Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 5
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Training Practice of Emergency Ultrasound Rapid Diagnosis Ability in Resident Physician Training

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Abstract: This study aimed to evaluate the application of the problem-based learning (PBL) teaching method in emergency ultrasound training, specifically its effect on improving rapid diagnostic ability and learning outcomes. From May 2020 to May 2025, 40 emergency ultrasound resident doctors were randomly selected and divided into a control group (n = 20, receiving conventional teaching) and an observation group (n = 20, receiving PBL teaching). After training, the observation group scored significantly higher than the control group in both rapid diagnostic ability for emergency ultrasound (including static image/dynamic video interpretation, standard section acquisition, rapid screening process and timeliness, quality of written diagnostic reports, and clinical decision support) and learning effect scores (learning interest, learning initiative, and self-confidence), with all differences showing statistical significance ($p < 0.05$). In conclusion, the application of the PBL teaching method in emergency ultrasound training for resident doctors effectively enhances their rapid diagnostic ability and learning outcomes.

Keywords: Emergency department; Ultrasound training; Rapid diagnosis ability; Resident physician; Learning effect

Online publication: May 31, 2026

1. Introduction

Ultrasound is an indispensable visual extension of modern emergency medicine, a “visual stethoscope” for clinicians, and a major tool for clinicians to quickly assess the condition of critically ill patients, and plays an irreplaceable role in treatment decision-making [1]. The ability of rapid diagnosis of emergency ultrasound determines the efficiency of emergency treatment. In the standardized training of residents, improving this ability is the key to shaping qualified emergency clinicians [2]. The conventional teaching method focuses on training the isolated technical operation and image recognition of resident doctors, which is difficult to meet the needs of highly integrated, time-critical and problem-oriented decision-making scenarios in emergency clinical practice, resulting in the difficulty of improving the ability of resident doctors from “drawing” to

"solving problems" [3]. The problem-based learning (PBL) teaching method can make up for the shortcomings of the conventional teaching method, focus on training the clinical competence of resident doctors, and be used in the standardized training of emergency ultrasound, starting from the real problems of clinical emergency, to guide resident doctors to integrate knowledge and refine diagnostic skills in independent exploration and collaborative discussion. In line with the connotation of emergency ultrasound rapid diagnostic capability, that is, to combine ultrasound examination with specific clinical problems in a limited time to form diagnostic ideas and guide emergency strategies [4]. The purpose of this study is to analyze the role of PBL teaching method in improving the rapid diagnosis ability and learning effect of emergency ultrasound in the training of resident doctors, which is described as follows.

2. Data and methods

2.1. General information

From May 2020 to May 2025, 40 emergency ultrasound resident training doctors were randomly selected and grouped according to different teaching methods. The control group (20 cases) was 21–30 years old, the average was (24.36 ± 2.27) years old, male/female (15/5); the observation group (20 cases) was 22–28 years old, the average was (23.89 ± 2.32) years old, male/female (14/6). Comparison of general data ($p > 0.05$).

2.1.1. Inclusion criteria

Resident doctors who received standardized ultrasound training in our hospital, who had the basic ability to deal with emergencies, and who had not received any systematic emergency ultrasound or bedside ultrasound training before enrollment. Participate voluntarily and sign the informed consent.

2.1.2. Exclusion criteria

Those who had studied systematically or could complete the key ultrasound assessment independently; those who withdrew from the training stage for various reasons; Due to visual acuity, hearing and other factors, ultrasound operators cannot be carried out normally.

2.2. Method

2.2.1. Control group

The control group was taught with conventional teaching method. At the beginning of the teaching, the centralized theoretical teaching centered on the technical module was carried out, and the physical principles of ultrasound, equipment operation and standardized image characteristics of key emergency examination items were systematically explained. Then, after the teacher's demonstration, the resident doctor repeatedly practiced the acquisition technique of specific sections on standardized patients or simulation teaching AIDS, and the teacher corrected the image quality and operation method immediately. Finally, the teacher leads the resident doctor to observe or practice, but the decision-making process is still dominated by the teacher.

2.2.2. Observation group

The PBL teaching method was used in the observation group.

(1) Design a streamlined, highly simulated emergency clinical scenario that provides critical history, vital signs, and limited physical examination, and embeds a clear "leading question".

