelity simulation training program was designed by the researcher for pediatric nursing students according to the students' needs regarding intravenous cannulation. It was constructed, revised and modified from the related literatures to improve the students' knowledge and practice regarding intravenous cannulation. The contents were prepared according to student's level of understanding in English language. Different methods of teaching were used as modified lecture, group discussion, and demonstration, and re-demonstration, suitable teaching media were included injection arm simulation, hand out to help proper understanding of the content.

Program construction:

Statement of objectives

General objective

The program was aimed to improve pediatric nursing students' knowledge and practice towards intravenous cannulation by using low fidelity simulation.

The specific objectives

At the end of this training program, the students should be able to:

- Define vein
- Illustrate anatomy of venous system
- List indications of intravenous cannulation
- Mention best sites for cannula insertion
- List characteristics of good veins
- Enumerate inappropriate cases for intravenous cannulation
- Discuss factors affecting condition of the veins
- Illustrate methods for improving vein prominence
- Enumerate complications of intravenous cannulation
- Identify parts of IV cannula
- List IV cannula different sizes
- Illustrate preparation for insertion of IV cannula
- Define simulation
- List advantages and disadvantages of simulation
- Enumerate types of simulators
- Discuss intravenous training arm.
- Apply practice for insert cannula, remove cannula, administering intravenous

medications and withdrawal of blood sample.

Implementation phase:

This period took five weeks from the beginning of third week of November 2020 to the end of third week of December 2020.

The implementation phase was achieved through sessions at a period of five weeks, each session started by a summary of the previous session and objective of the new one. Motivation and reinforcement during session were used to enhance motivation for the sharing in this study. The researcher was available at the previous mentioned settings three days per week according their academic schedule. The first day was for the theoretical part intervention, the second day for practical part application, and the third day for one group from pediatric nursing students. The studied students were divided into 10 groups; each group consisted of 10 students; the total numbers of sessions were 7 sessions distributed as the following; 3 sessions for knowledge and 4 sessions for practice. These sessions have lasted for 80 hours (30 for theory - 50 for practices).

- **Theoretical part as the following; the first session** of the training program included definition of vein, anatomy of venous system, indications of intravenous cannulation, best sites for cannula insertion, characteristics of good veins, inappropriate cases for intravenous cannulation, factors affecting condition of the veins. **The second session** methods of improving vein prominence, complications of intravenous cannulation, parts of IV cannula, IV cannula different sizes, care and maintenance of a Peripheral

intravenous Cannula, IV sites for intermittent therapy must be checked, Removal of a peripheral intravenous cannula. **The third session** included definition of simulation, advantages of simulation, disadvantages of simulation, types of simulators, Intravenous arm simulation

- **Practical part as the following; The fourth session** included insertion of IV cannula. **The fifth session** included removal of IV cannula. **The sixth session** included Administering intravenous medications. **The seventh session** included withdrawal of blood sample.

Evaluation phase:

After the implementation of the training program contents, the post test was carried out to assess pediatric nursing students' knowledge and practices by using low fidelity simulation and using the same formats of pretest; this was done immediately after implementation of the training program for two weeks.

Statistical analysis:

The collected data were organized, coded, computerized, tabulated and analyzed by using the Statistical Package for Social Science (SPSS) version 21. Quantitative data were described using numbers and percentages. Association between categorical variables was tested using Chi-square and Pearson coefficient test, r test mean standard deviation. Significant level value was considered when $p \leq 0.05$ and a highly statistical significant was considered at $p < 0.001$.

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Results

Table (1): Shows that more than two thirds (69%) of the studied students were in the age group 19 < 21 years with a mean age **19.7±0.5** years old, while less than three quarters (72%) of them were female and the majority (81%) of them did not attend previous training courses.

Figure (1): Reveals that more than half (54%) of pediatric nursing students had unsatisfactory total knowledge score in pre training program implementation. While the majority (88%) of them had satisfactory total knowledge, score in the post training program implementation phase

Figure (2): Indicates that more than two fifths (41%) of pediatric nursing students had incompetent level of total practices score in the pre- training program implementation phase, while the majority (85%) of them had competent level of total practices score in post training program implementation phase.

