Evaluation of the Diagnostic Readiness for Outbreaks of Priority Zoonoses in Cameroon. Challenges and Opportunities

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Abstract

The emergence and spread of zoonotic diseases pose significant threats to public health, animal health, and global health security. In Cameroon (a country situated at the Central and West Africa intersection and known for its rich biodiversity and close interactions between humans and animals), priority zoonoses represent a major public health concern. This paper examines the diagnostic landscape for priority zoonoses in Cameroon, focusing on the challenges and opportunities for disease detection and control. This study assessed the current state of diagnostic capacity for key zoonotic diseases in the country through a comprehensive review of existing literature, national surveillance data, and expert interviews. The analysis highlights several challenges, including limited laboratory infrastructure, inadequate funding, gaps in surveillance systems, and a lack of trained personnel. However, the study also identified promising opportunities for strengthening the diagnostic landscape such as enhanced collaboration between human and animal health sectors, improved access to diagnostic tools, and increased investment in capacity building. By addressing these challenges and capitalizing on the available opportunities, Cameroon can better prepare for and respond to priority zoonotic disease outbreaks, ultimately safeguarding the health of both humans and animals in the country.

Keywords: Cameroon, Diagnostic Readiness, Priority Zoonoses, Surveillance.

Introduction

Zoonotic diseases, which are infections that can be transmitted between animals and humans, have been recognized as a significant public health threat globally [1]. In the unique context of Cameroon, priority zoonotic diseases (10 selected zoonoses that pose significant health risks to humans and animals, have a high potential for outbreaks, and require coordinated efforts for control and prevention in Cameroon) represent a major concern [2, 3]. The emergence and spread of these priority zoonoses in Cameroon can be attributed to a complex interplay of factors, including rapid urbanization, deforestation, climate change, wildlife trade, and cultural practices that involve close contact with animals (Figure 1) [4, 5]. Understanding these unique factors is crucial for developing effective disease control and prevention strategies in Cameroon.

Given the importance of zoonotic diseases in Cameroon, a robust diagnostic landscape that enables early detection, surveillance, and control of these priority diseases is essential. The diagnostic landscape refers to the infrastructure, tools, and processes involved in identifying and characterizing infectious agents in humans, animals, and the environment. An effective diagnostic landscape is crucial for timely and accurate diagnosis, which is essential for initiating appropriate public health

interventions and mitigating the spread of these diseases [6].

Diagnostic readiness encompasses the infrastructure, resources, and protocols necessary for timely and accurate disease detection. Effective diagnostic systems are crucial for early outbreak detection, enabling prompt public health responses to mitigate the spread of diseases. The diagnostic readiness for zoonotic diseases is critical in Cameroon, given the country's vulnerability to these pathogens due to its geographic and ecological characteristics [6].

The evaluation of the diagnostic landscape for priority zoonoses in Cameroon is essential for several reasons. First, a comprehensive understanding of the current state of diagnostic capacity is necessary to identify gaps and weaknesses in the system. By identifying these challenges, stakeholders can develop targeted strategies to strengthen the diagnostic infrastructure and improve disease detection and surveillance. Second, assessing the diagnostic landscape can help prioritize investments and resources to address the most pressing needs in priority zoonotic disease diagnosis [7].

Cameroon faces several challenges in diagnosing priority zoonoses, including limited laboratory infrastructure, inadequate funding for diagnostic services, shortage of skilled personnel, and fragmented surveillance systems. The country's health system is already strained by competing priorities, and the diagnosis of zoonotic diseases often takes a backseat to other health concerns. Additionally, there is a lack of coordination and collaboration between the human and animal health sectors, leading to gaps in disease surveillance and response [8, 9].

This study was therefore conducted to assess the diagnostic readiness for outbreaks of priority zoonoses in Cameroon, identify strengths and challenges, and propose solutions. The following were the objectives of the study:

1. To assess the current diagnostic capacities for priority zoonoses in Cameroon.
2. To identify gaps and challenges in the existing diagnostic systems.
3. To propose strategies and opportunities to enhance diagnostic readiness.
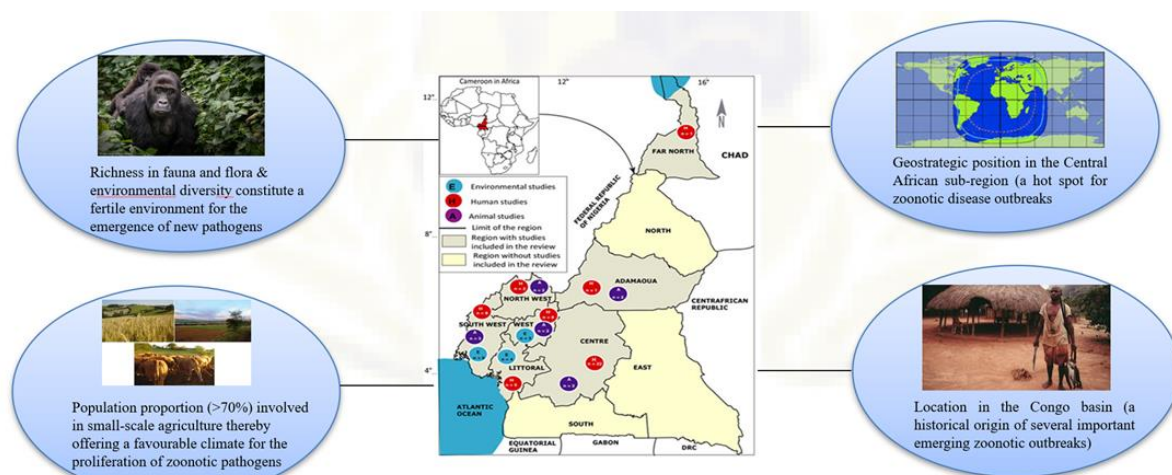

Figure 1. Factors Enhancing the Transmission of Priority Zoonoses in Cameroon

Materials And Methods

Study Area

This study was conducted in Cameroon. Cameroon is a Central African country located

in the Congo basin, a historical origin of several important emerging zoonotic outbreaks [10]. The country has a population of 28,922,121 [11] and is known for its diverse wildlife, high

livestock population, and dense human-animal interaction [12]. In addition to its rich biodiversity, the country harbours significant close interaction between humans, animals, and the environment [5,13]. This unique ecosystem increases the risk of zoonotic disease transmission and the challenges associated with containing and eliminating these diseases [4].

The country is susceptible to outbreaks of diseases such as EVD, Lassa fever, anthrax, HPAI, and MPOX, among others, and these diseases have potentially severe consequences on public health, animal health, and the economy [12, 14, 15].

Sampling Areas

The sampling areas included 46 facilities, including 29 healthcare facilities, 4 veterinary laboratories, and 13 research institutions in Cameroon across different regions and at all levels of care (primary, secondary, tertiary, and quaternary) [16].

Inclusion Criteria

The study's inclusion criteria were facilities and services involved in priority zoonoses diagnosis and surveillance in Cameroon, which were enrolled after an informed consent process.

Exclusion Criteria

1. Facilities and services not involved in priority zoonoses diagnosis and surveillance in Cameroon.
2. Unwillingness to participate in the study

Study Design and Data Collection

This was a mixed-methods study designed to assess the current state of diagnostic capacity for priority zoonotic diseases in Cameroon. Data was collected prospectively and retrospectively.

Prospective data collection was conducted through semi-structured questionnaire interviews with key stakeholders, including healthcare professionals, laboratory technicians, public health officials, researchers, and policymakers.

Retrospective data were collected from national surveillance data, public health initiatives, and previous studies and reports on the diagnostic landscape for zoonotic diseases in Cameroon.

Statistical Considerations

Data collected was entered into Microsoft Excel. An entry sheet was then created in EPI Info 7 to adapt the data to obtain correlation and association relationships between variables [17]. The threshold for statistical significance was set at $p = 0.05$. General timeliness and completeness of data were compared to the standard 80% recommended by the national guidelines [17]. Qualitative data were imported into NVivo 12, and a thematic approach was used to analyze the data. The readiness was rated good if the assessment result reached at least 80% of the expected points. The readiness was moderate if it ranged between 50% and 80% and was limited if the rating was below 50%. The readiness status for each priority zoonoses was calculated based on the same criteria.

Ethical Considerations

Ethical approval was obtained from the Cameroon National Ethics Committee before the study was conducted. Data was collected only from fully consented individuals. Administrative authorizations were also obtained from divisional delegations of public health in the divisions concerned, and permissions were obtained from District Medical Officers before the study conducted.

