

# ***Development and Implementation of the Three-Completeness, Four-Integration, and Five-Education Model in Clinical Anesthesiology Education***

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**Abstract:** As anesthesiology clinical education increasingly requires teaching models that integrate theoretical instruction with practical and professional development, the Three-Completeness, Four-Integration, and Five-Education preceptorship model (3-4-5 educational model) warrants systematic evaluation. To this end, forty anesthesiology trainees at Deyang People's Hospital were randomly allocated to a control group or an observation group (n = 20 each); the control group received conventional clinical teaching, while the observation group received instruction based on the 3-4-5 educational model. After training, theoretical knowledge, procedural skills, comprehensive clinical competence, and teaching satisfaction were compared. The observation group scored significantly higher than the control group in theoretical knowledge ( $91.58 \pm 2.89$  vs.  $82.36 \pm 3.25$ ) and procedural skills ( $92.17 \pm 2.95$  vs.  $81.52 \pm 3.61$ ; both  $P < 0.05$ ), and also showed significantly greater comprehensive competence ( $P < 0.05$ ). Teaching satisfaction was 100.00% in the observation group versus 70.00% in the control group ( $P < 0.05$ ). These findings support the 3-4-5 educational model as an effective approach for improving theoretical mastery, practical performance, comprehensive clinical competence, and teaching satisfaction among anesthesiology trainees, and suggest that it offers a promising framework for advancing anesthesiology clinical education.

## **1. Introduction**

Clinical teaching is fundamental to the standardized training of clinical anesthesiology professionals[1]. As a discipline characterized by high perioperative risk, technically demanding procedures, stringent requirements for emergency management, and complex clinical responsibilities, anesthesiology requires clinicians to demonstrate comprehensive competence in theoretical knowledge, procedural skills, emergency decision-making, communication, and professional ethics. Traditional clinical teaching has predominantly relied on an apprenticeship-based observational model, which has several inherent limitations, including fragmented instructional content, inadequate process oversight, an excessive emphasis on technical skills at the expense of professional development, and overly simplistic assessment mechanisms[1]. These limitations make it difficult to

achieve comprehensive, systematic, and high-quality educational outcomes throughout the clinical training process[2]. With the ongoing reform of medical education and evolving expectations for the development of healthcare professionals in the modern era, there is an urgent need to establish a clinical teaching framework that integrates standardized instruction, systematic management, practical application, and holistic professional development[3,4].

Accordingly, developing an integrated and sustainable teaching framework has become an important priority in the reform and management of clinical anesthesiology education. The Three-Completeness, Four-Integration and Five-Education Model integrated educational model (3-4-5 educational model) takes full-process and all-round education as its core framework, relies on job-based practical operations, standardized management, and clear accountability as its implementation pathways, and aims ultimately at the synergistic enhancement of professional competence and overall literacy. The Three-Completeness comprises all-member participation, full-process coverage, and all-round education[5]. The Four-Integration refers to the integration of on-the-job practical training, case-based debriefing, responsibility-driven management, and standardized assessment. The Five-Education encompasses the development of professional knowledge, practical skills, emergency response capabilities, communication skills, and professional competence. This framework aligns seamlessly with the contextual demands and educational positioning of clinical teaching in anesthesiology.

Against this background, drawing on the practical needs of clinical anesthesiology education, this study developed and implemented a systematic 3-4-5 educational model in clinical teaching practice and evaluated its effects on teaching quality, trainees' comprehensive competencies, and teaching satisfaction.

## **2. Methods and materials**

### **2.1. Study design and sample size**

A total of 40 clinical anesthesiology trainees in Deyang People's Hospital between January 2024 and April 2026 were enrolled as study subjects and randomly assigned into a control group (Group C) and an observation group (Group I) using a random number table method, with 20 trainees in each group. The inclusion criteria were trainees who met all of the following: (1) trainees currently undergoing standardized internship or residency training in anesthesiology; (2) full participation in the clinical teaching research without any absence; and (3) provision of informed consent and voluntary participation in the study. The exclusion criteria were patients who met any of the following: (1) withdrawal from clinical training midway; (2) prior clinical work experience in anesthesiology; and (3) presence of learning disabilities or psychiatric disorders.

