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GLOBAL TRENDS IN REGULATORY FRAMEWORKS AND THE PRACTICE OF RAPID DNA ANALYSIS: A COMPARATIVE STUDY OF DATABASES AND BORDER BIOMETRIC SYSTEMS

Schroeder K.

GTH DNA,
Washington, USE

Forensic DNA databases continue to develop and expand worldwide, both within traditional laboratory-based investigations and through the implementation of Rapid DNA analysis technologies conducted outside laboratory facilities. This article presents a comparative review of regulatory frameworks, organizational approaches, and practices relating to the use of Rapid DNA technologies in North America, Europe, the Asia-Pacific region, Latin America, and Africa, with particular emphasis on current trends and emerging directions for their application in law-enforcement and forensic activities.

This technology significantly expands the capabilities of traditional forensic investigations and is being used for the documentation of war crimes, the identification of deceased and missing persons, the accelerated analysis of samples in cases requiring immediate response, and efforts to combat human trafficking, the illegal movement of persons across state borders, and various forms of transnational fraud.

The United States has established the most advanced legal and organizational model for the use of Rapid DNA technology, based on the Federal Bureau of Investigation (FBI) Quality Assurance Standards revised in 2025. The revised standards permit the upload of DNA profiles generated in the course of criminal investigations to the Combined DNA Index System (CODIS). This framework is further supported by seven state-level programs and by the renewed Rapid DNA initiative at the southern U.S. border implemented pursuant to Executive Order No. 14165.

In Europe, the 2024 New Pact on Migration and Asylum substantially expanded the Eurodac database, which contains fingerprint and facial-image records. However, DNA data have not yet been integrated into border-control systems. At the same time, France, Ukraine, Germany, the Netherlands, and Italy have already implemented Rapid DNA technologies for criminal investigations, operations conducted outside national territory, and the identification of victims of armed conflicts and other emergency situations. Particular attention should be given to the experience of Ukraine, which has developed an

Correspondence address: Schroeder Kyle, Regional Director, EMEA, GTH DNA, Tacoma, Washington, USA, +1 360 929 2106, email: kschroeder@gth-gov.com

effective decentralized model for the use of Rapid DNA technology to support investigative activities and the identification of missing persons.

A number of countries in Latin America and Africa are gradually introducing Rapid DNA technologies not as an auxiliary tool but as a primary instrument for genetic identification and forensic support of law-enforcement activities.

In conclusion, global developments indicate a continuing expansion in the scope of Rapid DNA applications. Policymakers should consider implementing pilot regulatory models grounded in respect for human rights rather than waiting for the full development of traditional infrastructure.

Keywords: *Rapid DNA analysis; forensic DNA databases; CODIS; Eurodac; border biometrics; missing persons.*

Introduction

Forensic DNA has matured from a specialized laboratory technique into a global investigative infrastructure. More than sixty countries now operate a national DNA database, and the introduction of Rapid DNA technology has extended the reach of profiling beyond the accredited laboratory into police booking stations, crime scenes, disaster sites, military operations, and border checkpoints [1].

The central promise of Rapid DNA is not to replace the traditional laboratory but to supplement it: to deliver an investigative-lead profile from a single-source reference sample within approximately ninety minutes, sometimes in environments where the laboratory cannot practically reach. This article reviews the policy and operational landscape for Rapid DNA and DNA databasing across five regions - North America, Europe, Asia-Pacific, Latin America, and Africa - with particular attention to the decentralized Rapid DNA model developed in Ukraine for the identification of war victims and missing persons and the emerging use of DNA as a border biometric. The comparative picture suggests that jurisdictions are converging on a dual-track model in which Rapid DNA and traditional laboratory testing coexist, with Rapid DNA filling in the gaps left by traditional testing.

