

Evaluating Active Versus Passive Surveillance under IDSR 3rd Edition in Central Africa: A Comparative Implementation Analysis of Outbreak Detection, Reporting Completeness, and Cost-effectiveness (2018 to 2024)

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Abstract Central Africa faces recurrent outbreaks of cholera, measles, yellow fever, Mpox, and viral haemorrhagic fevers, compounded by fragile health systems, insecurity, and limited laboratory capacity. The 3rd Edition of the Integrated Disease Surveillance and Response (IDSR) framework provides updated guidance for strengthening early warning and response, yet implementation remains uneven across the region. This mixed methods implementation analysis combines a narrative review of policy documents, surveillance performance data (2018–2024), peer reviewed literature, and grey literature from Central African countries. Data were synthesized using thematic analysis and a comparative assessment guided by IDSR core functions, IHR (2005) capacities, and health system resilience dimensions (absorption, adaptation, transformation). Active surveillance approaches, including community based surveillance (CBS), active case finding, event based surveillance (EBS), and proactive rapid response teams, substantially outperformed passive facility

based models. Active strategies reduced outbreak detection delays by a median of 8 days, increased weekly reporting completeness by 39 percentage points, and lowered cost per true alert detected by 65%. Countries such as Cameroon, DRC, Gabon, and CAR demonstrated scalable innovations: integrated digital IDSR platforms, motorcycle courier laboratory networks, remote SMS hotlines in conflict zones, and the region's first functional cross-border mechanism in the Lake Chad Basin. However, six systemic challenges persist, namely workforce deficits, laboratory fragmentation, fragmented information systems, insecurity, financing gaps, and weak cross-border coordination. Low-cost, adaptive interventions—community surveillance supervisors, integrated digital platforms, sample transport networks, and cross-border coordination calls—can transform surveillance performance across Central Africa within 24 months. Intentional or structured governance, domestic financing, and active implementation are essential to achieving regional health security aligned with IDSR 3rd Edition and IHR (2005).

Keywords *Central Africa, Community-Based Surveillance, Cross-Border Coordination, Event-Based Surveillance, Health Security, Integrated Disease Surveillance and Response (IDSR), One Health, Surveillance Resilience.*

Introduction

Central Africa continues to face a high and recurrent burden of epidemic-prone diseases, driven by a combination of ecological, demographic, and health system vulnerabilities [2]. The region experiences frequent outbreaks of cholera, measles, yellow fever, Mpox, viral haemorrhagic fevers, and other priority conditions that challenge national capacities for early detection and rapid response [2, 4]. These threats are amplified by persistent structural constraints, including fragile health systems, limited laboratory capacity, protracted humanitarian crises, population displacement, and porous borders that facilitate cross border transmission [4, 16]. The COVID-19 pandemic further exposed weaknesses in surveillance architecture, underscoring the need for resilient, integrated, and adaptive systems that can function effectively under stress [18, 19].

In response, the Integrated Disease Surveillance and Response (IDSR) strategy has served as the cornerstone of national surveillance systems across the African region since its introduction in 1998 [19]. The release of the 3rd Edition of IDSR marked a significant evolution of the framework, incorporating updated technical guidance, expanded priority diseases, enhanced emphasis on event-based surveillance, and stronger alignment with the International Health Regulations (IHR 2005) [1]. The revised edition also promotes digital transformation, multisectoral collaboration, and community-level engagement, elements that are essential for building surveillance systems that can absorb shocks, adapt to changing epidemiological patterns, and sustain core functions during crises [3, 11].

Despite widespread adoption of IDSR, implementation across Central Africa remains uneven, and surveillance network resilience varies considerably between and within countries [4]. Many districts continue to struggle with incomplete reporting, delayed notification, limited data analysis, and

insufficient integration of community-based and event-based surveillance [15]. At the same time, several countries have demonstrated promising innovations, such as mobile reporting platforms, strengthened rapid response teams, and cross-border coordination mechanisms, that illustrate the potential of active, system-strengthening approaches to enhance surveillance performance [5, 6, 8].

Given the region's complex risk landscape, there is a growing need to critically examine how active surveillance is being operationalized and to identify strategies that reinforce the resilience, sensitivity, and timeliness of surveillance systems [3]. Understanding what works, what remains constrained, and what innovations can be scaled is essential to inform national policies, guide partner investments, and advance regional health security [12, 13]. Among health districts in Central Africa implementing IDSR 3rd Edition (2018–2024), what differences exist between active and passive surveillance systems in outbreak detection timeliness and sensitivity, reporting completeness, cost-effectiveness, and documented barriers or facilitators, as reported in peer-reviewed and grey literature?

This study therefore aims to assess the implementation of the IDSR 3rd Edition in Central Africa and to evaluate how active surveillance approaches contribute to building resilient surveillance networks capable of detecting and responding to public health threats more effectively [1, 19]. By synthesizing evidence from policy documents, surveillance performance data, and country experiences, the article provides insights to support stronger, more adaptive surveillance systems aligned with both IDSR and IHR (2005) requirements [1].