### **2.2. Intervention and teaching model**

Trainees in the control group received the conventional clinical teaching model used in the anesthesiology department. Clinical instructors delivered theoretical lectures based on the standard syllabus, covering core topics such as basic anesthesiology principles, the pharmacological effects of commonly used anesthetic agents, and the basic operation of anesthesia equipment. These lectures were delivered centrally once or twice a month, without dedicated or standardized instructional materials, and relied primarily on content from standard textbooks. During daily clinical practice, interns and resident physicians participated under the supervision of clinical instructors in preoperative anesthetic assessment, intraoperative anesthetic management, and postoperative recovery care. The learning process was predominantly observational, with limited opportunities for hands-on practice. Trainees performed only simple auxiliary tasks under supervision, such as passing

instruments and conducting preliminary monitoring of vital signs. Instruction primarily relied on ad hoc bedside teaching and brief post hoc debriefings. Problems encountered during clinical practice were addressed mainly through immediate verbal feedback, without systematic problem identification, summary, or targeted guidance plans. Standardized assessments of theoretical knowledge and clinical skills were conducted periodically.

Trainees in the observation group received the 3-4-5 educational model. Specifically, trainees in this group received instruction from a tiered teaching team comprising the department director, teaching team leaders, senior attending physicians, and resident physicians. Teaching was integrated throughout the entire perioperative care continuum, with clinical scenarios systematically incorporated into instructional activities ranging from preoperative visits, patient assessment, anesthetic plan formulation, and medication preparation to intraoperative airway management, vital sign monitoring and regulation, and emergency resuscitation coordination, and extending to postoperative anesthesia recovery, pain management, and complication prevention. Throughout the training process, trainees received comprehensive instruction in theoretical knowledge, procedural skills, clinical reasoning, emergency management, doctor–patient communication, patient safety, and professional responsibility.

### 2.3. Study outcomes

Baseline demographic characteristics of trainees in both groups were collected. After completion of the training, theoretical knowledge and clinical procedural skills were assessed using standardized examinations and clinical skills assessments, respectively. Trainees' comprehensive competency was evaluated using a Comprehensive Competency Scale covering four domains: emergency management, doctor-patient communication, clinical reasoning, and professionalism. Teaching satisfaction was also assessed using a structured questionnaire.

### 2.4. Statistical analysis

Statistical analysis was performed using SPSS version 26.0. Quantitative data were expressed as mean  $\pm$  standard deviation and compared using the Student's t-test. Categorical data were presented as numbers and percentages and compared using the chi-square test. A value of  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Demographics and basic values of trainees between the two groups

The control group included 11 men and 9 women, with an age range of 22-27 years and a mean age of  $24.36 \pm 1.25$  years. Among them, 16 trainees had a bachelor's degree and 4 had a master's degree. The intervention group included 10 men and 10 women, with an age range of 22-28 years and a mean age of  $24.51 \pm 1.32$  years. Among them, 15 trainees had a bachelor's degree and 5 had a master's degree. No statistically significant differences were found between the two groups in terms of sex, age, or educational level ( $P > 0.05$ ).

### 3.2. Comparison of assessment scores between the two groups

Compared with the control group, trainees in the intervention group had significantly higher scores in both theoretical knowledge (TK) and clinical procedural skills (CPS) ( $P < 0.05$ ), as detailed in Table 1.

Table 1. Comparison of Assessment Scores Between the Two Groups (mean  $\pm$  SD).

| Variables      | scores of TK     | scores of CPS    |
|----------------|------------------|------------------|
| Group C (n=20) | 82.36 $\pm$ 3.25 | 81.52 $\pm$ 3.61 |
| Group I (n=20) | 91.58 $\pm$ 2.89 | 92.17 $\pm$ 2.95 |
| t              | 9.481            | 10.216           |
| P              | 0.000            | 0.000            |

### 3.3. Comparison of comprehensive competency scores between the two groups

The intervention group achieved significantly higher scores on the Comprehensive Competency Scale than the control group, with significant between-group differences observed across all four domains: emergency management (EM), doctor–patient communication (DPC), clinical reasoning (CR), and professionalism ( $P < 0.05$ ), as detailed in Table 2.

