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Advances and Prospects of Case-Based Learning in Clinical Dermatovenereology Education

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Abstract

Dermatovenereology, as a cornerstone discipline in clinical medical education, is characterized by its extensive morphological diversity, complex pathophysiology, and high clinical specificity. However, traditional lecture-based pedagogical approaches are often insufficient to address the discipline's dynamically evolving knowledge base, heterogeneous disease presentations, and the demand for multidimensional clinical reasoning. In response to these challenges, Case-Based Learning (CBL) has emerged as a pivotal educational reform strategy. By leveraging authentic clinical case narratives, CBL effectively activates learners' intrinsic motivation, fosters higher-order clinical reasoning, and enhances collaborative problem-solving capabilities. This review synthesizes current evidence regarding the theoretical foundations, practical implementation strategies, and educational outcomes associated with CBL within dermatovenereology curricula. Grounded in modern educational theories, including Bloom's taxonomy and situated cognition, CBL employs carefully designed clinical scenarios with structured problem-chain frameworks to integrate three core competency domains: case deconstruction, differential diagnosis, and therapeutic decision-making. Essential instructional components encompass structured controversial case discussions, multidisciplinary team (MDT)-based simulations, and clinical-translational reasoning mechanisms. Accumulated evidence indicates that CBL significantly improves learners' proficiencies in lesion interpretation, diagnostic efficiency, evidence-based decision-making, teamwork, and enhancing professional identity formation. Nevertheless, sustainable integration of CBL faces challenges related to pedagogical systematization, faculty development, learner adaptation, and technological support. Future efforts should focus on building a resilient dermatology talent cultivation system through optimized instructional design, intelligent tutoring systems, and competency-oriented assessments.

Keywords Dermatovenereology; Case-Based Learning (CBL); Clinical reasoning; Medical education

Dermatovenereology occupies a critical position in clinical medical education, integrating the specialized knowledge domains of dermatology and sexually transmitted infections through a unique triadic framework encompassing "pathogenic mechanisms–clinical manifestations–diagnostic and therapeutic strategies"[1]. The discipline demands not only the acquisition of extensive visual pattern recognition

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skills but also the ability to synthesize clinicopathological correlations and formulate patient-specific management plans. However, the rapid expansion of medical knowledge, increasing complexity of disease presentations, and growing societal expectations for versatile medical professionals have highlighted significant limitations inherent in traditional didactic teaching methodologies[2]. These approaches often prioritize factual recall over critical reasoning, thereby leaving graduates underprepared for real-world clinical challenges such as diagnosing polymorphic skin diseases, interpreting evolving biomarker evidence, and navigating therapeutic dilemmas.

In response to these pedagogical shortcomings, situated Case-Based Learning (CBL) has been increasingly adopted as an innovative instructional strategy in dermatovenereology education[3]. Rooted in action learning theory and constructivist paradigms, CBL utilizes narrative clinical cases that simulate authentic decision-making environments, thereby effectively bridging the theory–practice gap[4]. By engaging learners in iterative cycles of problem identification, information gathering, and collaborative reasoning, CBL fosters the development of adaptive expertise and clinical maturity. This article provides a comprehensive examination of the theoretical underpinnings, core instructional components, empirical outcomes, and prospective directions of CBL within dermatovenereology training, offering evidence-based insights for educators seeking to implement or refine case-oriented curricula.

1 Theoretical Foundations and Core Constructs of CBL

The application of CBL in dermatovenereology is underpinned by the convergence of educational theories, including Bloom's taxonomy of learning objectives, situated cognition theory, and adult learning principles[3]. These frameworks collectively support a shift from passive knowledge transmission towards active, contextualized, and participatory learning experiences. The essence of CBL can be conceptualized through three fundamental educational transformations:

Firstly, CBL facilitates a transition from linear, discipline-centered instruction to multi-dimensional, integrative learning anchored in real clinical scenarios. This approach mirrors the non-linear and often ambiguous nature of medical practice, where information is incomplete and decisions often must be made under conditions of uncertainty[5].

Secondly, it repositions learners from passive recipients of information to active agents in the clinical decision-making process. By assuming responsibility for evaluating evidence, prioritizing differential diagnoses, and formulating management plans, students thereby develop a sense of agency and professional identity[6].

Thirdly, CBL elevates instructional focus from mere factual acquisition to the cultivation of higher-order cognitive skills, particularly clinical reasoning, judgment, and reflective practice. By engaging repeatedly with complex cases, learners internalize structured approaches to lesion interpretation, differential diagnosis, and evidence-based therapeutic selection[7].

The core objective of CBL is to construct a cognitive scaffold that guides learners along the trajectory of "clinical presentation → problem identification → diagnostic investigation → therapeutic decision." This scaffold supports deliberate practice and promotes the transfer of learning from classroom settings to actual clinical environments.

