Professional Review and Historical Perspective[a]

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Forensic Science Review's Professional Review & Historical Perspective section highlights contemporary issues and events in the profession of forensic science. To make contributions or to recommend books for review or events for listing, please contact Ray Liu (rayliu@uab.edu).

[a]The views expressed are those of the authors and do not necessarily reflect the view, the position, or the policy of *Forensic Science Review* or members of its editorial board.

FORENSIC SCIENCE AROUND THE WORLD

Upcoming Events[a]

2026 ACMT Seminar in Forensic Toxicology: Complexities in Testing, Interpretation, Litigation and Expert Testimony
(*https://education.acmt.net/forensic?emci=2e6ef4ee-4fd0-f011-8195-000d3a1d58aa&emdi=b7ba80e6-71d0-f011-8195-000d3a1d58aa&ceid=8113655*)

Jan. 20–21, 2026; Virtual
Phoenix, AZ, US

2026 Current Trends in Seized Drug Analysis Symposium
(*https:forensiceducation.cfsre.org/product?catalog=2026_Current_Trends_in_Seized_Drug_Analysis_Symposium*)

Jan. 26–30, 2026; Virtual
Horsham, PA, US

American Academy of Forensic Sciences — 78th Annual Meeting (*https://www.aafs.org/*)

Feb. 9–14, 2026; Ernest N. Morial Convention Center
New Orleans, LA, US

International Medicine and Biosciences Conference 2026 (Track: Chemistry and Biochemistry)
(*https://timbc.net/conference-track.php#*)

(Feb. 13–15, 2026)[b]; Zayed University Convention Center
Dubai, UAE

International Conference on Bloodstain Pattern Analysis in Forensics (ICBPAF-26)
(*https://iser.org.in/conf/index.php?id=100015087*)

Feb. 27–28, 2026; TBA[c]
Oslo, Norway

European Drugs Winter School 2026
(*https://www.euda.europa.eu/event/2026/03/european-drugs-winter-school-2026_en*)

Mar. 2–13, 2026; Virtual
Lisbon, Portugal

PITTCON Conference and Expo
(*https://pittcon.org*)

Mar. 7–11, 2026; Henry B. González Convention Center
San Antonio, TX, US

Medical Cannabis 2026: The 6th International Annual Congress on Controversies in Cannabis-Based Medicine
(*https://med-cannabis2026.com/general-information/*)

Mar. 9–10, 2026; Hotel Metropolo Kraków by Golden Tulip
Kraków, Poland

World Conference on Forensic Science and Research
(*https://forensicresearch.theiconicmeetings.com*)

Mar. 9–11, 2026; Hilton Garden Inn Paris La Villette; Virtual
Paris, France

18th Annual BBC (Behavior, Biology, and Chemistry) Meeting: Translational Research in Substance Use Disorders
(*https://ww2.uthscsa.edu/artt/bbc/index.asp*)

Mar. 20–22, 2026; Embassy Landmark San Antonio
San Antonio, TX, US

2026 American College of Medical Toxicology Annual Scientific Meeting
(*https://www.acmt.net/annualmeeting/*)

Mar. 20–22, 2026; Hilton Boston Park Plaza
Boston, MA, US

The SOT 65th Annual Meeting and ToxExpo
(*https://www.toxicology.org/events/am/AM2026/index.asp*)

Mar. 22–25, 2026; San Diego Convention Center
San Diego, CA, US

ACS Spring National Meeting & Exposition 2026
(*https://www.showsbee.com/fairs/62293-ACS-National-Meeting-Exposition-2026.html*)

Mar. 22–26, 2026; Georgia World Congress Center
Atlanta, GA, US

ICAMP 2026 — International Conference on Addiction Medicine, Mental Health and Psychiatry
(*https://conference.researchbib.com/view/event/166317*)

Mar. 23–26, 2026; Village Hotel Changi; Virtual
Singapore

Bode 2026 — Bode's Annual Forensic DNA Conference
(*https://www.bodeconference.com*)

Apr. 7–10, 2026; Hyatt Regency Baltimore Inner Harbor
Baltimore, MD, US

2026 Southwestern Association of Toxicologists Meeting
(*https://www.sat-tox.org/page-1417923*)

Apr. 8–10, 2026; TBA[c]
Tulsa, OK, US

2026 Addiction Medicine Conference
(*http://addiction-medicine.org/spring-conference/*)

Apr. 10–11, 2026; Renaissance Asheville Hotel; Virtual
Asheville, NC, US

International Association of Chemical Testing — 2026 Annual Conference
(*http://iactonline.org/page-1709724*)
Apr. 12–17, 2026; Hilton Cincinnati Netherland Plaza
Cincinnati, OH, US

Southern Association of Forensic Scientists — 2026 Annual Meeting
(*https://safsannualmeeting.com*)
Apr. 13–17, 2026; Hilton Head Island
Greenville, SC, US

Southeastern Association of Forensic Document Examiners
(*https://safde.org/events/*)
Apr. 21–24, 2026; Florida Department of Law Enforcement Training Center
Pensacola, FL, US

104th California Association of Criminalists Seminar
(*https://www.cacnews.org/events/seminar/seminars.shtml*)
Apr. 26–May 1, 2026; DOJ Riverside Criminalistics Laboratory
Temecula, CA, US

PainConnect 2026
(*https://painconnect.org/*)
May 5–8, 2026; Grand America Hotel
Salt Lake City, UT, US

American Psychiatric Association 2026 Annual Meeting
(*https://www.psychiatry.org/*)
May 16–20, 2026; Moscone Center
San Francisco, CA, US

American Society of Crime Laboratory Directors — 53rd Annual Symposium
(*https://www.ascld.org/ascld-annual-symposium/*)
May 17–21, 2026; DeVos Place Convention Center
Grand Rapids, MI, US

44th International Symposium on Capillary Chromatography and 21st GC×GC Symposium
(*https://www.chromaleont.it/iscc*)
May 17–22, 2026; Congress Centre
Riva del Garda, Italy

The Association of Firearm and Tool Mark Examiners — 57th Annual Training Seminar
(*https://afte.org/meetings/annual-seminars*)
May 24–29, 2026; Baltimore Marriott Waterfront
Baltimore, MD, US

IAFS 2026 — 24th Triennial Meeting of the International Association of Forensic Sciences
(*https://iafs2026.com*)
May 25–30, 2026; National Palace of Culture in Sofia
Sofia, Bulgaria

Symposia on Addictive Disorders — West Coast Symposium
(*https://hmpglobalevents.com/symposia-addictive-disorders*)
May 28–30, 2026; La Quinta Resort & Club
Palm Spring, CA, US

2026 Association for Psychological Science Annual Convention
(*https://www.psychologicalscience.org/conventions/2026-aps-annual-convention*)
May 28–30, 2026; International Barcelona Convention Center
Barcelona, Spain

74th ASMS Conference on Mass Spectrometry and Allied Topics
(*https://asms.org/conferences/annual-conference*)
May 31–Jun. 4, 2026; San Diego Convention Center
San Diego, CA, US

International Association for Identification — 109th Educational Conference
(*https://pnwdiai.org/annual-conference/*)
Jun. 2–5, 2026; ICICLE Village Resort
Leavenworth, WA, US

The College on Problems of Drug Dependence Annual Meeting
(*https://cpdd.org/meetings/current-meeting/*)
Jun. 13–17, 2026; Oregon Convention Center in Portland
Portland, OR, US

International Experts Summit on Forensic Science and Research (Forensic Research-2026)
(*https://forensic.theiconicmeetings.com/*)
Jun. 13–20, 2026; Golden Tulip Rome Piram Hotel
Rome, Italy

European Drugs Summer School 2026
(*https://www.euda.europa.eu/event/2026/06/european-drugs-summer-school-2026_en*)
Jun. 22–Jul. 3, 2026; Instituto Universitário de Lisboa
Lisbon, Portugal

Forensics Europe Expo
(*https://forensicseuropeexpo.com/*)
Jul. 1–2, 2026; Olympia London
London, UK

15th World Gene Convention 2025 (WGC 2026)
(*https://www.clocate.com/world-gene-convention-wgc/43385/*)
Jul. 22–24, 2026; Radisson Blu Seaside Hotel
Helsinki, Finland

Symposia on Addictive Disorders — Cape Cod Symposium
(*https://hmpglobalevents.com/symposia-addictive-disorders*)

Aug. 6–9, 2026; Omni Providence Hotel
Providence, RI, US

IACP Impaired Driving and Traffic Safety Conference
(*https://www.theiacp.org/IDTSconference*)

Aug. 21–23, 2026; Hilton Anaheim
Anaheim, CA, US

Midwestern Association of Forensic Scientists — 2026 Annual Meeting
(*https://mafs.net/page-18404*)

Aug. 23–28, 2026; Minneapolis Marriott City Center Hotel
Minneapolis, MN, US

Global Conference on Addiction and Psychiatry (GAB 2026)
(*https://irisconferences.co/addiction/*)

Aug. 24–26, 2026; Sheraton Skyline Hotel London Heathrow; Virtual
London, UK

From Scene to Certification: Bridging Forensic Pathology and Toxicology
(*https://www.cfsre.org/education/continuing-professional-education/online-live-education/from-scene-to-certification-bridging-forensic-pathology-and-toxicology*)

Sept. 14–17, 2026; CFSRE; Virtual
Horsham, PA, US

Society of Forensic Toxicologists/The International Association of Forensic Toxicologists — Joint Annual Meeting
(*https://www.soft-tox.org/soft-tiaft-2026*)

Sept. 19–24, 2026; Hilton Chicago
Chicago, IL, US

23rd International Congress of Therapeutic Drug Monitoring & Clinical Toxicology
(*https://www.iatdmct.org/events/iatdmct-2026-congress-rennes-september-27-30/*)

Sept. 27–30, 2026; TBA[c]
Rennes, France

Mid-Atlantic Association of Forensic Scientists/ Northeastern Association of Forensic Scientists — 2026 Annual Meeting
(*https://www.maafs.org/annual-meeting*)
(*https://www.neafs.org/neafs-annual-meeting*)

Oct. 4–8, 2026; Kalahari Resort & Conventions
Pocono Mountains, PA, US

SCIX 2026 (Annual Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies)
(*https://scixconference.org/scix-future-conferences*)

Oct. 4–9, 2026; Nugget Casino Resort
Sparks, NV, US

Robert F. Borkenstein Course on the Effects of Drugs on Human Performance and Behavior
(*https://www.cfsre.org/education/continuing-professional-education/online-live-education/borkenstein-drug-course-2026*)

Oct. 5–9, 2026; Fluno Center at UW-Madison; Virtual
Madison, WI, US

Symposia on Addictive Disorders — East Coast Symposium
(*https://hmpglobalevents.com/symposia-addictive-disorders*)

Oct. 9–11, 2026; Hilton West Palm Beach
West Palm Beach, FL, CA, US

National Association of Medical Examiners
(*https://name.memberclicks.net/future-name-annual-meetings*)

Oct. 16–20, 2026; Sheraton Kansas City Hotel at Crown Center
Kansas City, MO, US

Canadian Society of Addiction Medicine (CSAM-SMCA) Annual Meeting and Scientific Conference
(*https://csam-smca.org/events-training/events-conferences/*)

Oct. 19–21, 2026; Hyatt Regency Calgary
Calgary, AB, Canada

International Association of Chiefs of Police 2026
(*https://www.theiacpconference.org/*)

Oct. 24–27, 2026; Orange County Convention Center
Orlando, FL, US

Southwestern Association of Forensic Scientists — 48th Annual Conference (*http://swafs.us/*)

Oct. 25–30, 2026; Grand Junction Convention Center
Grand Junction, CO, US

ISHI 37: International Symposium on Human Identification
(*https://www.ishinews.com*)

Oct. 26–29, 2026; Rhode Island Convention Center
Providence, RI, US

American Academy of Forensic Sciences — 78th Annual Meeting
(*https://www.aafs.org/*)

Feb. 15–20, 2027; Rosen Shingle Creek Hotel & Convention Center
Orlando, FL, US

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[a]Click the website provided for further information of the event; if not working, copy the link to your browser and try again.
[b]Postponed; new date to be announced.
[c]TBA: To be announced.

Forensic Science in Latin America: I. South America

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Latin America (LATAM) is not a continent but a cultural region within the Americas distinguished by the predominance of languages descended from Latin, specifically Spanish and Portuguese. Contemporary definitions encompass 19 countries and 1 non-sovereign territory, unified by cultural rather than geographic criteria. Although debate persists regarding the inclusion of Francophone nations, this review adopts the most widely accepted definition: Spanish and Portuguese-speaking countries in the Americas. LATAM encompasses three subregions — South America, Central America and the Caribbean, and North America — each characterized by distinct historical trajectories and sociopolitical dynamics. This series of articles examines each subregion from a LATAM perspective, focusing on its development, identity, and challenges within the domain of forensic science.

