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Interdisciplinary integration: the source of innovation and development in legal medicine

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Legal Medicine integrates a knowledge framework, an academic structure, a disciplinary framework, and a technical system. It is fundamentally oriented toward serving the national judicial system by providing scientific evidence for cases involving Biological Identities. Given the complexity and diversity of biological entities, Legal Medicine inherently possesses strong practical applicability and a pronounced multidisciplinary nature.

Given the rapid advances in information technology and artificial intelligence, legal medicine imposes increasingly stringent demands on evidence, with growing emphasis on systematic integrity and logical coherence throughout the entire process of evidence generation and interpretation. Particularly with the continuous emergence of complex and novel types of crimes, reliance on a single discipline (such as forensic pathology, clinical forensic medicine, forensic genetics, or forensic toxicology) is no longer sufficient. Therefore, it is both urgent and essential to further strengthen interdisciplinary research in Legal Medicine, foster more original research outcomes, and better serve the demands of judicial practice.

A review of the global development of forensic science reveals that many of its core identification theories and techniques originated from other disciplines and were subsequently adapted for forensic application[1]. Notable examples include fingerprint identification[2], the ABO blood group system[3], DNA profiling[4], PCR technology[5], toxicological analysis[6], molecular pathology[7], clinical electrophysiology[8], virtual autopsy and forensic imaging[9], as well as AI-based biological age estimation[10]. In essence, forensic science has continuously advanced through interdisciplinary integration with fields such as biology, chemistry, and physics, evolving from a basic identification system into a highly sophisticated technological framework. This evolution has not only established the modern scientific foundation of forensic science but also significantly improved the objectivity, reliability, and precision of forensic evidence. Therefore, strengthening interdisciplinary collaboration and generating original innovations through such

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integration should be regarded as a key direction for future forensic research.

Interdisciplinary research is essential for breaking down barriers between disciplines and knowledge systems, fostering methodological innovation and technological breakthroughs, thereby propelling the development of Legal Medicine. Future interdisciplinary research in Legal Medicine should primarily focus on the following areas:

(1) **Cross-disciplinary collaboration among subfields of Legal Medicine.** For instance, the integration between forensic pathology and forensic toxicology can improve the evaluation of poisoning-related deaths. This challenge is particularly pronounced when histopathological evidence is scarce, leading to an over-reliance on toxicological findings at the expense of a thorough assessment of morphological and organ-level changes. Similarly, collaboration between clinical forensic medicine and forensic psychiatry can provide critical support in assessing the causal relationship between injury and disease, particularly in cases involving brain injury in patients with mental disorders.

(2) **Integration of Legal Medicine and Clinical Medicine**. Interdisciplinary research that integrates forensic pathology with neuroscience and cardiovascular medicine offers a promising approach to addressing key challenges in medico-legal evaluation. Such integration not only helps establish the causal relationship between traumatic brain injury and pre-existing conditions such as hypertension-related cerebrovascular disease, but also clarifies the relationship between disease and injury in cases of sudden cardiac death. This is particularly relevant in so-called "negative autopsy" cases where conventional autopsy findings are inconclusive. In an era of highly advanced medical science and technology, it is reasonable to believe that collaborative interdisciplinary research between forensic and clinical medical scientists can yield more robust and defensible evidence in negative autopsy cases.

(3) **Integration of Legal Medicine and Biology**. The scope of forensic identification extends beyond human-related analyses to include species identification and kinship analysis in animals and plants[11,12], giving rise to challenges, particularly in cross-species forensic investigations. Addressing these challenges requires strengthened integration with biological sciences to refine methodologies for kinship analysis and individual identification in forensic contexts.

(4) **Convergence of Legal Medicine with Science and Engineering**. The development of forensic-specific instruments and core technologies cannot be achieved solely within Legal Medicine. Collaborative efforts with engineering and applied sciences are essential. Notable examples include the development of postmortem imaging techniques[13], as well as neuroelectrophysiological techniques[14] and devices designed to objectively assess and detect exaggerated or feigned neurological dysfunction in areas such as muscle strength, joint mobility, male sexual function, urinary and bowel function, vision, and hearing. Additionally, artificial intelligence and big data technologies can support the development of forensic software for a range of applications, including ocular injury assessment[15], brain injury evaluation[16], age estimation in living individuals[17], and medical dispute analysis.

(5) **Integration of Legal Medicine with Humanities and Social Sciences (e.g., Law and Ethics)**. This primarily involves research in forensic ethics, forensic humanities, and forensic jurisprudence. Such work supports the standardization of forensic practice, quality control in the application of new technologies, and the clear definition of ethical boundaries. Moreover, incorporating humanistic perspectives can introduce a more humane dimension to the inherently technical and objective nature of Legal Medicine.

(6) **Strengthening International Exchange and Cooperation**. Unlike clinical medicine or life sciences, Legal Medicine exhibits considerable cross-national variation in its disciplinary systems, talent cultivation models, and forensic identification framework. Therefore, engaging in international collaboration and exchange is of great significance not only for resolving transnational cases, but also for improving the quality of talent cultivation and promoting the overall development of the discipline.

In summary, forensic practice requires interdisciplinary theories and technologies. Accordingly, researchers from multiple disciplines must strengthen collaboration to address practical challenges in forensic identification, generate original scientific contributions, and ultimately advance Legal Medicine.

DECLARATIONS

Authors' contributions

Conceived the framework and scope of the Perspective: Cong B, Chen T
Drafted the initial manuscript, curated the literature, and prepared the examples: Chen T
critically revised the manuscript for important intellectual content and provided supervision: Cong B

Availability of data and materials

Not applicable

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During the preparation of this manuscript, the AI tool ChatGPT (version 5.2, released 2025-12-11) was used solely for language editing. The tool did not influence the study design, data collection, analysis, interpretation, or the scientific content of the work. All authors take full responsibility for the accuracy, integrity, and final content of the manuscript.

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Conflicts of interest

Cong B is Editor-in-Chief of *Legal Medicine Research*. Chen T is Executive Editor-in-Chief of *Legal Medicine Research*. They were not involved in any steps of the editorial process, notably reviewer selection, manuscript handling, or decision-making.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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