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Effectiveness Of Demonstration On Use Of Intravenous Infusion Pump Among Third Year General Nursing And Midwifery Students At Selected Nursing Institute: A Quasi Experimental Study

Ms. Bharti Ganesh Sandalwar
M. SC Nursing, VSPM MDINE, Nagpur.

Mrs. Lata Sukare
Professor VSPM MDINE, Nagpur.

Dr. Pascaline David
Professor VSPM MDINE, Nagpur.

Ms. Stuti Sunar
Associate Professor VSPM MDINE, Nagpur.

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ABSTRACT

Introduction:

Intravenous infusion pumps are essential for accurate and controlled delivery of fluids and medications in clinical settings. Nursing students must develop both theoretical knowledge and hands-on skills to use these devices effectively. This study evaluated the impact of demonstration-based teaching on knowledge and practice regarding intravenous infusion pump use among third-year General Nursing and Midwifery (GNM) students.

Methodology:

A quasi-experimental one-group pre-test post-test design was used. A total of 80 third-year GNM students were selected through convenient sampling from a nursing institute. Data were collected using a structured knowledge questionnaire and an observation checklist to assess practice. A demonstration on intravenous infusion pump usage was conducted, followed by a post-test after seven days. Statistical analysis was done using paired t-tests and ANOVA.

Results:

Post-test scores showed a marked improvement in both knowledge and practice compared to pre-test scores, with the difference being statistically significant ($p < 0.05$). The mean knowledge score increased from 10.81 to 19.90, while the mean practice score rose from 6.20 to 22.42. Additionally,

demographic factors such as residential area were significantly associated with post-test knowledge, while having a healthcare provider in the family and the type of healthcare worker showed significant association with post-test practice scores. This indicates the role of both educational intervention and background exposure in influencing learning outcomes.

Conclusion:

Demonstration-based training significantly enhances nursing students' competence in operating intravenous infusion pumps. Integrating such practical teaching methods into nursing education can improve clinical readiness and promote safe patient care practices.

Keywords: Intravenous Infusion Pump, Nursing Students, Demonstration Method, Knowledge, Practice, Clinical Skills

INTRODUCTION

An infusion pump is a medical device designed to deliver fluids—such as nutrients and medications—into a patient's body in controlled amounts. It ensures precise and consistent delivery, making it essential for safe and effective patient care across clinical settings, including hospitals, nursing homes, and home care.[1] Operated via integrated software by trained professionals, infusion pumps offer greater accuracy than manual administration, especially in delivering small volumes at programmable rates and intervals.[2] These pumps are vital in administering antibiotics, chemotherapeutics, insulin, and pain relievers, and their importance is underscored by recommendations from the National Academy of Medicine.[1]

Intravenous infusion pumps have revolutionized therapy delivery by automating the process, thus reducing errors and enhancing treatment outcomes.[2] Different types of pumps serve distinct clinical needs: Volumetric Infusion Pumps (for continuous infusion), Syringe Pumps (for precise, small-volume dosing), PCA Pumps (enabling patient-controlled pain relief), and Enteral Pumps (for gastrointestinal feeding).[3] These innovations contribute to safer, more efficient care by minimizing medication errors and enhancing precision.[4] However, safe operation requires adequate training and strict adherence to protocols, making healthcare professionals' knowledge and competency critical.[4]

Nurses and nursing students are central to infusion therapy, often responsible for setup, programming, monitoring, and responding to alarms. Proficiency in using infusion pumps not only improves care quality but also supports better patient outcomes.[5,6] For nursing students, understanding infusion technology is foundational, preparing them for real-world clinical challenges.6 This includes recognizing different pump types, mastering setup and operation, responding to complications, and ensuring patient comfort and safety.[7]

Historically, intravenous therapy dates back to the 1600s, but it became standard after WWII. The first automated pump, the "Chronofuser," was developed by Watkins and laid the groundwork for modern systems.[8] Infusion pumps have since evolved to support high-precision applications, delivering everything from sedatives to parenteral nutrition.[8] By 2013, 72.9% of U.S. hospitals had adopted smart infusion pumps, a marked increase from 44% in 2007. Their use has been championed by safety organizations like ISMP and the Institute of Medicine to reduce medication errors.[9] In India, infusion

pumps were introduced in 1997, and their usage rose significantly after the advent of smart pumps in 2006—especially during the COVID-19 pandemic, which highlighted their critical role in intensive care.[10]

