

Four years after its creation: what role for the Laboratoire des Grandes Épidémies Tropicales (LAGET) in epidemic response in Chad?

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Abstract

Established in 2020 at the height of the COVID-19 pandemic, the Laboratoire des Grandes Épidémies Tropicales (LAGET) was created to strengthen Chad's capacity for diagnosis, research, and training in the face of emerging infectious diseases. Four years later, this narrative review retraces the laboratory's main achievements, from its initial structuring to its operational role in epidemic response. Through scientific publications, strategic partnerships, and its commitment to integrated surveillance, LAGET has positioned itself as a key actor within the One Health paradigm in Chad and the Central African region, and it is now part of the laboratory network of the National Public Health Institute of Chad.

Introduction

Recent pandemics, particularly the Coronavirus Disease 2019 (COVID-19) crisis, have revealed systemic weaknesses in emergency preparedness, especially in resource-limited settings such as those found in Central Africa.¹ This region continues to face the endemic circulation of high-risk epidemic-prone pathogens, including HIV, tuberculosis, yellow fever, and various arboviruses.²⁻⁴ In response to these challenges, an integrated public health approach rooted in the One Health paradigm, linking human, animal, and environmental health, has increasingly been recommended.⁵

It is within this framework that the Laboratoire des Grandes Épidémies Tropicales (LAGET) was established in December 2020 within the Good Samaritan University Hospital Complex (CHU-BS) in N'Djamena, Chad. Its creation is part of efforts to strengthen national diagnostic and surveillance capacities, as recommended by the World Health Organization (WHO) through the International Health Regulations.^{6,7}

Four years later, it is essential to assess LAGET's evolution, its actual impact on the Chadian health system, and its role within the broader regional ecosystem for epidemic surveillance and response. This article provides a structured overview of LAGET's development between 2020 and 2024, highlighting its core functions, scientific output,^{7,9-14} operational challenges, and medium-term prospects.

History

The LAGET was inaugurated on December 12, 2020, within the CHU-BS in N'Djamena, Chad, during the height of the global health emergency caused by the COVID-19 pandemic. Its establishment was prompted by the lack of local structures capable of rapidly diagnosing SARS-CoV-2, as well as other epidemic-prone infectious agents. From the outset, LAGET set out to fill this gap with a threefold mission: diagnosis, applied research and training. Through the joint efforts of Chadian researchers, hospital stakeholders, and international partners, the laboratory was rapidly equipped with an RT-qPCR platform, enabling it to contribute directly to the detection of the first COVID-19 cases at the national level. This central role was quickly acknowledged by the Ministry of Public Health, which provisionally accredited LAGET as a national reference structure for virological diagnostics in support of the national COVID-19 response plan.

As early as 2021, LAGET expanded its analytical capabilities to include other priority pathogens (hepatitis viruses, arboviruses, HIV), while engaging in a regional dynamic of scientific cooperation. From the outset, its approach aligned with the One Health paradigm, promoting integrated surveillance of infectious diseases at the human-animal-environment interface.

This strategic positioning was reinforced by the laboratory's first scientific publication in 2022 in the *Journal of Public Health in Africa*, which outlined LAGET's founding and ambitions within Chad's health landscape.⁷

Capacity development

Over its first four years of operation, LAGET significantly expanded its technical and diagnostic scope. Initially focused on SARS-CoV-2 detection *via* reverse transcription quantitative polymerase chain reaction (RT-qPCR), the laboratory quickly incorporated other diagnostic platforms to meet the needs of Chad's health system.

Starting in 2021, a complete molecular biology platform has been structured, enabling standardized protocols for the detection of HIV, hepatitis B (HBV) and C (HCV) viruses, and Zika virus (ZIKV). This diversification positioned LAGET as a key focal point for the surveillance of epidemic-prone pathogens particularly valuable in a Sahelian context with limited laboratory infrastructure.

Immunoassay equipment was also installed, enabling both quantitative and qualitative serological testing. These tools facilitated large-scale seroprevalence studies, such as the one conducted in 2024 across several Chadian provinces.⁹ The laboratory also performs targeted serology for HBV markers within research projects focused on at-risk populations.