South America, extending from 10°N to 60°S and comprising 42.9% of the American continent, possesses a rich pre-Columbian heritage, followed by European colonization and independence movements in the 19th century [1]. The 20th century introduced modernization, migration, and cycles of dictatorship with widespread human rights violations. Despite certain shared patterns, the region exhibits pronounced social, cultural, and economic diversity, necessitating a contextualized examination of its development and "historicity" [2].

Introduction

The history of forensic science in South America is closely tied to the consolidation of nation-states, formation of judicial and police systems, and adoption of scientific innovations that reshaped the concept of criminal evidence. Three major developments — *Legal Medicine*, *Criminalistics*, and *Forensic Anthropology* — have been central to this evolution.

Legal Medicine emerged in the first half of the 19th century alongside the professionalization of universities modeled on the French system. Medical schools in Argentina, Colombia, Chile, and Peru established departments that promoted advances in toxicology, forensic pathology, thanatology, and autopsy. This early integration of medical expertise into judicial processes laid the foundation for regional forensic development [3]. *Criminalistics* constituted a second major catalyst, influenced by European positivist criminology at the end of the 19th century and by rising migration and crime rates in South America. As a result, identification techniques such as photography, anthropometry, and fingerprinting were progressively incorporated into the legal practices of the countries of the region [2,4]. A decisive contribution came from Juan Vucetich, whose *Argentine dactyloscopy system* proved more reliable than European alternatives and ultimately positioned South America as a global reference for personal identification [4–6]. The third major development stemmed from physical anthropology at the beginning of the 20th century. These fields explored the morphology and evolution of pre-Hispanic populations and developed regionally specific approaches shaped by extensive ethnic mixing [1,7]. Later, in the late 20th century, these methodologies were revitalized through *Forensic Anthropology*, which became essential for identifying human remains in humanitarian investigations and clandestine mass graves [7]. Since then, South American forensic teams have gained international recognition for their technical sophistication and major contributions to human rights investigations.

Historical Development

South America has been profoundly influenced by significant social and political upheavals, including cycles of dictatorship, authoritarian regimes during the Cold War, and a persistent increase in organized violence and drug trafficking in recent decades. These conditions have prompted substantial advancements in criminal and forensic investigations, leading to the establishment of specialized laboratories, genetic databases, and international collaborative networks [2]. The initial article in this series examines 10 Latin American sovereign nations in South America — *Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Peru, Uruguay*, and *Venezuela* — whose demographic, historical, and scientific significance renders them an ideal basis for analyzing the evolution, current status, and future challenges of forensic science in the region.

Argentina

Argentina occupies a land area of 2,780,085 km², making it the second largest country in South America and the eighth largest worldwide. With a population of 46.7 million, it is the world's largest Spanish-speaking nation [8]. Argentina has played a central role in developing forensic science in this region. In the late 19th century, Juan Vucetich's fingerprint classification system established the country as a global leader in identification technologies and aligned it with European positivist criminology, which emphasized the biological determinants of criminal behavior. These ideas influenced debates on Penal Code reform and state responses to mass immigration [4]. Throughout the 20th century, the institutionalization of forensic practice advanced with the creation of the Forensic Medical Corps (CMF) under the National Supreme Court of Justice and the expansion of provincial forensic laboratories. These initiatives drove the professionalization of legal medicine and strengthened disciplines such as ballistics, document examination, and toxicology [8].

Following the return to democracy in 1983, forensic medicine and criminalistics were systematically integrated into the judiciary, Public Prosecutor's office, and security institutions. The CMF consolidated its role as the national reference body for forensic medicine, although each province maintains its own institutional structure [8]. This period also revitalized forensic anthropology and genetics for investigations into crimes against humanity. In this context, two pioneering institutions were established: the Argentine Forensic Anthropology Team (EAAF), founded in 1984 under the guidance of American forensic anthropologist Clyde Snow, and the National Genetic Data Bank, created in the same year by Law 23,511 [8,9]. Both have achieved international prominence for their roles in missing persons investigations and humanitarian missions.

Reforms toward an accusatory model began in the 1990s and culminated at the federal level in 2019. This shift has increased the relevance of scientific evidence in oral trials and necessitates rigorous documentation, validation, and reproducibility. Modernization efforts include digital case files, electronic notifications, digital signatures, and virtual hearings, although progress remains uneven across the provinces. Persistent challenges include limited interoperability, unequal capacities, and high workloads, all of which prolong evidence processing times [9,10].

Bolivia

Bolivia's tradition of legal medicine can be traced back to the establishment of its universities in 1825 and the tenure of José Passaman, who was acknowledged as the first "judicial law doctor" in the Americas. In 1859, a decree formalized the instruction and regulation of forensic medical practice. By 1889, Legal Medicine and Toxicology were integrated into medical curricula, and by 1893, all physicians were legally mandated to perform forensic duties [11]. Developments in the early 20th century institutionalized legal medicine in major cities and facilitated the establishment of rudimentary police forensic laboratories under the influence of European criminological positivism and regional forensic advancements [4].

A significant transformation occurred during the judicial reform of the 1990s, which introduced a more technical and specialized model of criminal investigation. The establishment of the National Institute of Criminal Investigations (IDIF) in 1997 solidified its role as the principal forensic institution under the Public Prosecutor's Office [11]. The IDIF has developed specialized units in legal medicine, genetics, chemistry, ballistics, document analysis, and field forensics, thereby strengthening the scientific foundations of judicial investigations [12,13]. The 1999 Code of Criminal Procedure (Law 1,970) implemented an accusatory and oral system, transforming the production and evaluation of scientific evidence [11]. Throughout the 2000s, the IDIF expanded through regional laboratories in departmental capitals, although uneven resource distribution has led to operational disparities [12,13]. The Bolivian Police also maintain their own forensic laboratories within the Special Force to Fight Crime, collaborating with the Public Prosecutor's Office and the judiciary.

Brazil

Brazil's forensic tradition can be traced back to the contributions of judicial law doctors during the monarchical period. In the late 19th and early 20th centuries, the notion of a "scientific police" emerged, characterized by the establishment of the Institutes of Forensic Medicine, Identification and Statistics Offices, Scientific Investigation Offices, and subsequently Police Technical Laboratories in Rio de Janeiro and São Paulo. This era was pivotal in laying the groundwork for contemporary forensic practices in the country [14]. However, following the 1964 coup d'état, the development of forensic science was hindered as the regime prioritized repressive structures over scientific advancements, leading to reduced investment in laboratories and academic collaborations [15].

As the largest and most populous nation in Latin America, with over 215 million inhabitants and considerable ethnic diversity, Brazil faces significant forensic challenges [16]. Public security data from 2024 indicate the magnitude of these challenges, with official statistics reporting 44,127 intentional violent deaths, 87,545 rapes, 34,974 commercial robberies, and 25,064 residential burglaries [17].

The increasing crime burden has increased the demand for effective forensic services. Forensic operations have been implemented in all states since the entry in force of Law 21,030/2009 [16]. In Brazil, forensic activities are governed by the Code of Criminal Procedure for criminal cases and the Code of Civil Procedure for civil forensic examinations.

Chile

Chile's forensic tradition emerged in the late 19th and early 20th centuries, coinciding with the formalization of legal medicine as a university discipline and its integration into the judicial system of the country. During the early 20th century, teaching hospitals in Santiago and Valparaíso incorporated forensic autopsies and clinical expertise, influenced by European discussions of judicial modernization and social hygiene [2,18]. Autopsy records from this era document the establishment of stable forensic practices, laboratories, and archival systems. The founding of the School of Medicine in 1883 marked the introduction of the first undergraduate Legal Medicine course [19,20]. A landmark case, the "Crime at the German Legation," is recognized as the first Latin American forensic odontology case, one which significantly contributed to the development of regional academic forensics [2,20]. Techniques such as judicial photography, Bertillonian anthropometry, and fingerprinting were widely disseminated throughout the Southern Cone and gradually integrated into police and judicial systems [5,6,21].

Throughout the 20th century, Chile developed a bimodal forensic system. Legal medicine, centralized within the Medical-Legal Service (SML) under the Ministry of Justice and Human Rights, assumed responsibility for thanatology, forensic clinics, toxicology, genetics, mental health, and the identification of human remains in cases of human rights violations and mass disasters [12,20]. The SML currently operates 39 offices nationwide. Criminalistics evolved within police institutions: the Carabiniers of Chile with its Criminalistics Department (LABOCAR) and the Chilean Investigative Police (PDI) with its Central Criminalistics Laboratory (LACRIM), both of which developed expertise in ballistics, document examination, friction ridge analysis, chemistry, computer forensics, and fire and explosives investigation [6]. Following the return to democracy, forensic anthropology and genetics gained prominence, particularly in the context of human rights investigations, as exemplified by the well-known Patio 29 case [20]. The Criminal Procedure Reform (2000–2005) introduced an accusatory model, oral trials, and stricter standards for scientific evidence, chain of custody, and expert cross-examination [20]. Law 19,970 (2004) established the National DNA Registry System, strengthening forensic genetics and coordination among SML, PDI, and Carabiniers laboratories, thereby establishing a regional benchmark [9,20].

Colombia

The origins of forensic science in Colombia can be traced back to the 19th century when legal medicine was institutionalized within the National Academy of Medicine, University of Antioquia (UdeA), National University of Colombia (UNAL), and university hospitals, drawing upon European scientific and judicial models [3,22]. In the early 20th century, identification procedures such as judicial photography, anthropometry, and fingerprinting were developed, aligning with broader regional trends [21]. The establishment of the Central Office of Legal Medicine in 1914 served as a precursor to the National Institute of Legal and Forensic Sciences (INMLCF), which was reorganized in 1991 following constitutional reforms [3,12,22–24].

Colombia's extended history of political violence and internal armed conflict has significantly influenced its forensic policies. The country has documented over 270,000 homicides, 7.5 million displaced persons, 32,000 kidnappings, 29,000 sexual assaults, and nearly 49,000 enforced disappearances [23,25]. In this context, the INMLCF and various forensic anthropology laboratories have assumed a central role in identifying missing persons through archaeological, genetic, and osteological methods, collaborating closely with the Search Unit for Missing Persons (UBPD) [1,9,23]. Colombia is now regarded as a regional leader in the application of forensic anthropology to human rights investigations, although this expertise has largely emerged from practical necessity rather than an established academic tradition [9,16,23].

Ecuador

The evolution of criminalistics and forensic science in Ecuador exemplifies the interplay between state modernization, judicial reforms, and the increasing integration of applied sciences into the justice system [4,21]. Their earliest recorded milestones trace back to the early 20th century with the introduction of Legal Medicine at the Central University of Ecuador (UCE), significantly influenced by the French medicolegal tradition and Latin American positivist criminology. During this era, university hospitals emerged as pivotal centers for forensic practice, with autopsies and medical toxicology as the cornerstones of judicial investigations [26].

By the 1960s, Ecuador had established its initial police forensic laboratories, initially within the Judicial Police and subsequently under the National Police of Ecuador. These laboratories were staffed by officers trained in Argentina who specialized in ballistics, handwriting analysis, and judicial photography [12,26]. A significant transformation occurred with the 2000 criminal procedure reform, which adopted an accusatory and oral model. This reform underscored the significance of expert testimony and scientific evidence, thereby strengthening the profes-

sionalization, standardization, and institutional status of forensic services nationwide [27,28]. Consequently, the National Service of Legal Medicine and Forensic Sciences (SNMLCF) was established in 2015, followed by the establishment of the National Directorate of Technical and Scientific Police Investigation (DINITEC) in 2019. Since 2014, Ecuador has maintained a national DNA database comprising approximately 650 profiles of missing persons and 800 genetic profiles of unidentified remains. However, specific legislation was not enacted until 2020 to regulate the management of the national genetic database under the SNMLCF [9].

Paraguay

Paraguay is a landlocked country distinguished by robust cultural continuity rooted in Guaraní–Spanish bilingualism and a mixed heritage shaped by centuries of social and political upheaval. Its development has been profoundly influenced by devastating armed conflicts. The War of the Triple Alliance (1864–1870) resulted in a population reduction of nearly 70%, causing a severe intellectual and institutional rupture that delayed the establishment of higher education until the creation of the National University of Asunción (UNA) in 1889 [29].