North America: A Maturing Rapid DNA Framework

The United States is the jurisdiction in which Rapid DNA has advanced furthest as a matter of national policy. In 2017 the U.S. Congress passed the Rapid DNA Act, authorizing the Federal Bureau of Investigation (FBI) to develop procedures for the use of Rapid DNA instruments in police booking stations and their integration with the Combined DNA Index System (CODIS) [2]. The most consequential recent development is the revised FBI Quality Assurance Standards (QAS) for Forensic DNA Testing Laboratories, which took effect on 1 July 2025 and for the first time allow crime-scene samples analyzed on Rapid DNA

instruments to be eligible for upload to CODIS, subject to laboratory oversight and the use of paired “A” and “B” swabs [3].

As of 2025, seven U.S. states - Arizona [4], Missouri [5], Kentucky [6], New Jersey [7], Connecticut [8], Oklahoma [9], and most recently Pennsylvania [10] - have implemented statewide Rapid DNA programs searching crime-scene profiles against mirror copies of their State DNA Index System. Louisiana [11] and Florida [12] have deployed Rapid DNA at arrestee booking stations [13]. The revised QAS is expected to accelerate this trend, and it is estimated that additional states or local programs may emerge in the coming years. The “A/B swab” requirement, under which one sample is processed on the Rapid instrument for investigative leads and the companion sample preserved for laboratory confirmation, is likely to become the de facto international standard.

Rapid DNA at the United States Border

Perhaps the most significant policy innovation in Rapid DNA has been its deployment as a border biometric. Beginning in May 2019, U.S. Immigration and Customs Enforcement (ICE) launched a Rapid DNA pilot program to verify claimed familial relationships among migrant family units arriving at the southern border. The initial pilot tested individuals who already presented indicia of fraud, and early results indicated that between 10-15 percent of tested parent-child claims could not be confirmed by DNA [14]. The program expanded from eleven to eighteen sites, processing approximately 1,800 relationship tests with results available within ninety minutes [15]. Officials described a strong deterrent effect in addition to its investigative value.

Executive Order 14165, “Securing Our Borders,” issued on 20 January 2025, revived and expanded the program. Section 9 directs the Attorney General and the Secretary of Homeland Security to enforce the DNA collection requirements of the DNA Fingerprint Act of 2005 for all aliens in detention, and instructs the Department of Homeland Security to use available technologies - including Rapid DNA- to verify claimed familial relationships [16]. U.S. Customs and Border Protection is now formally pursuing an expanded deployment of approximately twenty-five Rapid DNA instruments. In parallel, the U.S. military continues to use Rapid DNA for disaster victim identification (DVI), casualty identification, and high-value target identification.

Europe: Casework Leadership, Border Caution

European deployment of Rapid DNA is advanced operationally but narrower in scope. France has taken the most innovative approach [17]. Since late 2022, the Forensic Science Institute of the French Gendarmerie (IRCGN) has deployed Rapid DNA instruments to overseas territories - including New Caledonia, Mayotte, Guadeloupe, and French Guiana - which lie up to twenty-five flight-hours from metropolitan Paris. Samples are analyzed

locally under ISO 17025 conditions, and encrypted profiles are transmitted back to Paris for expert interpretation. Of 350 samples analyzed (77 % casework, 15 % references, 8 % cadavers), 240 yielded positive results, and 70 % of those matched an individual already registered in the French national DNA database [18].

The Netherlands [19] use Rapid DNA primarily for rush casework. Italy has piloted it for crime-scene analysis and human-remains identification. At the European border, however, unlike in the U.S., DNA remains conspicuously absent. The New Pact on Migration and Asylum, adopted in May 2024, reforms the Eurodac system by extending it beyond fingerprints to include facial images, by lowering the age of biometric capture to six years, and by extending data retention for certain categories of irregular arrivals [20]. It does not introduce DNA as a common European border biometric. National laws in several member states nonetheless permit targeted use of DNA for familial-relationship verification and human-remains identification in migration contexts, creating a fragmented landscape that may yet support pilot-scale deployment at specific border points.

Ukraine: A Decentralized Rapid DNA Model for War and Missing Persons

Ukraine has emerged as the most important European case study for the large-scale, decentralized use of Rapid DNA. The full-scale Russian invasion of 2022 generated an unprecedented volume of unidentified human remains, fragmented bodies, and missing-person cases that could not be processed by the pre-war forensic infrastructure. As of late 2024, the Unified Register of Persons Missing Under Special Circumstances, operated by the Ministry of Internal Affairs of Ukraine, contained approximately 55,000 records, with more than 90,000 people officially considered missing, including military personnel, civilians in occupied territories, and forcibly displaced children [21].

