

出國報告（出國類別：國外會議）

參加 2023 年第 75 屆美國鑑識科學  
學會年度會議報告書

服務機關：法務部法醫研究所

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## 摘要

本所派員參加第 75 屆美國鑑識科學學會 (American Academy of Forensic Sciences, AAFS) 年度會議，本屆年會會議期間為 2023 年 2 月 13 日至 18 日，為期 6 日，於美國佛羅里達州的奧蘭多羅森瓦溪會議中心舉行。本次的大會主題為「Science Works」。

美國鑑識科學學會成立至今已 75 年，本研討會議主題大致細分成 14 個領域，涵括人類學 (Anthropology)、犯罪學 (Criminalistics)、數位及多媒體科學 (Digital & Multimedia Sciences)、工程與應用科學 (Engineering Sciences & Applied Sciences)、法醫護理科學 (Forensic Nursing Science)、一般法醫刑事 (General)、法學 (Jurisprudence)、法醫齒科學 (Odontology)、病理/生物學 (Pathology/Biology)、精神及行為科學 (Psychiatry & Behavioral Science)、問題文書 (Questioned Documents) 及毒物學 (Toxicology) 等。參加本次年會有約 26 場不同領域之專題討論 (workshops)，許多學術、產業及實務單位亦透過年會進行最新研究成果交流，除了於年會中展示研究成果或進行口頭演說，廠商攤位也展示許多先進技術商品並與參加人員互動，使整個年會更為熱絡。

本所亦利用此次機會，於年會中發表研究論文 1 篇：「法醫兒童及少年死亡案件態樣分析研究及流行病學分析」(Epidemiology Analysis of Medical-Legal Investigation of Children and Adolescent Fatalities in Taiwan)。此研究完成回溯 10 年間 6 歲以下嬰幼兒死亡案例統計分析，發現死亡方式、死亡型態分布與年齡關聯性高。顯示與一般死亡統計作業相比，6 歲以下死亡流行病學分析的確有年齡細分組的必要性。而針對他殺死亡案件的加害者統計作業，以及涉及藥物濫用的嬰幼兒死亡案件，所涉及的藥物種類、濫用方式，更值得在後續計畫中持續關注。

感謝法務部每年支持本所參與此項國際會議，參與國際會議除了可拓展視野及對多元鑑識深入認識之外，更可提升我國於國際之能見度。

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## 目的

美國鑑識科學學會（American Academy of Forensic Sciences）成立於 1948 年，總部位於科羅拉多泉（Colorado Springs, Colorado State）。每年 2 月都會在美國不同城市舉辦年度會議，至今已 75 年，成員包括醫師、牙醫、人類學家、檢察官、律師等，每次會議約聚集了世界上大約 5,000 位知名學者，除了發表他們各自專業領域的最新發現，也傳遞各領域的最新研究進展及對鑑識結果的通用解讀，可說是最重要的法醫年會之一。

年會中每一篇研究報告及每一場演講皆為各自領域的專家經年累月的研究成果。藉由參加年度會議可汲取這些寶貴的知識及經驗，了解國際上鑑識研究最新發展並與國外專家學者交流；此外，也可作為與會人員之在職訓練，溫故知新。因此，本所每年編列預算派員參與年會，旨在於提升本所鑑識能力及鑑驗技術。而為了與國際交流互動並提升國際能見度，本所於 2022 年即投稿該學會，經該學會評審團認可後，將研究成果發表於 2023 年第 75 屆年會中。

此次參加國際會議，除希望能於國際會議中交流最新科技技術，更期待透過與國際上經驗豐富之專家學者進行互動，使本所研究能獲得啟發與更加精闢深入，對於成果之應用能更多元廣泛。

## 過程

112 年 02 月 12 日 抵達美國奧蘭多

112 年 02 月 13 日 於會場辦理報到手續

112 年 02 月 14 日 參加「NIJ R&D Symposium」及海報會議「NIJ R&D Symposium  
Poster Session」

107 年 02 月 15 日 參加 AAFS 特別演講「Science Works」、全體會議「The Role  
of Forensic Medicine in Forensic Science」、海報會議

112 年 02 月 16 日 參加病理學/生物學會議「Pathology/Biology Session」、海報會  
議「Poster Sessions」

112 年 02 月 17 日 參加病理學/生物學會議「Pathology/Biology Session」、發表本  
所研究成果「Epidemiology Analysis of Medical-Legal  
Investigation of Children and Adolescent Fatalities in Taiwan」研  
究成果海報展示、研究成果口頭報告

112 年 02 月 18 日 搭機返國

## 研討會專題內容

### 一、 特別演講：「Science Works」

建立實驗室標準並使其通過認證對於法醫鑑定至關重要，今年的主題演講邀請到 Kay Scott Griffi，過去是一名航空公司飛行員，他是世界上第一個 Collaborative High Reliability<sup>®</sup>和 Collaborative Just Culture<sup>®</sup>改進計劃的作者，該計劃由世界領先的國際認證機構 DNV 獨立審核和認證。

法醫科學涵括生物學（野生動物法醫生物學、人類法醫生物學）、化學（法醫毒物學、管制藥物毒品等）、微小跡證化學（微量物質、可燃液體、炸藥、槍擊跡證）、物理性跡證（血液型態分析、法醫文件審查、工具痕、槍枝比對、指紋鑑定、輪胎痕及足跡鑑定）、犯罪現場偵查（火災及爆裂物偵查、犯罪現場調查與重建）、醫學（法醫齒科學、法醫護理學、法醫死因鑑定、法醫人類學）、數位及多媒體科學（影音、影像科技分析、聲紋辨識、臉部鑑定、數位證據）。高信賴度的法醫科學需具有證據支持的科學（專家領域）、各領域之協力合作（其他法醫及科學領域）、客觀且獨立之判斷（無政治及利益相關者之影響）、值得信賴（公眾與利益相關者）；可靠組織的特徵，於其顧客服務中具備多樣性、公正性、包容、歸屬感、品質查核與改進、財務責任、隱私性、安全性（顧客、訪客、工作者）、標準化操作流程。

講者提出隱藏的科學理論，其中包含系統之可靠性、人的可靠性，可靠的系統應具備有效性及彈性，並包含兩種獨立之設計，影響系統可靠性因素包含人力績效、環境、資源分配合理性、系統設計、系統容量與負載，而影響人員之可靠性因素包含訓練、環境、注意力、壓力、疲勞、過勞、文化、程序、設備等，並提出須避免系統、個人、組織之偏見，透過減少錯誤、提高可靠性進而提升效益，讓我們對於實驗室的架構、規畫以及不足之處有更進一步之了解。

## 二、全體會議：「The Role of Forensic Medicine in Forensic Science」

法醫病理學和法醫人類學與其他主要依靠分析測試（例如：毒理學、DNA、指紋比對）之法醫學科不同，法醫人類學家和法醫病理學家為醫學專業，解釋主觀及客觀訊息以形成醫學意見，據研究調查，有 82% 的提供醫學意見之法醫病理學家曾經歷壓力與批評，一旦醫學專業人員不再願意進入法庭協助提供專業意見，將危及司法系統之運行。

法醫病理學家 Dr. Joyce deJong 提出目前法醫病理學面臨的最大挑戰為人力短缺，在美國的法醫病理學家需經歷長時間之培訓，大學醫學本科畢業（M.D.或 D.O.）、病理學住院醫師 3-4 年、進行法病理學研究 1 年，再經美國病理學委員會之認證使得為之，而自 2015 年起，與毒品相關死亡人數增加一倍以上、與槍枝相關的死亡人數也增加一倍以上，然而法醫病理學家的人數持續下降，講者每周都會收到屍檢報告延誤通知以及屍體冰存過長時間之警報。

死亡原因可以為千百萬種，疾病、受傷或是各種複雜的情況，法醫死亡調查含括現場調查之評估、醫療紀錄、警方報告、解剖檢查、實驗室檢驗結果、X 光檢查、後續跟進調查，以提供帶有死亡原因、死亡方式和其他相關信息之報告。

講者分享了兩個具法律爭議案例，主要提出法醫學家不論受雇於哪一方之辯護，應依所有資料評估其偵查及檢驗結果，提出可信之說明，且基於不正確的資料而作出的錯誤意見，應有權獲得豁免權。

法醫人類學家 Dr. Christian Crowder 提出法醫人類學在法庭上扮演之複雜角色，有時像病理學家一樣提出主觀見解，有時候提供客觀統計數據、文獻研究，法醫人類學最早為體質人類學，應用物理方法解決生物相關的問題，傳統運用於現場重建、創傷解釋、放射學觀察比較，近年應用於身分鑑別、協助建置未認領但已識別身分之案件資料庫、災害受難者身分辨識、大規模災難現場協助及管理。

其中法醫人類學面臨其挑戰為認證問題。北美主要法醫人類學之認證委員會為 American board of forensic anthropology (ABFA)，然而該委員會僅能夠對其提供之服務進行認證，無法對其實驗室進行認證，然而，未經認證之實驗室恐面臨幾項問題，缺乏對政策與程序的監督、品質與客觀性受質疑、法律上承擔較高之風險等，故為解決這樣的問題，研究團隊進行品質保證計畫，研究其客觀性與偏見性問題，承認並限制主觀意見，識別並盡量減少偏見之影響。

於 2019 年曾發表認知偏見如何影響法醫人類學分析，其中提到當執法部門提供與遺骸相關之服裝與個人物品、武器/工具、現場藥物、身分證資訊等皆可能造成相關偏見，而放射學觀察生前與死後之 X 光片也可能由於缺乏同儕複審之過程有所偏差，對於緩解偏見之建議，講者提出如果條件許可，個案應由一位人類學家進行重建而另一位進行分析、避免法醫提出武器與創傷之意見並在品質保證計畫下進行。

