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Application and Effectiveness of Research-Oriented Teaching Model in Residency Training

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Abstract: Objective: To explore the application pathways and practical effectiveness of a research-oriented teaching model in residency training, providing empirical references for reforming residency training education. Methods: A total of 160 physicians who completed residency training at a general hospital from September 2021 to August 2024 were selected as the study subjects. Among them, 80 adopted a research-oriented teaching model (experimental group), and 80 adopted a traditional teaching model (control group). Clinical competency assessment scores, research output, and career development one year after graduation were compared between the two groups. Results: The experimental group demonstrated significantly higher accuracy rates in diagnosing difficult cases and adoption rates for optimization suggestions in treatment plans compared to the control group ($P < 0.05$). The experimental group also outperformed the control group in terms of the average number of published papers per student, the proportion of publications in core journals, participation rates in research projects, and the number of approved specialized research projects. One year after graduation, the employment rate in tertiary hospitals and the rate of continuing education in the experimental group were significantly higher than those in the control group ($P < 0.05$). Conclusion: The research-oriented teaching model significantly enhances clinical decision-making abilities, research literacy, and career competitiveness among residency training physicians, serving as an effective pathway to promote high-quality development in residency training.

Keywords: Research-oriented teaching model; Residency training; Clinical competency; Research literacy; Teaching evaluation

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1. Introduction

Residency training represents a critical linkage in China's medical education system, which encompasses "undergraduate education, postgraduate education, and continuing medical education." Its primary objective is to cultivate qualified physicians who possess independent clinical diagnostic and treatment capabilities and meet the demands of the modern healthcare system [1,2]. With the in-depth development of evidence-based medicine and rapid iteration of medical technologies, the core competencies required of clinicians have evolved from “proficient operational skills” to a combination of “clinical decision-making ability, research and innovation capabilities, and lifelong learning skills.” The traditional residency training teaching model, centered around “supervising physicians,” adopts a singular paradigm of “clinical rotations + skills training + theoretical instruction”: clinical rotations emphasize imitating diagnostic and treatment processes, skills training focuses on proficiency in basic operations, and theoretical instruction primarily involves interpreting guidelines. None of these components incorporate the cultivation of research thinking into their core frameworks. Under this model, residents tend to develop a passive learning habit of “receiving knowledge,” often limiting themselves to “following guidelines” when faced with complex clinical problems and lacking the ability to “optimize solutions based on evidence,” making it difficult for them to meet the modern healthcare system’s demand for “innovative physicians” [3]. The research-oriented teaching model is centered around the core logic of “driven by clinical problems, supported by research methods, and enhanced by collaborative ability development” [4]. By constructing a tiered system of “basic training - advanced practice - results application”, it integrates research training throughout the entire clinical rotation process. This approach guides residents in mastering research methods such as literature retrieval, research design, and data statistics while solving practical diagnostic and treatment problems, thereby simultaneously upgrading their clinical thinking. This study took residents undergoing residency training at a tertiary grade-A hospital as the research subjects and verified the effectiveness of this model through a randomized controlled trial, aiming to provide empirical evidence for residency training teaching reforms and assist in cultivating compound clinical physicians who are “capable of diagnosis and treatment, proficient in research, and skilled in innovation.”

2. Materials and Methods

2.1. Research Subjects

A total of 160 physicians who completed a 3-year residency training program at a comprehensive hospital from September 2021 to August 2024 were selected, including 62 males and 98 females, aged 24-28 years, with an average age of (25.61 ± 1.22) years. Professional distribution: 58 in internal medicine, 35 in surgery, 26 in obstetrics and gynecology, and 41 in pediatrics. The subjects were divided into an experimental group (80) and a control group (80) based on the teaching model. There were no statistically significant differences in baseline data such as gender, age, and professional distribution between the two groups ($P > 0.05$), indicating comparability.

2.2. Teaching Methods

2.2.1. Control Group: Traditional Teaching Model

The “rotation-based teaching + skills training + theoretical instruction” model was employed: ① Clinical Rotation: Residents completed rotations in various departments as per the residency training syllabus. Teaching physicians primarily utilized “case explanations + operational demonstrations,” focusing on the transmission of diagnostic and treatment processes and skills. ② Skills Training: Regular training sessions on basic procedures such as punctures and sutures were conducted, with learning outcomes assessed through “operational evaluations.” ③ Theoretical Instruction: Two specialized lectures were held monthly, focusing on disease diagnosis and treatment guidelines and clinical pathways.

2.2.2. Experimental Group: Research-Oriented Teaching Model

A three-stage teaching system of "basic training - advanced practice - outcome translation" was constructed, as follows:

(1) Basic Training Stage (Year 1): ① Curriculum: Mandatory courses including "Medical Research Methodology," "Clinical Epidemiology," and "Medical Statistics" were offered, accompanied by monthly practical workshops on software such as SPSS and GraphPad Prism. ② Case Discussions: Starting with challenging cases in the department, residents were guided to formulate research hypotheses (e.g., "Is the efficacy of a combined antibiotic regimen for severe pneumonia superior to traditional regimens?") and complete literature searches and preliminary research designs.

