Effect of Blended Teaching Method Based on Stepwise Training Strategy on Clinical Thinking in Standardized Training of Cardiac Echocardiography Teaching for Resident

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Abstract: To analyze the influence of the mixed teaching method based on the ladder training strategy on residents in the standardized training of cardiac ultrasound teaching. Thirty residents who participated in the standardized training of cardiac ultrasound teaching in our hospital were selected, and the examination data of using conventional teaching method from January to December 2023 were included in group A, and the examination data of using mixed teaching method based on ladder training strategy from January to December 2024 were included in group B, and the teaching effect was compared. The scores of clinical thinking, theoretical knowledge and practical operation in group B were higher than those in group A ($P < 0.05$). The application of the mixed teaching method based on the ladder training strategy in the standardized training of cardiac ultrasound teaching can significantly improve the residents' clinical thinking ability and practical operation ability, and help them better grasp the relevant theoretical knowledge.

***Keywords*:** stepwise training strategy; blended teaching method; resident; echocardiography; standardized teaching training

1. Introduction

With the continuous improvement of medical devices, cardiac ultrasound has been widely used in the diagnosis of cardiovascular diseases and prognosis assessment, with the advantages of non-invasive, real-time and repeatable [1]. Residents who have comprehensive knowledge and skills related to cardiac ultrasound can improve the accuracy of early diagnosis and prognosis of cardiovascular disease [2]. Due to the high professionalism and complexity of cardiac ultrasound, higher requirements are put forward for the standardized training of residents, while the conventional teaching methods focus on imparting theoretical knowledge, ignoring the cultivation of their clinical thinking,“cramming”teaching makes it difficult for residents to diagnose complex cases quickly and accurately, affecting the accuracy of clinical decision-making [3]. Optimizing teaching methods, enriching the theoretical knowledge of cardiac ultrasound, improving their practical skills, and enhancing their clinical thinking ability can improve the accuracy of clinical diagnosis of cardiovascular diseases [4]. The ladder-like training strategy emphasizes that different teaching methods should be adopted according to students' learning stages and levels to ensure that teaching methods can match students' knowledge levels and learning needs, so as to improve the teaching effect [5]. Blended teaching method is a combination of online and offline teaching methods to stimulate students' interest and enthusiasm in learning and lay the foundation for improving the quality of teaching. The mixed teaching method based on stepwise training strategy was applied in the standardized training of cardiac ultrasound teaching for residents. According to the knowledge and understanding ability of residents on cardiac ultrasound, the teaching content was formulated in stages and levels to improve the practical ability of residents step by step. Blended teaching method not only breaks the limitation of learning space for residents, but also enables them to choose learning content and methods independently, so as to stimulate their interest in learning to the greatest extent and improve their learning effect. Through new teaching methods such as case analysis and problem-oriented teaching, residents' clinical thinking is trained and their ability to integrate theory with practice is improved. This study compared the effects on residents' clinical thinking, theoretical knowledge and practical skills before and after the implementation of the blended teaching method based on the ladder training strategy in the standardized training of cardiac ultrasound teaching, in order to confirm the effectiveness of this new teaching method and provide reference for clinical practice. Elaborated as follows.

2. Data and Methods

2.1 General information

30 residents who participated in the standardized training of cardiac ultrasound teaching in our hospital were selected, and the examination data of using conventional teaching method from January to December 2023 were included in group A, and the examination data of using mixed teaching method based on ladder training strategy from January to December 2024

were included in group B. The mean age was (41.68 ± 4.25) years (range, 30-56 years), and the mean working years was (18.46 ± 2.45) years (range, 5-30 years), male/female (12/18).

2.2 Methods

2.2.1 Group A

Group A used the conventional teaching method. The teacher explained the principle of cardiac ultrasound, operation skills, and the characteristics of cardiac ultrasound of common cardiovascular diseases to the residents face to face; the teacher demonstrated how to adjust the probe angle of cardiac ultrasound, obtain the standard section and identify the key image features on the spot; the teacher guided the residents to carry out real case examination to help them consolidate their knowledge; Instruct residents to discuss clinical cases and guide them to connect theoretical knowledge with real pathology.

2.2.2 Group B

In group B, the blended teaching method based on the ladder-like training strategy was used. (1) Grading principle: primary: understand the basic knowledge of cardiac ultrasound, can independently complete the basic operation of cardiac ultrasound, can identify common abnormalities in cardiac ultrasound images but can not independently analyze complex images. Intermediate: Deeply understand the theoretical knowledge of cardiac ultrasound, master the diagnostic criteria and differential points of common heart diseases, skillfully operate cardiac ultrasound equipment, accurately collect and preliminarily analyze and interpret high-quality images, and independently analyze complex cases but unable to independently solve rare or difficult cases. Advanced: Comprehensively understand the theoretical knowledge of cardiac ultrasound, master the latest research progress and technical trends, skillfully operate advanced cardiac ultrasound technologies such as three-dimensional ultrasound and speckle tracking imaging, accurately analyze and interpret images, and independently handle various complex and difficult cases. (2) According to the characteristics of cardiac ultrasound and the learning needs of different levels, different teaching contents are formulated to form a step-by-step learning path. (3) Input different levels of teaching videos, courseware and online tests on the online teaching platform, so that residents can choose their own learning time and content according to their own needs. Regular offline centralized lectures and Q & A are organized to ensure that residents at all levels can gain something. (4) By using offline lectures and online teaching platforms, residents at all levels can repeatedly practice the operation of cardiac ultrasound examination in a real or simulated environment. By introducing a step-by-step operation evaluation system, teachers give residents at different levels corresponding guidance and feedback to ensure that all residents can improve their operation level. (5) Emphasis should be placed on the cultivation of clinical thinking of residents at different levels. Teachers should guide residents to use their knowledge to comprehensively analyze, diagnose and formulate treatment plans through real or simulated clinical cases, strengthen the cultivation of residents from the perspective of improving critical thinking and problem-solving ability, and encourage residents to elaborate their opinions and questions through group discussions. (6) According to the learning situation of residents at different levels, stratified teaching is carried out to provide corresponding learning resources and guidance for residents at different levels.

