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Application of the CDID Teaching Model in Preoperative Anesthesia Visit Training and Its Impact on Patient Anxiety and Trainee Competence

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Abstract: *Objective:* To investigate the educational effectiveness of the CDID preoperative visit model, defined as Consultation, Direction, Instruction, and Digital integration, in anesthesia training, and to assess its influence on patients' preoperative anxiety, the success rate of preoperative visits, and the comprehensive competencies of trainees. *Methods:* Sixty anesthesia residents enrolled in the standardized training program at Shaanxi Provincial People's Hospital between 2024 and 2025 were randomly assigned to a CDID group or a conventional teaching group, each with thirty trainees. All instructors possessed teaching certification and at least five years of clinical experience. The conventional group received routine multimedia-based theoretical instruction. In contrast, the CDID group was trained through a four-stage framework including emotional reassurance, structured guidance, procedural instruction, and digital learning support. Teaching activities were supported by a self-developed educational platform, an interactive human-machine system, and a three-dimensional digital spinal model. At the end of the training period, patients' preoperative anxiety scores, the success rate of preoperative visits, and trainee assessment results were compared between groups. *Results:* No significant difference in baseline anxiety scores was observed between the two groups prior to the preoperative visit ($P = 0.90$). After the visit, patients managed by trainees in the CDID group showed significantly lower anxiety scores than those in the conventional group (51.97 ± 3.44 vs 55.77 ± 3.27, $P < 0.01$). The success rate of preoperative visits in the CDID group reached 100.0%, which was higher than that of the conventional group at 83.3% ($\chi^2 = 5.36$, $P = 0.02$). Trainees trained under the CDID framework achieved higher overall assessment scores compared with the conventional group (84.04 ± 3.48 vs 70.14 ± 3.33, $P < 0.01$). Significant improvements were observed in clinical practice performance and professional humanistic competence ($P < 0.01$), whereas theoretical knowledge scores did not differ significantly between groups ($P = 0.07$). *Conclusion:* The CDID educational model effectively reduces patient anxiety before surgery and improves the success rate of preoperative anesthesia visits while strengthening the overall competencies of anesthesia residents. It demonstrates particular advantages in clinical practice training and the development of professional humanistic qualities. Supported by theoretical knowledge and integrated with artificial intelligence technologies, this approach offers a novel perspective for advancing reforms in anesthesia education.

Keywords: Preoperative anesthesia assessment; Artificial intelligence; Teaching model; Anesthesia education; Residency training

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1. Introduction

Preoperative anesthesia assessment involves anesthesiologists visiting surgical wards prior to an operation to collect patient medical history, perform risk evaluation for anesthesia, design an individualized anesthetic strategy, and communicate anesthesia options and potential risks to patients. This process aims to maintain perioperative safety and support recovery after surgery [1,2]. A well-conducted preoperative anesthesia assessment can relieve preoperative anxiety, decrease the occurrence of postoperative complications, and improve both patient prognosis and satisfaction with perioperative care [3].

Under conventional teaching approaches, instruction on preoperative visits is largely lecture-based. The format tends to be monotonous and provides limited opportunities for interaction, which restricts students' engagement and intellectual participation. Consequently, learners frequently remain passive recipients of theoretical information, showing limited adaptability in clinical scenarios and weaker decision-making capacity, thereby affecting the effectiveness of training and skill acquisition.

The rapid development of digital technology in higher education has accelerated the transition toward information-based teaching approaches, which are increasingly recognized as a major driver of innovation in medical education [4]. Digital-supported instructional models combine multimedia technologies, virtual simulation platforms, and analysis of learning behaviors to enable intelligent and personalized teaching environments, which play a crucial role in the modernization of medical education.

To meet the emerging requirements of modern medical education, the education and research group in the Department of Anesthesiology at Shaanxi Provincial People's Hospital established a CDID-based instructional framework centered on Consultation, Direction, Instruction, and Digital integration. This framework has been applied to the teaching of preoperative anesthesia visits within the standardized residency training program. The present study applied this model within clinical teaching settings and assessed its educational impact using several indicators including patient anxiety scores before surgery, the completion rate of preoperative visits, and trainee examination performance. The aim was to evaluate the feasibility and effectiveness of the CDID approach in preoperative anesthesia visit education.

