Application of Patient Simulators Combined with Internet plus Scenario Simulation Teaching Models on Intravenous Infusion Nursing Education in China

Ying Wu[1], Yun Chen[1], Liuyan Zhang[1], Guohua Huang[1], Jinai He[1], Yutong Li[1]*, Yuzhen Renqing[2], Zhijuan Zhan[2]

[1]Department of Venous Catheterization, The First Affiliated Hospital of Jinan University, Guangzhou, China
[2]Department of Venous Catheterization, Linzhi People's Hospital, Linzhi, China
Email: wuying20050511@126.com, 18027370827@163.com, liuyan42168@126.com, jndxhgh@163.com, jinaihe@21cn.com, *liyutong@jnu.edu.cn

Abstract

Objective: To explore the effectiveness of applying patient simulators combined with Internet Plus scenario simulation teaching models on intravenous (IV) infusion nursing education, and to provide scientific evidence for the implementation of advanced teaching models in future nursing education. **Methods:** Enrolled 60 nurses who took the IV infusion therapy training program in our hospital from January 2022 to December 2023 for research. 30 nurses who were trained in traditional teaching models from January to December 2022 were selected as the control group, and 30 nurses who were trained with simulation-based teaching models with methods including simulated patients, internet, online meetings which can be replayed and scenario simulation, etc. from January to December 2023 were selected as the experimental group. Evaluated the learning outcomes based on the Competency Inventory for Nursing Students (CINS), Problem-Solving Inventory (PSI), comprehensive learning ability, scientific research ability, and proficiency in the theoretical knowledge and practical skills of IV infusion therapy. Nursing quality, the incidence of IV infusion therapy complications and nurse satisfaction with different teaching models were also measured. **Results:** The scientific research ability, PSI scores, CINS scores, and comprehensive learning ability of the experimental group were better than those of the control group ($P < 0.05$). The proficiency in the theoretical knowledge of IV infusion therapy in the experimental group indicated no statistical significance ($P > 0.05$), and their assessment results of practical skills, nursing quality of IV infusion therapy during training, and satisfaction with teaching models were all better than those of the control group with statistical significance ($P < 0.05$).

The incidence of IV infusion therapy complications in the experimental group was lower than that in the control group, indicating statistical significance (P < 0.05). **Conclusions**: Teaching models based on patient simulators combined with Internet Plus scenario simulation enable nursing students to learn more directly and practice at any time and in any place, and can improve their proficiency in IV infusion theoretical knowledge and skills (e.g. PICC catheterization), core competencies, problem-solving ability, comprehensive learning ability, scientific research ability and the ability to deal with complicated cases. Also, it helps provide high-quality nursing education, improve the nursing quality of IV therapy, reduce the incidence of related complications, and ensure the safety of patients with IV therapy.

Keywords

Specialty of Intravenous Infusion Therapy, Nursing Education, Patient Simulators, Internet Plus, Scenario Simulation Teaching Model

1. Introduction

IV infusion is one of the most effective and direct treatments in clinical practice. Statistics show that there are approximately 5 billion people receiving IV therapy in China every year, and 85% of nurses spend more than 75% of their total working time on IV infusions [1]. However, the risks of IV infusion have increased despite the development of medical technology and infusion equipment, and the scientificity, effectiveness, and safety of IV therapy have also attracted much attention. A large number of studies indicate that the incidence of IV therapy complications can be significantly reduced if IV nurses can identify the complications and provide targeted preventive intervention promptly [2] [3]. Therefore, it is necessary to adopt advanced and practical nursing education methods and update course content to cultivate skillful IV nurses to provide safe and effective IV therapy [4] [5].

2. Data and Methods

2.1. Data

Data were collected from 60 nurses who took the IV infusion therapy training program in our hospital from January 2022 to December 2023. 30 nurses aged 27 - 40 (mean age 32.7 ± 3.3) who were trained from January to December 2022 were enrolled in the control group, and 30 nurses aged 29 - 40 (mean age 33.1 ± 3.6) who were trained from January to December 2023 were enrolled in the experimental group. Two groups were comparable regarding the above information with no statistical significance (P > 0.05).