Table (2): Illustrates that, there was a highly statistical significant positive correlation between studied students total knowledge mean score and total practices score on pre and post training program implementation phase with (P value <0.001).

Table (1): Distribution of pediatric nursing students regarding their characteristics (n= 100).

Students characteristics	Studied students (n=100)	
	No.	%
Students age:		
19 < 21 years	69	69.0
21 < 23years	31	31.0
Mean ±SD = 19.7 ±0.5		
Gender:		
Female	72	72.0
Male	28	28.0
Previous training :		
Yes	19	19.0
No	81	81.0

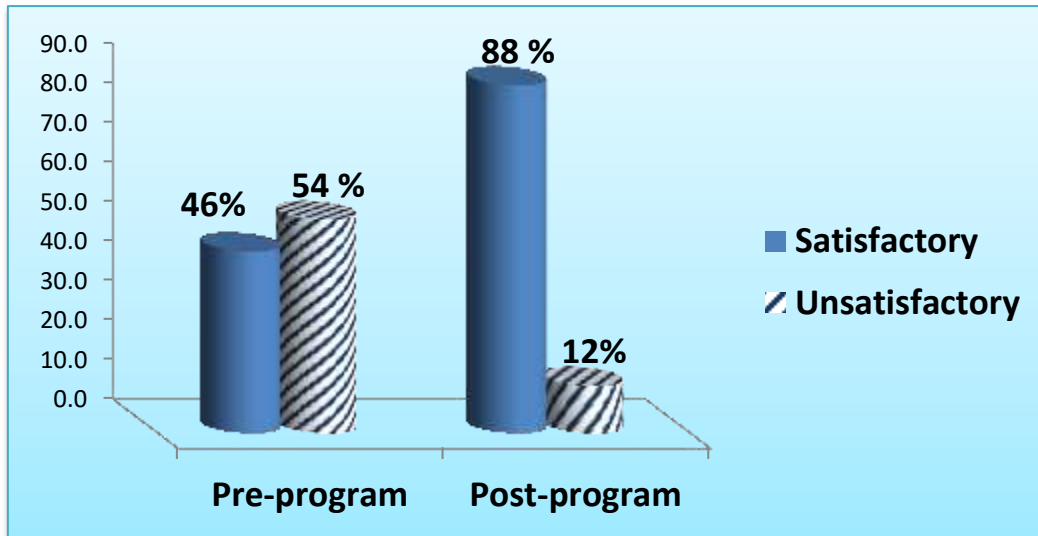


Figure (1): Distribution of pediatric nursing students regarding their total knowledge score pre and post low fidelity simulation training program(n= 100).

