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Research Article

Application of PDCA Cycle-Based Continuous Quality Improvement Activities in Nursing to Reduce the Flow Rate Deviation Rate of Disposable Infusion Devices

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Abstract

Objective: This study aimed to reduce the flow rate deviation rate of disposable infusion devices through PDCA (Plan-Do-Check-Act) cycle-based continuous quality improvement activities in nursing, thereby ensuring the effectiveness of patient medication and treatment safety. **Method:** A convenience sampling method was employed to divide patients using disposable infusion devices into a control group and an experimental group. The study compared the flow rate deviation rate of disposable infusion devices before and after the intervention. **Results:** Following the intervention, the flow rate deviation rate of disposable infusion devices significantly decreased from 37.8% to 8.8%. The patient education awareness rate increased from 83.3% to 93.1%. Nurses' theoretical examination scores improved from (86.90 ± 3.35) points to (93.55 ± 1.34) points, and their operational skills scores improved from (83.80 ± 2.57) points to (94.60 ± 2.83) points. The differences observed before and after the activity were statistically significant ($P<0.05$). **Conclusion:** PDCA cycle-based continuous quality improvement activities in nursing can effectively reduce the flow rate deviation rate of disposable infusion devices, which contributes to ensuring accurate and safe medication for patients.

Keywords: PDCA cycle; Continuous quality improvement; Infusion device

In modern nursing practice, ensuring the precision and safety of drug infusion is of paramount importance. Disposable infusion devices are widely utilized in clinical settings due to their convenience. However, when these devices are used for drug infusion, their flow rate deviation rate directly impacts patient treatment efficacy and medication safety [1-3]. An excessively high flow rate deviation rate can lead to inaccurate drug dosages, potentially affecting treatment outcomes, causing adverse reactions, and posing a significant threat to patient health. Therefore, effectively reducing the flow rate deviation rate of disposable infusion devices is crucial.

The PDCA cycle method, also known as the Deming Cycle, is a scientific and systematic management approach designed to achieve continuous quality improvement through four sequential stages: Plan, Do, Check, and Act. In the medical field, the application of PDCA cycle management has been proven to effectively enhance various nursing quality indicators [4-8]. This paper explores the application of PDCA cycle-based continuous quality improvement activities in nursing to address the flow rate deviation rate of disposable infusion devices.

Methods

General Information

A convenience sampling method was used to select patients utilizing disposable infusion devices from a hospital in Guangzhou. The study subjects were recruited during two periods: January to July 2024 and December 2024 to June 2025. Patients were divided into a control group (n=90) and an experimental group (n=102) based on their admission time.

Inclusion Criteria

1. Patients using disposable infusion devices.

2. Inpatients.

3. Patients capable of cooperating with the investigation.

4. Patients providing informed consent.

Exclusion Criteria

1. Non-inpatients using disposable infusion devices.

2. Patients who did not complete drug infusion according to established treatment measures.

3. Patients who did not continuously use disposable infusion devices.

4. Patients unwilling or unable to cooperate with the investigation.

There were no statistically significant differences in the general conditions of the two groups of patients ($P > 0.05$), as detailed in Table 1.

	t	χ^2	P
Gender		2.322	0.128
Age	-1.420		0.157
Degree of Education		6.695	0.082

Table 1: Descriptive Characteristics of the Study Participants.

Research Methods

P (Plan)

The control group patients underwent routine nursing procedures for disposable infusion device users. An investigation of this group identified four root causes for flow rate deviation: unsuitable placement of the disposable infusion device, obstructed venous access, the flow restrictor not adhering to the skin, and inappropriate ambient temperature. These led to four underlying causes: patients not mastering precautions for using disposable infusion devices, nurses not timely inspecting relevant conditions of patients using disposable infusion devices, poor patient compliance and cooperation, and inadequate environmental temperature and humidity control. Based on these, countermeasures were formulated: developing diverse educational materials for patients using disposable infusion devices, strengthening training and assessment for nurses regarding disposable infusion devices, optimizing patient management for disposable infusion devices, and optimizing ward temperature and humidity management.

D (Do)

Development of Diverse Educational Materials for Patients Using Disposable Infusion Devices

To enhance patients' understanding and compliance, we developed a series of educational materials. These included:

1. **Infusion Device Usage Manual:** A detailed, easy-to-understand manual explaining the correct usage, common problems, and precautions for disposable infusion devices.

2. **Video Tutorials:** Short, engaging video tutorials demonstrating proper device placement, adjustment, and troubleshooting.

3. **Interactive Q&A Sessions:** Regular sessions where patients and their families could ask questions and receive immediate feedback from nursing staff.

4. **Visual Aids:** Posters and infographics displayed in wards illustrating key steps and warnings.

Strengthening Training and Assessment for Nurses Regarding Disposable Infusion Devices

To improve nurses' professional skills and awareness, we implemented the following measures:

1. Regular Training Courses: Monthly training sessions covering the latest guidelines, best practices, and common errors related to disposable infusion devices.