2.2. Inclusion Criteria

1) Bachelor's degree or above; at least five years of clinical experience and obtain a nurse practitioner certificate. **2**) Voluntarily participate in this research and

sign a consent form.

2.3. Exclusion Criteria

1) No participation in other research. **2**) Intern nurses. **3**) Take leave for more than five consecutive days.

3. Methods

3.1. Teaching Methods

Teaching content included the improvement of IV infusion therapy management and quality, assessment of IV sites, prevention and control of infusion-related infection, assessment and treatment of complications, patient safety and practices, including PICC catheterization and central venous catheter maintenance, which were all taught by IV therapy experts in our hospital. The control group was educated with traditional teaching methods, including lectures, demonstrations, and group discussions. Professors taught them theoretical knowledge related to IV infusion therapy using slides, and the nurses had group discussions based on the course content after class. After finishing the theoretical part, educators would take them to nursing rounds every morning, demonstrating and explaining the key points of IV therapy. Then the nurses practiced under guidance, and educators would give them feedback and advice and answer their questions afterwards. The experimental group adopted the patient simulators combined with Internet Plus scenario simulation teaching models. Methods included lectures with slides, scenario simulation with patient simulators, recorded educational videos, WeChat group discussions, flipped classrooms, workshops, clinical demonstrations, case analysis, and critical thinking questions, in order to encourage inquiry-based learning. For instance, educators would create multimedia presentations about typical PICC maintenance cases with images, medical videos, references and clinical consultations, etc., to demonstrate the meaning and approaches of PICC maintenance to nurses in an all-round, multi-level and three-dimensional manner. In addition, videos of every nurse's IV therapy operation under scenario simulation would be recorded and shared in the group chat for peer evaluation and self-evaluation. Then educators would review and recapitulate the main points of IV therapy standards and pathology regarding their performance, and guided them to practice again with simulation technology to correct errors.

3.2. Evaluation Indicators

3.2.1. Assessment Based On CINS and PSI, and Evaluation of Comprehensive Learning Ability and Scientific Research Ability

Evaluated nurses' clinical competence with CINS (43 items on six factors) [6], ranging from 43 to 301 points (the higher the better). Evaluated nurses' problem-solving ability with PSI (25 items on five factors) [7], ranging from 25-125 points (the higher the better). Recorded and compared the comprehensive learning ability and scientific research ability of the two groups.

3.2.2. Assessment of Theoretical Knowledge, Practical Skills and Nursing Quality

Practical skills assessment results were evaluated by educators and head nurses based on nurses' practical skills, teamwork skills and other abilities through bedside demonstrations and scenario simulations, etc., rating from 0 to 100. Theoretical knowledge was assessed with a closed-book exam, grading from 0 to 100.

3.2.3. IV Cather-Related Complications

Recorded related complications such as bleeding, infection, catheter blockage, mechanical phlebitis, etc.

3.2.4. Nurse Satisfaction with Teaching Methods

A questionnaire-based survey was conducted to evaluate nurse satisfaction with educators and the quality of teaching content. Grading system (0 - 100 points): satisfied (>90 points), quite satisfied (80 - 89 points), dissatisfied (<80 points). Satisfaction rates were measured based on the number of nurses rating satisfied and quite satisfied.

3.3. Statistical Methods

Data were analyzed by SPSS26.0. The results were compared with an independent samples t-test indicating with ($\overline{x} \pm s$), and a chi-square test indicating with %. P < 0.05 was considered statistically significant.

4. Results

4.1. Comparisons of CINS Scores, Comprehensive Learning Ability, Scientific Research Ability

As shown in Table 1, the two groups' CINS scores, comprehensive learning ability, and scientific research ability before training were considered no statistical significance (P > 0.05). However, the post-training results of the experimental group in those three aspects were improved compared to those of the control group, indicating statistical significance (P < 0.05).