Ukraine has responded to this challenge in two complementary ways. First, it has dramatically expanded its network of DNA-capable laboratories. Before 2022, Ukraine had roughly only nine laboratories capable of performing DNA analysis for identification purposes; by 2024 this number had grown to more than twenty, approaching one in every region of the country [22]. This constitutes a genuine decentralization of the national DNA capacity rather than a concentration of effort in a single central laboratory. In 2024 alone, Ukraine's forensic services conducted more than 74,000 genetic examinations across approximately 151,000 biological samples - a throughput of more than 1,500 forensic tests per week, enabling the identification of more than 8,500 bodies in a single year [22].

Second, Ukraine has forward-deployed Rapid DNA [23] to the places where the need is greatest. In 2022, France donated a mobile DNA biometrics laboratory specifically to assist in the identification of the war dead [24]. The European Union and the International Organization for Migration (IOM) subsequently supplied additional mobile DNA laboratories and consumables to support the National Police of Ukraine in identifying civilian victims of

the war [25]. In February 2025, the United Nations Development Programme (UNDP) and the Government of the Netherlands donated 250 chips for ANDE portable DNA analysis instruments together with related collection supplies, enabling identification of remains in as little as 90 minutes rather than the several days to several months previously required [26].

Third, Ukraine has embedded its Rapid DNA deployments in an international legal and scientific framework. With financial support from the European Union, the International Commission on Missing Persons (ICMP) has trained Ukrainian scientists and is assisting the State Scientific Research Forensic Centre (SSRFC) in implementing a DNA-led identification process. This process serves a dual purpose: the humanitarian reunification of families with the remains of their loved ones, and the evidentiary documentation of war crimes through the scientifically defensible linkage of victims to specific crime scenes [27]. The Ukrainian model accordingly demonstrates that Rapid DNA, when coupled with an expanded network of accredited laboratories and international partnerships, can operate at a scale and in a context far beyond routine criminal casework - and that it can generate not only investigative leads but also admissible evidence for international criminal accountability.

Asia-Pacific and Latin America: Selective and Pragmatic Adoption

In the Asia-Pacific region, Rapid DNA is used selectively. Singapore's Health Sciences Authority was among the first in the region to deploy Rapid DNA for casework: the IntegenX RapidHIT™ 200 System has been used for urgent criminal investigations since March 2015, with profiles found concordant to conventional laboratory protocols and results enabling the apprehension of suspects before they could cross borders [28]. India is beginning to integrate Rapid DNA [29] into state forensic laboratories for rush casework but does not yet permit database uploads.

Latin America offers a different pattern, in which Rapid DNA is increasingly seen as a primary database platform rather than a supplement to a laboratory. Guyana has built its national DNA database on Rapid DNA, focusing on single-source crime-scene samples and outsourcing complex casework abroad [30]. Belize has moved rapidly from planning to deployment: the National Forensic Science Service installed a RapidHIT ID instrument [31] in its new Rapid DNA Section in early 2025, issued its first investigative lead to police in September 2025, and the Deoxyribonucleic Acid (DNA) Bill, 2025 - which would establish a national DNA database managed by the NFSS-received its first reading in the House of Representatives in October 2025 [32, 33, 34]. Barbados, whose Forensic Sciences Centre had not been fully operational for more than fifteen years, announced in mid-2025 that its modernized facility would deploy RapidHIT DNA testing technology and be fully operational by September 2025 [35, 36]. Mendoza, Argentina uses Rapid DNA [37] as a laboratory supplement within its provincial criminal genetic database [38].