現任法官 Pamela King 說明了在法庭上之人員分工，在美國最佳解決衝突問題的方法為交互詰問，最後由法官或是陪審團決定哪一方之舉證較有影響力，儘管過程可能會使得專家證人感受到人身攻擊，但事實並非如此，律師需進行他們受憲法保障之工作，他們有權獲得完整的詰問，法醫專家則協助他們進行辯護，而作為法醫病理學家，主要之目的並非協助破案，而是透過確定死亡方式來協助群眾。

講者提到在過去一個案例中判決書是這樣敘述法醫病理學家的，「我們需要專家始終竭盡全力、並始終保持客觀、在生成報告時不受調查人員、檢察官與辯護人之影響，並在任何時候都盡力做到客觀中立」，這也適用於在場的每個人。身為法醫人員，在法庭上代表的是科學而非正方或反方，避免受到檢察官、辯護律師、媒體偏見及壓力影響是法醫學者的責任，法醫人員能做的最重要的事情就是忠於你的見證、投入你所做的工作、並仔細檢查你的工作，確保自己能夠提出中立的意見。



### 三、專題演講：「High-Resolution Mass Spectrometry Screening in Forensic

#### Toxicology： Cost Benefit Analysis」

過去二十年激增的新興精神活性物質（NPS）使美國法醫毒理學調查之營運模式受到巨大的挑戰，早期免疫篩檢法（Immunoassay、IA）為最廣泛使用之技術，然而，在因應不斷出現的新型藥物，其有效性受到質疑。因此，專家建議以具備高靈敏度、靈活性及可改進之選擇性高解析質譜儀（High-Resolution Mass Spectrometry、HRMS）取代 IA 進行藥物篩檢，但由於資源有限、操作複雜以及判讀技術的培訓需求，使得相關實驗室採用 HRMS 技術方面進展緩慢。研究團隊在本研究中將試驗樣品進行 IA 與 HRMS 篩檢，進行成本效益分析、評估方法之有效性及效益對於實驗室之財務、資源管理、培訓與技術研發之影響，也提供正在考慮技術轉型之實驗室作為營運成本及收益之參考。

本研究中，液相質譜-四極柱-飛行時間質譜儀（Liquid Chromatography-Quadrupole-Time of Flight Mass Spectrometer、LC-QTOF-MS）於開發、優化和驗證符合已公佈的法醫學毒理調查標準與建議的篩選程序，HRMS 具備高特异性與靈敏度、可擴大篩檢範圍（非目標分析）、具備資料回溯性分析之潛力並可對新出現之藥品進行結構性分析之優勢，其缺點包含初期投入成本高昂、人員培訓、儀器較為複雜、專門的研發人員、規劃流程之時間成本較高、密集的開發方法與驗證、資料保存之規劃，可能會使得實驗室發展遲緩或無法開發新技術。講者講述了其方法之開發流程並整合篩檢結果之比較，高產實驗室（每年案件達 25,000 件）使用 HRMS 之成本較可能比使用 IA 低，案例量中等之實驗室運用質譜儀（Mass Spectrometer、MS）的篩檢可以具備其成本效益，較小型之實驗室（每年<1000 件），則投資回報率可能較低，而 HRMS 也不利於案件量持續減少之實驗室。

#### 四、專題演講：「**Validation of a Confirmatory Proteomic Mass Spectrometry Body Fluid Assay for Use in Publicly Funded Forensic Laboratories**」

在起訴性侵案件時，就目前血清學技術除了精子的顯微鑑定外，多屬推測性證據，雖短序列重複 DNA (Short Tandem Repeats、STR) 已經由科學證實可作為身分確認之技術，然而，並無法排除在性侵案件中遇有嫌疑人聲稱 DNA 係來自皮膚細胞或二次轉移性 DNA 可能性，因此運用微量的 DNA 進行 STR 分析體液並確效其來源係血液、唾液或精液，有助於調查性侵之案件。

蛋白質是由 20 種不同胺基酸組成之分子，長度從幾十種到數千種氨基酸不等，而每個細胞均有數十億個分子，因此無須放大即可檢測到，且蛋白質對時間及環境要求較低，較為穩定，即使部分降解也可檢測到，在不同的組織會表達不同的功能因此可識別其來源，具有其特異性及敏感性，在前一項研究中，講者之研究團隊已確認各種體液中可做為識別之蛋白質生物標記，血液(HBA、HBB、B3AT)、唾液(AMY1、CYTT、LEG1H)、精液(SEMG2、SEMG1、KLK3)。

研究團隊運用三段式四極柱質譜儀(QQQ-MS)監測目標，進行 510 個檢體之確效，包含大量血液、精液與唾液樣本，也包括模擬檢體、陳舊檢體、混合物、陰道分泌物、經血、來自輸精管切除術捐獻者之精液以及非人類之體液，已完成並建立質譜之開發工作(檢體萃取、蛋白質定量、蛋白質消化、高液相質譜法之流體分析、子離子母離子之選擇及監控、數據分析之指標以及判別標準之建立)，確效該方法，精確度於體液中為 100%、錯誤發現率為 0%。在已知含有某體液(包含混合物)之檢體中，每種體液之總靈敏度，血液為 98.3%，唾液為 98.7%，精液為 95.2%。

## 五、專題演講：「Bone Trauma and Thermal Alteration of Human Remains」

火災造成的死亡人數在美國逐年攀升，火災熱造成的人體損害程度是由溫度與持續時間決定，常見之傷害由輕至嚴重可分為燙傷水泡、遠端肢體火化燒焦、骨骼暴露且四肢脫節、頭骨和四肢的廣泛損傷碎塊、很少或沒有軟組織且骨骼支離破碎不完整，其中熱造成之骨折可分為四種型態：橫向與縱向骨折、縮小或彎曲的橫向骨折、網狀骨折、層狀脫落型態，其中定量分析對於燒傷之骨骼具有研究之價值。

鈍力創傷型骨折，於肢體具多種形態：不完全骨折、橫向骨折、粉碎性骨折、螺旋狀骨折、開放性骨折，於頭骨：凹陷性骨折、顱底骨折、線性骨折、星狀骨折。

該研究目標為提供刑事司法系統、法醫人類學家辨別傷害之準則，將死前鈍力創傷與熱損傷加以區別，提供熱創傷及鈍器外傷之數據以減低錯誤解釋。研究分為兩階段，第一階段為數據收集與分析，目標是記錄火災案件生前鈍力創傷證據之存留率，第二階段為資料分析與實驗設計，標準化資料收集、確認受影響之比率與控制因子，第三階段實驗驗證，提供完整之數據、發展評分系統並確效以辨別生前鈍力創傷與熱創傷。

在第一階段中研究團隊將受捐贈之完整 16 具大體（32 個四肢）進行機械衝擊以及熱處理，控制衝擊力、衝擊持續時間、衝擊位置、衝擊部位形狀（方或球形），並對骨折區域進行 X 光檢查，對側作為對照組，受到衝擊後之骨骼再經柴火燃燒使其經歷熱創傷，收集燒傷之溫度數據和定時攝影之數據。研究至目前為止，50%之下肢與 25%之上肢並不會形成拳擊樣態，可說明運用拳擊樣態鑑別生前燒死或死後焚屍是不可靠的，第二階段將持續進行。

而經火燒後之殘骸研究團隊也將其進行恢復及處理技術之測試，並於會議期間以海報形式展示（A Technical Note on Recovery and Processing of Burned Human Remains），由於被燒毀之遺骸由於水分及有機物質之流失，

會產生收縮、裂開以及骨質疏鬆之形態變化，這些變使得骨骼較為脆弱難以恢復與加工處理，透過該測試以期許能做為未解決案件的遺骸長期管理之參考以及人類學分析研究收藏之辦法。

過去研究 Triaca 等人<sup>1</sup>建議燒焦之骨骼以 80°C 之熱水浸泡 24 小時為最佳之處理程序，然而該研究是在燒焦之豬腳上進行，豬腳暴露於高溫中 30 分鐘，導致缺乏大部分之軟組織、也未有未完全燃燒骨骼之混和狀態，且該程序應用於人體遺骸燒毀之案件造成骨骼碎片的損壞，故研究團隊將燒毀之骨骼以鋁箔、牛皮紙袋打包運輸至實驗室，並進行不同之處理包含乾燥採集、乾燥刷洗、物理浸泡、熱水浸泡、蒸煮法，並於 1.5 年後再次評估其方法保存之持久性。

運送燒毀骨骼之包裝，經實驗證實鋁箔具較高的支撐力比牛皮紙袋更為安全並可最大限度減少運送之傷害。研究團隊提出處理燒傷骨頭的最佳做法取決於燒傷程度。未經火燒之骨骼，以自來水和牙刷處理較為妥適，若仍具組織沾附，建議以 60°C 之熱水浸泡 45 分鐘；若皮質骨變黑之骨骼，應避免直接用水浸泡，建議進行乾燥採樣必要時以沾濕之牙刷輕輕塗抹；若骨骼同時具有未燒傷及燒焦變黑之情形，建議對未燒傷之骨頭進行熱水浸泡，而燒焦變黑之骨頭使用毛巾使其穩定維持在水面以上，如果骨小梁呈現黑色，也應避免以水浸泡，若該骨骼具組織沾附，則先以乾牙刷輕刷，若組織仍黏著，建議以 60°C 之熱水蒸煮並用鑷子、牙籤或牙刷去除軟組織，無論骨骼之燒傷狀態均建議使用毛巾支撐易碎之骨骼。

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<sup>1</sup> Triaca A, Mahon TJ, Myburgh JA, 2022. Comparison of different maceration techniques on burnt remains. *Journal of Forensic Science*, 67, pp.676-682.