Objectives

Overall Objective

Evaluate active versus passive surveillance under IDSR 3rd Edition in Central Africa from 2018 to 2024.

Specific Objectives

1. To compare the timeliness and sensitivity of outbreak detection between active and passive surveillance systems for priority diseases (e.g., measles, yellow fever, Ebola) across selected health districts in Central Africa from 2018 to 2024.
2. To assess and compare reporting completeness (i.e., weekly/monthly IDSR summary forms) and data quality (e.g., timeliness, consistency, use of IDSR 3rd Edition case definitions) between health facilities employing active surveillance versus those relying on passive surveillance.
3. To conduct a cross-country comparison to examine variations in IDSR implementation across Central African countries, identify enabling factors and bottlenecks and highlight innovations and adaptive practices that strengthen surveillance resilience.
4. To propose evidence-based recommendations for system optimization.

Method of Study

Study Design

This article employs a mixed-methods implementation analysis, combining a narrative review of evidence with a comparative assessment of IDSR 3rd Edition implementation experiences across Central African countries. The approach integrates document review, secondary data analysis, and thematic synthesis to examine how active surveillance strategies contribute to system resilience.

Data Sources

The study draws on multiple categories of data:

1. Policy and technical documents: IDSR 3rd Edition guidelines, national surveillance strategies, IHR (2005) reports, Joint External Evaluation (JEE) findings, and national health security plans.
2. Surveillance performance data: routine IDSR indicators, timeliness and completeness reports, outbreak detection timelines, and event-based surveillance outputs from Ministries of Health and WHO AFRO.
3. Peer-reviewed literature: studies on surveillance system performance, resilience frameworks, and health systems strengthening in Central Africa.
4. Grey literature: WHO mission reports, Africa CDC assessments, partner evaluations, and operational field reports from outbreak responses.

Data Collection Procedures

1. The review concerned literature and technical documents published between 2015 and 2024.
2. Surveillance performance indicators were extracted from publicly available national and regional datasets.

Analytical Framework

The analysis is guided by three complementary frameworks:

1. IDSR 3rd Edition core functions and support functions.
2. IHR (2005) core capacities for surveillance and response.
3. Health system resilience dimensions (absorption, adaptation, transformation).

Data were synthesized using a thematic analysis approach to identify patterns related to system resilience, operational challenges, and effective implementation strategies.

Comparative Assessment

A cross-country comparison was conducted to:

1. Examine variations in IDSR implementation across Central African countries.
2. Identify enabling factors and bottlenecks.
3. Highlight innovations and adaptive practices that strengthen surveillance resilience.

Ethical Considerations

The study relies exclusively on publicly available secondary data and published materials. No individual-level or confidential

data were used, and therefore formal ethical approval was not required.

Results

Strategic importance of resilient surveillance systems for health security in Central Africa

The following results highlight the importance of robust, adaptive, and interoperable surveillance networks for preventing, detecting, and responding to priority diseases, public health events, and emerging threats in a region marked by recurrent epidemics and fragile health systems [2, 4] (Table 1).

Table 1. Key Epidemic-Prone Diseases and Outbreak Frequency in Central Africa (2018–2024)

Disease	Countries Most Affected	Average Annual Outbreaks	Typical Detection Delay (Days)
Cholera	DRC, Cameroon, Chad, CAR	8–12	7–14
Measles	DRC, CAR, Chad, Cameroon	15–20	10–21
Yellow Fever	Gabon, Congo, DRC, Cameroon	3–5	5–10
Mpox	DRC, CAR, Congo, Cameroon	6–10	7–14
Viral Haemorrhagic Fevers	DRC, Equatorial Guinea, Gabon	1–2 (Ebola/Marburg)	3–7
Polio (cVDPV)	DRC, CAR, Chad, Congo	4–8	5–15

Data sources: [2, 4, 22]

Table 2 contrasts low versus high resilience settings across six core surveillance metrics.

Table 2. Surveillance Resilience Indicators – High vs. Low Resilience Settings

Indicator	Low Resilience Settings	High Resilience Settings
Outbreak detection delay (median)	14+ days	3–5 days
Weekly IDSR reporting completeness	<50%	>90%
Alert verification time (median)	5–7 days	<24 hours
Laboratory sample transport time	10–21 days	2–5 days
Cross-border data sharing	Ad hoc or none	Systematic monthly
Reporting completeness during active conflict	<20%	>60%
IHR (2005) Surveillance core capacity score (JEE)	1–2	3–4

Data sources: [3, 4, 15]

Structural barriers to surveillance resilience are summarized in Table 3.

Table 3. Structural Barriers to Surveillance Resilience in Central Africa

Barrier Category	Specific Constraint	Affected Countries (Most Severe)
Workforce	No dedicated district surveillance officer in >40% of districts	CAR, Chad, DRC
Laboratory	<30% of districts have functional sample transport	CAR, Chad, DRC, Congo
Supply Chain	Regular stockouts of collection materials	All countries
Digital Infrastructure	Paper-based reporting in >50% of rural districts	CAR, Chad, DRC, Gabon
Insecurity	Active conflict zones with <20% reporting completeness	CAR, eastern DRC
Financing	Unpredictable government and donor funding	All countries

Data sources: [4, 6, 16]

The COVID-19 pandemic further stressed surveillance systems, reducing completeness and timeliness while temporarily expanding event-based surveillance capacity [18] (Table 4).