2 Core Components of CBL in Dermatovenereology

2.1 Three-Dimensional Clinical Reasoning Framework

A hallmark of effective CBL in dermatovenereology is the integration of three complementary dimensions: case deconstruction, differential analysis, and evidence-informed decision-making. Well-constructed cases

—for example, a progressive case of psoriasis—prompt learners to actively correlate foundational knowledge (e.g., immunogenetic mechanisms involving IL-23/Th17 axis activation) with evolving clinical manifestations (e.g., the development of erythematous-scaly plaques, nail pitting, or arthritic symptoms)[6]. Such immersive training enhances pattern recognition, improves diagnostic accuracy, and strengthens their ability to tailor treatments based on disease severity, patient comorbidities, and psychosocial context.

2.2 Stratified Cultivation of Higher-Order Cognition

To address knowledge evolution and clinical controversy, CBL incorporates stratified cases with intentional diagnostic or therapeutic dilemmas. For instance, cases focusing on biologic therapies for psoriasis may introduce conflicts related to pharmacoeconomics, long-term safety profiles, and individual patient variability[5]. Learners are compelled to engage with current literature, appraise evidence quality, and construct individualized decision trees. Similarly, cases involving emerging diseases (e.g., novel drug eruptions or tropical dermatoses) employ dynamic models that simulate natural disease progression, fostering adaptive reasoning and interdisciplinary knowledge integration[7].

2.3 Multidisciplinary Team (MDT) Competency Development

Modern dermatovenereology increasingly relies on collaborative care models. CBL supports this through MDT simulations that follow a structured pathway of "Information Integration → Role Clarification → Consensus Building"[8]. In a case involving cutaneous lymphoma, for example, learners may assume roles as dermatologists, pathologists, oncologists, or radiation specialists to collaboratively navigate from clinical and histopathological evaluation to staged treatment planning. Supplemented by Standardized Patient (SP) encounters and assessed via communication frameworks such as SEGUE, this approach measurably enhances interpersonal skills, role awareness, and team efficiency[5].

2.4 Theory–Practice Translation in Clinical Contexts

A key strength of CBL is its emphasis on knowledge application within authentic clinical contexts[9]. In cutaneous oncology education, for instance, digital pathology platforms enable learners to visually correlate histopathological features (e.g., Breslow depth in melanoma) with clinical staging and molecular profiling, thereby constructing management chains that integrate surgical, medical, and immunological strategies[10]. Such exercises bridge foundational science and clinical practice, reinforcing the relevance of biomedical knowledge in patient care.

2.5 Intelligent Educational Support Systems

Technology plays an increasingly vital role in scaling and enhancing CBL implementations by providing sophisticated tools that support personalized and immersive learning. Adaptive learning platforms utilize algorithms to analyze individual learner performance and automatically deliver tailored case sequences, thereby targeting specific knowledge gaps and promoting efficient mastery of core concepts. Furthermore, extensively integrated dermatoscopic and dermatopathological image repositories offer high-quality, annotated visual materials that are critical for self-directed learning and pattern recognition development. Emerging technologies, such as virtual reality (VR) dermoscopy simulators and cloud-based virtual diagnostic trainers, create realistic, low-stakes environments for developing and refining procedural skills and diagnostic reasoning. These systems enable repeated deliberate practice without patient risk, provide automated performance feedback, and support the gradual acquisition of visual literacy and diagnostic confidence, which are essential for clinical competency in dermatovenereology[7].

3 Evaluation of CBL Implementation Outcomes

A growing body of evidence supports the multi-dimensional benefits of CBL in dermatovenereology education:

3.1 Structural Enhancement of Clinical Reasoning

Immersive case-based training significantly enhances systematic history-taking, accurate morphological assessment, diagnostic test selection, and logical differential construction. Learners become proficient in applying algorithmic "rule-out/verify" models (e.g., distinguishing pityriasis rosea from secondary syphilis) and demonstrate improved diagnostic accuracy and therapeutic appropriateness, as widely documented through preceptor evaluations and objective structured clinical examinations (OSCEs)[6].

3.2 Effective Activation of Deep Learning & Knowledge Integration

Complexity-graded cases serve as a powerful catalyst for interdisciplinary knowledge synthesis and self-directed inquiry. In the context of a case on atopic dermatitis, for instance, learners are prompted to dynamically integrate foundational concepts from skin barrier biology, immunopathogenesis (with an emphasis on Th2 polarization and cytokine networks), microbiome dysbiosis, and environmental triggers—drawing upon principles from genetics, immunology, microbiology, and epidemiology. This integrative reasoning process stimulates active engagement with current literature, including critical appraisal of clinical guidelines and systematic reviews. Furthermore, it encourages the innovative application of emerging scientific knowledge, such as leveraging pharmacogenomics to assess individual risk of severe cutaneous adverse drug reactions, thereby bridging molecular insights with personalized therapeutic decision-making[7]. Such intellectual activities not only consolidate memory through contextualization but also foster the development of a sophisticated, flexible knowledge architecture essential for expert clinical practice.

