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The Practice of the PDCA Cycle in Quality Management of Physical Examination and Blood Collection Specimens

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Abstract: *Purpose:* To explore the effect of the PDCA cycle in the quality management of physical examination and blood collection specimens. *Methods:* The subjects who received physical examinations in our hospital from 2025.1 to 2026.6 were included. The total sample size was 120 cases. They were grouped according to the order of admission. Routine management was carried out in the nursing management work of our hospital before August 2025, and the 60 subjects included were named the control group. In August 2025, PDCA cycle management was started in the nursing management work, and the 60 subjects included were named the observation group. The incidence of blood collection adverse events, subject satisfaction and operation standardization scores were compared between the two groups. *Results:* The incidence of adverse events in blood collection was lower in the observation group (3.33%) than in the control group (16.67%), $P<0.05$. The subject satisfaction score of the observation group was higher than that of the control group, $P<0.05$. The normative score of nurses' blood collection operations in the observation group was higher than that in the control group, $P<0.05$. *Conclusion:* The implementation of PDCA cycle management in the quality management of blood collection specimens for physical examination has significant value in reducing the incidence of adverse events in blood collection, and can effectively improve subject satisfaction and operational standardization.

Keywords: Physical examination and blood collection; Specimen quality management; PDCA cycle; Adverse events; Satisfaction; Operational standardization.

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1. Introduction

Venous blood collection for physical examination is the most basic part of health examination. The quality of the specimen directly determines the accuracy of the test results. However, the blood collection flow for physical examination is large, and the blood collection task is heavy when group physical examinations are concentrated, which is prone to specimen defects. At the same time, repeated punctures will also increase

the pain of the subjects [1]. Traditional routine management is mostly post-processing, lacking pre-emptive prevention and dynamic supervision of the entire process. There is insufficient control over personnel operations, specimen transportation and other aspects, and quality loopholes are prone to occur [2]. The PDCA cycle is a set of standardized continuous quality improvement tools that achieve cyclic optimization of the process through a closed-loop model of planning, execution, inspection, and processing [3]. This study applies PDCA cycle management to the quality management of blood collection specimens for physical examinations and compares the effects of routine management and PDCA cycle management. It aims to reduce blood collection-related adverse events, improve the standardization of blood collection operations by nurses and the satisfaction of subjects, and provide a practical reference for quality control of blood collection for physical examinations.

2. Materials and methods

2.1. General information

The 120 physical examination subjects in our hospital from 2025.1 to 2026.6 were divided into groups according to the order of admission. Those who were admitted before August 2025 were included in the control group, and those who were admitted after August 2025 were named the observation group. In the control group, there were 32 males and 28 females; the age range was 25-65 years old, with an average age of (45.67 ± 12.34) years old; education level: 35 cases were college or above, 25 cases were high school or below; type of physical examination: 38 cases were group and 22 cases were individuals. In the observation group, there were 34 males and 26 females; the age range was 25-68 years old, with an average age of (46.12 ± 11.89) years old; education level: 33 cases were college or above, 27 cases were high school or below; type of physical examination: 36 cases in groups and 24 cases in individuals. The baseline data of the two groups were balanced, $P > 0.05$.

Inclusion criteria: complete venous blood collection and physical examination in our hospital; clear consciousness, normal communication, and able to cooperate with blood collection procedures; no severe coagulation dysfunction, and the skin of the upper limb blood collection site is intact; informed consent.

Exclusion criteria: severe liver and kidney dysfunction, severe anemia and coagulation dysfunction; infection, ulceration, and large-area scars at the puncture site of the upper limbs; mental disorders and inability to cooperate with blood collection operations; critically ill or emergency subjects requiring rescue.

2.2. Method

In the control group, routine nursing management of physical examination and blood collection specimens was implemented. Nursing staff completed venipuncture blood collection according to the standard blood collection process and performed basic disinfection, specimen collection, labeling, and inspection work. Carried out simple health notifications, carried out subsequent registration and processing when abnormal specimens occurred, and carried out regular business learning on a regular basis.