2. Skill Drills and Simulations: Hands-on practice with various infusion scenarios to enhance practical proficiency.

3. Theoretical and Practical Assessments: Regular evaluations to ensure nurses' mastery of knowledge and skills. Nurses who failed were required to undergo re-training until they passed.

4. Peer Mentorship Program: Experienced nurses mentored junior staff, providing guidance and support.

Optimizing the management of patients using disposable infusion devices

To ensure continuous and effective management of patients using infusion devices, we adopted these strategies:

1. **Standardized Infusion Rounds:** Nurses conducted hourly rounds to check infusion sites, flow rates, and patient comfort.

2. **Early Warning System:** Implemented a system to alert nurses to potential flow rate deviations based on predefined parameters.

3. **Patient Feedback Mechanism:** Encouraged patients to report any discomfort or perceived issues with their infusion devices promptly.

4. **Individualized Infusion Plans:** Developed tailored plans for patients with specific needs or conditions that might affect infusion flow.

Optimizing Ward Temperature and Humidity Management

To create an optimal environment for infusion, we focused on:

1. **Automated Monitoring Systems:** Installed sensors to continuously monitor and record ward temperature and humidity.

2. **Standardized Environmental Control Protocols:** Established clear guidelines for maintaining optimal temperature and humidity in infusion areas.

3. **Regular Equipment Maintenance:** Ensured that air conditioning and humidification systems were regularly inspected and maintained to function effectively.

4. **Patient Comfort Surveys:** Periodically surveyed patients to assess their comfort levels regarding ward environment.

C (Check)

During the "Check" phase, we regularly monitored and evaluated the effectiveness of the implemented measures.

1. **Flow Rate Deviation Rate Monitoring:** The flow rate deviation rate of disposable infusion devices was continuously monitored and recorded. Data was collected weekly and analyzed to identify trends and areas for further improvement.

2. **Patient Education Awareness Rate Survey:** A questionnaire was administered to patients to assess their understanding of infusion device usage and precautions. The awareness rate was calculated based on correct responses.

3. **Nurse Scores Evaluation:** Nurses' theoretical knowledge and operational skills were assessed through examinations and direct observation. Scores were compared before and after the intervention.

4. **Environmental Parameter Review:** Temperature and humidity data from ward monitoring systems were reviewed to ensure compliance with established standards.

A (Act)

Based on the results of the "Check" phase, the "Act" phase involved taking corrective actions and further refining the processes.

1. **Feedback and Adjustment:** The findings from monitoring and evaluation were fed back to the nursing team. Regular meetings were held to discuss results, identify remaining challenges, and propose adjustments to the improvement plan.

2. **Standardization and Institutionalization:** Successful interventions and improved practices were standardized and integrated into routine nursing protocols. This ensured that the improvements were sustained and became part of the hospital's quality management system.

3. **Continuous Improvement Cycle:** The PDCA cycle was reiterated, meaning that new problems or areas for further enhancement identified during the "Act" phase would become the "Plan" for the next cycle, ensuring ongoing quality improvement.

4. **Dissemination of Best Practices:** Successful strategies and outcomes were shared with other departments and institutions to promote broader adoption of effective quality improvement methods.

Results

Statistical Methods

All data were analyzed using SPSS 25.0 statistical software. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$) and compared using t-tests. Count data were expressed as percentages (%) and compared using chi-square tests. A P-value <0.05 was considered statistically significant.

Effect Confirmation

Comparison of Flow Rate Deviation Rate of Disposable Infusion Devices Before and After the Activity

Before the PDCA cycle-based continuous quality improvement activities, the flow rate deviation rate of disposable infusion devices was 37.8%. After the activities, the flow rate deviation rate significantly decreased to 8.8% as detailed in Table 2.

	Number of patients generating flow deviations	Number of patients without flow deviation	χ^2	P
Before the activity	34 (37.8%)	56 (62.2%)	23.063	<0.001
After the activity	9 (8.8%)	93 (91.2%)		

Table 2: The flow rate deviation of the one-time infusion device used by the patient.

Comparison of Patient Education Awareness Rate Before and After the Activity

Before the intervention, the patient education awareness rate regarding disposable infusion devices was 83.3%. After the implementation of the PDCA cycle, this rate increased to 93.1% as detailed in Table 3.

	Number of patients aware of health education	Number of patients unaware of health education	χ^2	P
Before the activity	75 (83.3%)	15 (16.7%)	4.530	0.03
After the activity	95 (93.1%)	7 (6.9%)		

Table 3: The patients' awareness of relevant knowledge education.

Comparison of Nurses' Theoretical and Operational Skills Scores Before and After the Activity

Before the activities, nurses' theoretical examination scores were (86.90 ± 3.35) points, and their operational skills scores were (83.80 ± 2.57) points. After the activities, theoretical scores improved to (93.55 ± 1.34) points, and operational skills scores improved to (94.60 ± 2.83) points as detailed in Table 4.

	Before the activity	After the activity	t	P
Operating score	86.90±3.35	93.55±1.34	-5.829	<0.001
Theoretical score	83.80±2.57	94.60±2.83	-8.918	

Table 4: The operational and theoretical competencies.