## 六、美國國家司法研究所的「Forensic Science Strategic Research Plan」

今年度的法醫年會中有多場演說為該計畫贊助之研究項目，為了解相關單位是如何分工並推進國家法醫學之發展，查閱相關資料整理如下：

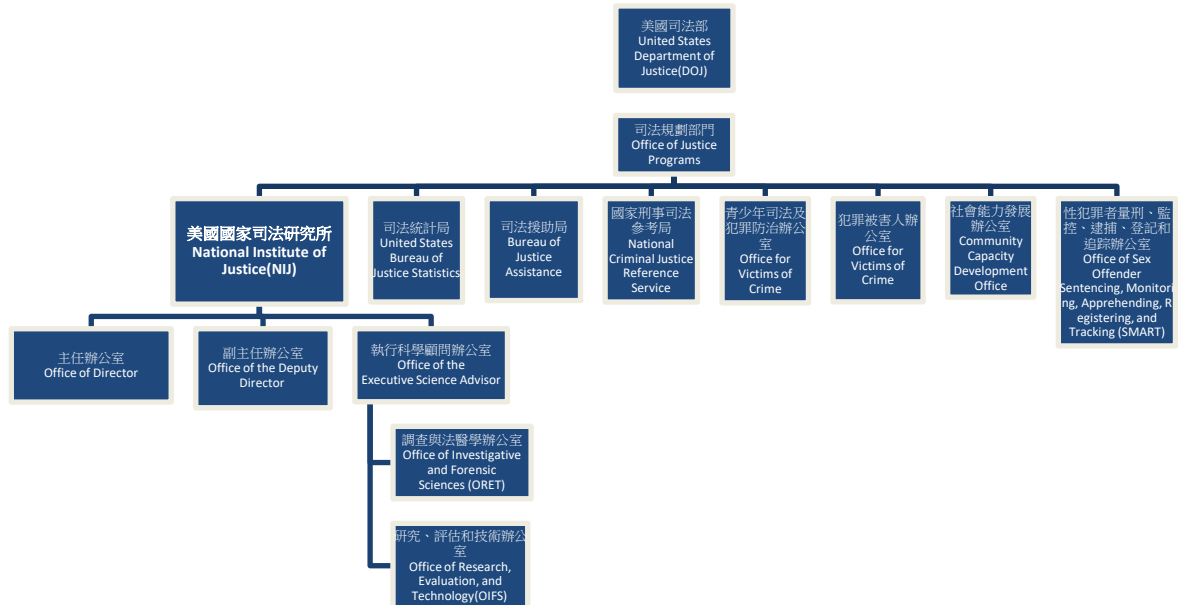


圖 1：美國國家司法研究所組織架構示意圖

### 1. 美國國家司法研究所簡介：

美國國家司法研究所 (NIJ) 係隸屬於美國司法部下之司法規劃部門，相關組織架構示意如圖 1。NIJ 是美國司法部 (DOJ) 的研究、發展和評估機構，致力於通過科學研究 (研發、測試和評估、技術與知識交流)，以提高對於犯罪和司法問題的認識與理解，並據以提供客觀和獨立的技術以利各地方解決刑事司法案件之問題並減少犯罪案件之發生。NIJ 同時也是聯邦政府在法醫學研究發展、培訓、提高實驗室效率和減少案件積壓之管理領導機構。

NIJ 支持的法醫學學科包含且不限於法醫生物學、DNA、微小跡證化學、物理性跡證、法醫毒理學、毒品查緝、犯罪現場調查、法醫病理學、法醫人

類學、數位及多媒體科學。透過積極發展研究以支持犯罪調查、起訴犯罪者、預防不法行為，以維護司法正義。

2. 戰略研究計畫之目的：

本研究計畫中提出之戰略重點與目前法醫學界面臨之挑戰息息相關，NIJ 將透過該計畫持續推廣研究成果以影響相關之從業人員（研究和技術開發人員、法律界、政策制定者等）。

3. 研究背景：

A. 為支持美國司法部之優先事項（減少暴力犯罪、支持司法調查、減少現有之積壓案件、推進新技術以加強公共安全、研究可創造更有效且公平之司法系統）而制定相關計畫。

B. NIJ 過去持續依據美國國家科學院（The National Academy of Sciences、NAS）、總統科學技術委員會（The President's Council of Advisors on Science and Technology、PCAST）、美國科學促進會（American Academy for the Advancement of Sciences、AAAS）、美國國家標準與技術研究院（National Institute of Standards and Technology、NIST）之研究建議持續改善其施政方針。

4. 研究計畫制定之影響因素：

A. 須滿足在科學、法律與政策環境中不斷變化的法醫學需求：

法醫科學研究與開發技術工作組（The Forensic Science Research and Development Technology Working Group、FSRD-TWG）是由地方、州、聯邦機構和實驗室之經驗豐富的法醫學各領域從業者組成之大約 50 人的委員會，通過 TWG，NIJ 可確定優先之研究需求，並定期發布相關需求，提供給對於解決當前問題有興趣之研究人員。

B. NIJ 的獨特使命：

NIJ 是一個以司法為中心的科學機構，為不同聯邦機構、州提供廣泛之法醫學服務。通過與不同機構間之合作，整合不同領域資源並使其效益

最大化，對於法醫學之進步具極大影響力。

C. 短、中、長期之投資：

NIJ 支持多樣化之研究項目，並將其研究成果提供給從業人員以及政策制定者。

D. NIJ 法醫學研究產生多樣化之研究成果，包含基礎、應用與研發中之項目。

5. 法醫學戰略研究計畫重點與研究目標：

A. 推進並發展應用法醫學研究。

- a. 優化現有之技術與方法。
- b. 創新技術與方法。
- c. 識別複雜條件、基質跡證之技術方法。
- d. 加快鑑驗流程之技術開發。
- e. 支持法醫學家結論之自動化工具。
- f. 分析與闡釋標準化準則。
- g. 驗證並建立標準化流程。
- h. 參考資料與數據庫之蒐集。

B. 支持法醫學基礎研究。

- a. 確認法醫學方法之有效性與可信度。
- b. 法醫學之決策分析（例如：實驗室間比對、同儕校閱）。
- c. 確認證據之侷限性。
- d. 證據之穩定性、永久性與運送之影響。

C. 最大限度發揮法醫學研究與開發之影響力。

- a. 展示研究成果至相關社群。
- b. 支持方法與技術之實踐。
- c. 評估 NIJ 法醫學項目之影響力。
- d. 查核法醫學研究對於司法系統之角色與價值。

- D. 培養多元化、高技能之法醫學工作人員。
  - a. 培養新生代之法醫學研究人員。
  - b. 促進實驗室之研究。
  - c. 增加法醫學之人力。
  - d. 評估其多樣性、可持續性、包容性。
- E. 協調學術界、業界、政府部門之間的合作，以幫助對應需求與資源。
  - a. 評估和解決現場需求：與從業者接觸了解其不斷變化之需求；傳達給研究人員、教育工作者和政策制定者。
  - b. 建立合作夥伴以最大化運用資源：與合作機構建立協議、協調利用各機構資源與優勢，並避免重複。
  - c. 促進訊息之共享：利用各種平台（座談會、網路研討會）進行知識共享、作為收集與提供解決方案之中央機構。
- 6. 與 NIJ 簽訂合作協議之法醫技術卓越中心（Forensic Technology Center of Excellence、FTCOE）：

FTCOE 是屬 RTI International 部門之一，RTI International 是一家協助客戶整合實驗科學、協助評估法醫實驗室操作和政策項目並發展專業知識的私營非營利性研究機構。RTI 擁有 5000 多名員工，為超過 75 個國家/地區之政府與企業提供研究與技術服務。NIJ 為解決研究成果無法立即應用於司法實務案件之問題，與 FTCOE 簽訂合作協議，委託其進行新開發之技術之驗證、並分享知識，以連結科學界與司法界，並加速其研究成果之應用。
- 7. 小結：NIJ 之角色與其貢獻
  - A. 與公私立機構建立合作關係，並作為學術界與實務連結之橋梁，鼓勵相互合作，並幫助其對應資源。
  - B. 推進法醫科學之發展，提供研究人員研究、創新技術、方法開發之優先事項與目標，並助其實踐應用於司法系統。
  - C. 資助研究項目之開發並協調相關資源，避免重複。



- D. 協助將研究成果發揮最大影響力，持續進行新知識、技術之共享，透過出版刊物、軟件開發、資料數據庫之建立、提供操作指引使其可推廣應用於各地方政府、州。

## 心得與建議

### 一、心得

歷經兩年多的新冠肺炎疫情影響，2023 年終於恢復實體會議，非常令人欣喜與激動，有幸奉派出國，也難得沒有了戴口罩的限制，久違的享受自由呼吸的空氣，隨時可以看見大家臉上生動表情，真的是非常幸福。

出發前因為正值疫情趨緩，航班不確定性高，經歷了航班被更動、取消，出發後機場交通設施故障、航班延誤，返程時又恰逢機場火災後停工停擺，航班延誤，差點滯留遠方，非常幸運地關關難過關關過，一路上非常感謝遇見的所有好心人還有給予很多心靈支持的同事與家人，讓我帶著滿滿的收穫與喜悅返家。

會議開始前兩周收到會議期間可以用來安排有興趣議題的 APP，提前將有興趣的主題都加入自己的行程內，著實非常便利，也能夠透過 APP 下載相關的資料以及建立筆記。在豐富多元主題的會議期間，有各國的學者運用不同的技術解決令大家很有共鳴的法醫領域中面臨的挑戰與難題，過去學習過的技術與原理，直面的應用在一場又一場的口頭報告內，也收穫了不少對於目前教科書上見解不同的研究內容，著實獲益良多。

本所於鑑驗業務壓力之下，人力不足且經費短絀，均需仰賴科技計畫爭取研究經費，以持續提升鑑驗品質。感謝法務部每年支持本所發展鑑驗技術及參與國際會議，與世界各國專家進行交流，並進一步提升本國於國際上之能見度，創造多贏局面。

## 二、建議

### 1. 提高本所業務單位之員額：

本組在鑑驗案件業務繁忙之壓力下，需兼辦法醫之人才培訓、法醫業務之督導、協助政策之推廣，實在無法有多餘之人力、時間投入研究工作，建議應補充 10-15 員額，可減少積壓案件提升鑑驗品質、提高實驗室效率並發展研究專業知能與技術。

### 2. 提供人員赴國外短期進修：

隨著社會變遷，人們生活型態之改變，犯罪手法日新月異，因此專業人員的在職訓練相當重要，除參加會議觀摩法醫鑑識新科技與方法外，亦可評估選擇可供學習之相關實驗室、機構，未來可派員前往學習相關鑑驗技術。

# 附錄

## 一、研究內容投稿摘要

### **Epidemiology Analysis of Medical-Legal Investigation of Children and Adolescent Fatalities in Taiwan**

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While overall the population of Taiwan is aging due to the low birth rate, the numbers of child abuse and child death is surging even with the historically lower youth population. Protecting children against abuse and neglect is an increasingly important challenge in Taiwan. The purpose of this study is to create a database to allow us to better understand and analyze child abuse morbidity and mortality data from Taiwan.