The Paraguayan Police, established in 1843 [30], was one of the earliest state institutions. Legal Medicine developed in the late 19th century within the UNA School of Medicine, influenced by Argentine and Brazilian academic models [4]. Autopsies, toxicology, and forensic psychiatry have gradually become essential judicial tools. However, the 20th century was marked by prolonged instability: the Chaco War (1932–1935) with Bolivia — South America's largest interstate conflict of the century — and the 1947 civil war, which eventually led to Alfredo Stroessner's dictatorship (1954–1989), a period defined by isolation, censorship, and widespread human rights violations [31].

Throughout much of the 20th century, criminalistics evolved primarily within the National Police, with laboratories focusing on identification, ballistics, and document examination. Following democratization, particularly from the 1990s onward, Paraguay initiated reforms aimed at professionalizing criminal investigations and integrating scientific disciplines into judicial proceedings [30]. The Code of Criminal Procedure (Law 1,286/1998) established an accusatory and oral system, strengthening the role of experts and the evaluation of scientific evidence.

Peru

Peru, the third-largest nation in South America, boasts one of the world's most profound civilizational histories, shaped by successive waves of ancient cultures and centuries of ethnic and cultural amalgamation. The contemporary Peruvian population is a cultural mosaic comprising Mestizo, Amerindian, European, African, and Asian ancestries. Despite this diversity, the nation has experienced significant economic and social upheaval, contributing to the emergence of violent insurgent movements.

The origins of forensic science in Peru can be traced back to the 19th century, coinciding with state modernization and the professionalization of the judiciary. In 1892, the Identification Office was established, initially adopting the Bertillonage system, which was subsequently replaced in 1915 by Juan Vucetich's fingerprint method and again in 1924 by the system introduced by Spanish criminologist Federico Olóriz Aguilera as part of a broader police modernization initiative. The first Criminalistics Laboratory was established in 1937 under the Investigation, Surveillance, and Identification Corps, the precursor to the Peruvian Investigative Police [32].

Peru has also made pioneering contributions to forensic sciences. The National University of San Marcos (UNMSM), the oldest university in South America, introduced its first Legal Medicine and Medical Ethics course in 1856, with earlier attempts dating back to 1835. In 1903, Italian-Peruvian physician Ugo Biffi, director of the Lima Institute of Hygiene, made seminal contributions to serology and forensic identification in advance of European developments. Law 2,949 (1918) formally recognized the role of the "judicial law doctor" and the establishment of the Central Morgue of Lima, recognized by contemporary authors as the first forensic institute in South America, marking the inception of institutionalized forensic science [33,34].

The "Leónidas Avendaño Ureta" Institute of Legal Medicine (IML) was formally established in 1985 (Law 24,128), centralizing training for forensic experts under the Public Prosecutor's Office, together with the National Police's Criminalistics Directorate (DIRCRI), which trains officers across diverse forensic specialties, pursuant to Legislative Decree No.1,219 [12]. The growing demand for forensic services and criminal procedural reform prompted the creation of the Public Prosecutor's Office of Experts in 2019, focusing on crimes such as corruption, money laundering, drug trafficking, and organized crime [35,36].

Two critical factors have fueled Peru's recent forensic expansion. First, internal armed conflict (1980–2000) resulted in thousands of disappearances and extrajudicial executions, driving advances in forensic anthropology and the excavation of mass graves [37]. Second, the criminal procedure reform (2006–2021) introduced an accusatory–adversarial system, transitioning Peru toward a more technical, transparent, and scientifically grounded justice model [38].

Uruguay

Uruguay, a small nation in the Southern Cone with a population predominantly residing in Montevideo, consistently demonstrates social and health indicators superior to those of many of its regional counterparts [39]. The country's forensic and criminalistics history can be traced back to 1877 with the establishment of the Chair of Legal Medicine at the University of the Republic (UDELAR), which was influenced by French and Argentine academic traditions. In the early 20th century, legal medicine was institutionalized within university hospitals, incorporating autopsies, toxicology, and forensic psychiatry into judicial procedures [39].

Throughout the 20th century, Uruguay enhanced its criminal investigation capabilities by establishing the National Bureau of Technical Police, now known as the National Scientific Police Directorate (DNPC). The DNPC has gradually emerged as a regional leader in applied forensic sciences, adopting advanced comparative and identification techniques. The Forensic Technical Institute (ITF), a component of the judiciary, was organized into four divisions: Forensic Medicine, Medical Criminology, Identification, and Chemistry/Toxicology, with the last of these becoming a regional pioneer in 1995 [1,12,39]. Courts may also seek technical support from UDELAR, particularly for specialized analysis. Despite these advancements, certain specialized procedures, including forensic chemistry, toxicology, histopathology, and anthropology, must be conducted in central laboratories in Montevideo, limiting nationwide coverage [12]. In 2011, Uruguay established the National Registry of Genetic Profiles under the DNPC, which was later expanded in 2018 into two components: the Evidence DNA Database and the Criminal Identification DNA Database. This system is now one of the largest in South America, surpassed only by Brazil and Chile [9].

Judicial reforms in the 1990s and the 2000s enhanced the role of scientific evidence in criminal trials. The 2017 Code of Criminal Procedure (Law No. 19,293) instituted an accusatory and oral model that clarified the rules for producing, contesting, and evaluating expert evidence [40,41]. In response, the ITF and DNPC implemented updated chain-of-custody protocols and procedures aligned with international standards in coordination with the Attorney General's Office [40].

Venezuela

Legal medicine in Venezuela originated formally in the late 19th century. In 1895, the Central University of Venezuela (UCV) established a Chair of Pathology, supported by a legal decree that created an institutional framework for forensic practice. In 1937, the Caracas Institute of Legal Medicine was founded under the Ministry of Justice through Decree 5,131, which provided forensic medical services to the judiciary. Beginning in 1942, Forensic Medical Offices were established nationwide, contributing to the decentralization of forensic services and strengthening national judicial capacity [42]. In 1958, following significant political upheaval, the Technical Corps of the Judicial Police (CTPJ) was created under the Ministry of Justice, integrating forensic medical services and becoming the country's principal law-enforcement body. However, its dual dependence on the executive and judicial branches created institutional tensions [43]. Under subsequent legal reforms during the Chávez administration, the CTPJ was reorganized in 2001 into the Scientific, Criminal, and Criminalistics Investigations Corps (CICPC), which consolidated forensic functions within criminal investigations [12,44]. Although legal medicine and criminalistics have become fundamental components of the justice system, their credibility has been challenged by high levels of impunity, corruption, weakened institutional autonomy, and pervasive public distrust [45].

Current Status

The current state of forensic science in South America is characterized by a complex yet increasingly coordinated interaction among medico-legal institutions, police-based forensic services, academic programs, and emerging professional organizations. Despite variations in structure, maturity, and resource allocation across countries, regional trends indicate a movement toward progressive institutional consolidation, enhanced specialization, and efforts to standardize technical practices. **Table 1** provides a summary of these contemporary arrangements, offering a comparative overview of the operational, educational, and professional components that shape forensic capacity in the region.

Operational Agencies

Throughout South America, current operational frameworks reflect the historical trajectories previously outlined, now functioning within more explicit judicial and police coordination structures. In Argentina, judiciary-based medico-legal services are combined with provincial criminalistics laboratories, maintaining coverage through a hybrid model that integrates the CMF, Public Prosecutor Office units, and provincial institutes. The National Public Prosecutor's Office supervises the General Directorate of Investigations and Technological Support for Criminal Investigations (DATIP), which includes laboratories

Table 1. Summary of main operational agencies, educational institutions, and professional organizations in South American countries

Country	Primary agency	Educational institution (university/training agency)	Professional organization/journal
Argentina[a]	CMF; FPPFS; DATIP	UBA; IUSE; IUV; state and private universities; judiciary and Ministry of Justice training units	EAAF; AMFRA; SADOL; other forensic societies
Bolivia[b]	IDIF; IITCUP	IDIF; UNIPOL; ANAPOL; police forensic training units; public and private universities	Regional medico-legal and criminalistics associations
Brazil[c]	SSP; FPFS	SENASP; FPNTC; ACF; AESP-CE; ACADEPOL-RJ; other state academies; private programs	State-level forensic councils; regional forensic societies
Chile[d]	SML; LABOCAR; LACRIM	UCh; regional universities; SML training divisions; police academies (Carabiniers of Chile and PDI)	Medico-legal societies; human-rights forensic networks
Colombia[e]	INMLCF; CTI; DIJIN	UNAL; UdeA; INMLCF programs; CTI and DIJIN academies	Forensic anthropology groups; collaboration with UBPD; regional forensic associations
Ecuador[f]	SNMLCF; DINITEC	UCE; PUCE; CECPOL; Public Prosecutor's Office training units	Regional medico-legal and expert associations
Paraguay[g]	National Police (criminalistics)	UNA; ISEPOL; limited forensic training units	Regional medico-legal and expert associations
Peru[h]	IML; DIRCRI	UNMSM; Prosecutor's Office training centers; police schools; forensic anthropology units	Regional expert associations focused on forensic anthropology and identification
Uruguay[i]	DNPC; ITF	UDELAR; DNPC programs; judicial training centers	UDELAR–DNPC–ITF network; medico-legal societies
Venezuela[j]	SENAMECF; CICPC	UCV; UC; UNES; National School of Prosecutors; CICPC academies; medico-legal instruction units	Regional organizations weakened by institutional instability

[a] CMF: Forensic Medical Corps; FPPFS: Federal and Provincial Police Forensic Services; DATIP: General Directorate of Investigations and Technological Support for Criminal Investigations; UBA: University of Buenos Aires; IUSE: University Institute of Security of the City; IUV: Juan Vucetich University Institute; EAAF: Argentine Forensic Anthropology Team; AMFRA: Association of Forensic Physicians of the Argentine Republic; SADOL: Argentine Society of Legal Odontology; APFRA: Association of Forensic Psychologists of the Argentine Republic.

[b] IDIF: National Institute of Criminal Investigations; IITCUP: Technical and Scientific Research Institute of the Police University; UNIPOL: Police University "Mcal. Antonio Jose de Sucre"; ANAPOL: National Police Academy.

[c] SSP: State Scientific Police; FPFS: Federal Police Forensic Service; SENASP: National Secretariat of Public Security; FPNTC: Federal Police National Training Center; ACF: Academy of Forensic Sciences in Paraná; AESP-CE: State Academy of Public Security in Ceará; ACADEPOL-RJ: Silvio Terra State Police Academy in Rio de Janeiro.

[d] SML: Medical-Legal Service; LABOCAR: Carabiniers of Chile's Criminalistics Department; UCh: University of Chile; PDI: Chilean Investigative Police; LACRIM: PDI Central Criminalistics Laboratory.

[e] INMLCF: National Institute of Legal and Forensic Sciences; CTI: Technical Investigation Corps; DIJIN: Criminal Investigation Branch; UNAL: National University of Colombia; UdeA: University of Antioquia; UBPD: Search Unit for Missing Persons.

[f] SNMLCF: National Service of Legal Medicine and Forensic Sciences; DINITEC: National Directorate of Technical and Scientific Police Investigation; UCE: Central University of Ecuador; PUCE: Pontifical Catholic University of Ecuador; CECPOL: National Police Training Center.

[g] UNA: National University of Asunción; ISEPOL: Higher Institute of Police Education.

[h] IML: "Leónidas Avendaño Ureta" Institute of Legal Medicine; DIRCRI: National Police's Criminalistics Directorate; UNMSM: National University of San Marcos.

[i] DNPC: National Scientific Police Directorate; ITF: Forensic Technical Institute; UDELAR: University of the Republic.

[j] SENAMECF: National Service of Forensic Medicine and Sciences; CICPC: Scientific, Criminal, and Criminalistics Investigations Corps; UCV: Central University of Venezuela; UC: University of Carabobo; UNES: National Experimental University of Security.

specializing in genetics, ballistics, document analysis, and computer science [46]. Argentina's federal justice system, comprising the nation, 23 provinces, and the Autonomous City of Buenos Aires, operates under diverse procedural frameworks, complicating efforts to standardize data.

Similarly, Chile maintains a mature dual structure in which the SML manages medico-legal practice nationwide, and the LABOCAR and LACRIM support investigative criminalistics.

Uruguay retains one of the region's most stable configurations through the DNPC and ITF, with a long tradition of integrating forensic genetics, anthropology, and toxicology into judicial procedures [8–10,20,39].

In Bolivia, the IDIF remains the central pillar for medico-legal and laboratory services, complemented by police criminalistics units that continue to absorb substantial operational demand (the Technical and Scientific Research Institute of the Police University [IITCUP] is the sole entity authorized to assess and issue forensic reports).