Discussion

Effectiveness of the PDCA Cycle in Reducing Flow Rate Deviation

The results of this study demonstrate that the application of PDCA cycle-based continuous quality improvement activities in nursing significantly reduced the flow rate deviation rate of disposable infusion devices. This aligns with the core principle of the PDCA cycle, which emphasizes systematic problem identification, solution implementation, and continuous monitoring for improvement. By meticulously planning, executing, checking, and acting upon identified issues, the nursing team was able to address the multifaceted causes of flow rate deviation, leading to a substantial improvement in infusion accuracy. This not only enhances the quality of nursing care but also directly contributes to patient safety by ensuring precise medication delivery.

Importance of Patient Education

Patients' knowledge regarding the use of infusion devices and their compliance are key factors in ensuring infusion accuracy. When patients fully understand the correct usage of infusion devices, necessary precautions, and the identification and management of abnormal situations, they can effectively avoid flow rate deviations caused by improper operation or insufficient cooperation. Therefore, continuous, personalized, and multimedia-based patient education is an indispensable part of reducing the flow rate deviation of single-use infusion devices. Health education content that is easy to understand and comprehend can provide patients with positive emotions, which is beneficial for the treatment and prognosis of their diseases [8,9].

Improvement in Nurses' Professional Capabilities

The substantial improvement in nurses' theoretical knowledge and operational skills scores underscores the importance of continuous professional development. Regular training, skill drills, and assessments, as implemented in the "Do" phase, equipped nurses with the necessary expertise to manage disposable infusion devices effectively. Enhanced nursing proficiency directly translates to better patient care, including accurate device placement, timely troubleshooting of obstructions, and vigilant monitoring of infusion parameters. This reinforces the idea that investing in staff training is crucial for achieving and maintaining high standards of quality in healthcare.

Role of Environmental Factors

The study also recognized the impact of environmental factors, specifically ward temperature and humidity, on the flow rate of disposable infusion devices. By optimizing ward environmental management, the nursing team addressed a previously overlooked aspect that could contribute to flow rate deviations. Maintaining stable and appropriate environmental conditions helps ensure the consistent performance of infusion devices, further contributing to the accuracy and safety of medication administration. This highlights the need for a holistic approach to quality improvement, considering all potential variables that might influence patient care outcomes.

The accuracy of infusion devices is crucial for ensuring precise delivery of medication doses and preventing adverse events [10]. Through continuous quality improvement activities in nursing based on the PDCA cycle, this study successfully reduced the flow rate deviation of single-use infusion devices. The findings confirm the effectiveness of the PDCA cycle in addressing flow rate deviations in single-use infusion devices. Future research could further investigate factors influencing flow rate deviations in different types of single-use infusion devices across various clinical scenarios, as well as the impact of more precise environmental control measures on infusion accuracy, thus providing more comprehensive guidance for clinical nursing practice.

References

1. Zhang W, Zhang M, Luo X, et al. (2019) Using PDCA cycle to continuously improve the quality of nursing shift work in the post-anesthesia care unit.
2. El-Gazar HE, Abousoliman AD, Shawer M, Coelho P, Zoromba MA (2024) How nursing practice environments limit implicit rationing of care and nurse-assessed adverse events: the role of flow at work. BMC Nurs 23: 19.
3. Hong Y, Ye Z, Gao Z, Rao Y (2020) Continuous improvement on the rationality of prophylactic injectable PPIs usage by a clinical pharmacist-led guidance team at a Chinese tertiary teaching hospital. J Int Med Res 48: 300060520954729.
4. Nguyen V, Nguyen N, Schumacher B, Tran T (2020) Practical Application of Plan–Do–Check–Act Cycle for Quality Improvement of Sustainable Packaging: A Case Study. Appl Sci 10: 6332.
5. Chen Y, Zheng J, Wu D, Zhang Y, Lin Y (2020) Application of the PDCA cycle for standardized nursing management in a COVID-19 intensive care unit. Ann Palliat Med 9: 1198-1205.
6. Li W, Liu Z, Song T, Zhang C, Xue J (2022) Effect Evaluation of Electronic Health PDCA Nursing in Treatment of Childhood Asthma with Artificial Intelligence. J Healthc Eng 2022: 2005196.
7. Li Y, Hong M, Liu G (2021) Changes in the Quality of Life, Psychological Status, Medication Compliance, and Prognosis of Patients with Acute Myocardial Infarction after PCI by Applying PDCA Cycle Management Model. Evid Based Complement Alternat Med 2021: 7318653.
8. Jiang Y (2022) The Application Effect of Clinical Nursing Pathways in Elderly Cataract Surgery Patients. Medical Journal of Chinese People's Health 34: 180-182.
9. Li H,Li F (2023) Advances in the Application of Continuity of Care for Elderly Patients with Chronic Diseases in China. Chinese Primary Health Care 37: 102-104.
10. Weinberg E, Rahematpura S, Gonzalez SA, Izzy MJ, Simonetto DA, et al. (2023) INFUSE: Rationale and design of a multi-center, open label, collaborative study to treat HRS-AKI with continuous terlipressin infusion. Contemp Clin Trials Commun 36: 101211.