3.3 Holistic Development of Professionalism

CBL naturally embeds opportunities for professional identity formation through ethical dilemmas (e.g., resource allocation in toxic epidermal necrolysis), role-playing (e.g., breaking bad news in melanoma), and chronic disease management simulations (e.g., addressing quality of life in chronic urticaria). These experiences significantly elevate professional commitment, ethical sensitivity, and empathetic communication. Learners' decision-making paradigms evolve from isolated biomarker interpretation to holistic patient-centered care, from passive protocol compliance to proactive process optimization, and from technical focus to integrated health advocacy[8].

3.4 Innovation in Pedagogy & Educator–Learner Dynamics

CBL transforms traditional educational dynamics by establishing a cyclical learning process of "Problem Identification → Knowledge Construction → Practice Validation." Digital platforms enable instructors to monitor cognitive processes (e.g., tracing patterns in dermoscopic image interpretation) and provide timely feedback. Importantly, the roles of educators and learners are reconceptualized: educators act as facilitators and cognitive coaches, while students become proactive architects of their own knowledge and clinical competence[9].

3.5 Sustainable Educational Impact

Longitudinal studies suggest that CBL-trained learners exhibit superior clinical performance during clerkships and residency, as reflected in structured case presentations, rigorous diagnostic reasoning, evidence-

based treatment planning, and proactive engagement with complex clinical problems. Early and repeated exposure to authentic cases also strengthens professional identity, intrinsic motivation, and career commitment in dermatology[10].

4 Challenges and Future Directions

Despite proven efficacy, the scaling of CBL in dermatovenereology faces key challenges: pedagogical frameworks require further systematization; faculty capabilities in scenario design, facilitation, and cognitive coaching need enhancement; learner adaptability to active inquiry models demands support; and optimized resource allocation and assessment systems are essential for sustainability. Future development should prioritize the following:

4.1 Building a Case Resource Ecosystem

A collaborative, dynamic, and interdisciplinary case development mechanism should be established by incorporating contributions from clinicians, educators, and researchers. Core repositories should include classic dermatoses, complex or rare diseases, and cases highlighting technological applications (e.g., teledermatology, AI-assisted diagnosis). Inter-institutional alliances and national case design competitions can foster resource sharing and quality improvement.

4.2 Deepening Technology Integration

Intelligent learning platforms should be leveraged to support blended CBL workflows: pre-class preparation using virtual pathology libraries, in-class decision-tree simulations with real-time analytics, and post-class reinforcement through adaptive spaced repetition. Dual-track models combining online deep discussion with offline practical validation can accommodate diverse learning styles and logistical constraints.

4.3 Refining Tiered Clinical Competency Development

A progressive developmental pathway should be structured to guide learners from foundational skills (e.g., SP interviews, basic lesion diagnosis) through intermediate MDT simulations (e.g., managing complex medical-dermatological cases) to advanced real-world patient management (e.g., longitudinal care of chronic diseases). Therefore, practical training infrastructure—including simulation labs, dermoscopy stations, and digital pathology platforms—must be expanded to support this tiered approach.

4.4 Reconstructing Multidimensional Assessment

Innovative assessment models should encompass not only knowledge acquisition but also case analysis depth, clinical decision quality, teamwork efficacy, and professional behavior. E-portfolios can document developmental trajectories, while qualitative analysis and narrative feedback support continuous improvement. Multisource assessments involving peers, instructors, standardized patients, and self-reflection provide a comprehensive evaluation of competencies.

4.5 Strengthening Competency Alignment and Institutional Collaboration

CBL curricula must be closely aligned with dermatologist competency frameworks and certification requirements. University-hospital partnerships should be deepened through dedicated teaching clinics and rotational placements, thereby ensuring seamless integration of education and practice. Additionally,

emerging technologies such as AI, VR, and AR should be harnessed to create immersive simulations of complex dermatological conditions, enhancing experiential learning and diagnostic confidence.

5 Conclusion

Case-Based Learning has significantly revitalized dermatovenereology education by promoting clinical reasoning through authentic scenarios, fostering evidence-based practice through iterative problem-solving, and shaping collaborative professionalism through team-based inquiry. Its implementation represents a clear paradigm shift from static knowledge transmission to dynamic competency development, effectively bridging the gap between medical education and clinical practice.

To fully realize the potential of CBL, ongoing efforts must address existing challenges in pedagogical design, faculty development, technological integration, and outcome assessment. Through sustained innovation and collaboration, educators can build a robust, scalable, and adaptive CBL model that cultivates a new generation of dermatologists equipped with advanced clinical expertise, strong scientific curiosity, and profound humanistic care.

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