Ecuador's SNMLCF and DINITEC operate within a progressively consolidating judicial–police framework, although national coverage continues to face logistical challenges.

Paraguay's Attorney General's Office leads medico-legal activities with support from National Police laboratories, while Peru sustains a dual but articulated system between the IML and DIRCRI of the National Police, which

together manage extensive caseloads in criminalistics and human rights-related investigations [13,22,26,29,32,47].

Brazil and Colombia continue to operate the most structurally complex and technically advanced systems. Brazil's model integrates state-level forensic institutes with the Federal Police's national capabilities, enabling highly specialized services in genetics, ballistics, toxicology, and digital forensics. Colombia's coordinated network, including the INMLCF, Technical Investigation Corps (CTI), and Criminal Investigation Branch (DIJIN), supports broad investigative needs and maintains regional leadership in human-identification practices. Venezuela remains an exceptional case: Despite the National Service of Forensic Medicine and Sciences (SENAMECF) and CICPC retaining formal authority over medico-legal and investigative functions, institutional instability, personnel shortages, and resource limitations continue to constrain operational development [14,42].

Educational Institutions

The educational frameworks across the region generally reflect the operational maturity of each nation. In Argentina, multisectoral training in legal medicine and forensic sciences is facilitated through national and provincial universities, although specialized programs are inconsistently available outside the major academic centers. Despite notable advancements in the medical field, the development of forensic sciences remains limited and fragmented, placing the country behind others in the region [8]. Legal medicine retains a strong tradition within medical schools, with historical ties to the CMF, whereas criminalistics programs are offered by the University Institute of the Argentine Federal Police, the University Institute of Security of the City (IUSE), and the Juan Vucetich University Institute (IUV), among other entities that provide technical and professional degrees nationwide. Forensic anthropology is primarily taught through field and laboratory practices inspired by the EAAF model [8].

Chile benefits from long-standing university involvement, particularly the University of Chile (UCh), and from structured postgraduate and continuing education programs through the Dr. Carlos Ybar Institute (SML), PDI, and Carabiniers of Chile's School of Specialties.

Uruguay's UDELAR continues to anchor legal medicine education and offers professional pathways aligned with DNPC and ITF technical needs [18–20,39].

Across the Andean region, Bolivia's IDIF, public and private universities, police academic institutions such as the Police University "Mcal. Antonio Jose de Sucre" (UNIPOL) and the National Police Academy (ANAPOL), and technical institutes support medico-legal and criminalistics education, although training quality varies across regions.

Ecuador's Central University (UCE) and the Pontifical Catholic University of Ecuador (PUCE) collaborate with police academies such as the National Police Training Center (CECPOL) to provide instruction on legal medicine, forensic pathology, and investigative techniques.

Colombia has a robust network of universities and technical programs in criminalistics, legal medicine, anthropology, and forensic sciences.

Paraguay has expanded its educational offerings through UNA and police academies such as the Higher Institute of Police Education (ISEPOL), particularly in the fields of crime scene management and forensic laboratory methods.

Forensic training is not available as an undergraduate degree in Peru, and only a limited number of institutions offer training at the postgraduate or specialization level, which constrains the professionalization of the field [22,26,29,32,36,48].

Brazil also lacks regular undergraduate programs in forensic sciences, and access to official positions is exclusively achieved through public competitions, with no specific degree in forensic sciences required (degrees in medicine, odontology, and natural sciences are accepted). Professional training and technical development are managed by the states and the National Secretariat of Public Security (SENASP) under the Ministry of Justice and Federal Police. Additionally, various police academies are responsible for training experts at the state level, such as the Academy of Forensic Sciences in Paraná (ACF), State Academy of Public Security in Ceará (AESP-CE), and Silvio Terra State Police Academy in Rio de Janeiro (ACADEPOL-RJ).

Venezuela's universities, including the UCV, University of Carabobo (UC), and National Experimental University of Security (UNES), and the National School of Prosecutors of the Public Prosecutor's Office maintain educational programs despite institutional constraints, ensuring continuity in medico-legal and criminalistics training [14,42].

Professional Organizations

Professional organizations in South America exemplify the region's broader scientific capacity, institutional stability, and historical development. Argentina is home to one of the internationally most widely recognized forensic organizations, the EAAF, alongside national medico-legal associations such as the Association of Forensic Physicians of the Argentine Republic (AMFRA), Argentine Society of Legal Odontology (SADOL), and Association of Forensic Psychologists of the Argentine Republic (APFRA), which contribute to regional training and methodological standardization.

Chile maintains active professional networks and societies focused on medico-legal practice, forensic pathology, and human rights investigations, including the Criminal Bar Association of Chile (COLCRIM) and the Chilean Society of Legal Odontology (SOLCH).

Uruguay benefits from stable collaborations between judiciary-linked institutions and academic laboratories [2,20,39]. Bolivia and Ecuador have established official professional organizations, namely the IDIF/IITCUP and SNMLCF/DINITEC, respectively, as well as specific regional organizations and associations.

Colombia has demonstrated strong professional consolidation through INMLCF specialists, academic laboratories, and interdisciplinary networks that have gained international recognition.

Peru has an experienced professional community in forensic anthropology and genetics, driven by long-term human rights investigations.

Ecuador and Paraguay maintain uneven but expanding professional activity anchored in police-based laboratories, expert associations, and university programs [24,26,29,32,38].

Brazil hosts a diverse landscape of state-level forensic councils, national associations, and active scientific societies that support cross-disciplinary research.

Venezuela's professional sector continues to function through university groups and practitioner networks, although institutional instability has limited broader organizational consolidation [14,42].

Concluding Remarks

A historical analysis of forensic science in South America reveals a convergence in the development and establishment of forensic medicine, criminology, and forensic anthropology, driven by political, social, and academic processes linked to state modernization and the institutionalization of justice. Since the late 19th century, European influence — particularly from France, Italy, and Spain — has been instrumental in establishing forensic medicine departments in universities across the region, thereby solidifying the role of forensic physicians as pivotal figures in the production of scientific truth and judicial legitimacy [1,19,34]. Concurrently, identification offices and police laboratories emerged, notably through the contributions of Juan Vucetich and his Argentine dactyloscopy system, which spread to Uruguay, Brazil, and Chile, positioning South America at the international forefront of forensic science. This development fostered a "transnational circulation of methods for identifying people" [21], a network that adapted European knowledge to the local context. During the 20th century, forensic science accompanied the strengthening of scientific police forces [4], while forensic anthropology emerged within the context of investigating human rights violations and armed conflicts, consolidating its humanitarian and scientific scope [1]. Collectively, these fields have evolved from empirical practices to institutionalized technical-scientific structures.

A similar trend is observable in the reforms to criminal procedure codes, which since the 1990s have transformed judicial systems toward adversarial and oral models. These reforms have enhanced transparency, the contestation of evidence, and the technical role of experts. However, implementation has been uneven: Some countries have achieved accredited and autonomous forensic structures, while others remain deficient in terms of infrastructure, training, and institutional coordination. Despite regulatory advances, gaps persist in harmonization with international standards and expert training [3,28]. The regional rise in crime, organized violence, and transnational crimes has necessitated improved monitoring, specialist training, technology acquisition, and international cooperation. Forensic responses require accredited laboratories, interoperable genetic databases, and integrated information systems. Continuing education and regional exchange of best practices are essential for reducing impunity [2,27]. The COVID-19 pandemic accelerated technological adoption but also highlighted the digital divide and lacks of infrastructure, cybersecurity, and digital literacy [49]. The emergence of artificial intelligence presents new possibilities in criminal investigations, although its application still lacks adequate resources [50].

Finally, the region reflects heterogeneity in forensic scientific information and production, resulting from technological and institutional inequalities [1]. While some countries have consolidated and specialized publications, others face gaps in documentation, research, and dissemination. Reducing these gaps requires public policies that strengthen collaborative networks, promote technological equity, and guarantee access to standardized forensic knowledge specific to South America [9].

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ADVANCING THE PRACTICE OF FORENSIC SCIENCE IN THE UNITED STATES

The National Association of Forensic Science Boards

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Introduction: The National Association of Forensic Science Boards and State Forensic Science Boards

The National Association of Forensic Science Boards

The National Association of Forensic Science Boards (NAFSB) was founded in 2023 as a grassroots initiative aimed at enhancing the effectiveness of state-level forensic science boards and commissions [1]. In recognition of the significant strides that these state entities have made in improving forensic science practices, the NAFSB was established to facilitate the exchange among them of best practices, research, and lessons learned. The association serves as a collaborative platform for states to share experiences and strategies tailored to their unique circumstances.

NAFSB was created as the product of longstanding discussions on supporting state and local forensic improvement initiatives and state board reviews [2]. Research on wrongful convictions highlighted the need for improvements in state-level governance and support for forensic science organizations, as did reports on existing boards [3–5]. This led to the establishment of a planning committee, which convened for the first time at the 2023 conference of the American Society of Crime Laboratory Directors (ASCLD).

The NAFSB is structured as a nonprofit 501(c)(3) organization governed by a nine-member Executive Committee comprising professionals from various sectors engaged with the forensic science community, including crime laboratory directors, legal experts, and policy advisors. The association is not a federal entity or national governing body but rather focuses on supporting and enhancing forensic science administration at the state level through collaboration and shared expertise.

In November 2023, The NAFSB held its inaugural conference in Austin, TX, hosted by the Texas Forensic Science Commission [6]. The conference brought together the leaders of state forensic science boards and other interested parties (lawyers, judges, advocates, etc.) to discuss challenges, share successes, and explore strategies for effective oversight. A second conference was hosted by the New York State Commission on Forensic Science in Albany, NY, in 2024 [7]. The 2025 conference was held at the University of New Haven on Oct. 21–22, 2025. Looking ahead, NAFSB plans to continue facilitating such collaborations, provide technical assistance, and serve as a resource for states aiming to establish or reform their forensic science boards.

The Current State of Forensic Science Boards

Currently, there are 12 forensic science boards (FSBs) actively involved in the NAFSB, and 2 states are working with NAFSB as they consider the development of FSBs. These boards function as multidisciplinary forums for stakeholder input, scientific review, and policy development, helping to align forensic practices with legal standards and public expectations. They differ in their powers, composition, and staffing, but all aim to uphold the quality and reliability of forensic science in the justice system.

There are numerous considerations involved in establishing and operating FSBs and considerable variation in their structures and functions. The different types of boards that exist or could be developed include regulatory or oversight commissions, scientific advisory boards, investigative councils, ad hoc task forces, and hybrid models that combine elements of multiple structures. Each type of board or commission may be designed to meet different goals, ranging from policy and quality assurance to discipline-specific scientific review or crisis-driven reform.

FSBs vary significantly in the parties they report to, with some answering to the governor, attorney general, legislature, or officials in public safety or public health

departments. This reporting relationship can influence the board's independence and scope of influence. Likewise, the purpose of a board may vary depending on the state's forensic or legal landscape, encompassing objectives such as strengthening public confidence, addressing laboratory needs, ensuring scientific validity, or serving stakeholder communities within the justice system.

FSBs include diverse memberships, including not only forensic professionals — like lab directors, scientists, quality managers, and medical examiners — but also legal stakeholders such as prosecutors, defense attorneys, judges, and legislators. Other valuable members include academics, statisticians, public advocates, and representatives from executive agencies. Every FSB collaborates with external experts to bolster their scientific advice or contribute to projects or investigations. This multidisciplinary approach is intended to ensure that all FSB activities are informed by multiple perspectives and balance scientific rigor, due process requirements, and justice system realities.

The authority of FSBs inherently varies as well. Some boards have regulatory or oversight power, including responsibilities for budgeting, policymaking, and licensing, while others serve an advisory or educational role, focusing on training, outreach, or fostering interagency coordination. FSBs also may be responsible for investigating professional misconduct. Recipients of federal grants under the Paul Coverdell Forensic Science Improvement Grants Program [8] are required to certify that an independent entity exists to investigate professional misconduct, and FSBs are ideally suited for that role. Policy makers should consider what structure, membership, and authority would be most effective for their jurisdiction, depending on local needs and capacities.

This article outlines the mission and priorities of the NAFSB and its role in supporting FSBs. A subsequent article will describe state FSBs in more detail, including their respective authorities, activities, and structure.

