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Extending the reach of rapid crime-solving

The French Gendarmerie has decentralized DNA analysis by mobilizing the latest technology to remote regions

Summary

- The French Gendarmerie evaluated the use of Rapid DNA technology to meet the needs of decentralizing DNA capabilities in remote regions.
- The small footprint and remote functionality of the Applied Biosystems™ RapidHIT™ ID System allowed the French Gendarmerie to incorporate the system into its fully autonomous mobile unit, enabling DNA analysis as close as possible to the crime scene.
- The system decreased operational response time, providing Rapid DNA analysis results and adding value to multiple types of investigations in the remote South Pacific Territory of New Caledonia.

"The RapidHIT ID System fits perfectly into our DNA analysis system; it's complementary to what we have already developed for our mobile laboratory."

– **Sylvain Hubac, Head of DNA Division, Forensic Science Laboratory, French Gendarmerie**

Introduction

The centralization of forensic crime-solving in France presents a challenge: France's overseas territories are spread over three different oceans, while their single central forensic laboratory is located in metropolitan France. So there exists a 2-tiered justice system in the sense that DNA analysis in the territories cannot be performed quickly enough to help identify the perpetrators and victims of crimes. We spoke to Lieutenant Colonel Sylvain Hubac, PhD in molecular biology and genetics and head of the DNA division of the Forensic Science Laboratory of the French Gendarmerie, also known as l'Institut de Recherche Criminelle de la Gendarmerie Nationale (IRCGN). He saw the deployment of Rapid DNA technology to the overseas territories as an opportunity to offer DNA analysis capabilities in real time that would be equivalent to what is offered in metropolitan France.

Hubac identified the primary benefit of the technology for the IRCGN: its mobility and versatility not only enhance on-site crime-solving in France, but also enable the decentralization of investigative lead generation for French-administered territories outside Europe.

Overview

The French Gendarmerie incorporates all the scientific disciplines and techniques that can be used to investigate a case—including genetics, toxicology, physics, chemistry, and forensic medicine—within one central forensic laboratory in metropolitan France. This enables the collaboration of experts across the various disciplines to determine the best techniques and solutions for each specific case.

With requests for DNA analysis from the territories comprising about 10% of the French Gendarmerie's 200,000 annual DNA analyses, there was a strong incentive to offer real-time analysis capability to the territories. However, Hubac points out that because Rapid DNA was new to France, the Gendarmerie had to be convinced of its effectiveness before it could be implemented in the overseas territories.

"We chose to first validate the RapidHIT ID solution in a local departmental laboratory close to the main IRCGN site," Hubac says. "We wanted to evaluate the use of the technology for criminal identification at the local level." What they wanted to double-check was that:

- There was a real interest in the technology on-site
- The technology would meet the demands of laboratory-level ISO accreditation
- Technicians on-site could develop a sufficient level of skill to use the machine
- The site was compatible with the new technology and connections were secure
- Communication between the central lab and decentralized sites could function effectively, particularly in the transfer of files related to analysis with the RapidHIT ID instrument

The IRCGN then had to submit their validation of the RapidHIT ID System to the Ministry of Justice—the department that legally authorizes the use of DNA analysis as well as the registry of results in the national database. In September 2021 accreditation was granted, proving the effectiveness of the RapidHIT ID System compared to the conventional analysis process.

Following accreditation, Hubac's team worked with the Gendarmerie's overseas officials to help identify a priority site to test the technology. The overseas team recommended the South Pacific territory of New Caledonia, based on concerns about potential violence related to a referendum on independence. In a sense, it was an ideal first test because it presented a model challenge: at more than 16,000 kilometers from metropolitan France, New Caledonia is the nation's most remote territory, with no forensic lab comparable to the laboratories in metropolitan France.

The RapidHIT ID System was transported from France to New Caledonia in a carrier by air; reliability of the transport was important to ensure performance of the system upon arrival. When the team arrived in Nouméa, New Caledonia, and recovered the instruments and reagents, they had to further check that the Nouméa criminal identification unit had all the necessary equipment for the installation and then double-check that everything on-site met installation requirements.

The installation began with an initial verification to see if the instrument had withstood transport, followed by a series of tests conducted with different media to help ensure that the instrument would obtain the same results in New Caledonia as had been obtained during the validation of the instrument in metropolitan France. The testing confirmed that the system was in perfect working order and would provide satisfactory results for real cases.

Training the regional technicians

Since operation of the RapidHIT ID System in an overseas territory is carried out locally, the criminal identification technicians in Nouméa had to be trained on the use of the system. The training took place in one day and included two phases—first, theoretical training to familiarize the technicians with the functioning of the instrument, as well as regulatory requirements for its operation; and second, technical training on the use of the instrument, as well as sample selection. Once training was completed, a course completion certificate was issued to each of the technicians.

After being trained and verified by the IRCGN, an on-site technician performs an analysis on the RapidHIT ID System by simply placing a swab with a biological sample of interest in the analysis cartridge of the instrument, and then inserting the cartridge into the instrument, which generates the analysis. Once the analysis is completed, the experts in France will be able to recover the analytical file for immediate examination of the results.

Hubac adds that even though training is required, the operation of the instrument is easy:

"In fact, that's why we wanted to implement it: it would be deployed in departments where people were not necessarily laboratory technicians," he explains. "Yes, it's under our own control in case of problems. But someone who is not trained in biology, chemistry, or physics can nevertheless handle the instrument."