2.3 Index observation

(1) Clinical thinking score: The improved ultrasound clinical thinking score scale of our hospital evaluated the clinical thinking ability of residents from the aspects of medical history summary, sonographic description, diagnosis and basis, differential diagnosis, and related knowledge development, and the score was positively correlated with the ability. (2) Examination results of theoretical knowledge (etiology and pathology, clinical signs and symptoms, ultrasonic typing, ultrasonic characteristics, differential diagnosis, treatment methods). (3) Examination results of practical operation: confirmation of patient information, inquiry of medical history, standard section examination and answering questions.

2.4 Statistical analysis

SPSS26.0 processing data, ($\bar{x}\pm$ s) and (%) represented measurement and enumeration data, which were tested by t value and X 2 respectively ($P < 0.05$).

3. Results

3.1 Comparison of clinical thinking scores

The score of clinical thinking in group B was higher than that in group A ($P < 0.05$), as shown in Table 1.

Table 1. Comparison of clinical thinking scores [$\bar{x}$±s(Minutes)]

Grouping	Number of cases	Medical history summary and sonographic description (30 points)	Diagnosis and basis (30 minutes)	Differential diagnosis (25 points)	Relevant knowledge development (15 minutes)	Total score (100 points)
Group B	30	24.26±2.38	25.12±2.41	20.47±2.53	10.39±1.84	90.56±5.19
Group A	30	20.14±2.13	20.36±2.15	16.69±2.08	8.25±1.32	82.24±7.61
T-value	-	7.065	8.072	6.321	5.176	4.947
P value	-	0.000	0.000	0.000	0.000	0.000

3.2 Comparison of theoretical knowledge assessment results

The score of theoretical knowledge in group B was higher than that in group A ($P < 0.05$), as shown in Table 2.

Table 2. Comparison of theoretical knowledge assessment results [$\bar{x}$±s(Minutes)]

Grouping	Number of cases	Etiology and pathology (10 points)	Clinical signs and symptoms (10 points)	Ultrasonic typing (30 points)	Ultrasonic characteristics (30 points)	Differential diagnosis (10 points)	Treatment (10 points)
Group B	30	8.54±0.92	8.35±0.87	25.76±2.42	25.81±2.53	8.29±0.94	8.43±0.89
Group A	30	7.48±1.15	7.16±1.07	20.83±2.17	20.98±2.24	7.35±1.06	7.25±1.13
T-value	-	3.942	4.726	8.307	7.828	3.634	4.493
P value	-	0.000	0.000	0.000	0.000	0.000	0.000

3.3 Compare the examination results of practical operation

The performance of group B was higher than that of group A ($P < 0.05$), as shown in Table 2.

Table 3. Comparison of practical operation examination results [$\bar{x}$±s(Minutes)]

Grouping	Number of cases	Confirm patient information (10 points)	Inquire about medical history (10 points)	Standard section inspection (10 points)	Answer the question (10 points)
Group B	30	8.15±1.34	8.26±1.31	8.32±1.28	8.13±1.25
Group A	30	7.02±1.15	7.13±1.08	7.18±1.04	7.04±1.12
T-value	-	3.505	3.645	3.786	3.557
P value	-	0.000	0.000	0.000	0.000

4. Discussion

Cardiac ultrasound is a commonly used non-invasive method for clinical diagnosis of heart diseases, with irreplaceable roles [6]. Based on the principle of ultrasonic reflection, it can real-time display cardiac structures and hemodynamic characteristics, provide clear cardiac images, measure key data of cardiovascular diseases such as congenital heart disease and valvular disease, improve diagnostic accuracy [7], and also evaluate curative effects and prognosis [8]. For example, it can monitor cardiac function in coronary heart disease patients after treatment, and safely detect fetal hearts, providing a basis for early diagnosis of congenital heart malformations [9].

This study showed that the clinical thinking score of group B was higher than that of group A ($P<0.05$), indicating that this mixed teaching method is beneficial to cultivating the clinical thinking of residents. It teaches according to the grading principle: junior residents learn the basics to build a cognitive framework; intermediate residents learn the diagnosis and operation of complex diseases to improve the ability to combine theory with practice. In the online and offline mode, residents learn knowledge through simulated cases, share experience through group discussions, promote independent thinking, expand clinical thinking, and hierarchical teaching also helps them improve their abilities.

At the same time, the theoretical and practical scores of group B were higher than those of group A ($P<0.05$). This teaching method divides residents into three levels: junior, intermediate and senior. Personalized teaching enriches knowledge and improves skills, and the combination of online and offline provides multiple practical opportunities to help them master operational skills.

In conclusion, this teaching method can significantly improve residents' clinical thinking and practical ability, help them master theoretical knowledge, and is worthy of promotion.

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