

Application of the Plan-Do-Check-Action Cycle in Reducing the Incidence of Forearm Hematoma in Patients After Transradial Artery Percutaneous Coronary Interventions

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Background: Transradial puncture has the advantages of significantly fewer complications, less patient pain, shorter hospital stays, and reduced hospital costs, but it tends to cause forearm hematoma, so reducing the rate of forearm hematoma is imperative. This study assessed the value of the plan-do-check-act (PDCA) cycle in standardizing nursing management in reduce the incidence of forearm hematoma in patients after transradial artery Percutaneous Coronary Intervention(PCI).

Methods: This study was conducted on 260 patients with acute myocardial infarction admitted to our hospital between January 2022 and June 2022 who underwent coronary intervention. The subjects were divided into control-group (n=130) and observation-group (n=130) in accordance with their admission time. The control-group received routine nursing care; and the observation-group, was applied with PDCA nursing management in addition to conventional treatment.

Results: The incidence of forearm hematoma in patients after radial artery PCI decreased from 24.62% to 8.46% ($P < 0.05$).

Conclusion: The PDCA cycle management model was effective in reducing the incidence of forearm hematoma without increasing adverse patient outcomes.

Keywords: plan-do-check-act cycle, radial artery puncture, PCI, forearm hematoma

Introduction

The American Heart Association (AHA) predicts that by 2035, approximately 130 million people will have cardiovascular disease, with coronary heart disease (CHD) being the leading cause of death in patients with CHD and a high rate of recurrence.¹ Cardiovascular Health and Disease Report 2020 states that 11.39 million people have CHD in China.² Radial artery access is currently indicated for all percutaneous procedures, but local vascular complications still occur and can lead to serious adverse events such as bleeding, combined forearm hematoma syndrome, and, if hemostatic care is inadequate, radial artery occlusion.³⁻⁶ Therefore, from this perspective, a standardized radial artery hemostasis protocol care may improve prognosis.

In 1954, scholar Deming created the Plan-Do-Check-Act (PDCA) cycle management model. It is a scientific idea for solving problems arising from work and has been widely recognized. The main feature of the PDCA cycle management model is to carry out quality management according to the sequence of Plan (P), Perform (D), Check (C), and Act (A) so that the management objectives can be developed step by step in order to achieve the final goal.⁷ By applying the PDCA cycle to reduce the incidence of forearm hematoma in patients after transradial PCI training and quality management, we summarized and identified the main causes of forearm hematoma and proposed appropriate corrective measures for each cause. The study is summarized and reported as follows.

Methods

Design

Study Subjects

This study was conducted on 260 patients with acute myocardial infarction admitted to our hospital between January 2022 and June 2022 who underwent coronary intervention. The subjects were divided into control-group (n=130) and observation-group (n=130) in accordance with their admission time. The control-group received routine nursing care; and the observation-group, was applied with PDCA nursing management in addition to conventional treatment (Table 1).

Planning

A brainstorming discussion was conducted to analyze the factors influencing the occurrence of forearm hematoma through investigation and certification; forearm hematoma cases were studied. Causes of formation are plotted as fishbone diagrams (Figure 1). The argumentation by Platonic analysis identified main causes, namely: irregular post-operative nurse balloon deflation and irregular postoperative patient limb movement (Figure 2).

Do

- (I) Using a combination of Chinese and Western early prevention and limb swelling to reduce limb pain. Collaborate with herbalists to produce herbs that can be applied externally to prevent forearm hematoma, and update the configuration based on the results.
- (II) The application of ice reduces the formation of hematoma after catheter removal.
- (III) Develop a radial artery balloon deflation process and optimize the balloon compressor deflation syringe. The rubber plug is set inside the syringe, and the inner wall of the syringe is sealed; one end of the push rod is located inside the syringe and connected with the rubber plug, and the other end is located outside the syringe, which can drive the rubber plug to slide along the axial direction of the syringe under the action of external force; the front end of the syringe is set with a scale toward the back end of the syringe, and the interface between the syringe and the compressor is changed from its own nipple shape to a spiral interface.
- (IV) Standardize the content and strengthen the education: ① Preoperative knowledge about PCI should be explained to patients and their families, introduce successful cases or share experiences with patients in the same ward, and distribute brochures about the surgery, including postoperative precautions and the importance of limb movement and pre-adaptation exercises for PCI. ② Timely inform the patient to avoid exertion and excessive activity of the operated limb and wrist braking to avoid displacement or loosening of the hemostat after surgery. ③ Instruct the patient to do grasping fist exercise for the fingers of the operated limb to promote blood circulation and reduce the occurrence of forearm swelling. ④ Emphasize the importance of compression of the puncture port to stop bleeding, and instruct the patient not to relax or

