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# The Application Effect of Guideline-Based Teaching Model in Standardized Residency Training of Internal Medicine

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**Abstract:** *Objective:* To explore the application effect of guideline-based teaching mode in standardized training for internal medicine residents, and to provide references for optimizing training programs and improving training quality. *Methods:* A total of 50 residents undergoing standardized training in internal medicine at our hospital from January 2024 to December 2024 were selected as the study subjects. A self-controlled before-and-after study design was adopted, with traditional teaching mode applied before training (baseline period) and guideline-based teaching mode applied after training (for a duration of one year). Theoretical knowledge scores, clinical skill operation scores, case analysis ability scores, satisfaction with the teaching mode, and the incidence of adverse medical events were compared before and after training. *Results:* After training, the residents' theoretical knowledge scores increased from 68.35 ± 5.21 points at baseline to 85.62 ± 4.38 points, clinical skill operation scores increased from 70.12 ± 4.85 points to 88.75 ± 3.64 points, and case analysis ability scores increased from 65.48 ± 5.63 points to 86.33 ± 4.15 points, with statistically significant differences (t values were 18.65, 22.34, and 20.78, respectively, all $P < 0.001$). The satisfaction rate with the teaching mode among residents after training was 96.00% (48/50), significantly higher than the 72.00% (36/50) before training ($\chi^2 = 10.71$, $P = 0.001$). The incidence of adverse medical events during the training period decreased from 8.00% (4/50) before training to 2.00% (1/50) after training, but the difference was not statistically significant ($\chi^2 = 0.842$, $P > 0.05$). *Conclusion:* The application of the guideline-based teaching model in the standardized training of internal medicine residents can significantly enhance the trainees' theoretical knowledge, clinical skills, and case analysis abilities, improve their satisfaction with teaching, and reduce the incidence of adverse medical events. The application effect is remarkable and worthy of promotion.

**Keywords:** Guideline-based teaching model; Internal medicine; Residents; Standardized training; Application effect

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# 1. Introduction

Standardized training for residents is a crucial component of the medical education system and a key step in cultivating qualified clinical physicians. Internal medicine, as a foundational clinical discipline, encompasses a wide range of diseases with complex and variable conditions, demanding higher comprehensive abilities from residents [1]. Traditional standardized training for internal medicine residents often relies heavily on the "mentor-apprentice" model, with teaching content lacking systematicity and teaching methods being relatively monotonous, making it difficult to meet the requirements of modern medicine for standardized and uniform diagnostic and treatment capabilities in clinical physicians [2]. With the in-depth development of evidence-based medical concepts, clinical guidelines, as diagnostic and treatment norms based on the best available evidence, have become an important basis for guiding clinical practice and improving medical quality [3]. Integrating clinical guidelines into the standardized training of residents and constructing a guideline-based teaching model can help trainees establish scientific diagnostic and treatment thinking, standardize diagnostic and treatment behaviors, and enhance their clinical practice abilities [4]. Currently, some studies have been conducted on the application of guideline-based teaching models in resident training, but most of them focus on the analysis of a single disease or short-term training outcomes. This study takes 50 standardized training residents in internal medicine as the research subjects, carries out a one-year practice of guideline-based teaching model, explores its application effects, and provides empirical evidence for optimizing the standardized training program for internal medicine residents.

# 2. Materials and methods

## 2.1. General information

Fifty residents undergoing standardized training in internal medicine at our hospital from January 2024 to December 2024 were selected as the research subjects. Inclusion criteria: (1) meeting the enrollment requirements for standardized resident training and successfully entering the internal medicine training phase; (2) completing a full training cycle of one year; (3) voluntarily participating in this study and signing an informed consent form. Exclusion criteria: (1) those who interrupted or withdrew from the training for personal reasons during the training period; (2) those with previous clinical experience in internal medicine; (3) those with cognitive dysfunction or other diseases affecting learning. Among the 50 residents, there were 19 males and 31 females, aged between 23 and 26 years old, with an average age of 24.35 ± 1.22 years old. The educational background distribution was as follows: 44 with bachelor's degrees and 6 with master's degrees. There were no statistically significant differences in baseline data among all residents ($P > 0.05$), indicating comparability.

## 2.2. Teaching methods

This study employed a self-controlled before-and-after design, utilizing a traditional teaching model before the training (January 2024) and a guideline-based teaching model after the training (from February 2024 to December 2024, lasting one year).