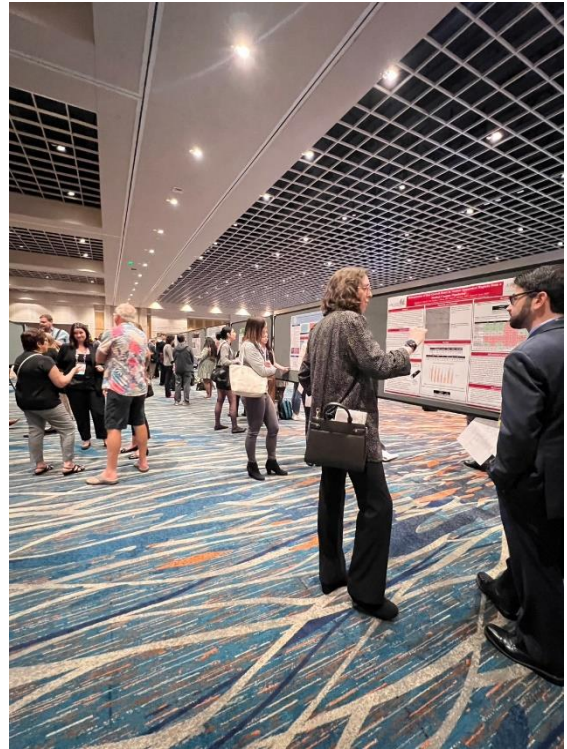
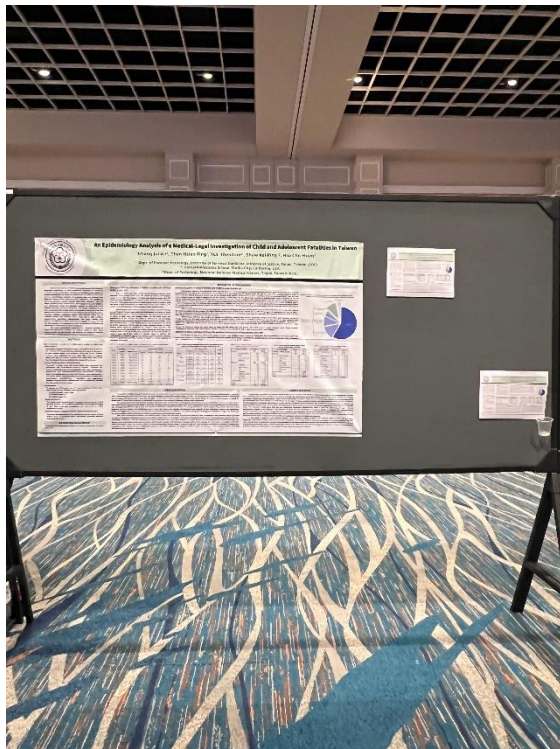
In this study, a database has been established for “Forensic Autopsy of Child and Adolescent Deaths” and used to analyze trends in child abuse deaths and correlated risk factors. We hope our results can both assist in the creation of more effective child abuse prevention programs and improve the quality of forensic investigation of child and adolescent fatalities in Taiwan.

To work toward a solution, it is necessary to examine the physical and mental extent of drug abuse and its relation to child abuse, and investigate the pattern of death, pattern of injuries of children and infants, and the risk factors of abusers. The database documenting the death patterns of different age groups has been updated annually and the mortality risk factors were analyzed. We studied the statistical correlations between the risk factors of guardians or caregivers such as psychological disorders, alcoholism, substance abuse, and mental retardation in addition to cases of child abuse that include domestic violence, care negligence, and suicide-homicide. Out of 19,431 medicolegal autopsy fatalities from the Institute of Forensic Medicine, Ministry of Justice in Taiwan, 1,054 (5.4%) involved children under 6 years of age. The data was collected and analyzed by age groups during 2000–2019. The accidental risk factors of different age groups were significantly different. It is worth noting that falling from height is the highest-ranked pattern of death for all age groups. In more than half of the 128 forensic autopsy deaths of homicides under the age of 6, most perpetrators were parents (75 cases, 58.6%) , showing that the deaths of pre-school childcare deaths were significantly related to the main caregivers such as parents. The epidemiological analysis reveals that child fatalities under 6 years of age have large differences of mortality statistics between the age groups compared to the general population.

In future work, the important areas for further statistical analysis should include the cases of perpetrators of other homicide deaths, the infant and young child deaths involving substance abuse, the types of illicit drugs-related, and the abuse patterns. These results can be used to establish strategies to help the frontline medical personnel, such as pediatricians, to identify child abuse, better formulate policies for child abuse prevention, protect the wellbeing of children and infants, and to improve judicial human rights.

**Keywords : Forensic Autopsy; Child Maltreatment; Patterns of Death**

## 二、本所發表研究成果之海報展示現場





# An Epidemiology Analysis of a Medical-Legal Investigation of Child and Adolescent Fatalities in Taiwan

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## INTRODUCTION

The trend of deaths of children and adolescents in the focus of long-term monitoring of child protection incidents in advanced countries in the world. Since children are limited in their ability to protect themselves, methods. In practice, they are divided into death by storm abuse, death by negligence, and suicide by homicide (parents commit suicide with negligence to care). Children and adolescents spend the greatest amount of time with their parents and other primary caregivers. The family residence has the most profound influence on the children's mental and physical domestic violence, substance abuse, and suicidal intent are at common factors for children over 1 year old or with mobility, manipulation, defiance and hard to classify the way of death, for that reason, it is necessary to rely on anatomical findings and pathological examination to assist judgment. This study established a database for "Forensic Anatomy of Child and Adolescent Deaths" to analyze the majority of forensic identification of child and adolescent death cases in Taiwan.

## METHOD

Epidemiological research on homicide cases related to infant and children deaths. This study used forensic autopsy cases from 2010 to 2019 by the Institute of Forensic Medicine, Ministry of Justice as the source of the forensic death case database. From the 10,431 forensic autopsy cases conducted in Taiwan from 2010 to 2019, 100 cases of infant and child age were statistically analyzed from these cases. Epidemiological data was forensic drug inspection and classification. Increased blood, urine and tissue fluids were monitored for headspace gas chromatography with mass spectrometry (HS-GC-MS), gas chromatography-mass spectrometry (GC-MS), liquid chromatography-mass spectrometry (LC-MS), liquid chromatography-mass spectrometry (LC-MS/MS), liquid chromatography-mass spectrometry (LC-MS/MS). Qualitative and quantitative chemical analysis of hair samples were also performed to monitor the effects of continued drugs. Age-related differences caused by age variables, further cases are divided into the following three age groups: (1) Children aged 3-6 (2) Children aged 7-10 (3) Children aged 11-18

This study used Microsoft Excel to compare epidemiological data for the ratio, and calculations are expressed as a 95% confidence interval. Conflicts of Interest: The authors declare that they have no conflict of interest. This study was approved by the Local Ethics Review Board of Anil Medical Care Corporation (Anil Medical Care Corporation, Taiwan) and National Sun-Sheng Memorial Hospital (NSMHI) (NSMHI, Taiwan).

## ACKNOWLEDGEMENT

This work was supported by Ministry of Justice, project no. 110-180-10-17-04.

## Analysis of the age, manner of death of infant and children under 6 years old

Between 2010 and 2019, of the 10,431 forensic autopsy cases received, 5.4% (563 cases) were infant and child age. The most common manner of death was natural causes with 379 cases (67.3%), followed by accidental causes with 256 cases (45.4%), homicide (128 cases), and undetermined causes (91 cases); both the latter 2 each accounting for 20.2% (Figure 1). The highest rate of infant and child age deaths 6 years old was found. Observing the distribution of manner of death by gender and age group (Table 2), it was found that the distribution of manner of death did not differ significantly by gender. On the other hand, the distribution of the manner of death is affected by age grouping. Although the most common manner of death was natural causes, the proportion of homicide cases increased with age. The proportion of homicide cases was 3.4% in the infant age group, 14.9% in the child age group, and 21.9% in the adolescent age group. The proportion of homicide cases was 3.4% in the infant age group, 14.9% in the child age group, and 21.9% in the adolescent age group. The proportion of homicide cases was 3.4% in the infant age group, 14.9% in the child age group, and 21.9% in the adolescent age group.