2. Materials and methods

2.1. Participants and grouping

A total of 60 anesthesia residents enrolled in the standardized residency training program for the 2024 and 2025 cohorts at our hospital were included in this study. Participants were randomly assigned to either the CDID teaching group or the conventional teaching group using a random number table method, each with 30 trainees. There were no statistically significant differences in baseline characteristics such as sex and age between the two groups, indicating good comparability ($P > 0.05$) (**Table 1**).

To evaluate the effectiveness of the CDID teaching model for preoperative visits, a standardized

assessment was conducted for trainees in both groups after completion of a three-month training period. Each trainee was randomly assigned two adult patients scheduled for elective surgery each day, with patient age not less than 20 years. The trainees completed the preoperative anesthesia visit between 16:00 and 17:30 on the day before surgery. The effectiveness of the CDID teaching model was comprehensively evaluated by analyzing patients' preoperative anxiety scores, the success rate of preoperative visits, and trainees' assessment results collected over a one-month period.

Table 1. Baseline characteristics of trainees in the two groups (mean ± SD, $n = 30$)

Group	Age (years)	Male	Female
Conventional teaching group	26.5 ± 1.93	16	14
CDID teaching group	26.5 ± 1.70	19	11
P	0.9	0.4	

2.2. Study methods

In perioperative management training, the CDID teaching model was introduced into the preoperative visit teaching process. This model consists of four sequential stages including Consultation, Direction, Instruction, and Digital support, forming an integrated multidimensional teaching framework.

The Consultation stage involves providing patients with basic knowledge of anesthesia, explaining the anesthesia procedure and related precautions, and clarifying potential risks and safety measures. This communication helps patients develop an accurate understanding of perioperative anesthesia and reduces preoperative tension and anxiety.

The Direction stage uses verbal explanations, written materials, and illustrated visual content to simulate anesthesia procedures and clinical scenarios. These approaches demonstrate the safety and comfort of anesthesia and help establish patient trust, thereby improving communication and cooperation before surgery.

The Instruction stage includes three components consisting of pre-anesthesia guidance, post-anesthesia guidance, and additional guidance based on patient feedback. Pre-anesthesia guidance provides individualized recommendations regarding diet, daily routines, medication use, and emotional regulation. Post-anesthesia guidance emphasizes health education on postoperative analgesia, nausea and vomiting management, and postoperative cognitive function. Additional guidance is provided after analysis of patient feedback questionnaires in order to address specific concerns, promote postoperative recovery, and complete the educational feedback cycle.

The Digital stage integrates hospital electronic medical record resources into the departmental anesthesia learning platform to establish an interactive teaching system and a clinical case database. The system provides strong human-computer interaction and realistic scenario simulation, allowing common communication situations during preoperative visits to be reproduced. Learning data from trainees are recorded in real time and feedback reports are generated automatically. The results are delivered to supervising instructors to support continuous formative evaluation. An artificial intelligence module analyzes trainee knowledge performance, identifies weak areas, and generates personalized learning recommendations, forming a digital teaching system characterized by closed-loop feedback [5].

For example, based on the anatomical characteristics of the spine, the teaching team developed a digital three-dimensional spinal simulation model that demonstrates anatomical structures from multiple perspectives and layers. During instruction, case discussions are combined with three-dimensional animation

demonstrations, integrating virtual simulation with partial physical practice to deepen trainees' understanding of neuraxial anesthesia principles and procedural techniques.

All components of this model are closely connected and mutually reinforcing. By optimizing instructional design and interaction mechanisms, trainee engagement and clinical reasoning ability are enhanced, leading to sustained improvement in the quality of preoperative visit education.

2.2.1. Training model

(1) Conventional teaching model: Instruction was provided by anesthesiologists with at least five years of clinical experience who also held certified teaching qualifications. Theoretical teaching of preoperative anesthesia visits was conducted using multimedia presentations based on the fourth edition of *Clinical Anesthesiology*. The teaching process was primarily lecture-oriented, with trainees mainly learning through listening and note-taking.