4.2. Comparisons of PSI Scores

As shown in Table 2, the two groups' PSI scores before training were considered no statistical significance (P > 0.05). However, the post-training PSI scores of the experimental group were higher than those of the control group with statistical significance (P < 0.05).

4.3. Comparisons of the Assessment Results of Theoretical Knowledge, Nursing Quality and Practical Skills

As shown in Table 3, the two groups' assessment results of theoretical knowledge, nursing quality and practical skills before training indicated no statistical significance (P > 0.05). However, the post-training assessment results of the experimental group in those three aspects were better than those of the control group with statistical significance (P < 0.05).

Table 1. Comparisons of CINS scores, comprehensive learning ability, scientific research ability [($\overline{x} \pm s$), points].

Group	Case (n)	CINS		Comprehensive Learning Ability		Scientific Research Ability	
		before	after	before	after	before	after
Control	30	29.54 ± 2.35	32.34 ± 3.21	25.42 ± 2.43	38.97 ± 3.69	62.42 ± 6.21	77.13 ± 7.32
Experimental	30	29.12 ± 2.11	35.93 ± 3.93	25.13 ± 2.36	49.64 ± 4.86	62.31 ± 6.18	86.96 ± 8.69
t		0.728	3.875	0.469	9.577	0.069	4.739
P		0.469	0.001	0.641	0.001	0.945	0.001

Table 2. Comparisons of PSI scores [($\overline{x} \pm s$), points].

Group	Case (n)	Rational		Avoidance		Positive		Negative		Impulsivity/Carelessness	
		before	after	before	after	before	after	before	after	before	after
Control	30	14.31 ± 1.24	18.45 ± 1.67	16.56 ± 1.36	20.75 ± 1.77	15.42 ± 1.31	17.37 ± 1.63	14.65 ± 1.42	17.34 ± 1.63	11.75 ± 1.43	14.45 ± 1.65
Experimental	30	14.11 ± 1.16	21.86 ± 2.63	16.26 ± 1.21	23.52 ± 2.57	15.31 ± 1.26	19.45 ± 1.96	14.52 ± 1.34	19.84 ± 1.89	11.33 ± 1.37	16.97 ± 1.87
t		0.645	5.995	0.903	4.862	0.332	4.469	0.365	5.486	1.162	5.535
P		0.521	0.001	0.370	0.001	0.741	0.001	0.717	0.001	0.250	0.001

Table 3. Comparisons of the assessment results of theoretical knowledge, nursing quality and practical skills [($\overline{x} \pm s$), points].

Group	Case (n)	Theoretical Knowledge		Nursing Quality		Practical Skills	
		before	after	before	after	before	after
Control	30	69.65 ± 6.48	82.32 ± 7.43	54.42 ± 1.31	71.37 ± 6.63	72.63 ± 7.73	83.45 ± 7.72
Experimental	30	69.14 ± 6.21	92.46 ± 9.87	54.31 ± 1.26	79.45 ± 7.96	71.15 ± 7.32	94.02 ± 9.76
t		0.311	4.496	0.332	4.272	0.761	4.652
P		0.757	0.001	0.741	0.001	0.449	0.001

4.4. Comparisons of the Incidence of Complications

As shown in Table 4, the incidence of catheter-related complications in the experimental group was lower than that of the control group with statistical significance (P < 0.05).

4.5. Comparisons of Nurse Satisfaction with Different Teaching Methods

As shown in Table 5, the overall satisfaction rate in the experimental group was higher than that of the control group with statistical significance (P < 0.05).

5. Discussion

1) At present, IV infusion is an extremely common treatment in clinical medicine which takes up almost 90% of nurses' working time [8] [9]. Studies reveal that IV therapy is soaring in popularity along with the rapid development of clinical medicine and medical equipment in recent years, which demands skillful IV nurses and stricter management and safety policies [10] [11]. Research also shows that IV infusion nursing education can improve nurses' ability to identify

Table 4. Comparisons of the incidence of complications [n (%)].