Table 1. Number and percentage of cases of infants and children under 6 years old and manner of death from forensic autopsy cases, 2010-2019

Year	Autopsy cases	Infants <6 years old	Children 6-10 years old	Adolescents 11-18 years old
2010	10727	111 (5.09%)	627 (2.33%)	15 (0.10%)
2011	1826	81 (4.43%)	47 (2.57%)	10 (0.55%)
2012	2155	96 (4.45%)	53 (2.46%)	6 (0.28%)
2013	1810	107 (5.91%)	68 (3.76%)	2 (0.11%)
2014	2090	83 (4.00%)	46 (2.20%)	7 (0.33%)
2015	1915	107 (5.59%)	51 (2.67%)	4 (0.21%)
2016	2182	122 (5.60%)	71 (3.25%)	18 (0.82%)
2017	2186	108 (4.94%)	58 (2.65%)	11 (0.50%)
2018	1460	95 (6.51%)	43 (2.94%)	9 (0.62%)
2019	1320	117 (8.86%)	51 (3.86%)	16 (1.21%)
Total	19431	1024 (5.27%)	279 (1.43%)	91 (0.47%)

## RESULTS & DISCUSSION

### Analysis of cause of death of infants and children under 6 years old

The cause of death, or the preceding cause of death that can clearly distinguish or explain the result of death. When discussing cause of death separately for infant and child age, the most common cause of death was natural causes, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common cause of death was natural causes, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common cause of death was natural causes, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common cause of death was natural causes, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases).

### Analysis of the perpetrators of homicide deaths of infants and children under 6 years old

An analysis of 128 cases of homicide deaths of infants and children under 6 years old found that the perpetrators in more than half of the cases were parents (75 cases, 58.6%), followed by other than parents (including parents' friends, cohabitants or boy/girlfriend, family members, etc.) accounted for 28.1%.

Table 2. Cause of forensic autopsy using gender, age distribution and manner of death of infants and children under 6 years old

Manner of death	Infants <6 years old		Children 6-10 years old		Adolescents 11-18 years old	
	Number	%	Number	%	Number	%
Natural causes	379	67.3	128	91.4	18	20.0
Accidental causes	150	26.7	28	20.3	9	10.0
Homicide	128	22.8	10	7.3	63	70.3
Undetermined	128	22.8	0	0.0	0	0.0
Total	563	100.0	166	100.0	90	100.0

Table 3. Cause of forensic autopsy using gender, age distribution and manner of death of infants and children under 6 years old

Manner of death	Male		Female	
	Number	%	Number	%
Natural causes	379	67.3	128	91.4
Accidental causes	150	26.7	28	20.3
Homicide	128	22.8	10	7.3
Undetermined	128	22.8	0	0.0
Total	563	100.0	166	100.0

Table 4. Cause of forensic autopsy using gender, age distribution and manner of death of infants and children under 6 years old

Manner of death	Male		Female	
	Number	%	Number	%
Natural causes	379	67.3	128	91.4
Accidental causes	150	26.7	28	20.3
Homicide	128	22.8	10	7.3
Undetermined	128	22.8	0	0.0
Total	563	100.0	166	100.0

## DISCUSSIONS

From 2010 to 2019, among the 10,431 forensic autopsy cases accepted by the Institute, 5.4% (563 cases) of infants and children under 6 years old died. The most common manner of death was natural death, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common manner of death was natural death, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common manner of death was natural death, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases).

## CONCLUSIONS

In this study, the statistical analysis of the death cases of infants and children under 6 years old of 6 in a retrospective 10 years was conducted. The most common manner of death was natural death, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases). The most common manner of death was natural death, accounting for 67.3% (379 cases), followed by accidental causes with 25.6% (150 cases), homicide with 20.2% (128 cases), and undetermined causes with 20.2% (128 cases).

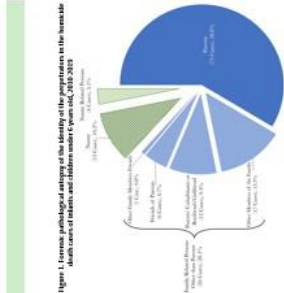


Table 5. Cause of death of children aged 2 to 6 from forensic autopsy cases, 2010-2019

Manner of death	Number	%
Natural causes	379	67.3
Accidental causes	150	26.7
Homicide	128	22.8
Undetermined	128	22.8
Total	563	100.0

Table 6. Cause of death of children aged 3 to 10 from forensic autopsy cases, 2010-2019

Manner of death	Number	%
Natural causes	128	91.4
Accidental causes	28	20.3
Homicide	10	7.3
Undetermined	0	0.0
Total	166	100.0

Table 7. Cause of forensic autopsy using gender, age distribution and manner of death of infants and children under 6 years old

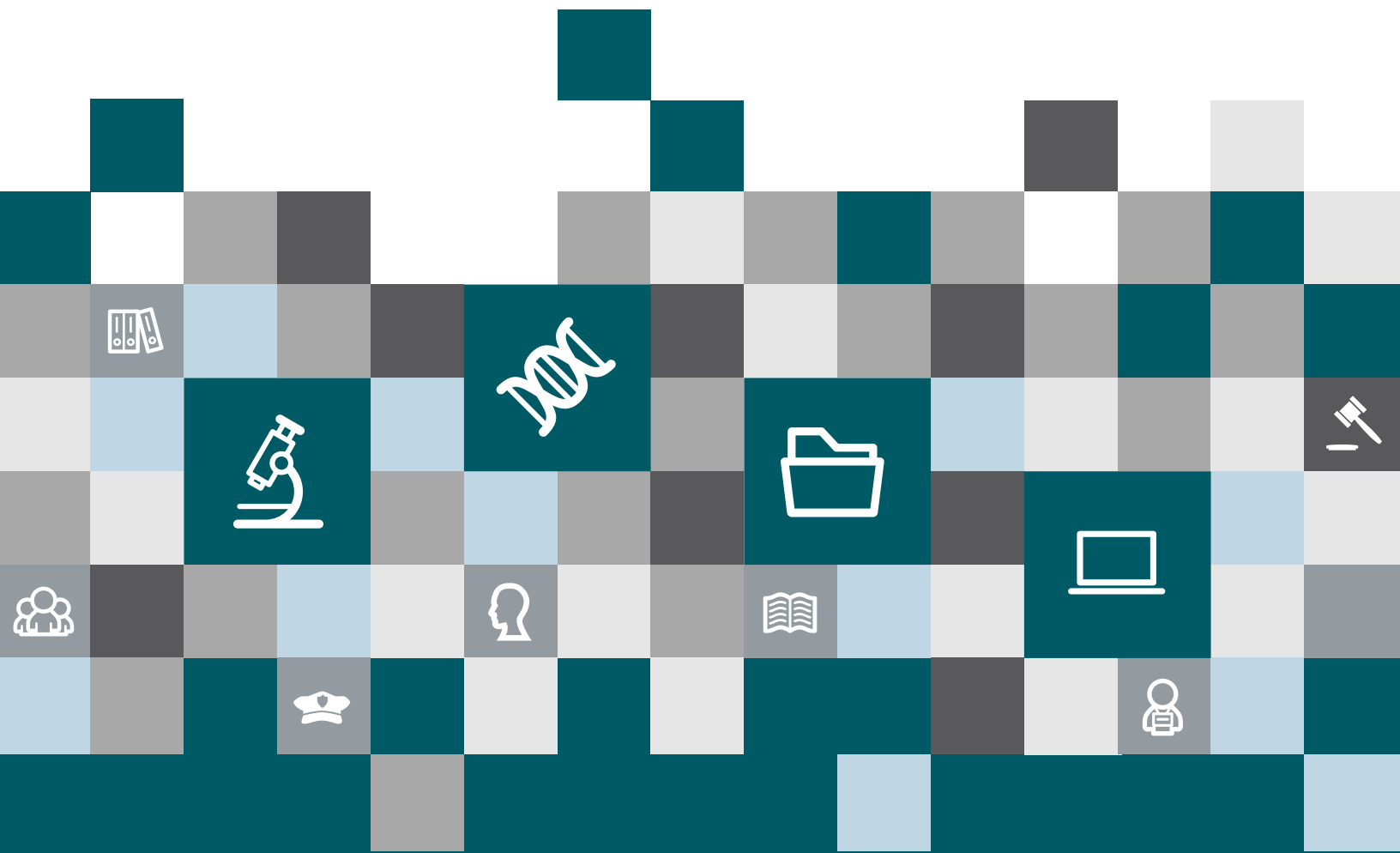
Manner of death	Male		Female	
	Number	%	Number	%
Natural causes	379	67.3	128	91.4
Accidental causes	150	26.7	28	20.3
Homicide	128	22.8	10	7.3
Undetermined	128	22.8	0	0.0
Total	563	100.0	166	100.0



NATIONAL INSTITUTE OF JUSTICE

# Forensic Science Strategic Research Plan

2022-2026



**U.S. Department of Justice**  
**Office of Justice Programs**  
**810 Seventh St. N.W.**  
**Washington, DC 20531**

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Director, National Institute of Justice

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The National Institute of Justice is the research, development, and evaluation agency of the U.S. Department of Justice. NIJ's mission is to advance scientific research, development, and evaluation to enhance the administration of justice and public safety.

The National Institute of Justice is a component of the Office of Justice Programs, which also includes the Bureau of Justice Assistance; the Bureau of Justice Statistics; the Office for Victims of Crime; the Office of Juvenile Justice and Delinquency Prevention; and the Office of Sex Offender Sentencing, Monitoring, Apprehending, Registering, and Tracking.

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## Message From the Director

The National Institute of Justice (NIJ) is dedicated to improving knowledge and understanding of crime and justice issues through science. It is a leading federal funder of forensic science research, development, and evaluation. Recognizing that forensic science is indispensable to preventing and solving crimes, we strengthen the connection between science and justice every day.

Our mandate for strengthening forensic science addresses challenges at all levels of government: federal, state, local, and tribal. More than 90% of forensic analysis — including DNA, drug chemistry and toxicology, and virtually all medicolegal death investigation — is done at the state, local, and tribal levels. NIJ works to improve communication and collaboration with stakeholders across the enterprise. Partnerships with other agencies and organizations, public and private, are essential to NIJ's success.