(2) CDID teaching model: The CDID teaching model was implemented through the following components.

First, theoretical instruction and pre-class preparation were organized by anesthesiologists with more than five years of teaching experience and certified teaching qualifications. Teaching content was based on the fourth edition of *Clinical Anesthesiology* and integrated with real clinical cases from the departmental independent learning platform. Cases were randomly selected from the database and distributed to trainees in advance. Trainees were required to review relevant literature and prepare brief reports before class.

Second, classroom instruction began with case-based scenarios. Based on feedback automatically generated from the preparation system, instructors raised targeted questions to clarify learning objectives. Participatory learning strategies were applied during the class to encourage trainees to express their viewpoints and develop clinical reasoning and teamwork abilities. Small group discussions and case analysis sessions were organized, during which each group analyzed the same case and presented their conclusions.

Third, after the class session, instructors summarized key knowledge points and emphasized important concepts, difficult topics, and common errors. These elements were organized into visualized knowledge maps. Follow-up assignments were then distributed to reinforce existing knowledge and introduce new concepts. Learning progress was monitored through platform-generated feedback, allowing instructors to provide individualized guidance.

Fourth, a digital simulation module was incorporated into neuraxial anesthesia teaching. The instructional team developed a digital three-dimensional spinal simulation model that demonstrates spinal anatomical structures and spatial relationships. After software optimization, the model was integrated into the teaching system and presented together with three-dimensional animation and real-time demonstrations. This visual approach improved trainees' understanding of neuraxial anesthesia principles and procedural techniques (**Figure 1**).

Fifth, CDID-based preoperative visit simulation and peer assessment were introduced during case teaching sessions. Instructors first demonstrated the procedure and explained the process. Trainees then conducted group-based simulation exercises. After the practice session, peer assessment was performed among trainees, and instructors summarized key points to reinforce the digital preoperative visit workflow and communication skills.

Figure 1. Self-learning platform of the Department of Anesthesiology and the CDID instructional system

2.2.2. Outcome measures and evaluation methods

(1) **Patient preoperative anxiety score:** Patient anxiety before surgery was assessed using the Self-Rating Anxiety Scale (SAS) [6,7]. The scale contains 20 items that evaluate the frequency of anxiety-related symptoms. The total raw score is obtained by summing the scores of all items and multiplying the result by 1.25, after which the integer value is taken as the standardized score. Higher scores indicate more severe anxiety. According to standard interpretation criteria, a SAS score of 50 or higher indicates the presence of anxiety. Scores from 50 to 59 represent mild anxiety, scores from 60 to 69 represent moderate anxiety, and scores of 70 or higher indicate severe anxiety.

(2) Success rate of preoperative visits: In this study, successful completion of a preoperative anesthesia visit was defined as a trainee completing the ward visit one day before surgery, during which the patient was able to understand anesthesia-related risks and procedures and signed the informed consent form after adequate communication. The success rate of preoperative visits was calculated as the number of successful preoperative visits divided by the total number of elective surgical patients during the same period multiplied by 100 percent.

(3) Assessment of trainees' preoperative visit performance: After completion of the training program, all trainees participated in a comprehensive assessment of preoperative visit performance. The evaluation followed a 100-point scoring system and consisted of three components.

The first component was theoretical medical knowledge with a maximum of 30 points. This dimension evaluated the ability to recognize anesthesia-related risks, assess surgical history and comorbid diseases including cardiovascular, respiratory, and endocrine disorders, and conduct consultation and evaluation for special patient conditions such as upper respiratory infection, drug allergy, drug dependence, and malignant hyperthermia.

The second component was clinical practice competence with a maximum of 40 points. Scores were assigned by the supervising anesthesiologist according to the trainee's performance during the preoperative visit. Assessment items included completeness of medical history collection, accuracy of anesthesia risk evaluation, and appropriateness of the anesthesia plan.

The third component was professionalism and humanistic competence, with a maximum of 30 points. This dimension evaluated professional ethics, responsibility awareness, patient communication skills, and demonstration of humanistic care.