Africa: Leapfrogging Traditional Infrastructure

Africa is the region in which the leapfrog potential of Rapid DNA is most visible. As of 2024, twenty-four African countries have reported performing forensic DNA analysis, yet many still lack full laboratory infrastructure and are embracing Rapid DNA as a primary rather than supplemental platform [39, 40]. Uganda is expanding its deployment of Rapid DNA [41] to support DVI and urgent casework: the Uganda Police Force Forensic Laboratory at Naguru received government approval for DNA testing in 2023, and Uganda hosts the East African Regional Forensic Referral Centre of Excellence - signaling a sustained investment in regional forensic capacity [42, 43]. Morocco's General Directorate of National Security (DGSN) operates the National Laboratory of Scientific and Technical Police in Casablanca, an ISO 17025–accredited forensic facility with a dedicated DNA division and Rapid DNA capability [44]. Zambia launched its first dedicated Forensic DNA Laboratory in May 2023 with UNDP and U.S. government support, and by December 2024 was reported to be finalizing its national DNA database [45, 46]. The country has in the past worked [47] with Rapid DNA technology to accelerate case investigations.

The strategic question for many African jurisdictions is whether to invest the years and capital required to build a full-service accredited laboratory before establishing a DNA database, or to launch a Rapid DNA–based database program now and build laboratory capacity over time. The Belizean approach - deploying Rapid DNA in advance of formally enacted database legislation, with complex casework outsourced to partner laboratories - suggests that a decentralized, leapfrog model is operationally and legally viable [32]. Such a model would rest on four pillars: the A/B swab discipline; the use of FBI QAS-style standards to support casework and reference-sample uploads; deployment into crime scenes and booking stations; and a clear policy that Rapid DNA complements rather than forecloses future laboratory development.

Conclusion

Global DNA databasing is entering a new phase characterized by three simultaneous trends: the integration of Rapid DNA into DNA database ecosystems of established jurisdictions; the emergence of Rapid DNA as a primary database platform in jurisdictions without full laboratory infrastructure; and the extension of DNA from criminal investigation into large-scale missing-persons identification, border management, and war-crime documentation. The United States has taken the lead on two of these fronts; Ukraine has emerged as the most significant case study for decentralized, large-scale Rapid DNA use in a context of armed conflict; Latin America and Africa are pioneering leapfrog models. For jurisdictions - including those of the South Caucasus and the post-Soviet space - considering how to position themselves within this evolving landscape, the comparative record suggests that early, pilot-scale engagement with Rapid DNA, coupled with clear policy and data-

protection frameworks, is more prudent than waiting for a fully built traditional laboratory. DNA is becoming not only a forensic tool but an element of modern governance, and its policy architecture deserves the same rigorous attention as its science.

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ԱՐԱԳ ԴՆԹ ՎԵՐԼՈՒԾՈՒԹՅԱՆ ՆՈՐՄԱՏԻՎ ԿԱՐԳԱՎՈՐՄԱՆ ԳԼՈԲԱԼ ՄԻՏՈՒՄՆԵՐԸ ԵՎ ԿԻՐԱՌՄԱՆ ՊՐԱԿՏԻԿԱՆ. ՏՎՅԱԼՆԵՐԻ ԲԱԶԱՆԵՐԻ ԵՎ ՍԱՀՄԱՆԱՅԻՆ ԲԻՈՄԵՏՐԻԿ ՀԱՄԱԿԱՐԳԵՐԻ ՀԱՄԵՄԱՏԱԿԱՆ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆ

Շրոդեր Կ.