NIJ's Office of Investigative and Forensic Sciences focuses on improving the quality and practice of forensic science through innovative solutions that support research and development, testing and evaluation, technology, and information exchange. To that end, we affirm the following guiding objectives:

- Advancing applied research and development in forensic science.
- Supporting foundational research in forensic science.
- Maximizing the impact of forensic science research and development.
- Cultivating a diverse, highly skilled forensic science workforce.
- Coordinating across the community of practice.

The demand for forensic analysis has grown by leaps and bounds as the value of forensic testing has been increasingly recognized. We see this most clearly with the rise in demand for DNA analysis and for more forensic drug and toxicology testing due to the opioid epidemic. To help meet this demand, NIJ supports research to improve the capacity and outputs of forensic science laboratories to help reduce the backlogs of evidence.



Providing timely information to law enforcement and the courts ultimately bolsters the administration of justice. NIJ employs a strategy that couples rigorous research and development with coordination and knowledge transfer to aid law enforcement and forensic science communities and help minimize wrongful convictions.

NIJ's Forensic Science Strategic Research Plan is part of a series of plans developed to support the U.S. Department of Justice's overarching goals on crime and justice topics. Through these plans, NIJ outlines its vision and highlights its partnerships with collaborators. We further the priorities of the U.S. Department of Justice by helping to reduce violent crime, supporting prosecutors, and advancing new technologies and strategies that enhance public safety.

Research can make a difference in individual lives, in the safety of communities, and in creating a more effective and equitable justice system. NIJ's strategic plan strives to respond to the real-world needs of victims, communities, and criminal justice professionals.

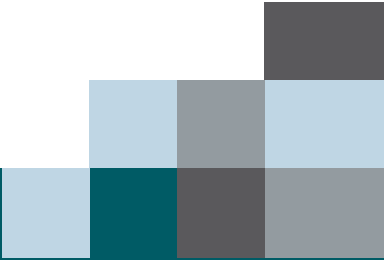
A handwritten signature in black ink, appearing to read 'Nancy La Vigne', with a long horizontal line extending to the right.

Nancy La Vigne, Ph.D.

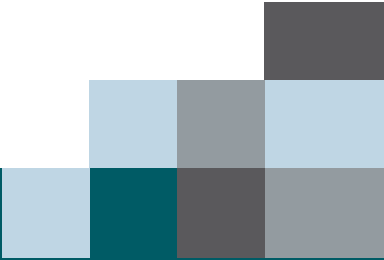
Director, National Institute of Justice

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# Introduction

## About the National Institute of Justice

As the research, development, and evaluation agency of the U.S. Department of Justice (DOJ), the National Institute of Justice (NIJ) is dedicated to improving knowledge and understanding of crime and justice issues through science. NIJ provides objective and independent tools to inform decision-making in the criminal justice community to reduce crime and advance justice, particularly in state, local, and tribal jurisdictions.

## Forensic Science Research Mission

NIJ's forensic science mission is to strengthen the quality and practice of forensic science through research and development, testing and evaluation, technology, and information exchange.

Forensic science disciplines supported by NIJ include, but are not limited to, forensic biology and DNA, trace evidence, impression and pattern evidence, forensic toxicology, seized drugs, crime scene investigation, forensic pathology, forensic anthropology, and digital/multimedia evidence. Advancements in these forensic disciplines lead to more accurate and reliable tools, greater laboratory efficiency, and increased value of evidence for the criminal justice system. NIJ actively collects the needs of forensic science practitioners and develops knowledge to help inform policy and best practice. Forensic science research supports the DOJ mission of ensuring the fair and impartial administration of justice through the development of objective methods that support the timely investigation of crime, prosecution of persons who have perpetrated crimes, and prevention of wrongful convictions.

## Strategic Research Plan Purpose

NIJ developed this Forensic Science Strategic Research Plan to communicate its research agenda and advance its forensic science research mission. The strategic priorities and objectives outlined in this plan closely parallel the opportunities and challenges faced by the forensic science community. This document should be of interest to crime laboratory and medicolegal death investigation professionals; researchers and technology developers (academia, government, and industry); the legal community (defense, prosecution, and judiciary); federal, state, local, tribal, and international partners; policymakers; and other stakeholders.

NIJ will continue to disseminate research findings resulting from this strategic research plan among these partners and constituent audiences to achieve the greatest impact over time.

## Background

One of the goals of forensic science research is to yield evidence-based solutions to real-world challenges. Our nation needs objective, effective, and creative solutions to address the issues facing an overwhelmed criminal justice system and under-resourced community of forensic practitioners. Only through research can we continue to develop accurate, reliable, cost-effective, and rapid methods for the identification, analysis, and interpretation of physical evidence and strengthen the scientific foundations



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of forensic practice (for more information on the impact of NIJ Forensic Science Research and Development, visit <https://nij.ojp.gov/library/publications/impact-nij-forensic-science-research-and-development>).

NIJ has over 50 years of experience in successfully identifying needs, funding research, and disseminating expert knowledge to the forensic science community.<sup>1</sup> NIJ identifies needs through regular stakeholder engagement with the forensic science community and has developed the only grant funding program in the nation that is fully dedicated to the broad spectrum of fields that make up forensic science. The program is highly competitive and receives hundreds of applications across multiple funding opportunities each year from academic, nonprofit, for-profit, federal, state, and local entities. The program's grants have led to tangible outputs and scientific advances that strengthen the fair and impartial administration of justice (to read about current solicitation programs, visit <https://nij.ojp.gov/funding/current>).<sup>2</sup>

The National Academy of Sciences (NAS) released the NIJ-commissioned report *Strengthening Forensic Science in the United States: A Path Forward* in 2009.<sup>3</sup> The report provided a pivotal reexamination of forensic science and, among many recommendations, pointed to standards, federal coordination, graduate education, and research as necessary prompts for institutional change. Despite progress by the community on many of these issues,

<sup>1</sup> National Institute of Justice, *NIJ Journal* 281, November 2019, <https://nij.ojp.gov/nij-journal/nij-journal-issue-281>.

<sup>2</sup> National Institute of Justice, *The Impact of Forensic Science Research and Development*, Washington, DC: U.S. Department of Justice, National Institute of Justice, April 2021, NCJ 300422, <https://www.ojp.gov/pdffiles1/nij/300422.pdf>.

<sup>3</sup> National Research Council, *Strengthening Forensic Science in the United States: A Path Forward*, Washington, DC: The National Academies Press, 2009, <https://doi.org/10.17226/12589>.

subsequent reports, most notably by PCAST,<sup>4</sup> the AAAS,<sup>5</sup> and NIST,<sup>6</sup> have identified significant areas of need for further change through research. In parallel, NAS released the NIJ-commissioned report *Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice*.<sup>7</sup> In that 2015 report, NAS found that NIJ had made considerable progress in meeting the agency’s mission to advance forensic science.

The 2015 report noted that “NIJ has a unique and critical role” among the diverse federal agencies working to impact the progress of forensic science, because NIJ focuses on extramural forensic science research and development. NAS affirmed that NIJ should continue on its current path and provide a plan for building on its progress by taking strategic steps to improve its “capacity to support high-quality forensic science research.” NAS also recommended that NIJ develop a strategic plan that demonstrates its research priorities and its actions to achieve them, improves transparency and communication, and retools its resources in order to prioritize research rather than capacity-building grant programs.

NIJ has acted on these recommendations, investing more than \$270 million in forensic science research and development over the past 12 years. In 2020, the administration of the operational laboratory capacity-building grant programs was transferred to the Bureau of Justice Assistance.<sup>8</sup> This transition allows NIJ to focus on its research goals and promote the vital role that forensic science research plays in improving justice system efficiencies and outcomes. NIJ continues to respond to the NAS recommendations through this strategic plan.

The broader scientific community has identified challenges facing forensic science. NIJ’s 2019 *Report to Congress: Needs Assessment of Forensic Laboratories and Medical Examiner/Coroner Offices* revealed a crime laboratory landscape in need of fundamental support to develop best practices, implement innovative tools and techniques, and analyze backlogs of evidence.<sup>9</sup> NIJ’s research investments are designed to address those challenges. NIJ helps meet those needs, disseminating actionable research findings to academic partners and practitioners at the federal, state, and local levels.

<sup>4</sup> President’s Council of Advisors on Science and Technology, *Report to the President: Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods*, Washington, DC: Executive Office of the President, President’s Council of Advisors on Science and Technology, September 2016, [https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast\\_forensic\\_science\\_report\\_final.pdf](https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf).

<sup>5</sup> American Academy for the Advancement of Sciences, “Forensic Science Assessments: A Quality and Gap Analysis,” accessed April 13, 2022, <https://www.aaas.org/resources/forensic-science-assessments-quality-and-gap-analysis>.

<sup>6</sup> NIST Forensic Science, “Scientific Foundation Reviews,” last updated May 11, 2022, <https://www.nist.gov/topics/forensic-science/interdisciplinary-topics/scientific-foundation-reviews>.

<sup>7</sup> National Academies of Sciences, Engineering, and Medicine, *Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice*, Washington, DC: The National Academies Press, 2015, <https://doi.org/10.17226/21772>.

<sup>8</sup> Capacity-building grant programs transferred to the Bureau of Justice Assistance include DNA Capacity Enhancement for Backlog Reduction Program; Paul Coverdell Forensic Science Improvement Grants Program; Postconviction Testing of DNA Evidence; Prosecuting Cold Cases using DNA Technology; Sexual Assault Forensic Evidence — Inventory, Tracking, and Reporting Program; and Strengthening the Medical Examiner-Coroner System Program.

<sup>9</sup> National Institute of Justice, *Report to Congress: Needs Assessment of Forensic Laboratories and Medical Examiner/Coroner Offices*, Washington, DC: U.S. Department of Justice, National Institute of Justice, 2019, <https://www.ojp.gov/pdffiles1/nij/253626.pdf>.