The NAFSB's Guide to Best Practices

The NAFSB has published a *Guide to Best Practices for Development of State Forensic Science Boards*, which outlines 10 foundational lessons to guide states in building effective, sustainable FSBs [9]. These lessons are based on practical experience from across the country and emphasize a collaborative, adaptable approach tailored to each state's needs. The guide stresses that FSBs should enhance existing quality assurance systems, support forensic science service providers (FSSPs), and build trust among stakeholders in the both scientific and justice communities. The guide recommends the following 10 best practices:

1. Understand the Current Environment: A successful board must start with a clear grasp of the state's existing forensic science infrastructure, including oversight mechanisms, accreditation status, and institutional dynamics. Boards should complement — not duplicate or conflict with — existing quality assurance and oversight systems and serve as collaborative allies to FSSPs and policymakers.
2. Define Purpose and Scope: Boards should ideally be proactively designed to meet specific needs, such as closing gaps in oversight or enhancing scientific rigor, rather than making reactive responses to crises. States must clearly define the problems the board is intended to address and align its structure and functions with those goals.
3. Clarify Authority and Activities: Boards may engage in a wide range of roles, from advisory and training functions to policymaking, licensing, accreditation support, compliance review, or even budget and personnel decisions. The board's responsibilities should be explicitly defined and closely linked to its founding rationale.
4. Align Membership with Mission: Membership should reflect the board's purpose, balancing scientific, legal, and public interests. Depending on its goals, a board may be structured as a stakeholder board (focusing on users and providers), an advisory board (emphasizing expert input), or an oversight board (emphasizing accountability and trust-building). A diverse and representative membership helps ensure legitimacy and effectiveness.
5. Establish Organizational Support: A successful board requires a supportive host agency — often within the judiciary, executive branch, or state forensic agency — to provide resources, staff, and institutional backing. Independence, transparency, and sustained funding are all essential for maintaining credibility.
6. Begin with a Planning Group: Before establishing a formal board, convene a planning group with broad stakeholder participation to define the board's mission, structure, and support needs. This group will help navigate political dynamics and align diverse interests while avoiding the marginalization of key communities.
7. Avoid Overreach at the Outset: Boards should start with realistic, achievable responsibilities and expand over time, if warranted. Attempting to build a perfect board from the outset can lead to failure due to lack of buy-in or unmanageable scope. Effective boards grow their roles as they gain trust and demonstrate value.
8. All Boards Should Advise: Regardless of other powers, every board should provide independent, expert advice to forensic science providers and justice stakeholders. Advisory functions can include leadership mentoring, budgeting guidance, standards implementation, and training.
9. Train the Board: Members should receive ongoing education about forensic science, quality systems, and

stakeholder needs. Resources include national forensic organizations, site visits to crime labs, and other FSBs through the NAFSB.

10. Stay Connected and Evolve: Engagement with peer boards and networks like the NAFSB is vital for continuous improvement. Boards must remain flexible and responsive to changing scientific, legal, and social conditions, and benefit from collective learning across jurisdictions.

Together, these 10 lessons offer a roadmap for states to design forensic science boards that are collaborative, functional, and responsive to the unique challenges of their forensic ecosystems. The NAFSB best practices have already been used effectively in multiple states to guide the creation or reform of FSBs.

Issues of Interest to Forensic Science Boards

Lab Independence

For many years, advocates have called for FSSPs to be organizationally independent of law enforcement and prosecutors [10]. The NAFSB has considered the insights that can be gleaned from labs that have successfully navigated this process, and how they have sustained effective operations over time [11]. Considerations include the evolving nature of the independence of forensic laboratories and their organizational, physical, and cultural dimensions.

The current state of lab independence varies significantly across jurisdictions, with some laboratories operating under the direct control of law enforcement agencies, while others have transitioned to models that grant greater autonomy. True independence involves more than just physical separation. It requires structural reforms, transparent governance, and cultural shifts that prioritize scientific integrity over investigative outcomes.

Independent labs are distinguished by key structural features, including clearly defined chains of command outside police or prosecutorial influence, independent oversight mechanisms, and budgetary authority [12]. The role of executive leadership is critical. Leaders must be empowered to make personnel, policy, and operational decisions free from external pressure. Different models have been discussed, including leadership appointments by independent boards, contracts, or civil service classifications, each with implications for how accountability and independence are balanced.

FSBs play a pivotal role in promoting and sustaining lab independence. These boards can act as buffers between laboratories and criminal justice agencies, providing oversight while protecting the scientific missions of the labs. Their functions may include monitoring key performance indicators, reviewing leadership practices, or participating in the appointment and evaluation of lab directors. When structured effectively, boards can support the independence of forensic science by enforcing ethical standards, safeguarding against conflicts of interest, and ensuring that laboratory outputs are guided by science.

Ultimately, lab independence is not a binary status but a continuum that requires ongoing institutional commitment and thoughtful design. FSB involvement is essential — not as a substitute for operational control, but as a partner in fostering transparency, accountability, and scientific integrity.

Crime Lab Directors

Crime lab directors have responded to established and proposed FSBs from a variety of perspectives based on the historical context and the current state of their relationships with the boards [13]. FSBs have often been created from a desire to introduce greater oversight, transparency, and consistency to forensic science practice, especially following national calls for reform and accountability. Boards have been established with varying scopes and compositions, often bringing together individuals from legal, scientific, and policy backgrounds to guide and review forensic laboratory operations. From the perspective of lab directors, these boards can be instrumental in enhancing the credibility of forensic science by promoting ethical standards, addressing systemic issues such as case backlogs, and aligning labs with broader criminal justice goals [14].

FSBs can add value by serving as a forum for stakeholder dialogue, offering a structured space for examining complex problems, and setting unified priorities across jurisdictions. When boards employ an informed and supportive approach, they can elevate the quality of services and provide meaningful policy guidance. FSBs have helped secure resources for crime laboratories and facilitated a broader recognition of forensic science as performing a critical public safety function. For example, by validating lab practices through external review, boards may increase public and political confidence in forensic outcomes.

Despite these benefits, lab directors have expressed concerns about the practical implementation and daily impact of board oversight. A recurring issue is the potential for boards to unintentionally interfere with lab operations, particularly when board members lack technical expertise. Directors have described situations where recommendations or mandates were made without a full appreciation of workload constraints, scientific complexities, or accreditation requirements. This disconnect could lead to

frustration, strained relationships, or slowed progress if not carefully managed. Another concern is the ambiguity in the respective roles and authorities of the board and the laboratory, which can create tension over decision-making boundaries.

To improve these relationships, directors emphasize the need for clearer communication, consistent engagement, and mutual education. They suggest that onboarding processes for board members should include exposure to laboratory environments and a foundational understanding of forensic science workflows. In turn, lab leaders must remain open to external feedback and be willing to explain operational realities to a non-technical audience.

There are numerous positive models. In Texas, the TFSC has developed robust transparency mechanisms such as an online Quality Incident list [13]. These transparency efforts are not intended to be punitive but rather to normalize and shed light on the quality process, which is designed to use human and organizational shortcomings as a springboard for improvement. By providing a consistent forum for sharing perspectives between legal end-users and forensic scientists, the TFSC helps laboratories understand their critical role in providing clear information to end-users in support of due process and fair outcomes. Similarly, the Wisconsin FSB has cultivated an environment of engagement, education, and mutual respect, emphasizing that successful oversight is not adversarial but supportive — aimed at building trust through shared goals. For example, the Wisconsin board has established evidence submission guidelines that facilitate the effective and efficient processing of forensic evidence across the state.

These examples highlight the need for oversight bodies to understand the operational realities of crime labs while also promoting high standards of scientific integrity. When properly structured, these boards not only elevate forensic practice but also contribute to more reliable, fairer outcomes in the justice system. Successful collaboration requires a shared commitment to improving the forensic system while respecting the distinct roles of oversight and management. With conscious efforts on both sides, FSBs and labs could foster a more constructive and effective partnership that ultimately serves justice and the public interest.

Legal Advisors for Crime Labs

Crime laboratories require access to legal advisors, and some FSSPs have dedicated advisors [15]. These forensic-science-oriented advisors have formed a national association, the National Association of Forensic Laboratory Counsel [16]. FSBs work in collaboration with legal advisors who help labs navigate complex legal environments — by offering guidance on compliance with discovery rules, subpoenas, privacy laws, employment regulations, and contractual obligations. In many cases, they serve as general counsel, akin to corporate legal departments, giving daily or even hourly advice to lab management. Their work ensures that the lab's practices align with evolving case law, state statutes, and regulatory frameworks, reducing legal exposure and ensuring operational integrity. Legal advisors provide essential support to crime laboratories by serving as translators, risk assessors, educators, and advocates within the legal system.

Because scientists and attorneys often speak different "languages," advisors help prosecutors, defense attorneys, and judges understand forensic science procedures and limitations in several ways, including explaining lab policies, testifying about lab protocols when necessary, and assisting analysts with courtroom preparation — especially when new legal rulings like *Smith v. Arizona* [17] introduce uncertainty about admissibility or testimony requirements. Legal advisors often support analysts directly in court, advocate for realistic expectations of forensic evidence, and clarify permissible testimony so that they may avoid overstating conclusions or introducing unsupported inferences.

Advisors also play a critical strategic and cultural role. They build trust with both the prosecution and defense by fostering transparency and encouraging early dialogue about legal concerns. Their involvement helps prevent misunderstandings and preempts litigation by resolving disputes before they escalate. In addition to legal advice, they contribute to staff training, legislative tracking, interagency collaboration, and risk management. Some even participate in cross-disciplinary working groups to address policy-level issues, such as the handling of dangerous substances or the development of new forensic procedures.

Finally, legal advisors help forensic labs assert their institutional interests, especially when those interests diverge from those of law enforcement or prosecutorial agencies. Labs must maintain scientific neutrality, even when embedded in justice systems focused on adversarial outcomes. Legal advisors help preserve this balance by acting as independent advocates for a lab's operational, ethical, and accreditation-related concerns separate from the parent agency. Their presence enhances the credibility, accountability, and autonomy of forensic institutions — ultimately strengthening the justice system as a whole.

Accreditation

FSBs typically have a significant role in the oversight or review of accreditation frameworks, audit requirements, and non-conformance reviews [18]. The current accreditation landscape includes accrediting bodies (like the ANSI National Accreditation Board and the American Association for Laboratory Accreditation, or A2LA), conformity assessment bodies, and scheme owners (e.g., International Organization for Standardization, OSAC). Accreditation standards provide a framework for high levels of technical competence, ethical practice, and courtroom readiness.

The TSFC has transitioned from a reactive approach to accreditation — where oversight and accrediting bodies would independently respond to individual lab issues — to a more integrated, collaborative model. This shift was motivated by the Joseph Colone case [19]. In this capital murder case, an analyst from a Texas forensic lab arrived at court unprepared to testify, bringing no case file or notes and lacking basic documentation to support their findings. The case revealed serious lapses in evidence handling, documentation, and quality assurance, which had not been adequately addressed either internally by the lab or externally through accreditation mechanisms.

The case led TFSC to issue formal "accreditation checklist items" — recommendations so critical that they are now evaluated during routine lab accreditation assessments [18]. Examples include clear policies for analyst trial preparation, lab documentation protocols, and processes for handling casework after staff transfer between labs. The goal was not only accountability but the proactive prevention of similar failures. The TFSC partnered with accrediting bodies to embed these requirements into accreditation assessments, reinforcing the importance of transparency, preparation, and documentation.

While accreditation facilitates technical compliance, oversight bodies like TFSC uniquely promote system-level improvement and public trust by enabling open, contextualized, and non-punitive dialogue around quality incidents, according to research led by Sarah Chu, who serves on the NAFSB Executive Committee [20]. The quantitative phase of her research analyzed 207 complaints and 98 self-disclosures submitted to the TFSC between 2016 and 2020, categorizing them by origin, content, and resolution. She found that self-disclosures increased over time while complaints declined, suggesting a shift toward internal accountability and proactive quality management. In contrast to reactive complaint-driven systems, TFSC's culture encourages FSSPs to self-report mistakes, provide context, and pursue remediation without fear of stigmatization or retribution.

Chu also conducted a qualitative analysis of TFSC's handling of self-disclosures, particularly those from the Texas Department of Public Safety Crime Laboratory involving evidence loss [20]. Using a theoretical framework that included considerations of patient safety, reintegrative justice, and systems repair, Chu found that TFSC's public process functioned as an act of constructive disclosure. The Commission created a safe, transparent space for providers to explain their actions, reflect on causes, and demonstrate corrective measures — an approach that diverged sharply from ANAB's more opaque role during the same period.

Chu's research highlights that TFSC embodies five key principles of forensic science quality infrastructure: safety culture, open disclosure, reintegrative shaming, systems repair, and anticipatory governance. The findings suggest that optimal oversight in forensic science requires the complementary roles of both accreditation bodies and state forensic commissions.

