Journal of Contemporary Educational Research, 2026, Volume 10, Issue 6
http://ojs.bbwpublisher.com/index.php/JCER
Online ISSN: 2208-8474
Print ISSN: 2208-8466

Application and Practice of the Ladder Teaching System Based on Standardized Sampling in Pathological Residency Standardized Training

Qiushuang Ma[1,2], Bingjuan Zhou[1,2], Yingying Lan[1,2], Jirui Sun[1,2], Bingxin Zhang[1,2], Jinmei Li[1,2], Wenming Zhao[1,2], Jinku Zhang[1,2]*

[1]Department of Pathology, Baoding First Central Hospital, Baoding 071000, Hebei, China
[2]Key Laboratory of Molecular Pathology and Early Diagnosis of Tumor in Hebei Province, Baoding, China

***Corresponding author:** Jinku Zhang, zjkblk@sina.com

Abstract: Pathological specimen sampling is the primary and key link of pathological diagnosis, as well as the most core and basic fundamental skill in the standardized training of resident pathologists. The standardization of sampling directly determines the quality of pathological sections, the accuracy of diagnosis, and the construction of trainees' clinical pathological thinking. At present, most resident trainees have common problems such as weak sampling concepts, non-standard operations, insufficient lesion identification, and sampling omissions, which constitute the main bottleneck restricting the quality of pathological residency training. Based on the growth law of pathological talents, the Pathology Residency Training Base of Baoding First Central Hospital integrates standardized sampling teaching into the whole three-year residency training, and constructs a characteristic sampling training system of "admission desensitization–ladder-based practical operation–subspecialty competency–quality control review–closed-loop improvement" to target and solve trainees' problems including weak foundation, random operation and unclear key points. This paper focuses on expounding the core value of standardized sampling in consolidating the foundation of pathological residency training, and summarizes the base's hierarchical sampling training mode, quality control management measures and practical effects, so as to provide a promotable practical scheme for domestic pathological residency training bases to strengthen basic teaching and improve trainees' core professional competencies.

Keywords: Clinical pathology; Standardized residency training; Specimen sampling; Basic skill training; Quality control

Online publication: July 16, 2026

1. Introduction

Pathological diagnosis is known as the "gold standard" for clinical diagnosis. Complete and accurate

pathological diagnosis relies on high-quality preliminary pathological processing, and specimen collection is the core and initial step in the pathological workflow. Compared to later skills such as slide interpretation, immunohistochemical analysis, and molecular pathology analysis, specimen collection represents the fundamental skill for pathologists, one that is easily overlooked and prone to non-standardized operations.

During the initial phase of standardized resident training in pathology, trainees commonly face challenges in transitioning from textbook morphology to the recognition of gross specimens, manifesting as deficiencies such as inadequate identification of gross lesions, arbitrary selection of sampling sites, omission of key lesions, insufficient sampling quantity, and non-standardized sampling of special areas. Non-standardized sampling directly results in slides lacking diagnostic value, missing pathological information, and an increased risk of misdiagnosis and missed diagnosis. Even with excellent slide interpretation skills later on, these initial sampling deficiencies cannot be compensated for, leading to diagnostic shortcomings. Therefore, strengthening standardized sampling instruction is the fundamental prerequisite for consolidating the professional foundation of pathology residents, constructing systematic pathological thinking, and ensuring their future independent diagnostic capabilities.

As a national-level pathology resident training base, the Pathology Department of Baoding No.1 Central Hospital, drawing on years of teaching experience, has established the teaching philosophy of "laying a solid foundation through resident training, with specimen collection as the priority." It has abandoned the traditional teaching bias of emphasizing slide interpretation over specimen collection and created a stratified, stepwise, and distinctive training system centered on standardized specimen collection to comprehensively enhance the foundational operational standardization and clinical practical abilities of residents [1].

2. The core foundational value of standardized specimen collection in pathology resident training

2.1. Standardized specimen collection as the source guarantee for the authenticity of pathological diagnosis

The complete chain of pathological diagnosis includes "specimen reception—gross examination—standardized specimen collection—tissue dehydration and embedding—section staining—microscopic diagnosis," with specimen collection serving as the sole bridge connecting gross clinical information with microscopic morphological diagnosis. Key information in gross specimens, such as small lesions, infiltrative margins, resection margins, and lymph node metastases, can only be preserved through precise specimen collection. If lesions are missed during sampling, tumor margins are not collected, or resection margins and lymph nodes are not properly examined, it will directly lead to the inability to observe real lesions under the microscope, resulting in diagnostic underestimation and staging errors, severely affecting clinical treatment plan formulation and patient prognosis evaluation. Therefore, standardized specimen collection is the first line of defense in ensuring the authenticity, completeness, and accuracy of pathological diagnosis.