(2) After identifying the problems, the resident doctors entered the individual learning stage and independently determined the ultrasound knowledge modules they needed to learn. The resident doctors used the standardized learning resource library and online resources to explore and learn the e-FAST process related to trauma and the key circulatory ultrasound assessment programs related to unexplained shock, such as heart, inferior vena cava, lung and deep vein. Starting from "what I need to know", Dr. Sumitomo builds a knowledge map directly related to clinical problems.

(3) Under the guidance of the teacher, the resident doctors shared their knowledge of verification in the group discussion around the initial case, and debated in depth how to plan ultrasound examination path, the possible positive signs of each section and their clinical significance. At the end of the discussion, the teacher corrects the obvious mistakes and timely raises advanced questions that can stimulate deep thinking, and then through collaboration, the group forms a preliminary, logical and clear ultrasound rapid assessment and diagnostic reasoning scheme.

(4) Translate written protocols into planned sonograms in high-end simulators or standardized patients in small groups. Teachers give real-time feedback on the "positive" or "negative" results found by the resident doctor. Resident doctors interpret the dynamically acquired image information while operating, and adjust the diagnostic ideas and follow-up examination focus according to the new findings at any time. For example, Dr. Sumipei found abdominal aortic aneurysm in shock cases as the primary problem and readjusted the priority of evaluation and treatment.

(5) After the simulation operation, each group summarized their own examination findings, final diagnostic reasoning and decision-making basis. The teacher systematically summarized each group and guided the group to review the core ultrasound diagnostic logic, key identification points and common traps of this type of clinical problems. The instructor issued a new question related to the topic of the initial case and asked the resident physician to independently complete a brief ultrasound evaluation plan.

2.3. Index observation

(1) Emergency ultrasound rapid diagnostic ability score

The improved scale of our hospital evaluated the emergency ultrasound rapid diagnostic ability of resident doctors from the aspects of static image/dynamic video interpretation ability, standard section acquisition ability, rapid screening process and timeliness, quality of written diagnostic reports, clinical decision support ability, etc., with 100 points for each item, and the score was positively correlated with the ability.

(2) Score of learning effect

The improved scale of our hospital evaluated the learning effect of resident doctors from the aspects of learning interest, learning initiative and self-confidence, with 10 points for each item, and the score was positively correlated with the effect.

2.4. Statistical analysis

SPSS26.0 processing data, ($\overline{x} \pm s$) and (%) represented the measurement and enumeration data, which were tested by t value and χ^2 respectively, and ($p < 0.05$) were statistically significant.

3. Results

3.1. Comparison of emergency ultrasound rapid diagnostic ability score

Before the training, the scores of emergency ultrasound rapid diagnosis ability of the two groups were compared ($p > 0.05$). After the training, the scores of static image/dynamic video interpretation ability, standard section acquisition ability, rapid screening process and timeliness, written diagnostic report quality and clinical decision support ability of the observation group were higher than those of the control group ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of emergency ultrasound rapid diagnostic ability scores [$\overline{x} \pm s$ (minutes)]

Grouping	No. of cases	Still image/ motion video interpretation capability		Standard section acquisition capability		Rapid screening process and timeliness		Quality of written diagnostic report		Ability of clinical decision support	
		Before training	After training	Before training	After training	Before training	After training	Before training	After training	Before training	After training
Observation group	20	72.28 ± 7.15	90.12 ± 4.35*	71.13 ± 7.38	90.56 ± 4.52*	72.09± 7.28	90.87 ± 4.61*	71.25± 7.34	90.38 ± 4.46*	71.78± 7.46	90.61 ± 4.54*
Control group	20	71.86 ± 7.26	81.68 ± 8.43*	72.36 ± 7.41	81.27 ± 8.64*	71.26± 7.34	81.19 ± 8.52*	72.63± 7.29	81.52 ± 8.47*	72.39± 7.42	81.35 ± 8.56*
t-value	-	0.184	3.978	0.525	4.260	0.359	4.468	0.596	4.139	0.259	4.273
p value	-	0.854	0.000	0.602	0.000	0.721	0.000	0.554	0.000	0.796	0.000

Note: Compared with the group before training, *$p < 0.05$.