The observation group implemented PDCA cycle management on the basis of the control group, and carried out full-process quality control of specimens according to the four stages of planning, execution, inspection, and processing. (1) Planning stage: Organize blood collection nursing staff to conduct a review of the current situation, summarize problems existing in blood collection for previous physical examinations,

and focus on sorting out common adverse events. Analyze the causes of problems from the four dimensions of personnel operation, subject education, materials and equipment, and specimen transportation, and clarify the key points for quality improvement. Set quality goals, formulate targeted improvement plans, clarify the responsibilities of each position, and refine the key points of management and control in each link, including pre-blood collection preparation, puncture collection, specimen processing, and transfer for inspection. (1) Execution stage: Implement various improvement measures, educate subjects before blood collection, inform them of fasting requirements, tourniquet pressure feeling, and correct compression method after blood collection, so as to relieve the stress of subjects. Standardize the operating procedures, control the scope of disinfection and drying time, reasonably control the duration of tourniquet ligation, and select appropriate blood collection needles to avoid forceful suction of blood. After the blood collection is completed, mix the specimens in a standardized manner, accurately affix specimen information labels, and classify and dispose of waste. Strengthen practical training for nurses and carry out training on puncture techniques, specimen processing, and risk identification. Optimize the specimen transfer process, set up special containers for specimen transfer, collect specimens regularly, and reduce the waiting time for specimen placement. (3) Inspection stage: The head nurse will set up a quality control team to conduct on-site inspections every day, inspecting disinfection operations, tourniquet use, puncture operations, specimen identification, compression guidance, and waste disposal one by one. Count the number of adverse events in blood collection every day, record the occurrence of hemolysis, coagulation, insufficient specimen volume, repeated punctures, and delays in test delivery. Regularly collect test subjects' satisfaction evaluations, compare the completion of quality goals, summarize existing problems, and distinguish between solved and unresolved problems. (4) Processing stage: Summarize the inspection results, solidify the well-implemented and effective operating procedures, and incorporate them into the department's blood collection work standards. In response to the still existing quality defects, we organized nursing staff to hold discussions, analyzed the root causes of unresolved problems, proposed a new round of rectification measures, transferred the remaining problems to the next round of the PDCA cycle, and continued to iteratively optimize the quality management of blood collection specimens.

2.3. Observation indicators

The occurrence of blood collection adverse events such as hemolysis, coagulation, insufficient specimen volume, repeated punctures, and delayed test delivery was counted in the two groups.

Blood collection subjects are invited to evaluate their satisfaction with nursing services, including six dimensions: reception service, operating technology, pain management, waiting time, environmental comfort, and health education. The first two dimensions have a full score of 20 points, and the last four dimensions have a full score of 15 points, for a total score of 100 points.

The head nurse evaluates the standardization of blood collection operations of nursing staff, including 6 dimensions: disinfection specifications, tourniquet use, puncture techniques, specimen identification, compression guidance, and waste disposal. The full score for each dimension is 10 points.

2.4. Statistical methods

The calculation software used for relevant data is SPSS25.0. Measurement data are described by mean ± standard deviation (SD) and tested by t-test; count data are described by frequency and proportion and tested

by χ^2. $P < 0.05$ is statistically significant.

3. Results

3.1. Compare the occurrence of adverse events in blood collection between the two groups

The incidence of adverse events in blood collection was lower in the observation group (3.33%) than in the control group (16.67%), $P < 0.05$. **Table 1**.

Table 1. Comparison of incidence rates of adverse events in blood collection (n, %)

Group	n	Hemolysis	Coagulation	Insufficient specimen volume	Repeat puncture	Delay in submission	Overall incidence
Control group	60	3(5.00)	1(1.67)	1(1.67)	3(5.00)	2(3.33)	10(16.67)
Observation group	60	1(1.67)	0(0.00)	0(0.00)	1(1.67)	0(0.00)	2(3.33)
χ^2	--	--	--	--	--	--	5.926
P	--	--	--	--	--	--	0.015

3.2. Compare the satisfaction scores of physical examination subjects between the two groups

The subject satisfaction score of the observation group was higher than that of the control group, $P < 0.05$. **Table 2**.