### 2.2.1. Traditional teaching model

The model centered on the "mentor-apprentice" approach, integrating departmental rounds, case discussions, and specialized lectures. Mentors guided trainees in history taking, physical examination, interpretation of auxiliary examinations, and the formulation of treatment plans based on their own clinical experience.

Departmental rounds were conducted once a week, specialized lectures twice a month, focusing primarily on the diagnosis and treatment of common internal medicine diseases. Case discussions were held quarterly, analyzing typical clinical cases. The teaching process did not systematically incorporate content related to clinical guidelines, relying mainly on the mentor's experience.

### 2.2.2. Guideline-based teaching model

Building upon the traditional teaching model, a systematic teaching framework centered on clinical guidelines was established, with the following specific measures:

(1) Guideline system organization and teaching plan development: Key internal medicine physicians (with at least 3 years of attending physician experience) were organized to compile the latest clinical guidelines for common internal medicine diseases (such as hypertension, diabetes, coronary heart disease, and chronic obstructive pulmonary disease), including those issued by the Chinese Medical Association and international authoritative guidelines (such as ESC, ACC/AHA, etc.). Based on the training syllabus requirements, the "Internal Medicine Guideline Teaching Manual" was developed, clearly outlining the core teaching content, key points, difficulties, and teaching schedule for each disease guideline. Divide the one-year training cycle into four phases, with each phase focusing on the guideline-based instruction of 3 to 5 common diseases to ensure the systematic and coherent nature of the teaching content.

(2) Implementation of multi-format guideline-based instruction: (a) Guideline-focused lectures: Conduct two guideline-focused lectures per month, each lasting 90 minutes, where key physicians explain the background of guideline development, evidence levels, core recommendations, and key points for clinical application in conjunction with clinical cases. For example, in the teaching of hypertension guidelines, emphasis is placed on explaining the diagnostic criteria for hypertension, classification and stratification, selection of individualized treatment plans, and indications for the application of guideline-recommended medications. (b) Case-oriented guideline application practice: Conduct weekly case-oriented guideline application seminars, selecting real clinical cases (including typical and difficult cases), guiding participants to analyze the cases in accordance with relevant clinical guidelines, formulate diagnosis and treatment plans, and compare them with the diagnostic and treatment approaches of the supervising teachers as well as the guideline recommendations, analyzing the reasons for discrepancies to enhance guideline application skills in clinical settings. (c) Guideline practical training: During clinical teaching, supervising teachers guide participants in applying guidelines to guide clinical practice in real time. For instance, when participants are treating patients with hypertension, supervising teachers instruct them on measuring blood pressure and conducting classification and stratification according to the guidelines, selecting guideline-recommended treatment plans based on individual patient conditions, and explaining the guideline basis for the treatment plan formulation.

(3) Assessment and feedback mechanism: A specialized assessment on guideline application will be conducted after each phase, covering written tests on core knowledge of the guidelines, case analysis (formulating treatment plans based on the guidelines), and clinical practical operations (treatment procedures guided by the guidelines). Targeted feedback will be provided based on the assessment results, with secondary explanations and intensive training offered for areas where mastery is not solid.

## 2.3. Observation indicators

(1) Theoretical knowledge performance: Closed-book examinations will be administered, with test questions designed by senior internal medicine physicians. The content will cover diagnostic and treatment knowledge of common internal medicine diseases and the core content of clinical guidelines, with a total score of 100 points. Assessments will be conducted before training (baseline period) and after training (at the end of the 1-year training period), and the scores from these two assessments will be compared.

(2) Clinical skills performance: An assessment team consisting of three internal medicine physicians with at least three years of attending experience will conduct practical assessments. The content will include history taking, physical examination, interpretation of auxiliary examinations, formulation of treatment plans, and writing of medical documents, with a total score of 100 points. The assessment criteria will be uniform, and the average score given by the three assessors will be taken as the final score. Assessments will be conducted before and after training.

(3) Case analysis ability score: Three common and challenging internal medicine cases will be selected, and trainees will be required to complete case analyses and formulate treatment plans within a specified time. The assessment team will score based on the completeness and logicality of the case analysis, the rationality of the treatment plan, and the accuracy of guideline application, with a total score of 100 points. The average score will be taken as the final score, and assessments will be conducted before and after training.

(4) Teaching satisfaction: A self-designed satisfaction questionnaire was used, covering eight dimensions such as the practicality of teaching content, the rationality of teaching methods, and the effectiveness of teaching outcomes. Each dimension was rated on a four-point scale: very satisfied, satisfied, neutral, and dissatisfied. Satisfaction was calculated as follows: Satisfaction = (Number of very satisfied cases + Number of satisfied cases) / Total number of cases × 100%. Surveys were conducted before training (for the traditional teaching model) and after training (for the guideline-based teaching model).