2.3. Statistical analysis

Data were analyzed using SPSS version 23.0 (IBM Corporation, Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD). Data were tested for normality. When the assumptions of normal distribution and homogeneity of variance were satisfied, comparisons between the two groups were performed using an independent sample *t*-test. Data that did not follow a normal distribution were analyzed using the rank sum test. Categorical variables were expressed as frequencies and percentages, and comparisons between groups were performed using the chi-square test or Fisher's exact test. All statistical tests were two-sided and a *P*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Preoperative anxiety scores of patients

Before the preoperative visit was conducted by trainees in both groups, patient anxiety levels were assessed using the SAS. The results showed no statistically significant difference in anxiety scores between the two groups before the visit ($P = 0.90$), indicating comparable baseline conditions between the groups. After completion of the preoperative visit, anxiety scores in the CDID group were significantly lower than those in the conventional teaching group (51.97 ± 3.44 vs 55.77 ± 3.27, $P < 0.01$). The difference was statistically significant (**Table 2**). These findings indicate that the CDID teaching model effectively reduces patient preoperative anxiety.

Table 2. Preoperative anxiety scores of patients in the two groups (mean ± SD, $n = 30$)

Group	Anxiety score before visit	Anxiety score after visit
Conventional teaching group	59.67 ± 3.96	55.77 ± 3.27
CDID teaching group	59.73 ± 3.17	51.97 ± 3.44*
P	0.9	<0.01

Anxiety scores were comparable between the two groups before the visit ($P > 0.05$), whereas a significant difference was observed after the visit (*$P < 0.05$).

3.2. Preoperative visit success rate

The success rate of preoperative visits was higher in the CDID group than in the conventional teaching group (100.0% vs 83.3%), and the difference reached statistical significance ($\chi^2 = 5.36$, $P = 0.02$) (Table 3). The results suggest that the CDID teaching approach enhances trainees' communication performance during preoperative visits and increases the likelihood of obtaining informed consent from patients.

Table 3. Success rate of preoperative visits among trainees in the two groups (%)

Group	Successful visits	Total patients	Success rate (%)
Conventional teaching group	25	30	25 (83.3)
CDID teaching group	30	30	30 (100.0)*
P			0.02

*Compared with the conventional teaching group, the difference was statistically significant ($P < 0.05$).

3.3. Assessment results of trainees' preoperative visits

The comprehensive assessment results of trainees' preoperative visits in the two groups are presented in **Table 4**. The total score of trainees in the conventional teaching group was 70.14 ± 3.33, whereas the CDID group achieved a score of 84.04 ± 3.48. The difference between the two groups was statistically significant ($P < 0.01$). Further analysis showed significant differences in clinical practice competence and professional humanistic competence between the two groups (both $P < 0.01$). However, no statistically significant difference was observed in theoretical medical knowledge scores ($P = 0.07$). These findings indicate that the CDID teaching model has clear advantages in improving trainees' clinical skills and humanistic communication competence.

Table 4. Assessment results of trainees' preoperative visits in the two groups (mean ± SD, $n = 30$)

Group	Theoretical knowledge	Clinical practice competence	Professional humanistic competence	Total score
Conventional teaching group	22.80 ± 2.51	27.12 ± 2.64	15.97 ± 1.83	70.14 ± 3.33
CDID teaching group	24.11 ± 2.87	31.40 ± 3.04*	23.34 ± 2.04*	84.04 ± 3.48*
P	0.07	<0.01	<0.01	<0.01

*Compared with the conventional teaching group, the difference was statistically significant ($P < 0.05$).

4. Discussion

Preoperative anesthesia assessment plays an essential role in perioperative care. During this process, anesthesiologists collect detailed medical history, evaluate anesthesia-related risks, formulate individualized anesthetic and perioperative management plans, and provide education about anesthesia procedures to patients and their families. Such communication helps relieve anxiety, reduce fear, and contributes to safer perioperative management and improved postoperative recovery [3,8]. Well-conducted preoperative visits can enhance the overall quality of anesthesia management and reduce the occurrence of surgical complications and postoperative adverse events. Furthermore, effective preoperative evaluation may decrease the economic burden caused by postponed or cancelled surgeries and promote more efficient use of medical resources.