Group	Case (n)	Catheter Blockage	Mechanical phlebitis	Bleeding	Infection	Incidence
Control	30	2	3	1	2	8 (26.67)
Experimental	30	1	0	1	0	2 (6.67)
x^2						0.038
P						4.320

Table 5. Comparisons of nurse satisfaction with different teaching methods [n (%)].

Group	Case (n)	Satisfied	Quite Satisfied	Dissatisfied	Satisfaction Rate
Control	30	19	4	7	23 (76.67)
Experimental	30	27	2	1	29 (96.67)
x^2					0.023
P					5.192

and prevent infusion-related complications and is of great significance in improving the safety of treatment [12]. Scenario simulation teaching methods, which have been widely used in nursing education, have proved effective for promoting student engagement and encouraging better communication and positive learning outcomes. However, it requires experienced educators, specific teaching venues and facilities, and there are also limitations, such as limited teaching hours and difficulty in reflecting individual differences [13] [14]. Thus, this study is designed to evaluate the effectiveness of patient simulators combined with Internet Plus scenario simulation teaching models on IV therapy nursing education.

2) Some studies have shown that scientific nursing teaching models are crucial to the improvement of nursing staff's comprehensive quality, professional knowledge and nursing skills [15]. Simulation-based teaching model focuses on encouraging independent learning, and creating a better emotional experience and an active learning atmosphere, which contributes significantly to enhancing the quality of nursing education and nurses' learning efficiency and professional skills [16] [17]. According to the results of this study, applying patient simulators combined with Internet Plus scenario simulation teaching models on IV therapy nursing education can significantly improve nurses' professional competence, comprehensive learning ability, and scientific research ability.

3) Nursing training should pay more attention to cultivating and improving nursing staff's ability to identify and solve problems, thereby enhancing the safety of clinical treatment, and reducing the incidence of complications and adverse reactions for better patient recovery. This study shows that participants' overall PSI scores are improved under patient simulators combined with Internet Plus scenario simulation teaching models, indicating that the application of this teaching model can effectively improve IV nurses' problem-solving ability

possibly because it can mimic real situations in clinical practice, including patients' symptoms and vital signs.

Some scholars stated in their studies that the fundamental purpose of nursing education is to develop knowledgeable professionals capable of providing safe, highly competent, and skilled patient care [18] [19] [20]. This study indicates that the assessment results of participants' theoretical knowledge, practical skills and the quality of nursing care were significantly improved under patient simulators combined with Internet Plus scenario simulation teaching models. Based on the outcomes, it is believed that the implementation of this teaching model can make great contributions to the enhancement of IV nurses' professional knowledge and skills to achieve high-quality nursing care.

4) Meanwhile, this study also finds that the value of simulation-based teaching models is demonstrated by a lower incidence of complications and increased nurse satisfaction.

6. Conclusion

In conclusion, nursing education with patient simulators combined with Internet Plus scenario simulation teaching models allows students to learn more directly and engage in practice and self-study anytime and anywhere, and can improve IV nurses' professional skills and knowledge, core competencies, problem-solving ability, comprehensive learning ability in an effective learning environment, and also reduces the incidence of complications.

Acknowledgements

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Luo, J., Tan, X.M., Yan, M., *et al*. (2022) Research Progress on Virtual Reality Technology in Intravenous Infusion Teaching. *Chinese Nursing Research*, **36**, 864-868.

[2] Li, W.H., Shi, Y., He, Y.X., *et al*. (2015) Application of PBL Combined PLTL Teaching Model in Training Young Tutors in Intravenous Infusion Therapy Team. *Nursing Journal of Chinese People's Liberation Army*, **12**, 59-61.

[3] Mou, C.Y. (2021) Application of SPOC-Based Microteaching Method in Clinical Teaching of Intravenous Infusion. *China Higher Medical Education*, **3**, 109-111.

[4] Yu, H.H., Zu, H.J. and Li, T.X. (2020) Effectiveness of Feedback-Led Teaching Method in Improving Venous Puncture Skills during Intravenous Infusion Clinical Instruction. *Modern Vocational Education*, **36**, 232-233.