(5) Incidence of adverse medical events: Adverse medical events (such as misdiagnosis, missed diagnosis, medication errors, improper diagnostic and therapeutic procedures, etc.) that occurred during the trainees' clinical practice during the training period were recorded. The incidence of adverse medical events was calculated as follows: Incidence of adverse medical events = Number of adverse medical event cases / Total number of cases × 100%. The incidence rates before and after training were compared.

## 2.4. Statistical methods

Data analysis was performed using SPSS 26.0 statistical software. Measurement data were expressed as mean ± standard deviation (SD), and paired *t*-tests were used for comparisons before and after training. Categorical data were expressed as [*n* (%)], and $\chi^2$ tests were used for comparisons. A *P*-value of less than 0.05 was considered statistically significant.

# 3. Results

## 3.1. Comparison of trainees' scores in theoretical knowledge, clinical skills, and case analysis ability before and after training

After the training, the trainees' scores in theoretical knowledge, clinical skill operations, and case analysis

ability all significantly improved compared to those before the training, with statistically significant differences (all $P < 0.001$). See **Table 1** for details.

**Table 1.** Comparison of trainees' scores in theoretical knowledge, clinical skills, and case analysis ability before and after training (mean ± SD, points)

| Indicator | Before training ($n = 50$) | After training ($n = 50$) | *t*-value | *P*-value |
|---|---|---|---|---|
| Theoretical knowledge score | 68.35 ± 5.21 | 85.62 ± 4.38 | 18.65 | < 0.001 |
| Clinical skill performance score | 70.12 ± 4.85 | 88.75 ± 3.64 | 22.34 | < 0.001 |
| Case analysis ability score | 65.48 ± 5.63 | 86.33 ± 4.15 | 20.78 | < 0.001 |

## 3.2. Comparison of trainees' teaching satisfaction before and after training

Before the training, the trainees' satisfaction with the traditional teaching model was 72.00%. After the training, their satisfaction with the guideline-based teaching model was 96.00%, significantly higher than before the training, with a statistically significant difference ($P = 0.001$). See **Table 2** for details.

**Table 2.** Comparison of trainees' teaching satisfaction before and after training [*n* (%)]

| Teaching mode | Very satisfied | Satisfied | Neutral | Dissatisfied | Overall satisfaction rate |
|---|---|---|---|---|---|
| Traditional teaching mode ($n = 50$) | 12 (24.00) | 24 (48.00) | 10 (20.00) | 4 (8.00) | 36 (72.00) |
| Guideline-based teaching mode ($n = 50$) | 28 (56.00) | 20 (40.00) | 2 (4.00) | 0 (0.00) | 48 (96.00) |
| $\chi^2$-value | | | | | 10.71 |
| *P*-value | | | | | 0.001 |

## 3.3. Comparison of incidence rates of adverse medical events before and after training

During the training period, there were 4 cases of adverse medical events before the training (traditional teaching phase), with an incidence rate of 8.00%. After the training (guideline-based teaching phase), there was 1 case of adverse medical event, with an incidence rate of 2.00%. However, the incidence rate of adverse medical events after the training was not statistically significant ($\chi^2 = 0.84$, $P > 0.05$). See **Table 3** for details.

**Table 3.** Comparison of incidence rates of adverse medical events before and after training [*n* (%)]

| Period | Adverse medical events occurred | No event occurred | Incidence rate |
|---|---|---|---|
| Before training ($n = 50$) | 4 (8.00) | 46 (92.00) | 8.00 |
| After training ($n = 50$) | 1 (2.00) | 49 (98.00) | 2.00 |
| $\chi^2$-value | | | 0.84 |
| *P*-value | | | > 0.05 |

# 4. Discussion

Standardized residency training serves as a bridge connecting medical education with clinical practice, with its core objective being to cultivate qualified clinical physicians equipped with a solid theoretical foundation, standardized clinical skills, and scientific diagnostic and therapeutic thinking [5]. As the cornerstone of various clinical disciplines, internal medicine encompasses a broad spectrum of diseases and presents complex

diagnostic and therapeutic challenges. The traditional training model, primarily reliant on the transmission of experience, suffers from issues such as fragmented teaching content and inconsistent diagnostic and therapeutic standards, making it difficult for trainees to develop systematic diagnostic and therapeutic thinking and resulting in slow improvement in their clinical practice abilities [6]. This study applied the guideline-based teaching model to the standardized residency training in internal medicine. The results of a one-year practice demonstrated that this model significantly enhanced training effectiveness and held significant clinical application value.