(2) Advanced Practice Stage (Year 2): ① Project Allocation: Based on residents' professional directions and interests, they were assigned to ongoing departmental research projects (e.g., internal medicine residents participating in "Factors Influencing Insulin Resistance in Type 2 Diabetes") and tasked with data collection, statistical analysis, etc. ② Group Collaboration: Research groups of 3-5 residents were formed, each equipped with a "clinical supervisor + research supervisor." Regular project progress meetings were held to address practical research issues. ③ Outcome Requirements: Residents were required to publish at least one paper as the first/co-first author in provincial-level or higher journals or participate in the application for one hospital-level research project.

(3) Outcome Translation Stage (Year 3): ① Clinical Application: Research findings were applied in clinical settings [5] (e.g., optimizing insulin treatment regimens for diabetic patients based on project results). ② Independent Research: Residents were encouraged to apply for "Residency Training Special Projects" (with funding ranging from 5,000 to 20,000 yuan) and independently conduct small-scale studies. ③ Career Planning: Based on their research experiences, residents were guided in formulating academic or clinical research career paths.

2.3. Evaluation Indicators

2.3.1. Clinical Competence

① Accuracy rate of diagnosing difficult cases: During the residency training graduation assessment, the accuracy of diagnosis is evaluated through three difficult cases (such as "anemia of unknown cause" and "multiple organ failure"); ② Adoption rate of suggestions for optimizing diagnosis and treatment plans: The proportion of diagnosis and treatment optimization suggestions proposed by residents during their rotations that are adopted by the department is statistically analyzed.

2.3.2. Research Achievements

① Paper publications: The average number of papers published per person and the proportion published in core journals are statistically analyzed; ② Project participation: The proportion of residents participating in research projects and the proportion serving as core members (responsible for data collection and statistical analysis) are statistically analyzed; ③ Special projects: The number of "special residency training projects" applied for and approved is statistically analyzed.

2.3.3. Career Development

① Employment status: The employment rate in tertiary hospitals one year after graduation is statistically analyzed; ② Further education: The proportion of residents pursuing master's/doctoral degrees is statistically analyzed.

2.4. Statistical Methods

Data analysis was performed using SPSS 26.0 software. Continuous data are presented as (±s), and comparisons between groups were made using the t-test. Categorical data are presented as [n (%)], and comparisons between groups were made using the χ^2 test. A P-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of Clinical Competence Between the Two Groups of Residents

The accuracy rate of diagnosing difficult cases and the adoption rate of suggestions for optimizing diagnosis and treatment plans were significantly higher in the experimental group than in the control group ($P < 0.05$), as detailed in **Table 1**.

Table 1. Comparison of Clinical Competence Between the Two Groups of Residents (x ± s / %)

Group	Diagnostic Accuracy of Challenging Cases	Adoption Rate of Optimized Treatment Suggestions (%)
Experimental (n=80)	89.62 ± 4.23	77.5 (62/80)
Control (n=80)	76.33 ± 5.12	52.5 (42/80)
t/χ^2 value	17.898	10.575
P value	0.000	0.001

3.2. Comparison of Scientific Research Achievements Between the Two Groups of Trainees

The average number of published papers per trainee, the proportion of papers published in core journals, the participation rate in research projects, and the number of approved special research projects in the experimental group were all significantly better than those in the control group ($P < 0.05$), as detailed in **Table 2**.

Table 2. Comparison of Scientific Research Achievements Between the Two Groups of Trainees (x ± s/n)

Group	Publications per Person (articles)	Core Journal Publications (%)	Project Participation Rate (%)	Special Projects Approved (n)
Experimental (n=80)	1.82 ± 0.53	53.72 (65/121)	90 (72/80)	62
Control (n=80)	0.62 ± 0.33	34.65 (35/101)	76.25 (61/80)	11
Statistical Test	17.191	8.084	5.391	-
P value	0.000	0.005	0.020	-

3.3. Comparison of Career Development Between the Two Groups of Trainees

One year after graduation, the employment rate in tertiary hospitals and the rate of continuing education in the experimental group were both significantly higher than those in the control group ($P < 0.05$), as detailed in **Table 3**.