Table 2 Comparison of comprehensive competency scores between the two groups (mean  $\pm$  SD).

| Variables      | scores of EM     | scores of DPC    | scores of CR     | scores of professionalism |
|----------------|------------------|------------------|------------------|---------------------------|
| Group C (n=20) | 80.59 $\pm$ 3.87 | 83.61 $\pm$ 3.07 | 82.14 $\pm$ 3.26 | 83.66 $\pm$ 3.15          |
| Group I (n=20) | 90.10 $\pm$ 2.96 | 92.88 $\pm$ 2.43 | 92.56 $\pm$ 2.71 | 94.80 $\pm$ 2.58          |
| t              | 9.647            | 10.588           | 10.992           | 12.236                    |
| P              | 0.000            | 0.000            | 0.000            | 0.000                     |

### 3.4. Comparison of satisfaction scores between the two groups

Trainees in the intervention group reported significantly higher teaching satisfaction scores than those in the control group ( $P < 0.05$ ), as detailed in Table 3.

Table 3 Comparison of satisfaction between the two groups [n (%)].

| Variables      | Very satisfied | Satisfied | Dissatisfied | Overall satisfaction |
|----------------|----------------|-----------|--------------|----------------------|
| Group C (n=20) | 20             | 6(30.00)  | 8(40.00)     | 14(70.00)            |
| Group I (n=20) | 20             | 11(55.00) | 9(45.00)     | 20(100.00)           |
| $\chi^2$       | -              | -         | -            | 7.059                |
| P              | -              | -         | -            | 0.008                |

## 4. Discussion

Clinical training in anesthesiology is a fundamental component of standardized residency training

and the development of professional competence among anesthesiologists. It encompasses a broad range of competencies, including perioperative anesthesia management, emergency and critical care, standardized clinical procedures, doctor–patient communication, and patient safety. High-quality clinical teaching therefore plays a central role in the professional development of early-career anesthesiologists by fostering sound clinical skills, systematic clinical reasoning, adherence to aseptic principles, and a strong sense of professional responsibility, while also strengthening emergency management and teamwork capabilities. By standardizing clinical practice and reducing preventable errors, effective clinical education contributes to patient safety and provides an essential foundation for the development of a competent anesthesiology workforce and the sustainable advancement of the specialty.

Accordingly, clinical education in anesthesiology must integrate theoretical knowledge, standardized procedural training, clinical reasoning, emergency management, communication skills, and professional ethics into routine clinical practice[6]. However, conventional anesthesiology teaching faces several practical challenges. With increasing surgical volumes, the competing demands of clinical workload and teaching responsibilities have placed substantial pressure on instructors, limiting the time and effort available for structured teaching[7]. In addition, fragmented teaching scenarios and the absence of standardized instructional content make it difficult to establish a coherent and systematic training framework. At the trainee level, limited opportunities for hands-on practice, insufficient awareness of patient safety and risk prevention, and underdeveloped emergency response capabilities may further impede competency development. These challenges are compounded by considerable variation in trainees' baseline knowledge and clinical skills, making traditional teaching approaches increasingly inadequate for meeting the increasingly complex competency requirements of contemporary anesthesiology training and creating substantial challenges for maintaining teaching quality.

Conventional clinical teaching in anesthesiology has traditionally relied on a preceptorship model centered primarily on observational learning and shadowing[8]. This approach allows trainees to become familiar with clinical workflows, acquire basic procedural skills, adapt to the operational pace of the department, and develop foundational clinical competencies. Consequently, it has remained a widely used approach in anesthesiology education. However, its limitations become increasingly apparent as the competency requirements of contemporary clinical training continue to evolve[9]. Instructional content is often fragmented and lacks standardized training plans and systematic process monitoring. Teaching activities may also vary considerably among instructors and across clinical settings, with limited coordination among different levels of the teaching team and insufficient continuity in competency development. Moreover, the emphasis on procedural demonstration may come at the expense of theoretical knowledge, clinical reasoning, emergency decision-making, and professional development. When combined with relatively limited assessment dimensions, these shortcomings make it difficult to provide comprehensive and continuous competency-based education throughout the clinical training process. These limitations suggest that effective anesthesiology education should move beyond the transmission of isolated knowledge and technical skills toward a more structured, integrated, and competency-oriented teaching framework. Such a framework should not only standardize the teaching process and strengthen quality control but also integrate clinical practice, theoretical learning, clinical reasoning, emergency management, communication, and professionalism throughout the training process[10].