For their part, accrediting bodies stress the value of open communication and collaboration between labs, regulators, and accreditation entities [18]. The annual feedback loop conducted by accrediting bodies is a key tool for maintaining alignment with regulatory needs. Forensic standards, supported by robust oversight and a culture of accountability, are essential for preserving the integrity of the justice system.

Adoption of Standards

The Organization of Scientific Area Committees (OSAC) for Forensic Science, administered by the National Institute of Standards and Technology (NIST), continues to expand its registry of forensic science standards [21]. The OSAC Registry now includes over 225 standards across more than 20 forensic disciplines, encompassing both published and proposed standards that have undergone rigorous technical and quality reviews. These standards aim to enhance the reliability, reproducibility, and scientific validity of forensic analyses nationwide [22].

Implementation of OSAC standards by FSSPs remains voluntary. To encourage adoption, OSAC has initiated outreach efforts, including an annual "Open Enrollment" period during which FSSPs can report their implementation status. As of August 2024, 182 FSSPs from 31 states and four foreign countries have submitted implementation forms, indicating full or partial adoption of relevant standards. OSAC provides resources such as detailed implementation guides and maintains an internal tracker to monitor adoption rates.

State forensic science boards play a pivotal role in promoting the adoption of OSAC standards. For instance,

the Texas Forensic Science Commission actively supports laboratories in implementing these standards by providing guidance and resources, including a database of implementation documents. FSBs can facilitate training, offer technical assistance, and serve as liaisons between laboratories and OSAC, thereby fostering a culture of continuous improvement and standardization within forensic science practices.

The integration of OSAC standards into forensic laboratories' quality management systems not only enhances the credibility of forensic evidence but also aligns with broader efforts to strengthen the justice system. By adopting these consensus-based standards, laboratories can ensure more consistent and scientifically sound practices, ultimately contributing to more reliable outcomes in criminal investigations and proceedings.

Academic Engagement

Advocates have called for crime laboratories to adopt a "research culture" and strengthen their links with universities [23]. The NAFSB has examined this issue in collaboration with university faculty members with deep ties to forensic practice, many of whom transitioned from crime lab leadership roles to academic appointments. They emphasize that academia can play a transformative role in forensic science by developing innovative research, creating tools and databases, offering specialized training, and supporting the implementation of national standards [24].

Successful partnerships include the establishment of university-based forensic institutes such as the Institute for Forensic Research, Training, and Innovation at Sam Houston State University. These centers serve as bridges between operational labs and researchers, facilitating access to resources, technical expertise, and funding. Academics contribute by conducting validation studies, producing open-source platforms, and organizing training for both students and current practitioners.

Structural challenges remain, such as data access limitations, laboratory staff shortages, and the need for clearer communication between labs and researchers. Aligning academic research with lab needs requires intentional relationship-building, shared goals, and mutual respect. Academic partners can play a positive role in shaping policy, engaging with FSBs, and serving on oversight or standards committees.

Ultimately, crime labs and academic institutions benefit from close collaboration: Labs gain access to innovation and training, while universities enhance the real-world impact of their research. Such partnerships are crucial for advancing the scientific integrity and operational effectiveness of forensic science nationwide.

Legislative Engagement of Stakeholders

A major barrier to the adoption of FSBs by many states is the difficulty that disparate criminal justice system participants face in the area of forensic science policy. Too often, the adversarial nature of the criminal justice system bleeds into the legislative process. This was initially the case with two recently passed pieces of forensic science legislation in Maryland related to forensic investigative genetic genealogy (FIGG) and facial recognition, which actually began as efforts to ban these practices. After multiple legislative sessions debating these heavily divisive topics, Maryland State Senator Charles Sydnor III recognized that a ban would not be successful and decided that a successful outcome was likely only by pursuing a collaborative, stakeholder-driven process [25]. The collaborative nature of the development of the FIGG bill facilitated the legislative changes that were needed in subsequent years.

Ultimately, Maryland approached the development of both FIGG and facial recognition legislation with an emphasis on balance — protecting civil liberties while allowing law enforcement to responsibly use emerging forensic technologies. Each element of the criminal justice community brought to bear distinct perspectives on defense, law enforcement, and policy. The need for compromise during the legislative process — such as adjusting language or narrowing use cases — to gain bipartisan support and ensure the legislation's passage presents an excellent lesson for forensic science boards and commissions looking to engage their stakeholders. Ultimately, developing an FSB in Maryland that prioritizes the representation of forensic science stakeholders who are willing to collaborate and compromise will lead to more efficient and effective forensic science legislation.

Board Training

Forensic science boards often include individuals from diverse professional backgrounds who may lack deep familiarity with forensic science policies and practices [26]. Effective training is critical to ensure that all board members can make informed, evidence-based decisions. The NAFSB has identified key training elements for FSB members, staff, and participants:

- Tailored Approaches: Training should consider the unique needs of each board member. For example, court-appointed representatives may require different orientations than judges or law enforcement personnel.
- Onboarding Support: Boards should implement structured onboarding processes to introduce new members to their roles, responsibilities, and the forensic science landscape.

- Governance Fundamentals: Training should include information on open meetings laws and other procedural expectations to ensure compliance and transparency.
- Collaborative Alignment: Understanding the roles of counterpart agencies or stakeholders (e.g., courts, prosecutors, labs) can help new members align decisions with broader justice system goals.
- Resource Navigation: Members should be made aware of where to seek additional guidance, documentation, or subject-matter expertise when needed.

FSBs may also contribute to the training of users of forensic evidence. For example, the Arizona Forensic Science Academy has sponsored long-standing efforts to strengthen forensic education more broadly for forensic scientists and users of forensic evidence. The academy offers multiple tracks — Basic, Advanced, and "3-D" academies — covering disciplines such as DNA, toxicology, digital forensics, and ethics. Arizona's model combines scientific rigor with practical training and is currently moving toward standardization and broader access through on-demand content and online resources.

The Illinois Forensic Science Commission has taken a statutory approach to training and oversight. The Commission, created in 2021, was designed to improve the delivery of forensic services and reduce inefficiencies that contribute to backlogs and errors. Its training responsibilities include both internal education — such as mandated ethics and legal updates for commission members — and external initiatives, including judicial training and the production of informational videos on forensic topics. The Illinois Commission has also hosted symposiums and maintains a shared digital resource library for ongoing professional development, as a part of which it is actively developing new training content, including foundational videos on core forensic disciplines and planned modules on ethics and continuing legal education programs for attorneys and judges. These initiatives are part of a broader strategy to increase transparency, encourage collaboration among stakeholders, and ensure that forensic science is both scientifically sound and legally admissible. The state has also proposed building blocks for future educational offerings tailored to the needs of both forensic scientists and justice system professionals.

Effective training is central to the success of forensic science boards. By investing in education — for both internal members and the wider criminal justice system — boards can better align scientific integrity with justice outcomes. However, there remains a need for standardized training frameworks and interstate knowledge sharing to elevate forensic governance nationwide. The NAFSB is planning to develop resources to fill these gaps [27].

Artificial Intelligence

At the 2024 NAFSB Conference, a panel of experts addressed the growing presence and potential of artificial intelligence (AI) in forensic science [28]. AI operates on fundamental statistical principles like regression, clustering, and topic modeling, and its predictive capabilities are already impacting forensic decision-making processes. AI is increasingly being applied in such areas as pattern recognition, classification, and predictive modeling — tools that are especially valuable in the analysis of forensic evidence like bullet striations, DNA mixtures, and handwriting.

Specific applications discussed include AI-driven comparisons of bullet striations using 3D surface data and random forest algorithms, as well as handwriting analysis based on the graphical decomposition of characters. These AI methods have shown high accuracy under controlled conditions, especially when large, high-quality datasets are available. Open-source tools developed by research consortia like the Center for Statistics and Applications in Forensic Evidence are helping bring transparency to these processes, allowing for reproducibility and independent validation. Nevertheless, limitations remain: The reliability of these systems can diminish with smaller or lower-quality datasets, and performance can be highly sensitive to how the AI is trained.

FSBs are concerned about the ethical and legal ramifications of AI. Proprietary algorithms — often used in forensic tools — raise concerns due to their lack of transparency, which makes it difficult for courts or defense counsel to evaluate their reliability. In forensic applications, AI developers should develop systems characterized by open data, open code, and clear standards of validation. There are also concerns about bias in AI systems, especially in predictive tools used in criminal justice more broadly. These systems rely on historical datasets that may be misleading in many circumstances. While AI holds significant promise for increasing efficiency in forensic science, its use must be carefully regulated to ensure that it enhances, rather than compromises, the pursuit of justice.

International Perspectives

Other countries have been making significant strides toward implementing robust forensic science oversight mechanisms, often mirroring the goals of U.S. FSBs. In the United Kingdom (UK), forensic science regulation has evolved from a voluntary model into a statutory framework [29]. The Forensic Science Regulator, originally a non-statutory role, was granted legal powers under the Forensic Science Regulator Act of 2021. This law mandates compliance with a Code of Practice that became enforce-

able in October 2023. The code covers a wide range of forensic science activities and allows for investigative and enforcement action when there is a risk to the integrity of the justice process. The UK's regulatory model emphasizes accreditation to ISO standards, practitioner competence, validated methods, and transparent quality management systems.

The UK experience shows how national oversight can address systemic issues by requiring declarations of compliance, encouraging self-reporting, and establishing proportional enforcement mechanisms. One of the key features of the UK model is that the Regulator's Code of Practice is admissible in court, increasing accountability and strengthening the practical implications of non-compliance. Additionally, the Regulator is responsible for publishing annual reports and can offer guidance not only domestically but internationally, highlighting a broader vision of global forensic science leadership and harmonization of practices.

In contrast, Australia's forensic oversight reform has been more reactive, driven by high-profile failures [30]. The state of Queensland underwent a significant transformation following a 2022 Commission of Inquiry into failures in DNA testing practices. The inquiry found critical deficiencies in governance, sample handling, and stakeholder engagement, prompting 126 recommendations and structural reforms. This led to the creation of Forensic Science Queensland (FSQ), a new agency designed to operate with enhanced transparency, accountability, and scientific integrity. An Interim Advisory Board was established to oversee the development of FSQ, along with multiple specialized committees to ensure multidisciplinary and independent input into forensic operations.

Queensland's evolving model underscores the importance of crisis-driven reform in catalyzing oversight structures [30]. FSQ has prioritized a shift from fast, quantity-based outputs to quality-focused, case-based forensic workflows. This includes new reporting lines, independent review processes, stakeholder consultation, and investment in people, infrastructure, and innovation. While not yet underpinned by national statutory regulation like in the UK, Queensland's experience illustrates how provincial or state-level reform can lay the groundwork for broader oversight and provide lessons for jurisdictions around the world considering similar forensic governance structures.

Conclusion

Like FSBs themselves, the NAFSB is a relatively small but growing part of the forensic science landscape. The NAFSB seeks to provide careful and thoughtful leadership for state-level FSBs to advance forensic science in the United States.