[5]   Meng, R., Zhu, M.Z., Suo, S.S., *et al.* (2020) Study on the Application Effect of Different Teaching Methods in the Training of Intravenous Infusion Therapy Group Members. *Contemporary Medical Symposium*, **18**, 203-205.

[6]   Wang, Y., Ding, R.M., Li, L.L., *et al.* (2022) To Evaluate the Application Effect of Recognition Intervention Reflection Cycle Inquiry Teaching on Clinical Nursing Teaching of Cancer Pain. *Nursing Practice and Research*, **19**, 2345-2349.

[7]   Li, X.Y., Xiong, R. and Li, Y. (2022) Application of Scene Simulation Teaching Mode Based on 3-Class in Nursing Teaching of Cardiopulmonary Bypass in Cardiovascular Surgery. *China Modern Medicine*, **29**, 151-154, 158.

[8]   Chen, S.L. (2021) Research on the Application of Online-Learning Platform-Based Mixed Teaching Mode in Intravenous Infusion Teaching and Assessment. *Modern Vocational Education*, **46**, 38-39.

[9]   Wang, J.J., Tan, Q., Qi, J.W., *et al.* (2021) Application of Direct Observation of Procedural Skills in Teaching Intern Nurses Intravenous Infusion. *Journal of Qilu Nursing*, **27**, 163-165.

[10] Cao, X. (2020) Application and Exploration of Intravenous Infusion Teaching with Flipped Classrooms. *China Health Care Nutrition*, **30**, 383.

[11] Wang, R., Li, L.H., Liu, Y.J., *et al.* (2020) Effectiveness of Using Virtual-Reality-Based System in Venipuncture Training for Undergraduate Nursing Students. *Health Vocational Education*, **38**, 82-84.

[12] Wang, Y.P. (2021) Application of Problem-Based Learning in Teaching of Nursing Practice of Intravenous Infusion Therapy. *Women's Health*, **25**, 153.

[13] Zhang, Y.G., Li, X. and Xu, L. (2022) Application Effect of Situational Simulation Teaching in the Hospital Infection Control for Anesthesiology Residents. *China Medical Herald*, **19**, 87-91.

[14] Cai, M., Shi, Y.R., Guo, L., *et al.* (2022) Application Effect of Situational Simulation Teaching Method in Undergraduate Clinical Nursing Education in Psychiatry Department. *China Medical Herald*, **19**, 74-77.

[15] Man, Z.P., Ma, R. and Liu, J.Y. (2022) Effectiveness of Combining Scenario Simulation Teaching with Mind Mapping in Improving ER Nurses' First Aid Skills. *International Journal of Nursing*, **41**, 405-408.

[16] Wen, F., Zhao, W.J., Xie, X.F., *et al.* (2021) A Study on the Influence of Situational Simulation Training Combined with Miller Pyramid Teaching on Emergency Response Ability and Nursing Skills of Operating Room Nurses. *Chinese Journal of Medical Education Research*, **20**, 1361-1364.

[17] Gao, M. (2020) Application of Scenario Simulation Teaching Combined with Flowchart Problem-Guided Education in Nurse Training in Operating Room. *Nursing Practice and Research*, **17**, 126-128.

[18] Chen, Y.L., Li, L., Li, S.Y., *et al.* (2022) Application of BOPPPS Model in Standardized Training for Nurses in Operating Room. *Journal of Nursing*, **29**, 18-20.

[19] Yao, Y.H., Wang, H.Y., Zhang, X.X., *et al.* (2022) Application of Formative Evaluation Combined with Formatting Target Teaching in the Practice Nurses' Teaching of Disinfection Supply Centers. *Journal of Nurses Training*, **37**, 1117-1120, 1140.

[20] Wang, P.F., Yan, C.L., Zhao, J., *et al.* (2022) Application of Modified Peyton's Four-Step Approach in Pre-Post Operation Training for Newly Recruited Nurses. *Journal of Nursing Science*, **37**, 63-66.