The 3-4-5 educational model provides a systematic and integrated framework for clinical anesthesiology education that addresses several limitations of conventional teaching[9]. The Three-Completeness encompasses both the depth and comprehensiveness of clinical teaching. The Four-Integration principle further emphasizes the integration of clinical practice, case-based debriefing, responsibility-driven management, and standardized assessment, thereby ensuring that teaching

remains closely connected to authentic clinical practice and professional responsibilities[9]. Meanwhile, the Five-Education component incorporates theoretical knowledge, practical skills, emergency response capabilities, communication skills, and professionalism into a coordinated competency-based training framework[10]. Compared with conventional teaching, this integrated approach establishes a more structured and standardized instructional system and promotes continuous quality control throughout the training process[10]. The tiered teaching structure distributes instructional responsibilities across different levels of the teaching team, while the full-process design embeds educational activities throughout the perioperative care continuum[8]. In addition, the integration of multiple competency domains extends teaching beyond technical skill acquisition to encompass clinical reasoning, emergency management, communication, patient safety, and professionalism. These features may help reduce fragmentation in clinical teaching, improve continuity and consistency of instruction, and better align clinical training with the comprehensive competency requirements of contemporary anesthesiology practice[10].

The present study demonstrated that trainees in the intervention group achieved significantly higher post-training scores in both theoretical knowledge and clinical procedural skills than those in the control group[11]. Importantly, the intervention group also showed significantly greater comprehensive competency across all four assessed domains, namely emergency management, doctor–patient communication, clinical reasoning, and professionalism[11]. These findings suggest that the 3-4-5 educational model may effectively overcome several limitations of conventional clinical teaching by integrating knowledge acquisition, practical skill development, clinical reasoning, emergency management, communication, and professional development into a coherent training framework[10]. Several features of the model may account for these improvements. First, the integration of routine case-based debriefings and discussions of complex cases and unexpected clinical events provides trainees with opportunities to actively analyze patient conditions, identify potential risks, and formulate and refine management strategies[12]. This approach may facilitate the transition from passive observation to active clinical reasoning, thereby strengthening trainees' ability to interpret clinical information and make appropriate decisions. Second, scenario-based simulations and structured emergency drills provide repeated opportunities to practice the recognition and standardized management of perioperative emergencies. Such experiential training may enhance trainees' preparedness for acute clinical situations and contribute to the observed improvement in emergency management competency. Third, targeted communication training embedded within preoperative assessment, informed-consent discussions, and patient reassurance may improve trainees' ability to communicate clinical information clearly and empathetically, while also strengthening their awareness of communication-related risks. This may explain the higher doctor–patient communication scores observed in the intervention group[13]. Finally, the continuous integration of patient safety principles, professional responsibility, and medical ethics into routine clinical teaching extends the focus of training beyond technical proficiency[9]. By reinforcing adherence to aseptic principles, risk awareness, accountability, and teamwork, the model may promote the development of professionalism among trainees. Regarding instructional satisfaction, the total satisfaction rate in the observation group reached 100.00%, which was significantly higher than the 70.00% observed in the control group. This marked difference underscores the favorable acceptance and strong endorsement of this novel training model among trainees[10].

Taken together, these findings highlight a key advantage of the 3-4-5 educational model: rather than focusing primarily on the acquisition of isolated knowledge or procedural skills, it provides an integrated approach to competency development that connects theoretical learning with clinical practice, emergency decision-making, communication, patient safety, and professionalism. The coordinated development across these domains may explain the consistently superior performance of trainees in the intervention group and suggests that the model has potential value for improving the

quality and comprehensiveness of clinical anesthesiology education.

In summary, the 3-4-5 educational model provides a systematic, practice-oriented, and competency-based framework for clinical anesthesiology education. By integrating standardized teaching, clinical practice, comprehensive competency development, and continuous assessment, the model addresses several limitations of conventional clinical teaching. In this study, its implementation was associated with significant improvements in trainees' theoretical knowledge, clinical procedural skills, comprehensive competency, and teaching satisfaction. These findings suggest that the 3-4-5 educational model has potential value as an integrated approach to improving the quality and effectiveness of clinical anesthesiology education and may provide a practical framework for competency-based medical education and the development of future anesthesiology professionals.

## 5. Conclusion

The 3-4-5 educational model significantly improves theoretical mastery, practical performance, and teaching satisfaction among anesthesiology trainees, offering a promising framework for anesthesiology education.

## Availability of data and material

The data of this study can be obtained from the correspondence author after publication of the study results for reasonable requests.

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