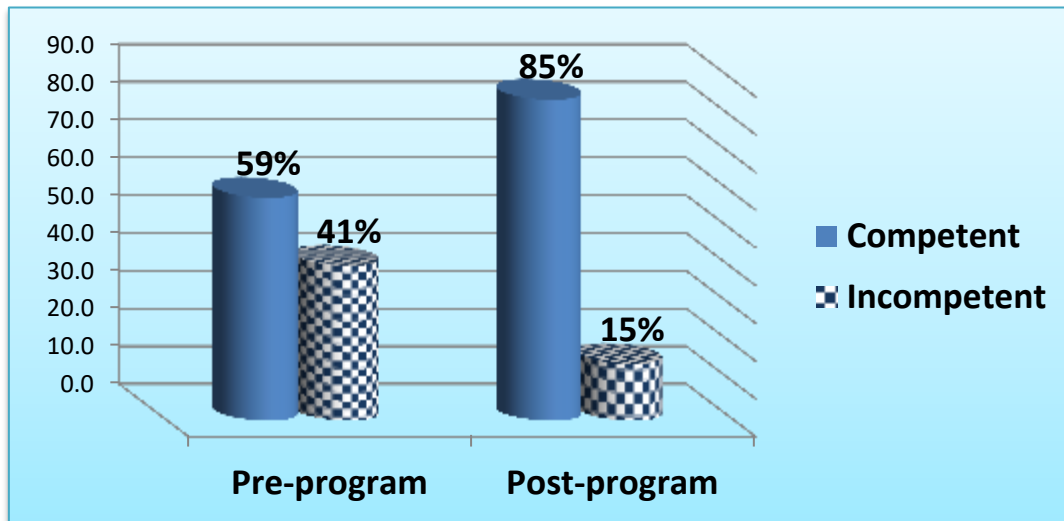


Figure (2): Distribution of pediatric nursing students regarding their total practices score pre and post low fidelity simulation training program (n= 100).

Table (2): Correlation between total knowledge score and total practices score among studied students pre and post low fidelity simulation training program

Total knowledge score				
	Pre training program		Post training program	
	r	p-value	r	p-value
Total practice score	0.263	0.008*	0.551	0.000**

** Highly statistically significant at $p < 0.001$

Statistically significant at $p < 0.05$

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Discussion

As regards to studied students characteristics, the findings of the present study revealed that more than two thirds of students were in the group from nineteen to less than twenty one years with a mean age of the studied students was $SD = 19.7 \pm 0.5$ years. From the researcher points of view, this may be explained by the fact that all the students admitted to any faculty at this age. These results agreed with the finding of the study done by **Indarwati & Primanda, (2021)** who conducted study entitled “Determinants of nursing students’ confidence in Peripheral intravenous catheter insertion and management” and reported that the majority of control and study groups were with age ranged between nineteen to twenty years.

Concerning gender of the studied students, the current study revealed that, nearly to three quarter of them were females. This may be attributed to the increase of numbers of females who studied in faculty of nursing than males and male in nursing started too increased day to day, but the females student nurses still represent the majority all over the world. This opinion supported by many related studies from varies multicultural regional and international countries. This results were consistent with the finding of the study done by **Stayt et al., (2015)** who conducted study entitled the “Effectiveness of clinical simulation in improving clinical performance in undergraduate nursing students” and found that more than three quarters of the studied students were female while less than one quadrant was male. In this respect, this finding was in the same context with **Indarwati & Primanda, (2021)** who found

that that three quarters of studied students were female.

According to students attendance previous training courses regarding intravenous cannulation using simulation, the present study showed that the majority of them had not attend the previous training courses on simulation. This results was in the same direction with **Mohamed, (2017)** entitled “Effect of simulation training on pediatric nursing students knowledge, practice and attitude regarding cardiopulmonary resuscitation” and reported that the majority of the students are had attending the previous training.

On assessing pediatric nursing students total knowledge score about intravenous cannulation, the current study showed that more than half of pediatric nursing students had unsatisfactory total knowledge score at the pre training program implementation phase. From the researcher points of view, this could be due to lack of student knowledge about intravenous cannulation and forget from the last study in the previous year. This finding was congruent with **Valizadeh et al., (2015)** entitled “The effect of simulation teaching on nursing students related to peripheral venous catheterization in children” and found that the total scores of students’ knowledge pre-program implementation were insufficient.

However after implementation of the training program, there was a significant improvement in the total knowledge scores of studied students who achieve satisfactory level of knowledge score. From the researcher points of view the improvement indicated that comprehensive content of training program and the program was a successful method to increase students’ knowledge acquired

knowledge and availability of lecture and power point and hard copy .So, it considered an effective learning method for them. This finding was in agreement with **Sood & singh, (2015)** who conduct a study to assess “The effectiveness of video assisted teaching regarding knowledge and practice of intra-venous cannulation for under-five children “and revealed that the majority of studied student had satisfactory level of knowledge score at the post test phase.

Similarly, this result is in harmony with the study done by **Jones et al., (2014)** entitled “measuring intravenous cannulation skills of practical nursing students using rubber mannequin intravenous training arms” and found that all of the studied students had satisfactory knowledge regarding intravenous cannulation after training program and found there were highly statistical significant differences between pretest and posttest.