A study exploring nurses' perceptions of advanced technology in ICUs employed a mixed-method design. It revealed that ICU nurses view technological advances positively, seeing them as learning opportunities. However, the need for hands-on training and simulation-based learning for new staff was emphasized to enhance competency with advanced devices.[11]

NEED OF THE STUDY

Since the early 20th century, technology has seen rapid advancement, significantly transforming human civilization and daily life. From electronic gadgets to advanced communication and transport, these innovations have enhanced convenience and productivity across sectors. Technology continues to revolutionize healthcare, contributing immensely to societal progress.[12]

Globally, the syringe pump market is projected to grow at a CAGR of 7.0% from 2022 to 2027. However, the COVID-19 pandemic impacted this growth due to surgical delays and ICU overcrowding. For example, the QEII Health Sciences Centre in Nova Scotia postponed most elective surgeries in April 2022. A study in PLOS ONE also reported increased waiting times for surgeries during the pandemic.[13]

In India, the demand for advanced intravenous medication delivery systems is rising, and the syringe pump market is expected to grow significantly between 2024 and 2028. The need for reliable, cutting-edge medical equipment is driving this trend.[14]

A study titled "Ending Infusion Confusion" developed a virtual IV pump educational module to improve nursing students' confidence and performance. Students who reviewed the module performed significantly better in programming IV pumps than those who did not. The module was found to be practical and user-friendly, with participants expressing higher satisfaction and comfort.[15]

Based on 16 years of clinical experience, the researcher observed that during the COVID-19 crisis—amid patient overload, staff shortages, and limited hospital beds—infusion pumps played a critical role in patient care. However, many nursing students lacked confidence in operating them due to insufficient knowledge and skills. As future healthcare providers, nursing students must develop competencies in handling such essential medical devices. While some studies assess nurses' knowledge of infusion pumps, very few focus on nursing students, and none specifically evaluate demonstration-based training. This highlights the need for targeted research in this area to enhance practical competencies among nursing students.

METHODOLOGY

Objectives of the Study

Primary Objective

To assess the effectiveness of demonstration on the use of intravenous infusion pump among third-

year General Nursing and Midwifery (GNM) students at a selected nursing institute.

Secondary Objectives

1. To assess the pre-test knowledge and practice regarding the use of intravenous infusion pumps among third-year GNM students.
2. To assess the post-test knowledge and practice regarding the use of intravenous infusion pumps among third-year GNM students.
3. To evaluate the effectiveness of demonstration on knowledge and practice regarding the use of intravenous infusion pumps among third-year GNM students.
4. To associate post-test knowledge and practice scores with selected demographic variables.

Research Approach

A quantitative research approach was adopted for this study.

Research Design

The study employed a quasi-experimental one-group pre-test post-test design to assess the effectiveness of the intervention.

Setting of the Study

The study was conducted at a selected nursing institute within the city.

Population

Target Population: All third-year General Nursing and Midwifery students.

Accessible Population: Third-year GNM students who were enrolled in the selected institute and available during the period of data collection.

Sampling Technique and Sample Size

Sampling Technique: Non-probability convenient sampling method was used.

Sample Size: The study included a total of 80 participants.

Tools for Data Collection

Description of the Tools

Section I – Demographic Variables:

A semi-structured questionnaire was used to collect background information. such as age, gender, residential area, and presence of any family member working in the healthcare field. This helped in analyzing the influence of demographic factors on learning outcomes.

Section II – Knowledge Assessment:

A self-administered questionnaire comprising 25 multiple choice questions related to intravenous infusion pump usage.

Section III – Practice Assessment:

An observation checklist with 30 procedural steps was used to evaluate practical skills.

Procedure for Data Collection

Pre-Test (Day 1): Administration of the self-administered knowledge questionnaire and observation checklist to assess baseline knowledge and practice.

Intervention (Day 1): A structured demonstration session on the use of the intravenous infusion pump was conducted for all participants.
Post-Test (Day 7): Re-administration of the same questionnaire and observation checklist to evaluate changes in knowledge and practice.

Reliability of Tools

Knowledge Questionnaire: The Karl Pearson correlation coefficient was used, and the result ($r = 0.99$) confirmed high reliability (> 0.8).
Observation Checklist: Reliability was established using the Inter-rater method, yielding a coefficient of 0.997, indicating excellent reliability.