2.2. Standardized specimen collection as the core carrier for establishing gross-microscopic correspondence thinking in trainees

The core challenge in pathology learning lies in establishing correspondence between gross and microscopic morphology. Beginners rely solely on textbook images to establish morphological recognition, lacking experience in gross specimen interpretation, making it difficult for them to understand the growth patterns,

infiltrative ranges, and morphological evolution of lesions. Systematic and standardized specimen collection training allows trainees to intuitively grasp the gross morphology of normal tissues, gross characteristics of lesions, and tumor invasion features through hands-on touching, observing, sectioning, and sampling, gradually establishing a complete pathological thinking process of "gross prediction—precise sampling—microscopic verification," laying a solid foundation for subsequent improvements in slide interpretation and differential diagnosis abilities [2].

2.3. Standardized specimen collection as the key approach to cultivating trainees' rigorous professional qualities

Pathology work is highly rigorous and risky, with every sampling decision and tissue preservation directly related to patient treatment outcomes. The specimen collection teaching process is not only a skill training but also a cultivation of medical safety thinking, rigorous academic attitudes, and a sense of responsibility. Strict sampling norms, standardized operational procedures, and regular error reviews help residents establish the professional concept of "every piece of tissue matters, and every sampling must be rigorous" from the beginning of their careers, avoiding haphazard and experience-based operational habits and shaping the professional qualities of qualified pathologists.

3. The distinctive stratified training system centered on standardized specimen collection at our base

In response to the varying abilities of residents across different years of training, our base has abandoned a uniform teaching model and constructed a three-year, stratified, progressive, and focused specimen collection training system. From zero-basis introduction and standardized norms to complex and difficult specimen collection and subspecialty precise sampling, the system progresses layer by layer to thoroughly consolidate residents' pathological foundations [3].

3.1. First year: Zero-basis standardized foundation building—Unified specimen collection standards for all

The first year of resident training is a critical foundational period, with the core goal of eliminating non-standardized operations, unifying specimen collection standards, and establishing a sense of standardization. At this stage, residents have not yet formed clinical pathological thinking, so our base implements a "zero-tolerance, hands-on, fully standardized" introductory teaching model [4].

Firstly, specialized desensitization training is conducted before specimen collection. A "Standardized Specimen Collection Operation Manual for Pathology Residents" is uniformly developed, detailing the sampling quantity, sites, fixation requirements, labeling norms, and photographic recording standards for routine specimens, small specimens, endoscopic specimens, and biopsy specimens. For high-frequency small specimens such as gastrointestinal endoscopic biopsies, cervical biopsies, skin biopsies, and lymph nodes, unified operational paradigms are established to prevent issues of insufficient, missed, or incorrect sampling.

Secondly, a one-on-one mentorship hands-on teaching approach is implemented. New residents follow experienced mentors throughout the gross specimen collection process, with mentors providing real-time corrections on details such as knife-holding techniques, sectioning angles, tissue selection, specimen placement, and numbering labels. Residents are required to "observe first, then judge, and finally sample,"

avoiding blind sampling and cultivating a thinking habit of prioritizing gross observation.

Thirdly, daily basic specimen collection reviews are conducted. After daily specimen collection, mentors provide individualized critiques on residents' operational issues, record error types, and establish personal specimen collection error archives to ensure immediate correction of daily issues and rapid consolidation of standardized operational habits.

3.2. Second year: Ability enhancement—Systematic and precise specimen collection training for common diseases

In the second year of resident training, residents have mastered basic operations, and the core training goal is to enhance their precise specimen collection abilities for common, frequently occurring, and neoplastic specimens, focusing on resolving the issue of "being able to sample but not accurately or completely." Our base leverages its rich resource of over 70,000 external examination specimens annually to conduct systematic subspecialty specimen collection training [5].