Results

Summary of Priority Zoonotic Diseases in Cameroon

Analysis of the data collected suggests an uneven distribution of priority zoonotic diseases across the national territory (Figure 2). Out of the ten priority zoonotic diseases

(Rabies, Anthrax, Highly Pathogenic Avian Influenza (HPAI), Ebola Virus Disease (EVD), Bovine tuberculosis (bTB), Invasive non-typhoidal Salmonella (iNTS) disease, Brucellosis, MPOX, Human African Trypanosomiasis (HAT), and Lassa fever), six (MPOX, Rabies, Anthrax, Trypanosomiasis, Avian Flu, & Bovine Tuberculosis) are currently endemic in the country with varying prevalence in different regions. Two (Lassa fever and Ebola Virus Disease) have no reported case, and two (Salmonellosis and Brucellosis) have no data available.
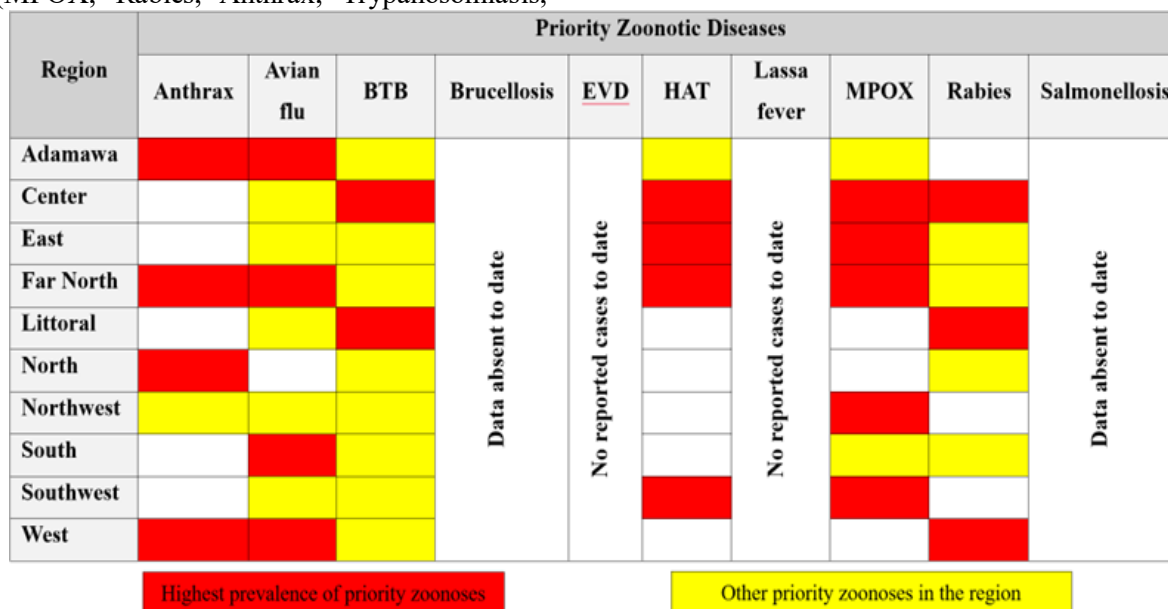

Figure 2. Overview of Priority Zoonotic Diseases in Cameroon [7]

Laboratory Infrastructure and Capacity

This evaluation revealed significant variability in laboratory infrastructure and capacity across Cameroon. While some central laboratories were well-equipped and staffed, many regional and lower-level laboratories had limited essential diagnostic tools and trained personnel (Table 1).

Table 1. Laboratory Infrastructure and Capacity In Cameroon

Region	Number of Laboratories selected	Equipped for Zoonotic Diagnosis	Trained Personnel	Availability of Diagnostic Kits
Adamawa	3	Partially	Limited	Moderate
Center	11	Yes	Adequate	High
East	3	Partially	Limited	Moderate
Far North	2	No	Inadequate	Low
Littoral	8	Yes	Adequate	High
North	2	Partially	Limited	Moderate
Northwest	4	Yes	Adequate	High
South	3	Partially	Limited	Moderate
Southwest	6	Yes	Adequate	High
West	4	Yes	Adequate	High

Diagnostic Readiness

The availability and use of diagnostic technologies vary across the country. National reference labs are equipped with advanced technologies such as PCR and ELISA, whereas primary healthcare labs primarily rely on microscopy and rapid test kits. Moderate diagnostic readiness levels were observed for 90% (9/10) priority zoonoses, and 10% (1/10) had critical diagnostic gaps (Table 2).