Table 1 The Characteristic of Respondents in Control Group and Intervention Group in Transradial Artery Percutaneous Coronary Interventions From 2022 (n=260)

Baseline Date	Control Group(n=130)	PDCA Group(n=130)
Age(years)	56.47+3.25	54.36+3.43
Gender		
Male	67(51.54%)	56(43.8%)
Female	63(48.46%)	74(56.92%)
Smoking	85(65.38%)	78(60%)
Hypertension	96(73.84%)	88(67.69%)
Diabetes	45(34.61%)	40(30.77%)
Hyperlipidemia	38(29.23%)	47(36.15%)
Intravenous and oral antiplatelet and anticoagulant drugs	15(11.54%)	23(15.33%)
Repeated punctures	8(6.15%)	6(4.61%)

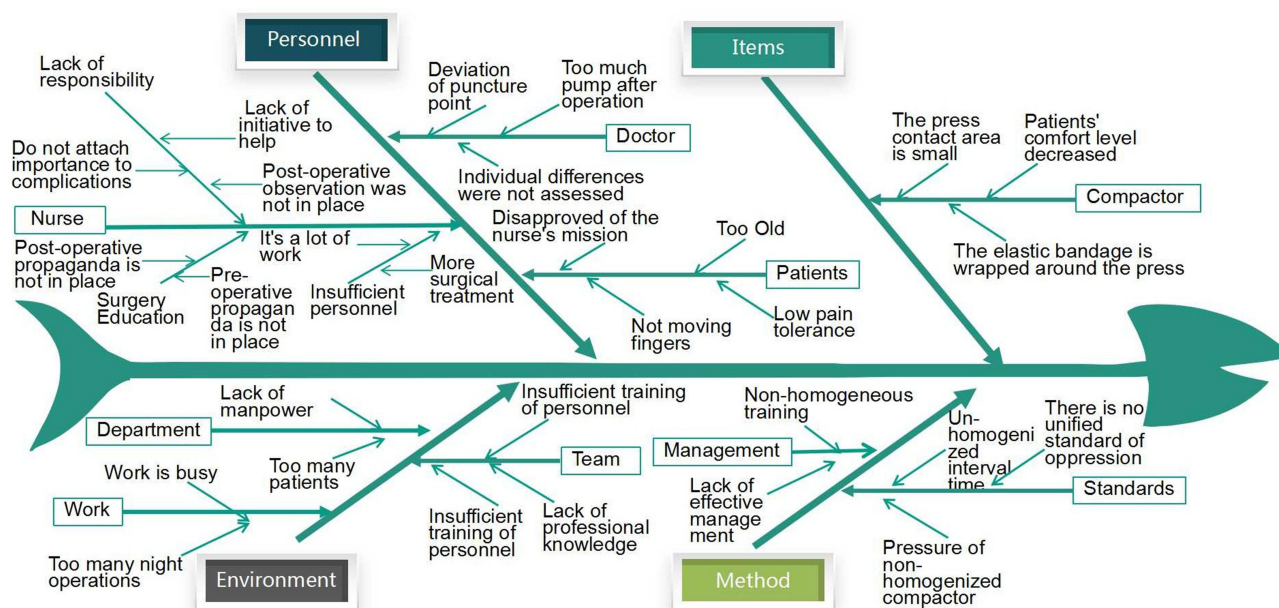


Figure 1 Fishbone diagram of cause.