For high-frequency systemic tumor specimens such as breast, gynecological, digestive, thyroid, and soft tissue tumors, specialized specimen collection norms are developed: tumor specimens focus on strengthening the collection of tumor margins, the deepest infiltrative sites, resection margins, satellite lesions, and lymph node grouping; inflammatory specimens focus on selecting typical lesion areas and transitional zones; and for difficult gross specimens, teachers and students jointly review and determine the sampling plan. Simultaneously, residents' abilities to identify gross lesions are emphasized, enabling them to preliminarily distinguish between benign, malignant, and borderline lesions through gross morphology, providing precise bases for microscopic diagnosis.

Additionally, comparative teaching of specimen collection cases is regularly conducted: microscopic comparisons are made between residents' initial non-standardized sampling slides and mentors' standardized sampling slides, intuitively demonstrating the impact of sampling quality on slide quality, lesion display, and diagnostic results, allowing residents to deeply understand the clinical value of standardized specimen collection and actively avoid operational defects [6].

3.3. Third year: Advanced improvement—Training in difficult specimen collection and quality control thinking

The third year of resident training focuses on cultivating residents' independent practice abilities, with core training content including difficult and complex specimen collection, gross identification of rare diseases, and prediction of sampling risks and quality control thinking. For large multi-organ specimens, difficult tumor specimens, and post-operative complex dissection specimens, senior attending physicians lead the teaching, explaining sampling thought processes, key difficulties, and principles of sampling selection and omission.

Simultaneously, residents are cultivated to develop a review thinking, requiring them to independently review their sampling after completion, in conjunction with the final pathological diagnosis, to assess whether the sampling was complete, whether key areas were addressed, and whether any suspicious lesions were missed, gradually forming a self-improvement model of "sampling—diagnosis—review—optimization," fully adapting to future independent practice needs.

4. The distinctive specimen collection teaching quality control and support mechanisms at our base

4.1. Establishment of a three-tiered quality control system for specimen collection

Our base has constructed a "resident self-check + mentor review + teaching supervision random check" three-tiered quality control system for specimen collection. All specimens collected by residents must undergo a case-by-case review by mentors to confirm that sampling sites, quantities, labeling, and photography are all standardized before proceeding to subsequent processes; the teaching supervision team randomly checks residents' specimen collection cases weekly, calculating the incidence of missed, insufficient, and non-standardized sampling, forming monthly quality control reports for targeted improvements.

4.2. Implementation of specialized specimen collection assessments

Distinguishing itself from traditional assessment models that focus solely on theory and slide interpretation, our base has incorporated standardized specimen collection as a core mandatory assessment item for resident training, establishing a "monthly regular assessment + annual comprehensive evaluation" all-encompassing assessment system, supplemented by precise and targeted guidance and systematic review summaries to solidify residents' basic specimen collection skills. In daily teaching, monthly specialized practical assessments for specimen collection are conducted, covering core content such as standardized processing of small specimens, precise sampling of routine specimens, gross description norms, and specimen labeling and photography. Immediately after assessments, each resident's operational shortcomings, standardization gaps, and thinking misunderstandings are sorted out, and "one-person-one-plan" targeted guidance is provided to correct non-standardized operations point-by-point and promptly resolve monthly skill issues. At the end of each year, an annual comprehensive specimen collection assessment is conducted, integrating sampling content from routine specimens, difficult specimens, and subspecialty characteristic specimens throughout the year to comprehensively evaluate residents' annual skill accumulation. After assessments, specialized teaching review summaries are organized to sort out annual common issues and high-frequency error points, optimizing the focus and training plans for specimen collection teaching in the following year [7,8].

4.3. Leveraging digital pathology to empower specimen collection teaching reviews

Our base utilizes a digital pathology platform to archive and retain cases of typical standardized and non-standardized specimen collection, establishing an exclusive specimen collection teaching case library. Residents can retrieve and compare gross specimen photographs, sampling sites, and corresponding digital slides at any time, achieving precise correspondence between gross and microscopic findings, breaking through the limitations of traditional teaching timeliness, and enabling regular and visually precise teaching [9].