Discussion

Like many other countries in Africa, Cameroon grapples with the burden of zoonotic diseases. While the country has improved its healthcare infrastructure and capacity over the years, several diagnostic challenges still hinder its readiness to rapidly diagnose and manage priority zoonoses. From the findings of this study, the country faces significant challenges in meeting the diagnosis readiness level for priority zoonoses, especially at the primary healthcare level, primarily due to the lack of point-of-care tests for 80% (8/10) of these diseases.

Point-of-care tests are diagnostic tests that can be performed near the patient, often at the primary healthcare level, without the need for sophisticated laboratory equipment or specialized training. These tests provide rapid results, allowing for timely diagnosis and initiation of treatment. In the case of priority zoonotic diseases, prompt diagnosis is crucial for early outbreak detection to enable rapid response to prevent further transmission [18].

It is worth noting that most outbreaks occur at the community/PHC level. Hence, the absence of PoCTs, especially at this level, hampers healthcare providers' ability to quickly and accurately diagnose these diseases, leading to delays in treatment and increased risk of disease spread within communities [19].

The unavailability of PoCTs for these priority zoonoses in Cameroon directly impacts patient care and outcomes. Without rapid diagnostic tools, healthcare providers would struggle to differentiate between zoonotic diseases and other common illnesses with similar symptoms, leading to misdiagnosis and inappropriate treatment. This can result in prolonged illness, increased healthcare costs, and potential complications for patients [20].

Effective surveillance and control of zoonotic diseases rely on timely and accurate diagnosis. Without PoCTs, Cameroon faces challenges in detecting and responding to outbreaks of priority zoonoses promptly. This can lead to difficulties in implementing targeted control measures, such as quarantine, treatment, and vaccination, to prevent further transmission of these diseases [21, 22].

As observed in the study, RT-PCR is available for 40% (4/10) of the priority zoonoses at the quaternary level only, 40% (4/10) at both tertiary and quaternary levels, and ELISA is available for only 20% (2/10) at both tertiary and quaternary levels of healthcare. Though present at these levels, the country is hampered with challenges such as limited access to well-equipped laboratories capable of conducting the necessary diagnostic tests for priority zoonoses as well as limited trained personnel with the required expertise to conduct these relatively complex tests for priority zoonoses [23, 24].

Furthermore, some of the priority zoonoses, such as rabies and HAT, fall within the Neglected Tropical Diseases (NTD) category [25] and are consequently affected by worldwide neglect, limited funding for research, and limited investments from the traditional pharmaceutical and diagnostics development industry. Therefore, access to diagnostic tests for these NTDs is usually limited due to global shortages and high costs [26].

Despite these challenges, there are several opportunities that the country can harness to mitigate them:

Firstly, the country can explore the opportunity of strengthening surveillance

systems for zoonotic diseases in Cameroon by improving coordination between human and animal health sectors, enhancing data sharing mechanisms, and implementing a One Health approach to disease surveillance. This key approach contributed to eliminating HAT as a public health problem in Benin, Uganda, and Rwanda [27].

Investing in training programs for healthcare workers, veterinarians, and laboratory technicians can enhance diagnostic capacity for priority zoonotic diseases in Cameroon. This includes training on disease recognition, sample collection, laboratory testing, and data interpretation, which has proven useful in the detection of foreign animal diseases and zoonotic disease threats in the United States of America [28].

Furthermore, upgrading laboratory infrastructure and ensuring access to quality reagents and equipment can significantly improve the diagnostic readiness for priority zoonotic disease outbreaks in Cameroon. Establishing regional reference laboratories can also facilitate timely and accurate diagnosis. Upgrading existing testing facilities, expanding testing for Lassa fever to new catchment areas, and establishing a national reference laboratory have contributed to a better understanding and reporting of Lassa fever outbreaks (including peak outbreak seasons) in Nigeria [29].

Lastly, embracing technology such as telemedicine, mobile health applications, and digital surveillance systems can enhance the early detection and response to zoonotic disease outbreaks in Cameroon. These tools can facilitate real-time data sharing, communication, and decision-making during outbreaks. This could also be a potential solution to the paucity of data on priority zoonoses in the country, as observed during this study. Modern platforms designed for the collection of large-scale data from local healthcare institutions, electronic medical records, and surveillance data have been used to rapidly detect and respond to outbreaks of zoonotic diseases in China [30]. The following opportunities were identified for improvement:

1. **Capacity Building**
   Investing in infrastructure and personnel training would be essential in enhancing diagnostic capabilities. Collaborations with international health organizations can provide technical assistance and resources.