In addition, an electrophoresis system was incorporated into the technical platform to study HIV-1 resistance to antiretrovirals and *Plasmodium* resistance to artemisinin. This component enhances LAGET's ability to contribute to therapeutic monitoring and molecular surveillance within a translational research framework. As part of its medium-term projects, the laboratory plans to acquire a portable genomic sequencing platform (such as the Oxford Nanopore MinION) in collaboration with international partners. Once operational, this capability would allow local genetic studies of pathogens such as SARS-CoV-2 variants, HIV, *Plasmodium*, Human Papillomavirus (HPV), *etc.*¹⁵

The development of these capacities has been driven by a policy of continuous human resource strengthening, notably through

the training of senior technicians and biologists with expertise in HIV-1 bioinformatics analysis. In this context, the supervision of several PhD students in partnership with national and international universities serves as a strategic lever for the sustainable development of local expertise. The availability of highly qualified human resources thus emerges as a key pillar for ensuring scientific autonomy and the long-term sustainability of research and diagnostic activities. Since its inception, LAGET has benefited from sustained methodological support provided by several partner institutions, including the Chantal Biya International Reference Center (CIRCB, Cameroon), the Universities of Reims Champagne-Ardenne and Montpellier (France), the University of Rome Tor Vergata, the Italian National Research Council (CNR), as well as experts based in Gaborone. This multisectoral collaboration has fostered a strong culture of quality and scientific reproducibility within the laboratory.

In the same spirit of professionalization, LAGET has invested in an integrated Laboratory Information Management System (LIMS), which facilitates sample traceability, statistical data analysis, and the production of operational reports on a national level.

Through this gradual yet structured development, the laboratory has successfully transitioned from an emergency response unit to a key player within the country's epidemiological surveillance architecture.

Research activities and partnerships

Since 2022, LAGET's scientific output has gained significant *momentum*, with several peer-reviewed publications addressing topics such as SARS-CoV-2 seroprevalence at both local and national levels, viral genomics, and vaccine perception. This growing body of work reflects not only the laboratory's expanding analytical capacity but also its direct contribution to evidence-based public health policymaking.^{9,14}

Since its establishment, LAGET has been actively involved in numerous applied and translational research initiatives in collaboration with both national and international institutions. The laboratory is currently engaged in several large-scale research projects focused on emerging pathogens and treatment resistance.

In 2023, LAGET took part in a Global Fund campaign to assess HCV viral load among people living with HIV/AIDS (PLWHA), in collaboration with specialized departments of CHU-BS.

The laboratory also collaborated with the NGO MAGIS on several campaigns aimed at screening, diagnosing, and monitoring pregnant women infected with the HBV. These campaigns included systematic vaccination of newborns within 24 hours of birth, in line with WHO recommendations.¹⁶

Additionally, LAGET conducts serological testing for HBV markers as part of research protocols aimed at better understanding vertical and community-level transmission dynamics in Chad. The laboratory is also involved in research on HIV-1 resistance to antiretroviral therapy and *Plasmodium falciparum* resistance to artemisinin.

LAGET also partners with the Livestock Research Institute for Development (IREDD), strengthening its engagement in the intersectoral dimension of the One Health paradigm and supporting coordination of responses to zoonoses and other emerging pathogens at the human-animal-environment interface.

The laboratory has joined several regional scientific networks, including the WHO Africa Laboratory Surveillance Innovation Network (RISLNET), and benefits from ongoing technical and scientific mentorship provided by academic partners.

In addition to these projects, several field experiences and retrospective analyses carried out by LAGET-affiliated clinicians and researchers between 2014 and 2024 have provided valuable insights into HIV care, drug resistance, and emerging viral threats in Chad. For instance, hospital-based observations in N'Djamena suggested that sustained free access to highly active antiretroviral therapy (HAART) may significantly reduce loss to follow-up, with reported rates dropping from over 70% to below 15% in some cohorts.

During the COVID-19 pandemic, temporary disruptions in HIV care delivery were observed in N'Djamena, particularly in 2020, mainly due to movement restrictions and health system reallocation. Although these disruptions did not result in a marked increase in all-cause mortality according to internal observations, they highlighted the urgent need for more resilient and adaptable health service models in epidemic contexts.¹⁷

Also, in a 2024 serological study, we provided the first evidence of ZIKV circulation in both humans and livestock in Chad, with similar prevalence rates in HIV-positive and HIV-negative participants, confirming the relevance of the One Health approach.¹⁸ In line with this strategy, LAGET secured substantial funding in 2025 from the French Ministry for Europe and Foreign Affairs, through the French Embassy in Chad (FEF-R project). The aim is to produce and consolidate seroprevalence and prevalence data on key strategic arboviruses, while also reinforcing health care training, surveillance, and diagnostic capacities for these pathogens, particularly ZIKV, dengue (DENV), yellow fever (YFV), and chikungunya (CHIKV) viruses, all of which represent major public health threats in Chad. Collectively, these studies reinforce LAGET's role not only as a diagnostic and training platform, but also as a national research hub producing evidence to guide public health interventions.