Table 2. Comparison of subjects' satisfaction scores (mean ± SD)

Group	n	Reception service	Operating techniques	Pain management	Waiting time	Comfortable environment	Health education	Total score
Control group	60	16.23 ± 2.89	15.60 ± 2.11	11.95 ± 2.34	10.73 ± 2.56	12.84 ± 2.01	12.17 ± 2.12	79.52 ± 5.67
Observation group	60	18.45 ± 1.12	17.89 ± 1.34	13.67 ± 1.26	13.45 ± 1.38	13.89 ± 1.03	13.78 ± 1.15	91.13 ± 3.89
t	--	5.548	7.097	5.013	7.245	3.601	5.171	13.079
P	--	0.000	0.000	0.000	0.000	0.001	0.000	0.000

3.3. Compare the normative scores of blood collection operations of the two groups of nurses

The normative score of nurses' blood collection operations in the observation group was higher than that in the control group, $P < 0.05$. **Table 3**.

Table 3. Comparison of nurses' blood collection operation normative scores (mean ± SD)

Group	n	Disinfection specifications	Tourniquet use	Puncture techniques	Specimen identification	Compression guidance	Waste disposal
Control group	60	8.89 ± 0.89	8.45 ± 1.01	8.23 ± 1.12	8.92 ± 0.95	8.01 ± 1.23	8.95 ± 0.87
Observation group	60	9.34 ± 0.56	9.12 ± 0.67	9.01 ± 0.78	9.45 ± 0.43	8.78 ± 0.89	9.56 ± 0.34
t	--	3.315	4.282	4.427	3.937	3.929	5.059
P	--	0.001	0.000	0.000	0.001	0.000	0.000

4. Discussion

Blood collection in physical examination centers has the characteristics of large flow of subjects, concentrated group physical examinations, and complex personnel composition. Unqualified specimens and poor punctures will interfere with test interpretation and increase the physical and mental pain of subjects [4]. The traditional management model focuses on post-event remediation, lacks system risk prediction, and is difficult to achieve full-process quality control. Therefore, closed-loop quality management tools need to be introduced to improve the management and control of all aspects of physical examination and blood collection [5]. PDCA cycle management is a closed-loop quality management model of planning, execution, inspection, and processing. The main purpose is to find existing problems, formulate improvement plans and implement them, and then conduct quality inspections to solidify effective measures and enter the remaining problems into the next cycle to achieve continuous quality improvement and break the static and passive management shortcomings of traditional management [6-7].

This study shows that PDCA cycle management can reduce blood collection adverse events, improve nurses' operational standardization, and improve subject satisfaction. The reason why PDCA cycle management can reduce adverse events in blood collection is that the multi-dimensional risk points of personnel, education, materials, and transportation are comprehensively sorted out in the planning stage, and the use of tourniquets, specimen mixing, and transportation processes are standardized in the execution stage to avoid the causes of hemolysis, coagulation, insufficient specimen volume, and delayed inspection from the source. At the same time, puncture operation training is strengthened to reduce repeated punctures and achieve pre-emptive control of specimen quality [8]. The improvement in operational standardization is due to the regular on-site supervision by the head nurse during the inspection phase, which supervises disinfection, puncture, specimen identification, waste disposal and other items one by one, promptly corrects irregularities, cooperates with special practical training, strengthens nurses' awareness of standard operations, and promotes the implementation of standardized standards in various blood collection operations [9]. The improvement in subject satisfaction is due to the fact that during the execution phase, health education before and after blood collection was strengthened, pain relief was provided, and the blood collection waiting and specimen handling processes were optimized, which not only reduced the physical pain caused by repeated punctures, but also improved the service experience such as reception and health education, and comprehensively improved the medical experience of subjects [10].

5. Conclusion

In summary, PDCA cycle management is used for quality management of blood collection specimens for physical examinations. It can build a full-process closed-loop control system, resolve various risks in the blood collection process in advance, improve nurses' operational level, reduce blood collection adverse events, and improve subject satisfaction. This management model has strong operability and is suitable for promotion and use in physical examination and blood collection rooms.

Disclosure statement

The author declares no conflict of interest.

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