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NEW BOOKS AND BOOK REVIEW

New Forensic Science Books

AI and ML-Driven Cybersecurity: Industrial IoT and WSN with Python Scripting

A. Buja
CRC Press: Boca Raton, FL, US; Nov., 2025

AI Forensics: Investigation and Analysis of Artificial Intelligence Systems

J. C. Sremack
Chapman & Hall: London, UK; Forthcoming

Anatomy of IoT Botnets and Detection Methods

U. Garg, N. Gupta, R. Singh, A. Gehlot, A. Dumka
CRC Press: Boca Raton, FL, US; Nov., 2025

Artificial Intelligence and Digital Forensics: Advancements, Applications, Challenges, and Solutions

N. K. Chaudhary, A. Patel, A. Mishra, C. Kumawat, Eds
CRC Press: Boca Raton, FL, US; Sept., 2025

Career Paths in Forensic Psychology: A Primer for a Rewarding Career at the Intersection of Law and Psychology

J. Fairfax-Columbo, A. Desai, S. Grisamore, D. DeMatteo
Routledge: NY, NY, US; Sept., 2025

Carrion Ecology, Evolution, and Their Applications

M. E. Benbow, J. K. Tomberlin, A. M. Tarone, Eds
CRC Press: Boca Raton, FL, US; Jul., 2025

Case Studies in Forensic Psychology: Diversity in Clinical Practice

R. J. Tully, J. Bamford, Eds
Routledge: Abingdon, Oxon, UK; Sept., 2025

Cognitive Cyber Crimes in the Era of Artificial Intelligence

R. K. Chakrawarti, R. Rawat. K. B. Singh, A. S. A. Raj, A. Singh, H. Rawat, A. Rawat, Eds
Scrivener Publishing: Beverly, MA, US; Jan., 2026

Crime Scene Investigator (CSI) Field Guide

S. Lambert
CRC Press: Boca Raton, FL, US; Nov., 2025

Crime Science: Modern Technologies to Combat Crime

L. Stolzenberg, S. J. D'Alessio
Routledge: NY, NY, US; Aug., 2025

Criminal Profiling: Applied Theories

K. Borgeson, R. C. Kendall, S. Cappadona
CRC Press: Boca Raton, FL, US; Dec., 2025

Cyber Security, Forensics and National Security

V. Aseri, S. K. Choudhary, A. Kumar, Eds
CRC Press: Boca Raton, FL, US; Oct., 2025

Digital Defence: Harnessing the Power of Artificial Intelligence for Cybersecurity and Digital Forensics

A. Kumar, N. K. Chaudhary, A. S. Shastri, M. Singh, A. J. Kulkarni, Eds
CRC Press: Boca Raton, FL, US; Apr., 2025

Digital Forensics in the Next-Generation Internet of Medical Things: Balancing Security and Sustainability

H. K. Saini, S. Rani, M. Ouaissa, Z. A. El Houda, H. Moudoud, Eds
CRC Press: Boca Raton, FL, US; Nov., 2025

The Dutch Sherlock: Forty Years of Detective Work by the Famous Dutch Forensic Pioneer Co van Ledden Hulsebosch

A. van Asten, M. Aalders, Coordinators
Routledge: Abingdon, Oxon, UK; Oct., 2024

Evidence, Crime, and Forensics in the Early Modern Mediterranean

L. A. Homza, A. L. Scott, Eds
Routledge: Abingdon, Oxon, UK; Aug., 2025

Flies in Science and Forensics

Omkar, Ed
CRC Press: Boca Raton, FL, US; Dec., 2025

Fluorescent Particles in Forensic Engineering

S. Ganguly, P. Das, R. Jain, Eds
CRC Press: Boca Raton, FL, US; Oct., 2025

Forensic Pathology of Unexpected and Unexplained Deaths

S. K. Gupta
CRC Press: Boca Raton, FL, US; Sept., 2025

Forensic Sciences and Quality Management: Addressing the Era of Standardization in Challenging Environments

R. C. Parra, A. G. Alvarez-Godoy, Eds
Wiley/Blackwell: Hoboken, NJ, US; May 2026

Forensic Skeletal Trauma: Scientific Foundation and Guide to Professional Practice

D. C. Boyd
John Wiley & Sons: Somerset, NJ, US; Forthcoming

Generative AI for Cybersecurity and Privacy

Y. Baddi, Y. Maleh, I. Alsmadi, M. Lahby, Eds
CRC Press: Boca Raton, FL, US; Nov., 2025

A History of Forensic Sciences in 10 Publications: How They Established Current Practice

S. Doyle
John Wiley & Sons: Somerset, NJ, US; Dec., 2025

How to Become a Forensic Psychologist

J. Bailey, J. Harrower, D. Anand
Routledge: Abingdon, Oxon, UK; Oct., 2025

Human Skeletal Remains: A Field Guide to Identification, Recovery, and Preservation

T. A. White, H. R. Parsons, S. S. White
CRC Press: Boca Raton, FL, US; Sept., 2025

International Cases in Forensic Psychology: Inside the Criminal Mind

K. J. Reddy
Routledge: Abingdon, Oxon, UK; May, 2025

Key Topics in Forensic Psychology

T. Cole, D. Mojtahedi
Routledge: Abingdon, Oxon, UK; Nov., 2025

Knight's Forensic Pathology, 5th ed

S. Pollak, P. Saukko, B. Knight
CRC Press: Boca Raton, FL, US; Dec., 2025

Law for Forensic Scientists

V. W. Weedn, K. E. Meison
CRC Press: Boca Raton, FL, US; Sept., 2025

Machine Learning in Forensic Evidence Examination: A New Era

N. Ansari, Ed
CRC Press: Boca Raton, FL, US; Sept., 2025

Mastering Cybersecurity: A Practical Guide to Cyber Tools and Techniques, Volume 2

A. Bhardwaj
CRC Press: Boca Raton, FL, US; Nov., 2025

Mathematical Methods for Accident Reconstruction: A Forensic Engineering Perspective

H. Franck, D. Franck
CRC Press: Boca Raton, FL, US; Sept., 2025

Pathology of Neck Injury, 2nd ed

P. Vanezis
CRC Press: Boca Raton, FL, US; Sept., 2025

Practical Approach to Open Source Intelligence (OSINT), Volume 2

A. Bhardwaj
CRC Press: Boca Raton, FL, US; Dec., 2025

Practical Bomb Scene Investigation, 4th ed

J. T. Thurman
CRC Press: Boca Raton, FL, US; Nov., 2025

Principles and Practice of Forensic Mechanical Engineering

F. M. Blum
CRC Press: Boca Raton, FL, US; Oct., 2025

The Routledge International Handbook of Homicide Investigation

C. Allsop, S. Pike, Eds
Routledge: Abingdon, Oxon, UK; Sept., 2025

Securing Android Apps: A Practical Approach for Secure Development

S. Kalaria
CRC Press: Boca Raton, FL, US; Nov., 2025

Simpson's Forensic Medicine, 15th ed

J. Payne-James, R. M. Jones, Eds
CRC Press: Boca Raton, FL, US; Sept., 2025

A Visual Atlas of Skeletal Growth and Development

K. E. Stull, H. M. Garvin, Eds
CRC Press: Boca Raton, FL, US; Aug., 2025

Book Review

Advances in Forensic Biology and DNA Typing

Anna Barbaro, Amanath Mishra (Eds)
CRC Press: Boca Raton, FL, US; 2025

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Advances in Forensic Biology and DNA Typing, edited by Anna Barbaro and Amaranth Mishra, who possess extensive forensic experience, is the result of collaboration with leading international experts in forensic biology and laboratory management. It covers fundamental DNA typing methods, recent advances in the field, and practical guidance on laboratory operations and quality assurance.

The book is organized into three sections: **Traditional Methods**, **New Technologies**, and **Laboratory Management**. This structure provides readers with a foundation in standard forensic DNA typing, insight into emerging technologies, and guidance on laboratory management and quality assurance.

Traditional Methods

The six chapters in this section introduce DNA extraction, quantitation, nuclear DNA marker amplification, rapidly mutating Y-STRs, and mitochondrial DNA. Each chapter provides the biological background, methodological developments, detailed protocols, challenges, and future applications of each method. The chapters on nuclear DNA amplification, rapidly mutating Y-STRs, and DNA extraction from teeth include case studies and current references (2024), making them particularly useful for students and non-scientists seeking to understand standard methods in forensic DNA profiling.

- **DNA Extraction.** This chapter discusses the purpose and challenges of extracting DNA from forensic evidence. It summarizes traditional extraction methods, including organic, anion-exchange, silica-based techniques, and differential extraction. The chapter would benefit from a dedicated summary comparing the advantages and limitations of each method.
- **DNA Extraction from Teeth.** This chapter explains the biology of teeth and why it is a preferred tissue for DNA extraction. It describes methods for tissue collection from teeth and forensic applications of DNA typing extracted from teeth associated with identification and kinship analysis. The chapter provides detailed protocols as well as extensive references.
- **DNA Quantitation.** This chapter reviews methods ranging from spectroscopic/fluorescent techniques to quantitative PCR for low-template and degraded samples. A discussion comparing and contrasting commercial forensic kits would enhance the chapter.
- **Nuclear DNA Markers.** Comprehensive overview of VNTRs, RFLPs, autosomal, X-, and Y-STRs, SNPs, and indels, with applications to analysis of DNA from challenging samples. The chapter compares the different nuclear DNA markers and provides interesting case studies.
- **Rapidly Mutating Y-STRs.** A well-written chapter discussing the history and biology of Rapidly Mutating Y-STRs (RM-Y STRs), mutation dynamics, applications of RM-Y STRs, a comparison of different commercial kits, and case studies.
- **Mitochondrial DNA.** Covers mtDNA biology, extraction, enrichment, and sequencing but lacks forensic context and case studies.

New Technologies

Seven chapters address emerging forensic methods, including biological fluid identification by epigenetic approaches, touch DNA forensics, rapid DNA, forensic genealogy, DNA phenotyping, microbial forensics, animal evidence processing, and pharmacogenomics. Each chapter includes the respective biological foundations, detailed protocols, forensic context, and case studies.

- **Biological Fluid Identification by Epigenetic Approaches.** A comprehensive review of current epigenetic markers used to identify biological fluids associated with evidence. The review includes discussions of DNA methylated markers, histone modification markers, micro-RNA, non-coding RNA markers, and chromatin accessibility markers. The chapter describes the advantages and limitations of the technology, as well as the ethics and future directions of this emerging field.
- **Touch DNA Forensics.** A very comprehensive review of touch DNA discussing the biology, impact on forensic science and criminal investigations, advantages, challenges, and limitations of the technique. The associated genetics, laboratory techniques, and interpretation software are discussed throughout this informative review.
- **Forensic Genealogy.** Engaging overview that includes the historical development of merging DNA sequence analysis with genetic genealogy to provide a powerful investigative tool, detailed methods and workflow, case applications (e.g., Golden State Killer), DNA database comparisons, and ethical / privacy considerations.
- **Current Trends in Forensic Phenotyping.** A thorough and detailed review of the literature and advances in forensic phenotyping, including the genetics and

biology of Single Nucleotide Polymorphisms used to predict visual appearance, ancestry, and age. Advantages and limitations of the method plus ethical and policy issues are discussed.
- **Microbial Forensics.** Covers microbiology and microbiome analysis for crime scene investigations, food safety, biothreat analysis, geolocation, environmental contamination, postmortem interval estimation, and the application of microbiomes to differentiate human biological tissues.
- **Animal Evidence Processing.** Detailed and extensive discussion of techniques in veterinary and wildlife forensics using genetic, molecular, chemical, and immunological methods. The chapter covers crime scene analysis, the collection and storage of evidence, laboratory techniques and analysis, challenges, and future prospects in animal forensics. The chapter is the most extensive in the book, providing the novice with an excellent overview of this discipline. It is supported with numerous case studies and over 100 references.
- **Pharmacogenomics.** Provides background on the clinical application of pharmacogenomics and personalized medicine.

Laboratory Management

The last section covers challenges in DNA analysis, DNA databases, laboratory information systems, and quality certification programs. These topics, though seemingly routine, are critical for operational and information management in forensic laboratories.

- **Challenges in Forensic DNA Analysis.** This chapter examines the factors that complicate STR interpretation, including mutations, biological and amplification artifacts, and technical issues related to instrumentation. Forensic samples often contain low-template, degraded DNA, frequently from multiple contributors or contaminated with inhibitors. The chapter also discusses laboratory strategies for mitigating these challenges and the legal considerations involved in interpreting DNA evidence.
- **DNA Databases.** Reviews national and international DNA databases, policies, security, ethics, and future challenges.
- **Laboratory Information Management Systems (LIMS).** Explains their purpose, architecture, workflow, implementation, and challenges. The chapter is broadly applicable, but it would be appropriate to include a disclaimer from the author or the editors.
- **Quality Certification.** Covers ISO/IEC 17025, ISO/IEC 17020, ASCLD/LAB, ANAB, FQS, and Accredia, including processes, benefits, and distinctions. The chapter emphasizes the importance of quality certification and updating standards as innovative technologies like AI and bioinformatics emerge.

Concluding Remarks

Advances in Forensic Biology and DNA Typing is a comprehensive resource for forensic scientists, laboratory directors, educators, students, and attorneys. It is an authoritative and well-structured reference, balancing fundamental methods, emerging technologies, and laboratory management practices.

In this reviewer's opinion, a future edition would further enhance the value of this book by: (a) including a chapter discussing probabilistic genotyping for DNA mixture deconvolution, a method that has advanced significantly over the past decade; (b) incorporating forensic context/relevence and case studies in the **Mitochondrial DNA** and **Pharmacogenomics** chapters; and (c) clearly differentiating the term "forensic laboratory information management system" from the private institution by the name of Forensic Laboratory Information Management System (*www.CLIMS.com*) and further broadening the scope of the contents in the **Laboratory Information Management Systems (LIMS)** chapter.