NIJ took a systematic approach to the development of this strategic research plan, recognizing four important factors:

- I. Evolving practitioner needs within a dynamic scientific, legal, and policy environment.
- II. NIJ's unique mission as an applied-science agency within the U.S. Department of Justice, serving the interests of the broader forensic science community.
- III. The short-, medium-, and long-term investments needed to be responsive to change.
- IV. The diverse forms of outputs and outcomes generated by NIJ's forensic science research, which consists of foundational, applied, and transitional projects.

### **Factor I: Evolving Practitioner Needs Within a Dynamic Scientific, Legal, and Policy Environment**

The [Forensic Science Research and Development Technology Working Group \(FSRD-TWG\)](#) informs the first factor. This group is composed of over 50 members of the federal, state, and local forensic science community who identify, discuss, and prioritize their operational needs and requirements. The group includes practitioners representing biology/DNA, trace evidence, toxicology, crime scene examination, anthropology, pathology, impression/pattern evidence, and seized drugs. NIJ regularly publishes an updated list of the FSRD-TWG needs as a guide to researchers interested in addressing current forensic science problems. These needs, as well as those published by other federal forensic science committees, also help to inform the objectives and priorities of NIJ's research and development activities (for more information on OSAC research and development needs, visit <https://www.nist.gov/osac/osac-research-and-development-needs>).

### **Factor II: NIJ's Unique Mission**

NIJ is uniquely positioned as a justice-focused science agency that serves the broader forensic science community and provides insight into future research and practice through interaction and collaboration. NIJ defines collaborative spaces where practitioners and researchers can connect, exchange, and enhance ideas. These spaces also serve to build relationships and transfer knowledge between partners so that research findings can inform practice. Leaders in the community recognize these goals, believe in these benefits, and actively volunteer for NIJ working groups, where collaboration is fostered between [academic researchers](#) and [publicly funded forensic laboratories](#). In addition to convening working groups, NIJ encourages collaboration between [academic researchers](#) and [publicly funded forensic laboratories](#).



## For additional information on:

- Connecting researchers with forensic laboratories, visit <https://nij.ojp.gov/topics/forensics/connecting-researchers-forensic-laboratories>.
- The Forensic Science Research and Development Technology Working Group (FSRD-TWG), visit <https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational>.
- The Forensic Laboratory Needs Technology Working Group (FLN-TWG), visit <https://nij.ojp.gov/topics/articles/forensic-laboratory-needs-technology-working-group-opening-new-channel-improve>.
- The NSF Industry-University Cooperative Research Centers (IUCRC) Program, visit <https://iucrc.nsf.gov/>.

### Factor III: Short-, Medium-, and Long-Term Investments

NIJ supports a mix of research and development spanning from early-stage research all the way to end-stage development and implementation. Within this portfolio, NIJ maintains a diverse collection of projects at all stages of maturity, from concept to adoption, and translates and disseminates results to practitioner and policymaker audiences.

### Factor IV: The Diverse Outputs and Outcomes Generated by NIJ's Forensic Science Research

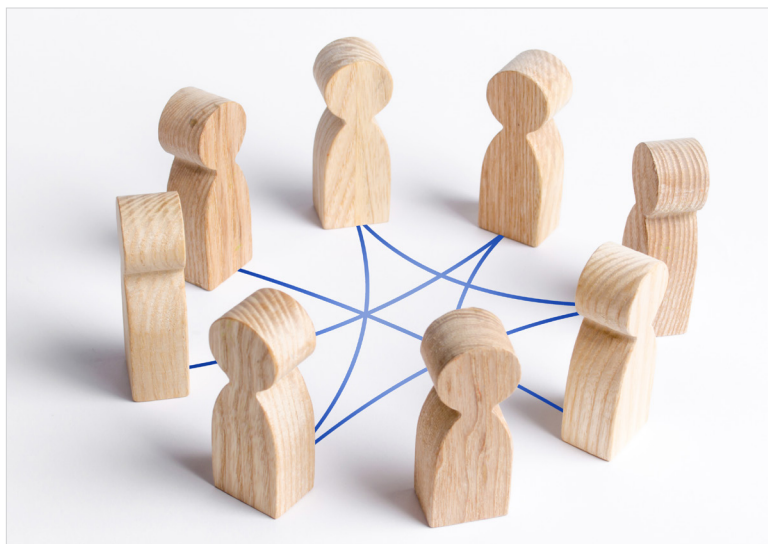
NIJ evaluates the products of its efforts and determines how well these outputs align with the priorities outlined in this strategic plan. NIJ seeks to accelerate research outcomes by maintaining a strong technology transition component. This is accomplished largely through NIJ's Forensic Technology Center of Excellence, which helps to transfer state-of-the-art technology and knowledge into practice by partnering with federal, state, and local crime laboratories and medical examiner/coroner offices.<sup>10</sup> The NIJ Forensic Laboratory Needs Technology Working Group, established in 2018, provides a forum for crime laboratory directors and academic researchers from around the country to develop coordinated approaches to addressing technology implementation challenges in the forensic laboratory.<sup>11</sup> The working group's ultimate goal is to increase laboratory efficiency, ensure that resources are focused appropriately and keep up with demand, and support innovative technology implementation strategies for a stronger justice system.

<sup>10</sup> National Institute of Justice, "NIJ Announces \$4.5M in New Funding for the Forensic Technology Center of Excellence," January 7, 2022, <https://nij.ojp.gov/nij-announces-45m-new-funding-forensic-technology-center-excellence>; and Forensic Technology Center of Excellence, accessed April 13, 2022, <https://forensiccoe.org/>.

<sup>11</sup> "Forensic Laboratory Needs Technology Working Group (FLN-TWG)," Forensic Technology Center of Excellence, accessed April 13, 2022, <https://forensiccoe.org/forensic-laboratory-needs-technology-working-group/>; and "The NIJ Forensic Laboratory Needs Technology Working Group — Progress to Date and Future Plans," Forensic Technology Center of Excellence, accessed April 13, 2022, <https://forensiccoe.org/nij-forensic-laboratory-report/>.

## Research Partners and Shared Goals

NIJ and the broader community of interest recognize that forensic science research is a challenging endeavor that can only succeed through broad collaboration between government, academic, and industry partners. Forensic science practitioners are constantly presented with increasing demands for quality services in the face of diminishing resources. As part of its long-term strategy for success, NIJ actively seeks to partner practitioners with researchers to help develop solutions to these challenging issues. NIJ coordination and funding help these partnerships bear fruit.



*Andrii Yalanskyi/Shutterstock*

NIJ and its partners have a shared goal of supporting a strong forensic science research enterprise. Building sustainable partnerships is of paramount importance, as is connecting academic, industry, federal, state, local, and international organizations that can help foster and coordinate research and development. To this end, NIJ collaborates with several outside agencies. NIJ works with the National Science Foundation ([Center for Advanced Research in Forensic Science](#)) and the National Institute of Standards and Technology ([Center for Statistics and Applications in Forensic Evidence](#) and [Organization of Scientific Area Committees for Forensic Science](#)), as well as the Federal Bureau of Investigation ([Research and Support Unit](#)). For a summary of Federal Forensic Science Research and Development Programs, visit <https://forensiccoe.org/federal-forensic-science-research-development-programs-2021/>.

## Definitions

The following are a few basic terms used to define and distinguish key concepts in forensic science. Other points of clarification are provided throughout the document as footnotes with applicable references.

- **Quantitation** — To measure the quantity or concentration of an analyte in a sample, along with the associated measurement uncertainty.
- **Destructive** — A test that consumes, alters, or otherwise damages a sample, affecting its condition or availability for further testing.

- **Uncertainty** — A parameter, associated with the result of a measurement, that characterizes the range of the values that could reasonably be attributed to what is being measured.
- **Decision analysis** — A formalized approach to assessing the accuracy, reliability, and reproducibility of expert conclusions, in aggregate, using a given method, test, or workflow.
  - **Black box testing** — A method of testing the performance of a system that focuses exclusively on the ultimate outcome (correct or incorrect), without regard to the internal details of the process. In a forensic science context, this often refers to measurement of the rates of examiner error when employing typical current practices.
  - **White box testing** — A method of testing the performance of a system that focuses on how specific internal processes impact the overall outcome. This can be used to identify the most significant factors contributing to error.
  - **Error** — The tendency of a set of measurements to deviate from the true value.
- **Human factors research** — A multidisciplinary field that examines ways in which human performance (e.g., the judgments of experts) can be influenced by cognitive, perceptual, organizational, social, cultural, and other factors.
- **Technology transition** — Efforts to facilitate the transfer of the results of research and development into operational use and practice. This can include the demonstration, testing, evaluation, adoption, implementation, and general use and acceptance of a technology.

# Forensic Science Strategic Research Plan: Priorities and Objectives

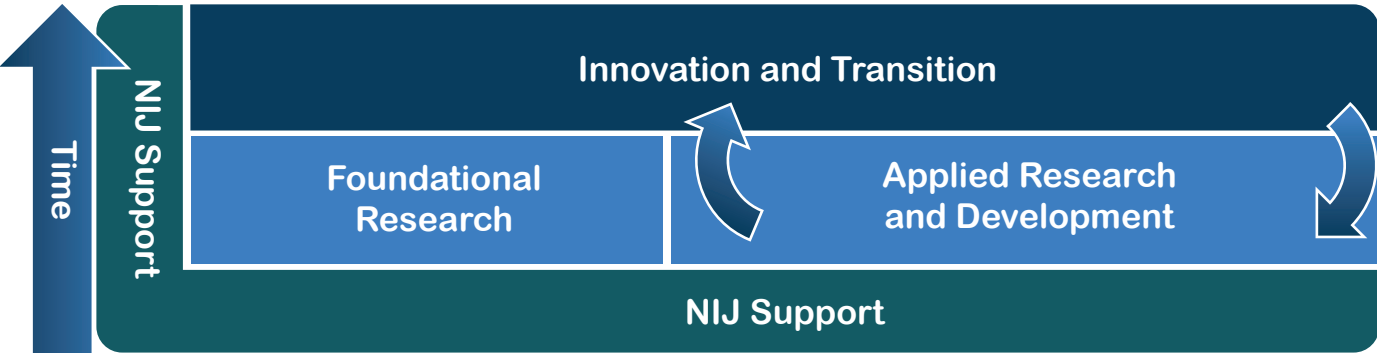
NIJ sponsors research, development, and evaluation to bring innovation to forensic science, better understand the limits of current forensic methods, and inform forensic science policy and practice.