RESULT

Table no. 1: Description of third year general nursing and midwifery students with regards to demographic variables.

n=80

Demographic Variables	Frequency (f)	Percentage (%)
Age in years		
20-21	60	75
22-23	17	21.3
≥24	3	3.8
Gender		
Male	10	12.5
Female	70	87.5
Area of residence		
Urban	49	61.3
Semi Urban	9	11.3
Rural	22	27.5
Family members working as health care worker		
Yes	7	8.8
No	73	91.3

Type of health care workers		**n=7**
Nurse	05	71.4
Doctor	0	0
Paramedical	0	0
Group D worker	1	14.3
Other	1	14.3

Table No. 2 (A): Table showing the comparison of pretest and posttest of knowledge score regarding intra venous infusion pump among third year General Nursing and Midwifery Students.

n=80

Level of knowledge	**Score Range**	**Level of Pre test Knowledge Score**		**Level of Post test Knowledge Score**	
		No of GNM third year students (f)	**Percentage (%)**	**No of GNM third year students (f)**	**Percentage (%)**
Poor	0-20% (0-5)	4	5	0	0
Average	21-40% (6-10)	38	47.5	0	0
Good	41-60% (11-15)	32	40	7	8.75
Very Good	61-80% (16-20)	7	7.5	41	51.25
Excellent	81-100% (21-25)	0	0	32	40
Minimum score		4		11	
Maximum score		18		24	
Mean knowledge score		10.81 ± 3.29		19.90 ± 2.72	
Mean % Knowledge Score		43.25 ± 13.18		79.60 ± 10.90	

Table No. 2 (B): Table showing the comparison of pretest and posttest practice score regarding

intra venous infusion pump among third year General Nursing and Midwifery Students.

n=80

Level of practice	Score Range	Level of Pretest Practice Score		Level of Post test Practice Score	
		No of GNM third year students (f)	Percentage (%)	No of GNM third year students (f)	Percentage (%)
Poor	0-20% (0-6)	71	88.75	0	0
Average	21-40% (7-12)	9	11.25	1	1.25
Good	41-60% (13-18)	0	0	13	16.25
Very Good	61-80% (19-24)	0	0	38	47.5
Excellent	81-100% (25-30)	0	0	28	35
Minimum score		4		12	
Maximum score		11		30	
Mean practice score		6.20 ± 1.03		22.42 ± 4.10	
Mean % Practice Score		20.66 ± 3.45		74.75 ± 13.68	

Table No. 3 (A): Table showing the comparison of pretest and posttest of knowledge score regarding intra venous infusion pump among third year General Nursing and Midwifery Students.

n=80

Test	Mean	SD	Mean Difference	Df	Calculated t-value	Table value	Calculate p-value	Level of significance
Pretest	10.81	3.29						

Posttest	19.90	2.72	9.08±3.98	79	20.412	1.98	0.0001	S, p<0.05

Table No. 3 (A) presents a statistical comparison of pre-test and post-test knowledge scores regarding intravenous infusion pump usage among third-year GNM students. The analysis was conducted using a paired t-test to determine the effectiveness of the demonstration intervention.

The mean knowledge score in the pre-test was 10.81 ± 3.29, while the post-test mean score significantly increased to 19.90 ± 2.72, resulting in a mean difference of 9.08 ± 3.98. This substantial increase indicates a marked improvement in knowledge following the intervention.

The calculated t-value was 20.412, which is much higher than the table value of 1.98 at a degree of freedom (df) of 79. The calculated p-value was 0.0001, which is highly significant at the 0.05 level ($p < 0.05$).

These statistical results confirm that the demonstration method had a significant positive effect on the knowledge of nursing students regarding the use of intravenous infusion pumps. The intervention successfully enhanced their theoretical understanding, validating the effectiveness of structured educational strategies in nursing training.

Table No. 3 (B): Table showing that comparison of pretest post practice score regarding use of intravenous infusion pump among third year General Nursing and Midwifery Students.

n=80

Test	**Mean**	**SD**	**Mean Difference**	**Df**	**Calculate t-value**	**Table value**	**p-value**	**Level of significance**
Pretest	6.20	1.03	16.22±4.06	79	35.72	1.98	0.0001	S,p<0.05
Posttest	22.42	4.10						

Table No. 3 (B) illustrates the statistical comparison of pre-test and post-test practice scores regarding the use of intravenous infusion pumps among third-year GNM students. The data clearly shows a significant improvement in students' practical skills following the demonstration-based intervention.

In the pre-test, the mean practice score was 6.20 ± 1.03, which is in the poor category, indicating insufficient practical competency. After the demonstration, the post-test mean score increased markedly to 22.42 ± 4.10, placing the majority of students in the very good to excellent performance range. This results in a mean difference of 16.22 ± 4.06, demonstrating a strong positive shift in practical skill levels.