3.2. Scoring of comparative learning effect

Before the training, the scores of learning effect in the two groups were compared ($P > 0.05$). After the training, the scores of learning interest, learning initiative and self-confidence in the observation group were higher than those in the control group ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of learning effectiveness scores [$\overline{x} \pm s$ (minutes)]

Grouping	Number of cases	Interest in learning		Learning initiative		Self-confidence	
		Before training	After training	Before training	After training	Before training	After training
Observation class	20	6.15 ± 0.68	8.68 ± 0.84*	6.23 ± 0.64	8.71 ± 0.89*	6.13 ± 0.62	8.65 ± 0.86*
Control class	20	6.21 ± 0.65	7.26 ± 0.75*	6.18 ± 0.63	7.28 ± 0.74*	6.19 ± 0.66	7.23 ± 0.71*
t-value	-	0.285	5.639	0.248	5.525	0.296	5.694
p value	-	0.777	0.000	0.804	0.000	0.768	0.000

Note: Compared with the group before training, *$p < 0.05$.

4. Discussion

The results of this study showed that after the training, the score of the observation group was higher than that of the control group ($p < 0.05$), indicating that the application of PBL teaching method in the training of resident doctors is conducive to improving their ability of rapid diagnosis of emergency ultrasound. PBL teaching method comprehensively simulates and optimizes the real path of emergency clinical decision-

making from learning motivation, cognitive construction to behavioral output, thus laying the foundation for the cultivation of emergency ultrasound rapid diagnosis ability [5]. Conventional teaching methods treat knowledge and skills as isolated learning modules, which makes it difficult for resident doctors to diagnose emergency cases quickly. PBL teaching method takes clinical problems in real clinical situations as the initial driving force, and provides a learning situation integrating "knowledge gap" and "time pressure" for resident doctors, so that resident doctors can actively carry out targeted knowledge retrieval and screening to solve problems, and this process runs through a clear clinical goal orientation. Through the progressive mode of "independent inquiry-collaborative debate-simulation exercise" under the PBL teaching method, the resident doctors learned the physical principles of ultrasound, anatomical knowledge, image signs, specific pathophysiology, differential diagnosis logic and so on, and constructed a highly structured knowledge network centered on clinical problems from the cognitive level. PBL teaching method emphasizes repeated simulation decision-making exercises and dynamic feedback, so that resident doctors can complete image interpretation and disposal thinking while conducting ultrasound scanning, internalize the technical operation into an efficient clinical information collection and judgment behavior, and ultimately improve the rapid diagnosis ability of emergency ultrasound of resident doctors.

After the training, the learning effect score of the observation group was higher than that of the control group ($p < 0.05$), which confirmed that the application of PBL teaching method in the training of resident doctors was conducive to improving their learning effect. PBL teaching method is deeply in line with the cognitive law of adult learning, and can be used in emergency ultrasound learning to promote learners to actively optimize the learning path. The conventional teaching method is mainly to transfer knowledge, which leads to the superficial memory and mechanical operation of ultrasound knowledge learned by resident doctors. PBL teaching method is based on structured clinical problems, which transforms the learning motivation of external inculcation into active exploration driven by internal clinical needs, and ensures that resident training doctors change from "I want to learn" to "I want to learn", which can enhance the concentration and continuity of resident training doctors in acquiring knowledge. PBL teaching method focuses on specific problems, searches, screens and integrates fragmented ultrasound, anatomy, pathology knowledge and operation essentials independently, establishes a structured cognitive system, forms a "knowledge schema" connected with clinical decision-making path, and lays a foundation for improving the learning effect of resident doctors. The group discussion in PBL teaching method can not only deepen the understanding of relevant knowledge and skills of resident doctors, but also expose and correct their cognitive biases in the collision of views, and strengthen their differential diagnosis thinking. In the process of simulation exercise, residents extract and apply ultrasound-related knowledge and skills in a "quasi-actual combat" environment full of time pressure and dynamic feedback, which promotes the transformation of knowledge from declarative memory to procedural skills and conditional decision-making ability, and effectively copes with the disconnection between theory and practice. By constructing the cognitive cycle of "demand stimulation-active construction-collaborative correction-situational application", PBL teaching method can stabilize the learning results and ensure that the knowledge learned by resident doctors can be efficiently applied to complex emergency scenarios.

5. Conclusion

To sum up, PBL teaching method is used in the training process of emergency ultrasound for resident doctors,

which is conducive to better improve the rapid diagnosis ability and learning effect of emergency ultrasound.

Disclosure statement

The authors declare no conflict of interest.

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