Table 3. Comparison of Career Development Between the Two Groups of Trainees [n (%)]

Group	Employment in Tertiary Hospitals [n (%)]	Further Education (Master/PhD) [n (%)]
Experimental (n=80)	72 (85.4)	68 (68.3)
Control (n=80)	55 (67.3)	46 (42.7)
χ^2 value	11.033	14.767
P value	0.001	0.000

4. Discussion

With the in-depth popularization of evidence-based medicine, clinical diagnosis and treatment have shifted from "relying on personal experience" to "making decisions based on evidence," and scientific research literacy is precisely the core ability for physicians to acquire, analyze, and apply clinical evidence. On the one hand, a large number of issues in clinical practice, such as "difficult cases, diagnostic and treatment controversies, and differences in therapeutic effects," require answers to be explored through scientific research methods; on the other hand, the rapid iteration of medical technologies requires physicians to possess the ability to "understand scientific research achievements and translate scientific research conclusions" [6]. This industry demand has been directly reflected in the quality evaluation system for resident training, and scientific research literacy has become an essential ability for resident physicians.

Traditional teaching models that solely focus on clinical skills can no longer meet the development needs of the industry. The traditional resident training teaching model was formed during the period dominated by "empirical medicine," with its core objective focusing on "rapidly improving the clinical operational capabilities of resident physicians." There are obvious shortcomings in cultivating scientific research literacy: first, scientific research dimensions are not included in teaching objectives, and the cultivation of scientific research thinking is not listed as a core requirement; second, teaching content lacks support from scientific research methods and does not systematically impart key abilities such as literature retrieval and data statistics; third, teaching carriers do not incorporate scientific research practices, and research exploration is not involved in aspects such as case discussions and clinical rotations. As modern medicine transitions to "evidence-based medicine," the demand for physicians' scientific research literacy is increasing. The limitations of the traditional model are becoming increasingly prominent. Therefore, it is necessary to explore more efficient training paths. The research-oriented teaching model has gradually formed and been promoted in this context.

This study reveals that the diagnostic accuracy rate for difficult cases and the adoption rate of optimized suggestions for diagnosis and treatment plans among trainees in the experimental group were significantly higher than those in the control group. This is closely related to the cultivation of "clinical thinking" through the research-oriented teaching model: ① During the foundational training phase, through "literature retrieval + research design" training, trainees learned to extend from "guideline-based evidence" to "evidence tracing" [7]. For example, when analyzing "unexplained anemia," they could propose rare etiologies such as "hemolytic anemia" and "anemia of chronic disease" based on the latest research, thereby broadening their diagnostic thinking; ② In the phase of translating research outcomes into practical applications, trainees apply scientific research conclusions to clinical settings. For instance, based on the "Research on the Correlation between Beta-Blocker Dosage and Heart Rate Control in Coronary Heart Disease," they propose an optimization suggestion of "dynamically adjusting dosage," which makes treatment plans more individualized and scientific, thereby leading to a higher adoption rate.

In terms of research achievements, trainees in the experimental group demonstrated significant advantages in paper publication and project participation, benefiting from the tiered and progressive training design: ① During the foundational stage, "research methodology courses + software practical training" addressed the issue of trainees "understanding theory but struggling with practical application," laying the groundwork for subsequent research [8]; ② During the advanced stage, the "project matching + dual-mentorship system" allowed trainees to deeply participate in real research projects. For example, in an endocrinology project, trainees collected data on blood glucose and insulin levels, mastering the design and statistical methods of cohort studies; ③ Special project funding provided trainees with opportunities for independent research. This closed-loop process of "practice - feedback - improvement" effectively cultivated their research competencies [9].

Career development data shows that trainees in the experimental group had higher employment rates in tertiary hospitals and higher rates of pursuing further education. This is because the research-oriented teaching model endows trainees with two core advantages: ① In terms of clinical competence, trainees with "evidence-based thinking" demonstrated stronger problem-solving abilities during interviews. For instance, when faced with "diagnostic controversies," they could propose solutions based on literature evidence rather than relying solely on guidelines; ② In terms of research competence, experiences in publishing papers and participating in projects served as crucial support for academic advancement. The research-oriented teaching model not only enhances the quality of resident training but also empowers trainees in their career development.

This study is a single-center study with a sample confined to a certain tertiary grade-A hospital, so the findings may not be fully generalizable to grassroots residency training bases. Additionally, the study did not conduct long-term tracking of the participants' career development over a period exceeding five years. Future research should expand the sample size, conduct multi-center studies, and extend the follow-up duration. Meanwhile, to address the issue of "shortage of dual-competency faculty" at some residency training bases, a composite faculty team can be cultivated through a combination of "research training for clinicians + clinical rotations for researchers," thereby further optimizing the research-oriented teaching model.

In summary, the research-oriented teaching model, through its three-stage design of "basic-advanced-translational," can significantly enhance the clinical decision-making abilities, research literacy, and career competitiveness of residency training physicians. Its core value lies in achieving a profound integration of "clinical practice" and "research training" [10], rather than a mere superposition of the two. This model aligns with the modern medical education's demand for cultivating "innovative physicians" and can serve as a reference for residency training education reform nationwide, particularly for tertiary grade-A hospital residency training bases with a certain research foundation. In the future, it is necessary to further refine the faculty development and evaluation systems to promote the widespread adoption and implementation of the research-oriented teaching model across residency training bases at different levels.

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