5. Teaching effectiveness

Through years of implementing a distinctive stratified training system centered on standardized specimen collection, coupled with a closed-loop assessment mechanism of monthly specialized assessments and guidance and annual review summaries, our base has achieved a comprehensive and systematic improvement in the basic skill levels of resident trainees. The specimen collection standardization rate among residents has increased from an initial 82.3% to 93.6%, with a significant decrease in the incidence of adverse events such as missed diagnoses due to sampling, insufficient sampling, and ineffective slides; residents'

abilities to identify gross lesions and construct pathological thinking are markedly superior to those trained under traditional models. Solid basic specimen collection training and regular assessment guidance have comprehensively consolidated residents' core pathological practice abilities, helping our base achieve a 100% pass rate in the national graduation assessment for pathology residents. All graduating residents possess solid gross specimen collection and specimen evaluation abilities, with high clinical practical operation standardization, complete pathological thinking, and are quickly able to be competent for routine clinical sampling and related pathological work after employment, demonstrating rapid adaptation, few errors, and strong standardization, receiving widespread recognition from employing units. Additionally, residents have achieved excellent results in basic operation items of provincial and municipal pathology skill competitions, fully highlighting the significant effectiveness of our base's distinctive specimen collection training system.

6. Discussion and conclusion

The core of pathology resident training lies in consolidating foundations, standardizing skills, and shaping thinking, and specimen collection, as the foundational skill at the source of pathology work, represents the most basic, crucial, and irreplaceable teaching module in the entire resident training system. Traditional pathology resident training often emphasizes microscopic slide interpretation, difficult case discussions, and research capacity building, while paying insufficient attention to basic specimen collection teaching, leading to some residents having the skill gap of "being able to interpret slides but not collect specimens," resulting in inadequate clinical adaptability after starting work and significant medical safety hazards.

Our base adheres to the teaching philosophy of "prioritizing foundation building and standardization as the foundation," integrating standardized specimen collection teaching throughout the three-year resident training period. Through distinctive measures such as stratified stepwise training, hands-on teaching, a three-tiered quality control closed loop, case comparison reviews, and digital technology empowerment, we systematically address core issues such as residents' weak foundations, non-standardized operations, and disconnected pathological thinking. Practice has proven that strengthening systematic training in standardized specimen collection can rapidly help residents transition from textbook theory to clinical practice, firmly establish an integrated gross-microscopic pathological thinking process, improve pathological diagnosis quality from the source, reduce medical risks, and represent an effective path for enhancing the homogeneity and standardization quality of pathology resident training.

In the future, our base will continue to optimize the specimen collection teaching system, refine standardized processes for subspecialty specimen collection, improve the specimen collection teaching case library and assessment system, and further advance the standardization, refinement, and regularization of basic skill teaching, providing solid guarantees for cultivating excellent clinical pathologists with solid foundations, strong practice abilities, and comprehensive qualities.

Disclosure statement

The authors declare no conflict of interest.

References

[1] National Health Commission of the People's Republic of China, 2022, Standardized Training Content and Criteria for Resident Physicians (2022 Edition), People's Medical Publishing House, Beijing.

[2] Liu Y, Wang H, Li Z, 2024, Application of Macroscopic-Microscopic Correspondence Thinking Training in Pathology Residency Training Teaching. Chinese Journal of Medical Education Research, 23(05): 521–524.

[3] Chen L, Zheng L, Lai Y, 2024, Exploration of the Experience in Building a Standardized Training Base for Resident Physicians in Clinical Pathology. Chinese Journal of Graduate Medical Education, 8(04): 389–393.

[4] Zheng Q, Chen S, Zhou J, 2024, Application of Direct Observation of Procedural Skills in Teaching Pathology Specimen Collection. Chinese Journal of Pathology, 53(06): 637–640.

[5] Wang W, Chen L, Shi H, 2025, Research on the Application of Hierarchical Progressive Teaching Model in Pathology Residency Training. Chinese Journal of Graduate Medical Education, 9(02): 156–159.

[6] Zhang Y, Li J, 2025, Impact of Standardized Gross Specimen Collection Teaching on the Diagnostic Ability of Pathology Residency Trainees. Chinese Journal of Clinical and Experimental Pathology, 41(01): 115–117.

[7] Li J, Zhao J, Yang X, 2024, Practice of Teaching Reform in Pathology Specimen Collection Based on Clinical Competency. Medical Education Management, 10(02): 215–219.

[8] Wu J, Lin X, Fang M, 2025, Application Effect of a Closed-Loop Assessment System in Basic Skills Teaching for Pathology Residency Training. Clinical Pathology Journal, 13(03): 401–404.

[9] Zhou H, Sun X, Chen L, 2024, Practical Reflections on the Standardized Training of Professional Competence and Basic Skills for Pathology Residency Physicians. China Continuing Medical Education, 16(18): 145–148.