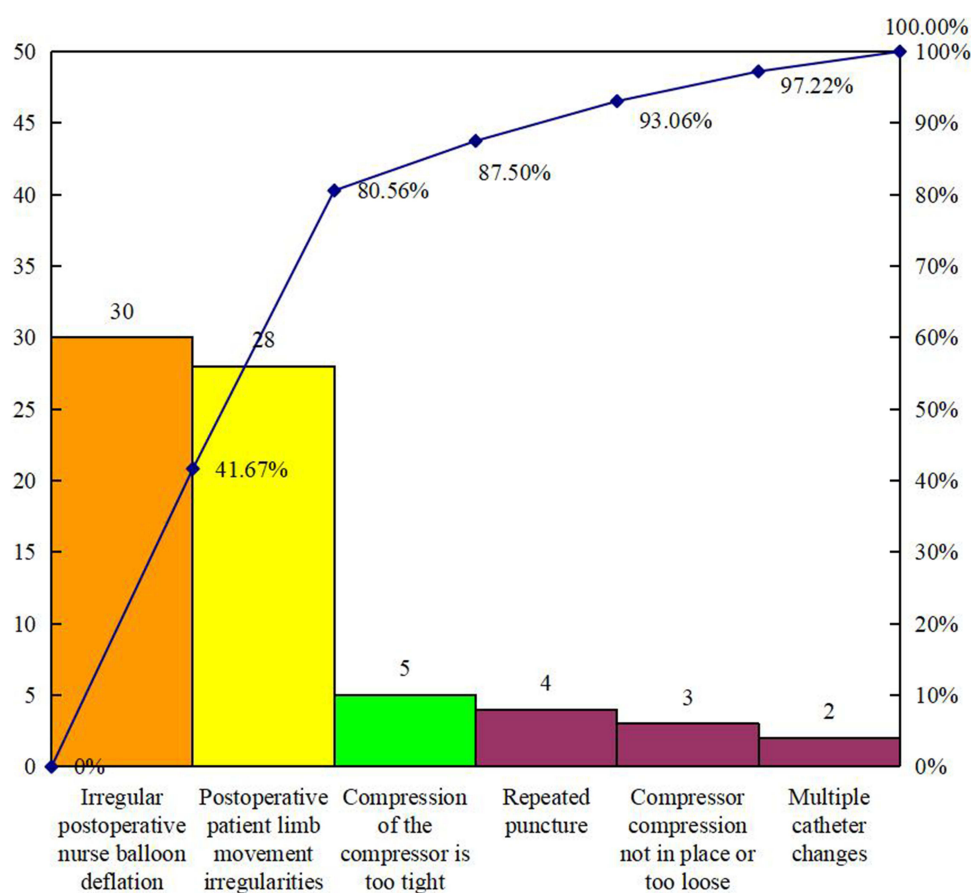


Figure 2 Proportions of causes.

release the compression without permission, and to inform the medical staff for treatment in case of discomfort.

- (V) Develop postoperative finger activity norms and provide one-on-one guidance on functional exercises for the radial artery puncture hand: to prevent local swelling and pain in the puncture hand, do finger exercises on the patient's puncture hand appropriately, 3 times-5 times per hour for 20s-30s each time, and pad the arm at about 45 degrees to prevent blood reflux. Making postoperative finger activity videos: A nurse was selected to record finger activity videos, which were distributed to patients using the WeChat platform, and the QR code of the video was pasted at the patient's bedside, so that patients and their families could watch and learn at any time.

Check

The nurse manager and quality control staff ensure that quality of care checks and care for each patient are adequately implemented. Patient care is able to be fully implemented.

Act

Several recommendations for improvement were made in response to the problems, and the nurse manager and members of the quality team followed up on the issues identified and took steps to ensure the effectiveness of patient care and staff training.

Inclusion Criteria and Exclusion Criteria

Inclusion criteria: age ≥ 18 years; NYHA cardiac function classification in class I–II, Patients with cardiac function class III–IV who can tolerate the procedure. Exclusion criteria: Combination of serious arrhythmia, heart valve disease, and so on.

Statistical Methods

All data were incorporated into the SPSS Statistics 22.0 software for statistical analysis. The χ^2 test was used to analyze the relationship between control-group and observation-group. The enumeration data were expressed as a percentage (%), $P < 0.05$ indicated a statistically significant difference.

Ethical Considerations

The study was approved by the Institutional Review Board of the author's institution, specifically the Jinhu Hospital Health System, through a full-board review conducted in January 2022 (No. 3–2022-0123). Informed consent was obtained from all participants in the study.

Results

Mean of control-group age was 56.47 ± 3.25 , male was 67 (51.54%), female 63 (48.46%), history of smoking 85 (65.38%), history of hypertension 96 (65.38%), history of diabetes mellitus 45 (34.61%), history of Hyperlipidemia was 38 (29.23%), Intravenous and oral antiplatelet and anticoagulant drugs 15 (11.54%), Repeated punctures was 8(6.15%). Mean of observation-group age was 56.36 ± 3.43 , male was 56(43.8%), female 74 (56.92%), history of smoking 78(60%), history of hypertension 88 (67.69%), history of diabetes mellitus 40 (30.77%), history of Hyperlipidemia was 47 (36.15%), Intravenous and oral antiplatelet and anticoagulant drugs was 23 (15.33%), Repeated punctures was 6(4.61%). From January 2022 to March 2022, there were 130 patients after transradial PCI, of which 32 patients with forearm hematoma occurred, with an incidence of 24.62%. During the implementation of PDCA, from May 2022 to June 2022, the condition of 130 patients after transradial artery puncture was investigated and forearm hematoma occurred in 11 patients, whose incidence was 8.46% ($P < 0.05$) (Table 2).