On investigating students’ total practices score regarding intravenous cannulation, the finding of the present study indicated that more than two fifths of studied students had incompetent level of practices in the pre training program implementation. From the researcher point of view this may be due to lack of continuous training performed for students regarding intravenous cannulation. The finding of the current study is inconsistent with **Valizadeh et al., (2015)** who showed that more than two three quarters of studied subjects had incompetent level of total practices regarding intravenous cannulation in the pre-educational program implementation.

In addition, after low fidelity simulation training program implementation the majority of studied students had competent level of practices. From the

researcher point of view this may be due to using of low fidelity simulation (partial arm simulation) as a teaching methods that enables pediatric nursing students to effectively identify and target the weakest skills through evaluation of performance during the practice and doing it multiple times as needed until the skills were mastered. Also simulation had the ability to repeat scenario, ensure safe environment, meet clinical skill competence and facilitate psychomotor skills. This finding congruent with **Sood & singh, (2015)** who found that there is significant improvement of practice mean score of the studied participant after training.

Finally, the present study showed that there was a highly statistically significant positive correlation between students’ total knowledge mean score and total practices score on pre and post implementation of the training program ($p < 0.001$). From the reasecher point of view this could be due to students practices directly influenced by their knowledge besides knowledge is the baseline for the practices and essential to achieve best practices. This finding was on the same context with the study done by **Stayt et al., (2015)** who mentioned that there was a positive correlation between students’ knowledge and practices at the post program phase.

Conclusion

The low fidelity simulation-training program had a significant positive effect in improving students’ knowledge and practices towards intravenous cannulation using low fidelity simulation. Meanwhile, there was a highly statistically significant relation between students’ total knowledge score and practices score with their characteristics pre and post low fidelity simulation training program implementation. Meanwhile, there was a highly

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statistically positive correlation between studied student total knowledge score and total practices score pre and post training program implementation.

Recommendations

- Simulation – based learning should be introduced in nursing curriculum development to enhance student acquisition of knowledge with better performance.
- Continuous training program for pediatric nursing students using low fidelity simulation .
- Further researches the study should be replicated on a larger probability sample in other different settings is highly recommended to achieve generalizable results.

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تأثير التدريب باستخدام المحاكاه منخفضه الدقه علي معلومات وممارسات طلاب تمريض الأطفال تجاه القسطره الوريديه

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هدفت هذه الدراسه الي تقييم تأثير التدريب بإستخدام المحاكاه منخفضه الدقه علي معلومات وممارسات طلاب تمريض الأطفال تجاه القسطره الوريديه وقد تم التصميم الشبه تجريبي لاجراء هذه الدراسه. واجريت هذه الدراسه في معمل مهارات تمريض الأطفال بكلية التمريض -جامعه بنها في مدينه بنها.وشملت علي عينة عشوائيه منتظمه من طلاب تمريض الأطفال من الفرقة الثالثه قسم تمريض الأطفال بكلية التمريض -جامعه بنها. حيث كشفت النتائج علي ان مستوي معلومات الطلاب عن القسطره الوريديه قبل تنفيذ البرنامج التعليمي أكثر من نصف العينه (٥٤%) قد حصلوا علي مستوي غير مُرضي من المعلومات عن القسطره الوريديه بينما معظمهم (٨٨%) قد حصلوا علي مستوي مُرضي من المعلومات عن القسطره الوريديه بعد تنفيذ البرنامج التعليمي. بالنسبة لمستوي ممارسات الأمهات عن القسطره الوريديه فان أكثر من نصف العينه (٤١%) كان لديهم مستوي غير كفاء قبل تنفيذ البرنامج التعليمي مقارنة بان اكثر من نصف العينه (٨٥%) كان لديهم مستوي كفاء من الممارسات بعد تنفيذ البرنامج التعليمي. وأوصت الدراسه بأن هناك حاجة إلي استخدامالتقييم المستمر لمعلومات وممارسات طلاب تمريض الأطفال باستخدام المحاكاه منخفضه الدقه.