Using a paired t-test, the calculated t-value was 35.72, which is far higher than the critical table value

of 1.98 at 79 degrees of freedom (df). The p-value was 0.0001, which is highly statistically significant at the 0.05 level ($p < 0.05$).

These results confirm that the demonstration method was highly effective in enhancing the practical skills of GNM students in operating intravenous infusion pumps. The statistically significant improvement suggests that hands-on, demonstration-based training plays a crucial role in clinical skill development and should be emphasized in nursing education to ensure competent and safe patient care delivery.

DISCUSSION

The present study aimed to evaluate the effectiveness of demonstration-based training on the knowledge and practice of third-year General Nursing and Midwifery (GNM) students regarding intravenous infusion pump usage. The findings showed a statistically significant improvement in both theoretical understanding and practical competency after the educational intervention. These results align well with the growing body of evidence supporting simulation-based and virtual learning in nursing education.

The pre-test results revealed a concerning gap in practical skills, with 88.75% of participants falling into the "poor" category, and a mean practice score of only 6.20 ± 1.03 (20.66%). Knowledge scores were also moderate, with most students scoring in the average or good range (mean = 10.81 ± 3.29 or 43.25%). These findings echo those reported by Uzelli Yilmaz & Sari (2021), who also found baseline deficiencies in knowledge and skill among first-year nursing students regarding IV therapy before simulation interventions. Their study concluded that simulation significantly enhanced students' clinical assessment and performance, which was also demonstrated in the current study.[16]

Following the demonstration, a dramatic improvement was observed. The post-test knowledge mean increased to 19.90 ± 2.72 (79.60%), and practical scores rose to a mean of 22.42 ± 4.10 (74.75%). These findings support the results of Terry et al. (2016), who showed that an online IV pump emulator was just as effective as face-to-face simulation in improving student performance. Although their intervention was digital, the learning principle—interactive, repeated exposure to skills in a safe environment—parallels the live demonstration method employed in this study.[17]

Moreover, Reyes et al. (2008) emphasized the effectiveness of a virtual simulator system in improving IV skills, reporting increased confidence and accuracy in clinical performance. This correlates with the present study's outcome, where students not only improved scores but also moved entirely out of the "poor" performance category, suggesting increased competence and confidence.[18]

The statistical analysis reinforces these findings. The paired t-tests for knowledge ($t = 20.412$, $p = 0.0001$) and practice ($t = 35.72$, $p = 0.0001$) showed highly significant improvements, verifying the efficacy of demonstration-based learning. Such statistical significance aligns with similar results reported in both Reyes et al. and Uzelli Yilmaz & Sari, where post-intervention improvements in mean scores were also statistically validated

Additionally, demographic factors were partially associated with learning outcomes. The association

between residential area and post-test knowledge scores ($F = 7.32$, $p = 0.001$) suggests that socio-environmental influences may affect theoretical learning, perhaps due to resource availability or educational exposure. The presence of a healthcare provider in the family and the type of healthcare worker showed significant association with post-test practice scores ($t = 3.49$, $p = 0.002$; $F = 9.42$, $p = 0.031$), highlighting the role of familial and contextual clinical exposure in skill acquisition. These associations echo findings in Terry et al., where prior familiarity and context positively influenced simulator-based performance.

In contrast, age and gender showed no significant association with either knowledge or practice scores, consistent with previous research indicating that simulation-based interventions benefit learners across demographic profiles equally.

CONCLUSION

Intravenous infusion pumps are essential tools in modern clinical practice, playing a critical role in ensuring accurate and safe delivery of fluids and medications. For nursing professionals, especially students in training, acquiring both theoretical knowledge and practical skills in using such technology is vital for delivering competent patient care. Demonstration-based teaching has proven to be an effective strategy in bridging the gap between theoretical understanding and clinical application. This study emphasizes the importance of integrating structured demonstrations into nursing curricula to enhance students' confidence and competence in using medical equipment.

Effective training not only improves skill development but also reinforces patient safety by reducing the likelihood of errors in handling complex devices. As future frontline caregivers, nursing students must be adequately prepared to adapt to advancements in healthcare technologies. It is also important to recognize that educational interventions should consider students' backgrounds and exposure levels to healthcare environments, which may influence their learning readiness and engagement.

Incorporating interactive, hands-on learning experiences within the educational framework ensures better preparedness among nursing students. This approach can significantly contribute to shaping a technically skilled and clinically safe nursing workforce, capable of meeting the demands of a rapidly evolving healthcare system.

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