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Soon after the installation of the RapidHIT ID System in New Caledonia, the technology proved its worth in a burglary case where the perpetrator had left a piece of chewed sugar cane at the crime scene; rich in saliva, it was an ideal sample for obtaining usable DNA. From the sugar cane sample, the criminal identification technicians used the RapidHIT ID System to extract a genetic profile that matched an offender profile in the national database. "It allowed the Gendarmerie to identify the perpetrator immediately," says Hubac, "as opposed to a typical delay of a month or two."

In addition to obtaining investigative leads and identifying perpetrators, New Caledonia has been using the RapidHIT ID System to identify accident victims. For example, in a fatal car crash case, there was doubt about the identity of the deceased as well as the circumstances of the person's death. Through the use of the RapidHIT system, the technicians were able to perform analysis of the undentified human remains, enabling them to quickly identify the victim and help reconstruct the accident. New Caledonia's RapidHIT ID System consistently proves its value by reducing operational response time, saving weeks in the generation of results and empowering judicial investigations.

The experience with Rapid DNA in New Caledonia has led Hubac to recommend the deployment of new devices in other territories of major interest for the Gendarmerie where emergency requests cannot be responded to within an ideal time frame.

Innovating mobility

Leveraging the RapidHIT ID System's small benchtop footprint and remote functionality, the French Gendarmerie incorporated the system into its fully autonomous mobile unit to enable DNA analysis as close as possible to the crime scene.

The impetus to add autonomous mobile forensic investigative capabilities began with a 2013 Germanwings plane crash in the French Alps in which more than 150 people died. As a military unit, the Gendarmerie had the means to directly access the remote crash scene to collect evidence from the victims' bodies to identify them.

"We realized the importance of being able to identify the victims of an accident or crime scene as soon as possible for the families of the victims," Hubac explains.

They began to explore potential laboratory systems and build out their mobile forensic capabilities. The ISO 17025–certified mobile laboratory they developed can be equipped to meet different needs. This required the development of a variety of boxes (travel cases) to allow the easy transport of equipment, and eliminate the need for recalibration once it has been transported. That helps save time at crime scene investigations.

Hubac's team partnered with Thermo Fisher Scientific to optimize laboratory instruments for transport and use in the mobile units. These instruments include the Applied Biosystems™ 3500xL Genetic Analyzer for Human Identification, as well as high-speed extraction systems like the Thermo Scientific™ KingFisher™ Flex Purification System and real-time PCR systems like the Applied Biosystems™ 7500 Real-Time PCR System. It was logical then for the Gendarmerie to turn to Thermo Fisher to help them expand their mobile capabilities with the RapidHIT ID System.

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Integrating the RapidHIT ID System into their mobile crime investigation capabilities, Hubac explains, enabled them to offer three different mobile solutions. First, in cases where there are many victims to be identified (such as a disaster like the 2013 crash that inspired the program) or many DNA traces that need to be collected from a crime scene, the mobile laboratory is deployed carrying the equipment needed to analyze a higher volume of samples, such as the 3500xL sequencer.

Second, for situations where there are fewer samples to analyze but the samples are DNA-rich (e.g., blood, saliva, or sperm) and the site is challenging—for example, a crime scene or a small disaster at a location where there is no laboratory and limited utilities—the IRCGN worked with an industrial solutions partner to develop a large transport case for the RapidHIT ID System that carries everything needed for the operation of the instrument, including a generator that enables more than 48 hours of operation without electricity, and a refrigerator that keeps the reagents and samples at the right temperature to guarantee optimal functioning. By collaborating with airborne troops, this large box can also be directly attached to an operational paratrooper who can be dropped directly into the field with the box and offer DNA analysis capabilities on-site, even close to a war combat zone.

Third, the team developed a smaller model of the RapidHIT ID System travel case, which can be transported inside the mobile DNA lab or sent directly by airplane anywhere in the world.

After two years of development, the Gendarmerie's RapidHIT ID System is now fully integrated into their mobile DNA lab.

"Our DNA solutions for analysis close to the crime scene are quite complementary. The mobile laboratory allows us to do genetic analysis in large-volume cases, and, in other cases, we can implement the RapidHIT ID System, which is more easily transportable to anywhere in the world with minimal logistics," Hubac explains. "Based on our experience, I would say that in order to provide complete crime scene DNA analysis, you need both a solution like the mobile lab and the RapidHIT ID System, so you can respond to any situation."

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Conclusion

At the beginning of the project, Hubac wasn't sure there was a need for a fast DNA technology that could analyze one sample at a time. But during the two-year pilot the team rarely encountered scenes requiring analysis of a large quantity of samples. The majority of crime scenes encountered required analysis of less than 10 samples in a very short time, as close as possible to the crime scene, providing investigators with potentially useful information in the first few hours after a crime is committed—which is of major interest to French authorities.

"That's why the RapidHIT system has its place for the Gendarmerie, why we designed the system transport boxes, and why we enabled DNA analysis in remote territories that can be as effective as if one were in a laboratory in Paris," Hubac explains. "And this is a project that must be developed in other territories—whether it's a remote territory such as Guadeloupe, Guyana, or Mayotte, or any geographical area that has no laboratory—precisely to increase operational response time, because we realized that when we have DNA analysis results in the shortest possible time, we bring true added value to judicial investigations."

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