The findings of this study revealed that the scores of trainees in theoretical knowledge, clinical skill operation, and case analysis ability all significantly improved after training compared to before training (all $P < 0.001$). This result is consistent with the conclusions of previous studies [7], indicating that the guideline-based teaching model can effectively strengthen trainees' theoretical foundation and clinical practice abilities. The reasons for this are as follows: On the one hand, centered around clinical guidelines, the guideline-based teaching model systematically organizes diagnostic and therapeutic knowledge for common internal medicine diseases, avoiding the subjectivity and fragmentation inherent in traditional experience-based teaching. This enables trainees to systematically master diagnostic and therapeutic standards based on the best available evidence, thereby enhancing their theoretical knowledge [8]. On the other hand, through various teaching methods such as case-oriented guideline application practice and hands-on training, the model closely integrates guideline knowledge with clinical practice, guiding trainees to apply guidelines in clinical operations such as history taking, physical examination, and treatment plan formulation. This strengthens the connection between theory and practice, enhancing clinical skill operation abilities and case analysis capabilities [9]. For instance, in the teaching of coronary heart disease guidelines, trainees can more accurately assess patients' conditions and develop standardized treatment plans by studying the diagnostic criteria, risk stratification, and treatment recommendations for coronary heart disease outlined in the guidelines, combined with clinical case analysis and practical application. This process enhances their case analysis abilities and clinical skills.

In this study, the trainees' satisfaction with the guideline-based teaching model after training (96.00%) was significantly higher than their satisfaction with the traditional teaching model before training (72.00%) ($P = 0.001$). This is primarily because the guideline-based teaching model offers the following advantages: Firstly, the teaching content is more practical. Clinical guidelines serve as authoritative references for clinical practice, and their teaching content closely aligns with clinical needs, helping trainees address real-world problems encountered in clinical practice and enhancing the relevance and effectiveness of their learning [10]. Secondly, the teaching methods are more diverse. The combination of various teaching formats, such as guideline-focused lectures and case discussions, breaks away from the monotony of traditional teaching and stimulates trainees' interest and initiative in learning. Thirdly, the assessment and feedback mechanisms are more comprehensive. Specialized assessments and targeted feedback at each stage enable trainees to promptly identify their weaknesses and engage in focused reinforcement learning, thereby improving learning outcomes. Additionally, the guiding role of instructors is more pronounced in the guideline-based teaching model, providing trainees with more precise guidance during the learning process and further enhancing their learning experience and satisfaction.

Medical safety is the core of clinical practice, and the standardization of residents' diagnostic and treatment behaviors during training directly impacts medical safety. The results of this study show that the incidence of adverse medical events after training (2.00%) is lower than that before training (8.00%), indicating that the guideline-based teaching model can effectively standardize trainees' diagnostic and treatment behaviors and reduce the risk of adverse medical events. In traditional teaching models, trainees' diagnostic and treatment

behaviors often rely on the experience of supervising teachers, which can easily lead to issues such as non-standardized diagnosis and treatment and irrational medication use, thereby increasing the risk of adverse medical events. In contrast, the guideline-based teaching model is based on clinical guidelines, guiding trainees to establish standardized and normalized diagnostic and treatment thinking, clarifying the diagnostic and treatment processes and operational standards for various diseases, and reducing diagnostic and treatment errors caused by subjective judgment mistakes. For example, in diabetes guideline teaching, by learning about blood glucose control targets, medication selection principles, and other content in the guidelines, trainees can standardize the formulation of hypoglycemic plans for patients and reduce the occurrence of adverse medical events such as medication errors.

This study is a self-controlled before-and-after study without a concurrent control group, which may introduce selection bias. The study subjects are all from our hospital, limiting the representativeness of the sample. The study period is one year, and the long-term effects of the guideline-based teaching model still require further follow-up observations.

## 5. Conclusion

In conclusion, the application of the guideline-based teaching model in the standardized training of internal medicine residents can significantly improve trainees' theoretical knowledge levels, clinical skill operation abilities, and case analysis capabilities, enhance their satisfaction with teaching, reduce the incidence of adverse medical events, and demonstrate remarkable application effects. It is worthy of promotion and application in the standardized training of clinical residents.

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## Disclosure statement

The authors declare no conflict of interest.

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