Training and capacity building

From its early years, LAGET established itself as a hub for academic training and mentorship in Chad. In close collaboration with the Faculty of Medicine of CHU-BS, it regularly hosts students for practical internships, contributes to applied teaching in molecular biology, and supervises final-year theses in medicine, biology, and public health.

Since 2021, LAGET has provided regular training for master's and doctoral students involved in research programs related to molecular biology, public health, and infectious diseases. These hands-on sessions include training on RT-qPCR and serology platforms, as well as on procedures for managing biological samples. Many of these training activities have been conducted with support from experts at CIRCB, the Universities of Reims, Montpellier, Rome Tor Vergata, and the Italian CNR as part of broader capacity-building programs.

The laboratory also implemented an internal continuous training program for its own staff, including modules on biosafety, data management using the LIMS system, epidemiological monitoring, and statistical analysis of results. This initiative ensures a high level of quality, scientific rigor, and operational autonomy.

In parallel, academic partnerships have been established for the co-supervision of master's and doctoral students, particularly in the fields of public health, molecular biology, and bioinformatics. These collaborations help build a new generation of Chadian scientists trained to international standards and engaged with the One Health paradigm.¹⁹ One of LAGET's key strengths lies in its coordinated scientific mentorship of students, which includes the writing of peer-reviewed articles based on laboratory-generated

data, thereby strengthening the integration of education with validated knowledge production.¹⁴

As part of its commitment to strengthen surveillance of anti-malarial drug resistance, the LAGET facilitated a doctoral training at the University of Botswana-University of Pennsylvania joint molecular laboratory (August 2024 - April 2025). This immersion enabled the transfer of advanced technology and expertise in molecular biology applied to tropical infections, especially malaria. During the internship, hands-on training was provided on: i) optimized DNA extraction from dried blood spots (DBS) (modified Chelex protocol); ii) conventional and real-time PCR techniques; iii) nested-touchdown PCR for amplification of the *Pfk13* gene of *Plasmodium falciparum*, a key molecular marker of artemisinin resistance;²⁰ iv) genotyping of human pharmacogenetic variants (*CYP2C8*2* and *HbS*) by restriction fragment length polymorphism-polymerase chain reaction (PCR-RFLP); and v) Sanger sequencing and bioinformatics analyses of amplicons (BioEdit, MEGA, SnapGene). A total of 406 DBS samples collected in the CHU-BS of N'Djamena, Chad, were successfully extracted using the Chelex protocol. Among them, 52 (12.8%) were used to amplify the 849 bp *Pfk13* gene fragment and were successfully sequenced for mutation analysis; genotyping of human variants yielded: *CYP2C8*2* (n=376), T allele frequency of 21.9%; *HbS* (n=377), S allele frequency of 6.72%. The preliminary results are in progress for publication.

Recently, a collaborative HIV-1 genotyping training initiative supported by the French Embassy in N'Djamena was established in partnership with UMRS 1320 Cardiovir (Joint Research Unit 1320 – Cardiology and Viruses, France) and the CIRB. This initiative aims to provide PLWHA with access to antiretroviral (ARV) resistance genotyping assays. A PhD student was trained in the standardized French National Agency for AIDS Research (ANRS) genotyping protocols (<https://hivfrenchresistance.org/>). This capacity-building effort will support the implementation of genotyping assays for PLWH with ARV resistance in the CHU-BS cohort and across Chad. Retrospective and prospective preliminary findings will be published in a collaborative manuscript in 2026.

Impact, limitations, and resilience

In just four years, LAGET has significantly transformed the landscape of diagnostics and biomedical research in Chad. Its impact can be seen across multiple dimensions: improved pathogen detection capacity, expansion of epidemiological surveillance, development of a skilled health workforce, and the emergence of nationally produced scientific output recognized at the regional level.