NIJ has identified five strategic research priorities for the Forensic Science Strategic Research Plan, under which a comprehensive set of objectives and action items are organized:

- I. Advance Applied Research and Development in Forensic Science.
- II. Support Foundational Research in Forensic Science.
- III. Maximize the Impact of Forensic Science Research and Development.
- IV. Cultivate a Diverse, Highly Skilled Forensic Science Workforce.
- V. Coordinate Across the Community of Practice.

Research and development in the natural sciences generally builds on a foundation of basic research, extends acquired knowledge into applied research and development, and culminates in the successful transition of promising technologies into practice. NIJ’s criminal justice mission prioritizes applied science and technology transition with the potential to benefit the forensic science enterprise. NIJ supports the research infrastructure necessary for innovation to blossom (see Exhibit 1). This includes development of the forensic science workforce as well as partnerships to promote information and resource sharing.

**Exhibit 1. NIJ’s role in forensic science innovation and technology transition**



# Strategic Priority I: Advance Applied Research and Development in Forensic Science

The objective of NIJ's applied research and development in forensic science is to meet [the needs of forensic science practitioners](#). NIJ supports applied research and development that aids the forensic science community through the development of methods, processes, devices, and materials. Applied research and development may result in improved procedures or otherwise resolve current barriers. It may not always provide immediate solutions but can move the state of the art forward and optimize the implementation of available technologies.

## Objectives

### I.1. Application of Existing Technologies and Methods for Forensic Purposes

- Tools that increase sensitivity and specificity of forensic analysis.
- Methods to maximize the information gained from forensic evidence.
- Nondestructive or minimally destructive methods that maintain evidence integrity.
- Technologies to improve the identification and collection of evidence.
- Machine learning methods for forensic classification.
- Reliable and robust fieldable technologies.
- Rapid technologies to increase efficiency.
- Imaging technologies to visualize evidence.

### I.2. Novel Technologies and Methods

- Identification and quantitation of forensically relevant analytes (e.g., seized drugs, gunshot residue).
- Differentiation techniques for biological evidence (e.g., body fluid identification).
- Investigation of novel or nontraditional aspects of evidence (e.g., microbiome, nanomaterials).
- Reliable and robust fieldable technologies.
- Increased efficiency of evidence analysis with rapid technologies.
- Crime scene documentation and reconstruction technologies.

### **I.3. Methods To Differentiate Evidence From Complex Matrices or Conditions**

- Detection and identification of evidence during collection or analysis.
- Differentiation of compounds or components of interest in complex matrices.
- Identification of clandestine graves.

### **I.4. Technologies That Expedite Delivery of Actionable Information**

- Methods and workflows to enhance or inform investigations.
- Enhanced data aggregation, integration, and analysis within and across datasets.
- Expanded triaging tools and techniques to develop actionable results.
- Technologies and workflows for forensic operations at the scene.

### **I.5. Automated Tools To Support Examiners' Conclusions**

- Objective methods to support interpretations and conclusions.
- Technology to assist with complex mixture analysis.
- Evaluation of algorithms for quantitative pattern evidence comparisons.
- Library search algorithms to assist in the identification of unknown compounds.
- Systems that quantitatively weigh results when performing biological profile analysis of unidentified human remains.
- Computational methods to support bloodstain pattern analysis.

### **I.6. Standard Criteria for Analysis and Interpretation**

- Standard methods for qualitative and quantitative analysis.
- Evaluation of expanded conclusion scales.
- Evaluation of the use of methods to express the weight of evidence (e.g., likelihood ratios, verbal scales).
- Assessment of the causes and meaning of artifacts in a forensic context.

### **I.7. Practices and Protocols**

- Optimization of analytical workflows, methods, and technologies.
- Effectiveness of communicating reports, testimony, and other laboratory results.
- Implementation of new technologies and methods, including cost-benefit analyses.
- Laboratory quality systems effectiveness.
- Research regarding proficiency tests that reflect complexity and workflows.
- Connectivity and standards for laboratory information management systems.

### **I.8. Databases and Reference Collections**

- Development of reference materials/collections.
- Databases that are accessible, searchable, interoperable, diverse, and curated.
- Databases to support the statistical interpretation of the weight of evidence.

# Strategic Priority II: Support Foundational Research in Forensic Science

NIJ supports research to assess the fundamental scientific basis of forensic analysis. If forensic methods are demonstrated to be valid and the limits of those methods are well understood, then investigators, prosecutors, courts, and juries can make well-informed decisions. This can exclude the innocent from investigation and help prevent wrongful convictions.

## Objectives

### II.1. Foundational Validity and Reliability of Forensic Methods

- Understanding of the fundamental scientific basis of forensic science disciplines.
- Quantification of measurement uncertainty in forensic analytical methods.

### II.2. Decision Analysis in Forensic Science

- Measurement of the accuracy and reliability of forensic examinations (e.g., black box studies).
- Identification of sources of error (e.g., white box studies).
- Research and evaluation of human factors.
- Interlaboratory studies.

### II.3. Understanding the Limitations of Evidence

- Understanding the value of forensic evidence beyond individualization or quantitation to include activity level propositions.

### II.4. Stability, Persistence, and Transfer of Evidence

- Effects of environmental factors and time on evidence.
- Primary versus secondary transfer.
- Impact of laboratory storage conditions and analysis on evidence.



# Strategic Priority III: Maximize the Impact of Forensic Science Research and Development

The ultimate goal of NIJ's research and development is to make a positive impact on forensic science practice. For this to happen, the products of research and development must reach the community. These products include peer-reviewed publications, presentations, databases, patents and inventions, software, best practice guides, and more. Implementation of new technology and methods into practice can be aided by NIJ stewardship, in partnership with researchers and practitioners. This can ultimately result in better accuracy, increased efficiency, and improved workflows.

## Objectives

### III.1. Disseminate Research Products to Communities of Interest

- Communicate with new and existing audiences across diverse media.
- Improve access to research publications (e.g., open access, public access).
- Support data sharing and accessibility.

### III.2. Support the Implementation of Methods and Technologies

- Assist technology transition for NIJ-funded research and development.
- Demonstrate, test, and evaluate new methods and technology.
- Pilot implementation and adoption into practice.
- Develop evidence-based best practices.

### III.3. Assess the Impact of NIJ Forensic Science Programs

- Identify and collect measures of program performance (e.g., publications, citations, patents).
- Analyze program impact over time.
- Act on findings to optimize program effectiveness.
- Communicate findings to the public.

### **III.4. Examine the Role and Value of Forensic Science in the Criminal Justice System**

- Understand how forensic science impacts the criminal justice system.
- Evaluate the implementation of new and innovative policies and practices.
- Understand the costs and benefits of forensic science services.

# Strategic Priority IV: Cultivate a Diverse, Highly Skilled Forensic Science Workforce

NIJ supports the development of current and future forensic science researchers and practitioners through laboratory and research experience. Student engagement and the promotion of diversity, equity, and inclusion within the forensic science workforce are critical elements of this effort. NIJ advocates for representation of a diverse range of perspectives in the forensic science community.

## Objectives

### IV.1. Foster the Next Generation of Forensic Science Researchers

- Enrich undergraduate experiences.
- Support graduate research in forensic science.
- Provide postgraduate opportunities.
- Support early-career new investigators.

### IV.2. Facilitate Research Within Public Laboratories

- Create opportunities for research.
- Cultivate a workforce of researchers within public laboratories.
- Promote partnerships with academia.

### IV.3. Advance the Forensic Science Workforce

- Assess and evaluate staffing and resource needs.
- Examine the use and efficacy of forensic science training and certification programs.
- Research best practices for recruitment and retention.
- Support workforce development (e.g., leadership, public speaking, mentorship) and continuing education.

- Evaluate the workforce and workforce pipeline.
- Research the safety, wellness, health, and workplace needs of forensic practitioners.

#### **IV.4. Implement a Process for Assessment, Outreach, and Sustainability for Diversity and Inclusion**

- Collect demographic data to assess diversity and inclusion in NIJ programs.
- Identify and engage in actions to increase inclusivity.

# Strategic Priority V: Coordinate Across the Community of Practice

The forensic science enterprise benefits from collaboration across academic, industry, and government sectors. NIJ serves as a coordination point within the forensic science community to help meet the challenges caused by high demand and limited resources.

## Objectives

### V.1. Assess and Address the Needs of the Field

- Engage with forensic practitioners and laboratory leadership to understand their evolving needs.
- Communicate engagement outcomes to researchers, educators, and policymakers.
- Implement programs that address needs and build connections among stakeholders.

### V.2. Engage Federal Partners To Maximize Resources

- Understand agencies' current activities and priorities.
- Establish agreements and partnerships.
- Coordinate to leverage agencies' resources and strengths and avoid duplication.

### V.3. Facilitate Information Sharing

- Promote the sharing of information (e.g., data, methods, validation plans) among NIJ's federal, state, and local partners.
- Employ various platforms (e.g., symposia, webinars, working groups) for information sharing.
- Serve as a central agency for the collection and distribution of information on evidence-based solutions.

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## NIJ Forensic Science Strategic Research Plan Working Group

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