Under traditional teaching approaches, education on preoperative visits is largely centered on theoretical instruction. Teachers typically follow the curriculum and transmit knowledge sequentially, while opportunities for structured synthesis and classroom interaction remain limited. Consequently, students often develop only a superficial understanding of theoretical concepts. Restrictions related to clinical teaching resources and ethical requirements often limit students' exposure to real clinical cases. With fewer opportunities for hands-on practice, trainees may struggle to develop clinical reasoning skills and independent judgment. As a consequence, students may demonstrate incomplete history taking and inadequate evaluation of anesthesia-related risks when faced

with complex clinical scenarios. This situation may cause preoperative visits to become procedural rather than meaningful and may also influence the quality of communication with patients [9].

Furthermore, conventional teaching approaches often lack integration of information technology and digital resources. The limited variety of instructional methods may reduce students' motivation and engagement in learning. Therefore, incorporating digital teaching strategies into traditional anesthesia education to increase learning motivation and improve the effectiveness of preoperative visits has become a key focus in current medical education reform.

The CDID teaching model, which consists of Consultation, Direction, Instruction, and Digital components, represents a novel instructional framework developed by our department according to the characteristics of preoperative anesthesia visits. The model adopts a student-centered approach with electronic patients as the core educational element. By integrating case-based learning with digital interactive technologies, a triadic learning system involving students, teachers, and virtual patients is established. Through the stages of Consultation, Direction, and Instruction, trainees progressively develop communication skills, anesthesia risk assessment ability, and clinical responsiveness.

The introduction of digital simulation enables trainees to repeatedly practice within a virtual environment, which reduces potential clinical safety risks and enhances visual understanding as well as application of knowledge. The use of a three-dimensional spinal anatomical model allows visualization of spinal structures from multiple perspectives, providing a clearer and more systematic presentation of neuraxial anesthesia concepts [10]. For example, in the case of elderly patients undergoing transurethral resection of the prostate, trainees can complete case-oriented learning tasks on the digital platform, including surgical features, physiological changes in older adults, common complications, and key aspects of preoperative evaluation. The system generates personalized teaching feedback based on the anesthesia method selected by the trainee and demonstrates spinal anatomical characteristics and indications for neuraxial anesthesia across different age groups. This process improves trainees' understanding of clinical cases and strengthens their independent reasoning and analytical ability [11].

The findings of this study indicate that the CDID teaching model is more effective than conventional teaching in reducing patient preoperative anxiety, improving the success rate of preoperative visits, and enhancing trainees' overall assessment performance. No significant difference was observed in theoretical knowledge scores, suggesting that the CDID model performs comparably to traditional teaching in terms of fundamental knowledge acquisition. In contrast, scores in clinical practice competence and professional humanistic competence were significantly higher, indicating that the CDID model is particularly beneficial for developing higher-level clinical reasoning and communication abilities. These findings are consistent with previous research showing that digital and blended learning approaches promote knowledge transfer in medical education [11,12]. By establishing a closed educational cycle consisting of theory, practice, and feedback, the CDID model stimulates active learning and improves clinical competence and communication skills, thereby enhancing overall teaching quality.

Several limitations should be acknowledged. Implementation of the CDID model requires instructors with strong theoretical knowledge, extensive clinical experience, and familiarity with educational information technologies. In addition, the model demands considerable teaching resources and time investment. Furthermore, when artificial intelligence systems are used to provide learning feedback, algorithm-generated outputs may exhibit variability and uncertainty. Therefore, instructors should interpret AI-generated feedback with critical judgment and combine it with direct evaluation of trainee performance.

5. Conclusion

In conclusion, the CDID preoperative visit teaching model shows significant advantages in anesthesia education. Future work should focus on multicenter implementation and further refinement of the curriculum structure and digital platform functions. These efforts may provide new perspectives for improving anesthesia education and promoting the development of patient-centered perioperative care.

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Disclosure statement

The authors declare no conflict of interest.

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