Դատափորձագիտական ԴՆԹ փվյալների բազաները շարունակում են ակտիվորեն համալրվել, զարգանալ և ընդլայնվել ամբողջ աշխարհում՝ ինչպես ավանդական լաբորատոր հետազոտությունների շրջանակներում, այնպես էլ լաբորատորիայից դուրս իրականացվող Արագ ԴՆԹ (Rapid DNA) վերլուծության տեխնոլոգիայի ներդրման միջոցով: Սույն հոդվածում ներկայացվում է Արագ ԴՆԹ վերլուծության տեխնոլոգիաների նորմատիվ կարգավորման, կազմակերպչական մոտեցումների և կիրառման պրակտիկայի համեմատական ուսումնասիրությունը Հյուսիսային Ամերիկայում, Եվրոպայում, Ասիա-խաղաղօվկիանոսյան տարածաշրջանում, Լատինական Ամերիկայում և Աֆրիկայում՝ հատուկ ուշադրություն դարձնելով դրանց կիրառման արդի միտումներին և հեռանկարային ուղղություններին իրավապահ և դատափորձագիտական գործունեությունում: Նշված տեխնոլոգիան էապես ընդլայնում է ավանդական դատափորձագիտական հետազոտությունների հնարավորությունները և կիրառվում է պատերազմական հանցագործությունների փաստագրման, զոհված և անհետ կորած անձանց նույնականացման, անհապաղ արձագանքում պահանջող գործերով նմուշների արագացված վերլուծության, ինչպես նաև մարդկանց թրաֆիքինգի, պետական սահմանով անձանց ապօրինի

փեղափոխման և փարաբնույթ անդրազգային խարդախությունների դեմ պայքարի նպատակներով:

Նշվում է, որ Ամերիկայի Միացյալ Նահանգները ձևավորել է Արագ ԴՆԹ վերլուծության կիրառման առավել զարգացած իրավական և կազմակերպչական մոդել, որը հիմնված է Հետաքննությունների դաշնային բյուրոյի (FBI) Որակի ապահովման ստանդարտների (Quality Assurance Standards)՝ 2025 թվականին վերանայված խմբագրության վրա: Նշված խմբագրությունը նախատեսում է քրեական հետաքննությունների շրջանակում ստացված ԴՆԹ պրոֆիլների ներառման հնարավորություն ԴՆԹ-ի համակցված ինդեքսավորման համակարգում (Combined DNA Index System – CODIS): Այս համակարգը լրացուցիչ աջակցվում է առանձին նահանգների յոթ ծրագրերով, ինչպես նաև ԱՄՆ-ի հարավային սահմանին Արագ ԴՆԹ վերլուծության վերագործարկված ծրագրով, որն իրականացվում է թիվ 14165 Գործադիր հրամանագրի համաձայն:

Ընդգծվում է, որ Եվրոպայում, 2024 թվականի Միգրացիայի և ապաստանի նոր պակտի շրջանակում, էականորեն ընդլայնվել է Eurodac փվյալների բազան, որը ներառում է մատնահետքերի և դեմքի պատկերների վերաբերյալ փվյալներ: Միևնույն ժամանակ, ԴՆԹ փվյալները մինչ օրս չեն ինտեգրվել սահմանային վերահսկողության համակարգերում, իսկ Ֆրանսիան, Ուկրաինան, Գերմանիան, Նիդեռլանդները և Իտալիան արդեն ներդրել են Արագ ԴՆԹ վերլուծության տեխնոլոգիաները քրեական գործերի քննության, ազգային տարածքից դուրս իրականացվող գործողությունների, ինչպես նաև զինված հակամարտությունների զոհերի և այլ արտակարգ իրավիճակներում տուժած անձանց նույնականացման նպատակներով: Հատուկ ուշադրության է արժանի Ուկրաինայի փորձը, որտեղ ձևավորվել է Արագ ԴՆԹ վերլուծության արդյունավետ ապակենտրոնացված մոդել՝ նախատեսված քննչական գործողություններին աջակցելու և անհետ կորած անձանց նույնականացման համար:

Արձանագրվում է, որ Լատինական Ամերիկայի և Աֆրիկայի մի շարք պետություններ աստիճանաբար ներդնում են Արագ ԴՆԹ վերլուծության տեխնոլոգիաները ոչ թե որպես օժանդակ, այլ որպես գենետիկական նույնականացման և իրավապահ գործունեության քրեագիտական ապահովման հիմնական գործիք:

Եզրակացության մեջ նշվում է, որ համաշխարհային զարգացման միտումները վկայում են Արագ ԴՆԹ վերլուծության տեխնոլոգիայի կիրառման ոլորտների հետագա ընդլայնման մասին: Առաջարկվում է պետական քաղաքականություն մշակողներին դիտարկել մարդու իրավունքների պահպանման վրա հիմնված կարգավորման փորձնական մոդելների ներդրման հնարավորությունը՝ չսպասելով ավանդական ենթակառուցվածքների լիարժեք ձևավորմանը:

Բանալի բառեր՝ *Արագ ԴՆԹ վերլուծություն, դափափորձագիտական ԴՆԹ տվյալների բազաներ, CODIS, Eurodac, սահմանային բիոմետրիա, անհետ կորած անձինք:*

ГЛОБАЛЬНЫЕ ТЕНДЕНЦИИ НОРМАТИВНОГО РЕГУЛИРОВАНИЯ И ПРАКТИКА ПРИМЕНЕНИЯ ЭКСПРЕСС ДНК-АНАЛИЗА: СРАВНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ БАЗ ДАННЫХ И ПОГРАНИЧНЫХ БИОМЕТРИЧЕСКИХ СИСТЕМ

Шрёдер К.

Судебно-экспертные ДНК-базы данных продолжают активно пополниться, развиваться и расширяться во всём мире как в рамках традиционных лабораторных исследований, так и посредством внедрения технологии экспресс ДНК-анализа, осуществляемого вне лабораторных помещений. В настоящей статье представлен сравнительный обзор нормативного регулирования, организационных подходов и практики использования технологий экспресс ДНК-анализа в Северной Америке, Европе, Азиатско-Тихоокеанском регионе, Латинской Америке и Африке с акцентом на современные тенденции и перспективные направления их применения в правоохранительной и судебно-экспертной деяельности. Указанная технология существенно расширяет возможности традиционных судебно-экспертных исследований и находит применение при документировании военных преступлений, проведении идентификации погибших и без вести пропавших лиц, ускоренном анализе образцов по делам, требующим безотлагательного реагирования, а также при противодействии торговле людьми, незаконному перемещению лиц через государственную границу и различным формам трансграничного мошенничества.

Отмечается, что Соединённые Штаты Америки сформировали наиболее развитую правовую и организационную модель применения технологии экспресс ДНК-анализа, основанную на Стандартах обеспечения качества Федерального бюро расследований (FBI Quality Assurance Standards) пересмотренных в 2025 году. Указанная редакция предусматривает возможность введения ДНК-профилей, полученных в рамках уголовных расследований, в Комбинированную систему индексирования ДНК (Combined DNA Index System - CODIS). Данная система дополнительно поддерживается семью программами отдельных штатов, а также возобновлённой программой применения экспресс ДНК-анализа на южной границе США, реализуемой в соответствии с Исполнительным указом № 14165.

Подчеркивается, что в Европе, в рамках Нового пакта о миграции и убежище 2024 года, была существенно расширена база данных Eurodac, которая включает сведения об отпечатках пальцев и изображениях лиц. Вместе с тем ДНК-данные до настоящего времени не интегрированы в системы пограничного контроля.

В то же время Франция, Украина, Германия, Нидерланды и Италия уже внедрили технологии экспресс ДНК-анализа для расследования уголовных дел,

проведения операций за пределами национальной территории, а также идентификации жертв вооружённых конфликтов и иных чрезвычайных ситуаций. Особого внимания заслуживает опыт Украины, где была сформирована эффективная децентрализованная модель применения экспресс ДНК-анализа, предназначенная для поддержки следственных действий и идентификации без вести пропавших лиц.

Констатируется, что ряд государств Латинской Америки и Африки постепенно внедряет технологии экспресс ДНК-анализа не в качестве вспомогательного, а как основной инструмент генетической идентификации и криминалистического обеспечения правоохранительной деятельности.

В заключение отмечается, что глобальная тенденция развития свидетельствует о дальнейшем расширении сферы применения технологии экспресс ДНК-анализа. Предлагается разработчикам государственной политики рассматривать возможность внедрения пилотных моделей регулирования, основанных на соблюдении прав человека, не дожидаясь полного формирования традиционной инфраструктуры.

Ключевые слова: *экспресс ДНК-анализ, судебно-экспертные ДНК-базы данных, CODIS, Eurodac, пограничная биометрия, без вести пропавшие лица.*

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