The implementation of robust, high-throughput routine molecular tests for SARS-CoV-2, HIV, and viral hepatitis, large-scale seroprevalence surveys, and projects focusing on drug resistance to HIV, HBV, and *Plasmodium* have all contributed to the production of national data that was previously unavailable. In addition, LAGET's role in mentoring students and early-career researchers is helping to strengthen the country's scientific autonomy in a sustainable way.⁹ However, these advances are challenged by several structural limitations. The laboratory still relies on *ad hoc* external funding, which undermines the sustainability of certain technical and research activities. Equipment renewal, reagent shortages, and maintenance issues are frequent obstacles. Recruiting and retaining qualified personnel, particularly in bioinformatics and data management, also remains difficult in a context of limited financial incentives.

In response to these constraints, LAGET has developed a resilience strategy based on the diversification of scientific and technical partners; resource-sharing with other national institutions; and the co-development of research projects with African and European universities.

This proactive approach, rooted in local realities and built on adaptability, has enabled the laboratory to sustain operations even during times of financial or logistical challenges. It serves as an example of an emerging academic laboratory model in sub-Saharan Africa.

Outlook and recommendations

Looking ahead to 2025-2028, the LAGET stands at a strategic crossroads in its development. Following an initial phase of technical and academic consolidation, several priority areas must be strengthened to ensure its long-term sustainability, regional reach, and alignment with public health objectives.

First, the formal institutionalization of LAGET within the national health system with a clearly defined status and dedicated budget lines is essential to safeguard its core functions. Such institutional recognition would also help stabilize human resources, ensure equipment maintenance, and secure the supply chain for critical reagents and materials.

Second, the development of the planned genomic sequencing platform in partnership with international institutions should enable the laboratory to take a major step forward in pathogen genomic surveillance, particularly for SARS-CoV-2 variants, HIV, *Plasmodium*, and other epidemic-prone agents. This capacity would strengthen LAGET's role in translational research and its integration into African genomic surveillance networks.

Thirdly, the implementation of flow cytometry technology will enable high-precision immunological monitoring, which is essential for CD4⁺ T cell counting in HIV/AIDS management. It will also support research on host immune responses during malaria and *Mycobacterium tuberculosis* infections and help characterize immune profiles in the context of viral hemorrhagic fevers. Additionally, this technology will contribute to the diagnosis of hematological disorders and immunodeficiencies, while fostering scientific autonomy and enhancing the region's capacity to contribute to global research efforts. Furthermore, better integration of the laboratory into regional scientific diplomacy mechanisms such as the African Union, the Africa Centres for Disease Control and Prevention, or the Economic Community of West African States (ECOWAS) network of public health laboratories could consolidate its status as a reference center for Central Africa. This would require political, logistical, and diplomatic support, especially for data sharing, knowledge exchange, and coordinated responses to health crises.

Several strategic areas should be further consolidated to sustainably strengthen LAGET's capacities. These include the development of partnerships with national universities to train a new generation of specialists in bioinformatics, molecular epidemiology, and biostatistics; the promotion of South-South collaborations to foster locally driven innovation; and the design of a scientific communication strategy to improve the dissemination of laboratory-generated data to policymakers, technical and financial partners, and affected communities. In addition, strengthening institutional collaborations aimed at the joint submission of research proposals represents a key lever for ensuring the sustainability of scientific and technological activities.

These perspectives outline an ambitious yet realistic vision of LAGET as a strategic scientific infrastructure contributing to

Chad's health sovereignty and the subregion's resilience in the face of epidemic threats.

Conclusions

Four years after its creation, the LAGET has established itself as a strategic structure for Chad in the fight against emerging infectious diseases. Its rapid development, driven by an integrated vision of diagnostics, research, and training, has enabled it to respond effectively to public health emergencies while embedding itself in a dynamic of scientific production and long-term partnerships.

Beyond its role in the COVID-19 response, LAGET has demonstrated its relevance through a context-specific One Health approach that is tailored to local realities and focused on innovation. However, maintaining these achievements will necessitate stronger institutional support, qualified human resources, and deeper integration into regional and international networks.

Coordinated support from health authorities, technical partners, and academic institutions is essential to secure LAGET's future as a national and regional reference platform. In this sense, LAGET represents an emerging model of an African laboratory, serving health sovereignty, the training of the next generation of scientists, and the collective response to epidemic threats.

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