Table 2 Comparison Table of Data Before and After Improvement

Element	Control-Group(n=130)	Observation-Group(n=130)
Number of cases of forearm haematoma	32	11
No cases of forearm haematoma	98	119
Rate of occurrence	24.62%	8.46%
χ^2		12.288
P		0.001

Discussion

With the continuous progress of society and the continuous improvement of living standards, the traditional nursing model can no longer meet the patient's care needs, and can not effectively improve the patient's quality of life or reduce the incidence of complications, and prolong the disease course. The Plan-Do-Check-Act (PDCA) management method was first applied in the United States to improve the quality of management. In recent years, with the continuous development and progress of nursing discipline, PDCA management system has been applied more and more in nursing work, which can help nurses accumulate practical and effective nursing experience, avoid nursing errors and gradually improve the quality of nursing management.⁸ As a circular management method, PDCA mainly includes four aspects of plan, do, check and act in accordance with the principles of "large ring nests the small ring, while the small ring props up the large ring".⁹ Therefore, the application of the PDCA cycle method to the nursing care of reducing the incidence of forearm haematoma in patients after transradial artery PCI is of great significance in providing quality nursing care for patients and improving clinical outcomes.

With the continuous improvement of coronary artery disease interventional diagnosis and treatment technology, the feasibility of transradial coronary artery intervention in clinical application has been widely recognised, which has the advantages of small trauma, fast postoperative recovery, and reduction of patients' postoperative bedtime.¹⁰ However, it is worth noting that the majority of patients undergoing coronary intervention are elderly, mostly with hypertension and diabetes. Elderly patients' reduced physical function greatly increases the possibility of forearm haematoma after the operation, therefore, it is crucial to give the necessary nursing management to alleviate patients' pain and improve patient satisfaction.

At present, coronary intervention via the radial artery route has become a routine route for coronary intervention in our department. The distal radius approach is currently the most recommended surgical approach for PCI because of less bleeding and ease of maneuvering, but it is prone to forearm hematomas.¹¹ In order to reduce the incidence of forearm haematoma in the radial artery puncture route, to reduce the pain of the patients, and to increase the satisfaction of the patients, the PDCA management model was used in our hospital with a view to improving the incidence of forearm haematoma after transradial artery intervention. Some studies have reported an incidence varying from 0.04% to 14.4%.^{12,13} Our forearm hematoma incidence was 24.2%, which is much higher than that reported in the literature. The results of this study showed that the occurrence of forearm haematoma in the PDCA group was 8.46%, which was significantly lower than that in the control group, which was 24.62%, and the difference was statistically significant ($P < 0.05$). It was confirmed that the incidence of forearm haematoma could be significantly reduced by applying the PDCA cycle management model and strengthening the professional training of nurses, so that both the nursing level of nurses and the pain of patients could be reduced and the satisfaction of patients could be improved. The current situation and causes were analysed through discussion, and the causes of postoperative forearm hematomas were listed and classified, and finally identified as 2 aspects, namely, irregular deflation of the nurse's airbag and irregular limb movement of the patient in the postoperative period. In this regard, all nursing staff in the cardiovascular department were trained during the implementation stage, and the key points of nursing learning were emphasised through PPTs and dynamic diagrams; the department formulated a mechanism for nurses' training and assessment, and carried out training on hematoma-related knowledge, and so on. For patients' failure to comply with medical advice, two nurses were specially arranged to serve as health education, actively communicate with patients and their families, and actively provide feedback to physicians when patients have a sense of abnormality or when their families find abnormalities in the skin around the

puncture, so as to facilitate early detection of haematoma. There are some major limitations of this study, mainly due to the small number of participants and the need for future studies with larger sample sizes to support the findings.

Conclusion

In conclusion, the application of PDCA cycle management model can significantly reduce the incidence of forearm haematoma after transradial artery puncture intervention, improve the quality of medical services, enable patients to better cooperate with the treatment, alleviate the pain of the patients, improve the satisfaction of the patients and enable them to be discharged from the hospital successfully. Therefore, the PDCA management model is worth popularizing and applying in clinic.

Ethical Approval

The studies involving human participants were reviewed and approved by the Institutional Ethical Committee of the Jinhu County People's Hospital (ethical review number: No.2022-3-12). The patients/participants provided their written informed consent to participate in this study. The present study fulfils the requirements of the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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