2. **Enhanced Surveillance Systems**
   Integrating LIMS with PHSS should be considered as this will improve data sharing and outbreak detection. Implementing middleware solutions to facilitate data integration is a key opportunity.

3. **Standardization of Protocols**
   Standardized diagnostic protocols should be developed and enforced across all laboratories. This will ensure consistency and reliability in diagnostic practices.

4. **Strengthening Supply Chains**
   Reliable and sustainable supply chains should be developed for diagnostic kits and reagents to ensure uninterrupted diagnostic services.

Table 2. Overview of Diagnostic Readiness of Cameroon to Outbreaks of Priority Zoonoses

Priority zoonotic disease	Pathogen	Cases	Fatality rate	Diagnostic readiness level*	Situation overview
Anthrax	*Bacillus anthracis*	4-10/year	4.0%	64.5% (51/79)	• Only Real Time-Polymerase Chain Reaction (RT-PCR) testing is available. • Testing is conducted only at tertiary and quaternary healthcare levels. • No point-of-care-tests (PoCTs) available at PHC level.
Avian flu	*Orthomyxoviridae* family	11-22/year outbreaks/year	49.8%	50.6% (40/79)	• No PoCTs available at PHC level. • RT-PCR is available at the quaternary level only.
BTB	*Mycobacterium bovis*	11-18/year	5.2%	53.2% (42/79)	• No PoCTs available at PHC level. • Enzyme-linked immunosorbent assay (ELISA) is available at the tertiary and quaternary levels only.
Brucellosis	*Brucella spp*	Data absent to date	N/A	53.2% (42/79)	• No PoCTs available at PHC level. • ELISA is available at the tertiary and quaternary levels only.
EVD	Ebola virus	No reported case	N/A	69.6% (55/79)	• RT-PCR is available at the quaternary level only. • High-profile outbreaks resulted in international focus and funding, enabling critical diagnostics to be developed and introduced. These diagnostics are, however, limited in Cameroon and not available at the PHC level. • No available tests in-country that have regulatory approval beyond WHO EUAL.
HAT	*Trypanosoma brucei*	600-750/year	6.0%	77.2% (61/79)	• Regulatory-approved RDT available at PHC level. • RT-PCR is available at the quaternary level only. • Card Agglutination Test also available at all levels of healthcare.
Lassa fever	Lassa virus	No reported case	N/A	64.5% (51/79)	• Limited WHO-approved diagnostics. • Limited commercially available tests. • Tests are not easily deployable at the PHC level. • RT-PCR is available at the quaternary level only.
MPOX	Mpox virus	37 cases (from 1979 – 2023)	2.2%	78.5% (62/79)	• Regulatory-approved RDT available at PHC level. • PCR is available at the tertiary and quaternary healthcare levels. • Sequencing available at the quaternary level. • BSL-3 facility available.
Rabies	*Rhabdoviridae* family	1,340/year	14.9%	50.6% (40/79)	• No PoCTs available at PHC level • RT-PCR is available at the quaternary level only.
Salmonellosis	*Salmonella spps*	Data absent to date	N/A	48.1% (38/79)	• No PoCTs available at PHC level • Specimen culture available at Secondary, healthcare level. • PCR available at tertiary and quaternary healthcare levels.

*Key factors evaluated: Laboratory infrastructure, quality assurance, presence of regulatory-approved diagnostics, availability of diagnostics (for PHC, hospital, reference lab levels, availability of Target Product Profiles [TPPs]), etc.

Conclusion

Sub-optimal testing capabilities, limited access to laboratory services, and limited access to PoCTs significantly undermine Cameroon's diagnosis readiness level for most priority zoonoses. Addressing these challenges will require a multi-faceted approach that includes strengthening diagnostic capacity, enhancing training for healthcare personnel, improving surveillance systems, expanding access to laboratory services, and improving health infrastructure through strategic investments. By addressing these key areas, Cameroon can improve its readiness to effectively diagnose and manage priority zoonoses, ultimately improving public health outcomes and mitigating the impact of these diseases on both human and animal populations. A collaborative and integrated approach involving multiple sectors and stakeholders is essential to build robust and sustainable systems for combating priority zoonotic diseases in Cameroon and safeguarding public health.

Conflict of Interest

The authors wish to declare no conflict of interest in this manuscript.

Acknowledgement

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