TEITELBAUM'S COLUMN ON FORENSIC SCIENCE: HISTORICAL PERSPECTIVE

Forensic Aspects of Nicotine, Tobacco, and Cigarettes: A Short Story on How the World's Most Destructive Artifact Was Developed

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In recognition of Jeff Teitelbaum's extensive work promoting forensic science knowledge and history, this article will present a brief history of nicotine and cigarettes. It accompanies my commentary, "Nicotine: The Neglected Forensic Drug" [Forensic Sci Rev 37:30; 2025], which describes the medicolegal aspects of nicotine in greater detail.

From a Sacred Medicinal Plant to a Lucrative Global Industrial Product

> *The cigarette is the deadliest artifact in the history of human civilization. It is also a defective product. The cigarette is the seatbeltless car, the lead-painted cribs, the car with the faulty brakes, the open unguarded manhole, the rickety ladder, the fouled maggoty meat, the Daikon shield, the smokestack spewing fumes ...* [1]

Tobacco plants are a member of the nightshade family (Solanaceae, which also includes tomatoes and potatoes), and have been cultivated in South America since 5000 BCE. The main type of tobacco plant grown in the Americas before colonization was *Nicotiana rustica*, which produced a harsh bitter smoke. *Nicotiana tabacum*, which was cultivated by indigenous people in the Caribbean, produced a slightly milder smoke. It is this type of tobacco that Christopher Columbus encountered in 1492 and brought back to Europe.

[a]James Wigmore has been a practicing forensic scientist for over 35 years and has testified in over 700 criminal cases across Canada, as well as in personal injury cases, wrongful death hearings, coroner's inquests, and police board hearings. A more detailed biographical overview can be found in his previous Commentary on Cannabis [*Forensic Sci Rev* 35:74; 2023]. His website is *www.wigmoreonalcohol.com*.

Do You Inhale?

> *The history of cigarettes, especially in the 19th, 20th, and 21st centuries, is one of lies, deceit, coverups, greed, misinformation, perversion of science, racism and fake news by the tobacco industry to maintain its huge profits, by encouraging the use of one of the most dangerous products ever invented by humans.* [2]

Even though smoking has been practiced for thousands of years, lung cancer was until the past century or so virtually unknown. This is because virtually no one inhaled the tobacco smoke, as it was too bitter and aversive; instead, tobacco was typically smoked in a pipe or a cigar and puffed around the oral cavity, where the nicotine would be absorbed slowly. It would also be absorbed from the cigar tip by the mouth. It was not, however, inhaled into the lungs, as it was too harsh and bitter.

In 1910, the surgeon Alton Ochsner, a young medical student at Washington University, was eager to participate in the autopsy of a patient who died of lung cancer, thinking that it might be the only lung cancer death he would see in his career. Later, lung cancer was still quite rare in the 1920s, accounting for only 1% of all cancer deaths [3].

The huge increase in lung cancer deaths since then (*see* **Figure 1** [4]) was due not only to the huge increase in cigarette consumption driven by the excessive marketing of the tobacco companies, but also to tobacco companies designing cigarettes into ideal devices to deliver highly addictive nicotine rapidly to the brain via the lungs, bypassing the slow absorption through the oral cavity.

This was accomplished by reducing the bitterness due to the basic pH of the smoke and adding sugars, licorice,

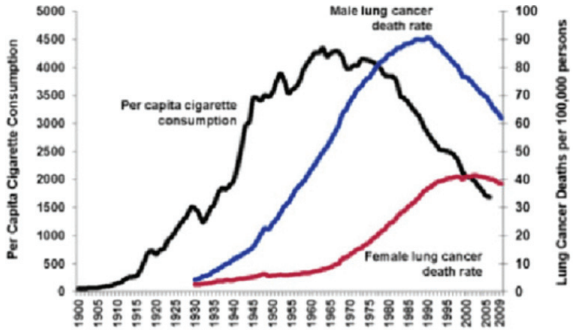

Figure 1. The adult per capita cigarette consumption rate and male and female lung cancer death rate in the US, 1900–2009 [4].

cocoa, and other flavorings such as menthol [5–7], and not least through constant advertising depicting the good life you would have if only you inhaled cigarette smoke deep into your lungs (*see* **Figure 2** [8]). The final touch to cigarette design that would make cigarettes even more deadly while giving the illusion of protection was the addition of filters [9].

According to the Office of the Surgeon General, smokers today have a greater risk of developing lung cancer than did smokers in 1964, as ventilated filters enabled smokers to inhale cigarette smoke and the carcinogens it contains deeper into their lungs [10].

Down the Rabbit Hole

> *Doubt is our product since it is the best means of competing with the body of fact that exists in the minds of the general public. It is also the means of establishing a controversy.* [11]

The numerous court cases against the tobacco industry have resulted in the release of over 9 million internal documents revealing that tobacco companies actively funded and promoted research that minimized the harms of smoking cigarettes and suppressed research showing its harms [12].

These internal documents confirmed that the tobacco companies:

- Knew in the 1950s yet vigorously denied that cigarette smoking caused cancer [13];
- Funded research showing that type A behavior and not cigarette smoking causes cancer and lung disease [14];
- Funded studies that showed that the risk of developing Alzheimer's disease was lower in smokers than in non-smokers, although nonfunded independent researchers found a greater risk [15];
- Promoted studies (later withdrawn) reporting that nicotine and smoking helped to prevent COVID-19 [16] — similar to the promotion of tobacco smoking during the outbreak of the bubonic plague in London in 1665 (*see* **Figure 3**) [17];
- Publicized distortions of the history of Nazi Germany and tobacco control [18] and promoted the view that smoking is entirely voluntary [19];
- Encouraged cigarette smoking in the military by giving out free cigarettes and running other promotions [20];
- Encouraged smokers to believe that low-tar cigarettes were safer [21];
- Promoted the claim that air pollution kills more people and is more toxic than cigarette smoke [22];
- Promoted the falsehood that vaping is 95% safer than cigarette smoking [23]; and
- Funded studies of e-cigarettes (ECs) that were 67× as likely to find no harm from ECs as were studies without a conflict of interest [24].

Figure 2. Cigarette advertisement in the 1920s instructing smokers to inhale [8].

Figure 3. During an outbreak of the bubonic plague in London in 1665, everyone from university students to grave diggers was encouraged to smoke in order to ward off the disease [17].

Merchants of Death

> "*Tobacco is a legal drug that kills many of its users when used exactly as intended by the manufacturers.*" —*WHO Global Report on Trends in Tobacco Smoking, 2015* [25]

> "*I'll tell you why I like the cigarette business. It costs a penny to make. Sell for a dollar. It's addictive. And there's fantastic brand loyalty.*" —*Warren Buffet, as quoted in Barbarians at the Gate. The Fall of RJR Nabisco (1989)* [26]

While it is now well known that smoking cigarettes causes lung cancer, according to a report of the Surgeon General of the United States in 2014, smoking has also been linked to diseases of nearly all organs of the body.

Cigarettes cause about one death per one million smoked, with a latency of about 20–25 years [27]. Thus, the 6 trillion cigarettes smoked in 1990 will cause about 6 million deaths in 2015, or one death every 5 seconds [28].

In the same study, Proctor estimates the value that cigarette companies place on a human life. As tobacco companies make about one cent on each cigarette sold, they make about $10,000.00 per million cigarettes sold, equivalent to the death of one smoker—one of their customers.

Proctor further illustrated the toxicity of cigarettes by calculating the number of cigarettes produced by specific cigarette manufacturing plants and the number of deaths caused each year, based on 1 million cigarettes being equivalent to one death (*see* **Table 1**).

Table 1. Factories of death. The estimated number of deaths caused based on the number of cigarettes manufactured [28]

Cigarette manufacturing plant (location)	Cigarettes produced[a]	Deaths caused[a]
Philip Morris's Richmond plant (US)	146 billion (2010)[b]	146,000
Philip Morris's Bergen op Zoom plant (The Netherlands)	96 billion (2006)[b]	96,000
Hong He Cigarette Factory (Yunnan, China)	65 billion (2005)[b]	65,000
Imperial Tobacco's Thane Road Cigarette Factory: Nottingham, UK	50 billion (2008)[b]	50,000
Reemtsma, Berlin, German	36 billion	36,000

[a] Per year data.
[b] Years data available.

From E-Cigarettes to Nicotine Pouches (Déjà Vu All Over Again)

> *Flavour chemicals are present in almost all e-cigarettes currently on the market in the USA and globally. Concerns are rising among public health professionals that flavored e-cigarette products may make e-cigarette use attractive to youth. Second, high doses of some flavour chemicals may be safe when ingested, but quite unsafe when inhaled.* [29]

As cigarettes have come under increasing social and legal attack, the cigarette market decreased considerably from 41% of US adults in 1944 to only 11% in 2024 [30] (*see* **Table 2**). Consequently, the tobacco industry pivoted away from cigarettes alone and sought new nicotine delivery systems.

Table 2. US adult vaping and smoking rates, 2022–2024 [30]

Age group (years)	Users (%)	
	E-Cigarette	Cigarette
18–29	18	6
30–49	8	13
50–64	4	18
65+	1	9

The industry's new delivery system was electronic cigarettes (e-cigarettes), which employ a battery to heat a NiCad coil to temperatures below the combustion point that vaporizes a solution containing a high concentration of nicotine, propylene glycol, flavorings, and other chemicals. The most popular e-cigarette was JUUL, whose extensive advertisements targeted youth with portrayals of the use of e-cigarettes as hip and cool (**Figure 4**). In fact, JUUL was so successful that it lost a $462 million US lawsuit for its deceptive and false advertising [31].

Figure 4. JUUL e-cigarette advertisements, like those for cigarettes, were directed at youth [31].

The next drug delivery system that the tobacco industry has pushed is nicotine pouches inserted into the mouth. The nicotine again is heavily flavored and sweetened to make it more attractive to youth. As with filtered cigarettes and e-cigarettes, the tobacco industry greatly downplays the harmfulness of pouches.

Major highlights of the timeline of tobacco products (cigarettes) compiled in Ref. [32] have been combined below with additions by this author (*see* **Table 3**).

Table 3. Major highlights of the timeline of tobacco (cigarette) use from Ref. [32], with author's additions

Year	Study/Finding [Ref.]
6,000 BCE	Indigenous people in South America first cultivate the tobacco plant
c. 1	Tobacco smoking becomes widespread in the Americas and is used in religious ceremonies
1492	Christopher Columbus takes a gift of tobacco leaves back to Europe
1558	The first attempt to cultivate tobacco in Europe fails
1600	Tobacco was first introduced to England, probably by Sir John Hawkins [33]
1614	Tobacco shops opened across Britain selling Virginia blend tobacco
1700	African slaves are forced to work on tobacco plantations years before the spread of cotton fields
1776	Tobacco helps finance the American Revolution and is used as collateral for loans from France [34]
1826	Nicotine is isolated for the first time
1861	The first American factory produces 20 million cigarettes
1880	Bonsack develops the first cigarette rolling machine
1890	4 billion cigarettes are sold this year in the US
1912	First reported link between smoking and lung cancer
1918	An entire generation of young men returns from WWI addicted to cigarettes
1924	Over 70 billion cigarettes are sold this year in the US
1939–1945	Another generation of young men returns from WWII addicted to cigarettes
1964	The US Surgeon General links cigarette smoking to lung cancer and heart problems
1967	Senator Robert Kennedy gives an address to the first World Conference on Smoking and Health
1992	The nicotine patch is introduced
1997	For the first time in history, an American tobacco company CEO (Bennet Lebow) admits at trial that cigarettes cause cancer
1999	The Master Settlement Agreement (MSA) between the US and tobacco companies costs the tobacco industry $206 billion over 25 years [35]
2006	Philip Morris USA Inc and other major US tobacco companies are convicted under the Racketeer Influenced and Corrupt Organizations Act (RICO) and are ordered to issue corrective statements [36]
2018–present	Tobacco companies promote and push highly addictive nicotine in other nonsmoking and less obtrusive forms such as e-cigarettes, pods, and pouches [37]

Conclusion

Tobacco companies have designed and developed cigarettes into the most destructive artefact known to humanity. More people have been killed by tobacco-associated diseases in the 20th century than died in both world wars combined.

Robert Kennedy's address to the first World Conference on Smoking and Health in 1967 [38] makes an appropriate hopeful conclusion for this short history.

> *The cigarette industry is peddling a deadly weapon. It is dealing in people's lives for financial gain. The industry we seek to regulate is powerful and resourceful. Each new effort to regulate will bring new ways to evade. Still, we must be equal to the task, for the stakes involved are nothing less than the lives and health of millions of people around the world. But this is a battle than can and will be won.*

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