Table 4. COVID-19 Stress Test – Performance of Surveillance Systems in Central Africa

Indicator	Before COVID-19 (2019)	During COVID-19 Peak (2020–2021)	After COVID-19 (2023–2024)
Average weekly IDSR completeness (region)	62%	48%	58%
Timeliness of reporting (within 24h)	55%	41%	52%
Districts with functional event-based surveillance	18%	47%	35%
Rapid response team deployment within 48h	32%	28%	31%

Data sources: [15, 18]

3rd Edition of IDSR core capacities in early warning and response

These findings highlight the updated technical guidance, new priority conditions, digital innovations, and enhanced multisectoral

approaches introduced in IDSR 3.0, and how these elements address persistent gaps in surveillance and response across Central African countries [1, 3]. Table 5 quantifies the performance of community-based surveillance in conflict-affected health zones in DRC.

Table 5. Community-Based Surveillance in DRC – Performance During Active Conflict

Indicator	Health Zones with CBS	Health Zones without CBS	Difference
Reporting completeness during active conflict	55%	12%	+43 pts
Outbreaks first detected at community level	34%	6%	+28 pts
Community alerts reported (monthly per 100k)	18–25	2–5	5–12 × higher
Time from community event to formal alert	1–2 days	5–10 days	4–8 days faster

Data sources: [6, 9]

The following table 6 demonstrates the operational value of multisectoral surveillance.

Table 6. One Health Impact – Early Warning for Zoonotic Diseases

Country	One Health Coordination	Zoonotic Disease Alerts Shared (2024)	Early Warning Achieved?	Days of Advance Warning
Cameroon	National Platform	45	Yes (anthrax)	10 days
DRC	Technical Working Group	38	Partial (mpox)	3 days
Gabon	Inter-ministerial	22	No	0 days
Chad	None	8	No	0 days
CAR	None	3	No	0 days
Congo	None	2	No	0 days

Data sources: [5, 25]

Cameroon detected an anthrax outbreak 10 days before human cases appeared by monitoring livestock mortality through the One Health platform. This shows how animal health surveillance can predict human outbreaks days in advance, a compelling “why One Health matters” exhibit.

Post-IDSIR 3.0 improvements across the region, including expanded priority conditions, increased digital reporting, and broader EBS coverage, reflect the impact of updated technical guidance and stronger alignment with IHR (2005) [1, 3] (Table 7).

Table 7. Summary Comparison of Core Capacities (Pre-IDSIR 3.0 vs. Post-IDSIR 3.0)

Core Capacity	Pre-IDSIR 3.0 (~2018)	Post-IDSIR 3.0 (~2024)	Change
Priority conditions covered	12 diseases	22 conditions	+83%
Districts with EBS functional	<5%	35% (regional)	+30 pts
Timely digital reporting (≤24h)	41%	67%	+26 pts
Confirmation within 7 days (lab)	32%	55%	+23 pts

One Health coordination (countries)	1 country	3 countries	+2
Outbreaks first detected at community level	<5%	34% (where CBS exists)	+29 pts
Functional cross-border mechanisms	0	1 (Lake Chad)	+1

This table tells the entire “progress story” of the 3rd Edition in Central Africa.

Community-based surveillance (CBS) in the DRC demonstrated substantial gains in reporting completeness, early detection, and alert generation during active conflict, highlighting the value of community engagement in fragile settings [6]. One Health coordination also showed measurable benefits: Cameroon's national platform enabled early warning of an anthrax outbreak ten days before human cases appeared, demonstrating the operational value of multisectoral surveillance [25]. Post-IDSr 3.0 improvements across the region, including expanded priority conditions, increased digital reporting, and broader EBS

coverage, reflect the impact of updated technical guidance and stronger alignment with IHR (2005) [1, 3] (Table 7).

Practical Strategies for Operationalizing an “Active Approach” to IDSr Implementation

Findings detail actionable methods such as active case finding, community-based surveillance, event-based surveillance, cross-border coordination, and real-time data use that can transform IDSr from a policy framework into a functioning, resilient surveillance ecosystem [5, 6, 8].

As shown in Table 8, active case finding consistently outperformed passive surveillance.

Table 8. Impact of Active Case Finding on Outbreak Detection

Strategy	Setting (Country)	Cases Detected per 1,000 Screened	Detection Delay (Days)	Outbreak Size (Cases)
Passive surveillance only	Rural DRC	0.8	14 days	1,240
Active case finding (door-to-door)	Rural DRC	12.4	4 days	320
Passive surveillance only	Urban Cameroon	1.2	10 days	890
Active case finding (market + school)	Urban Cameroon	9.7	3 days	215

Data sources: [5, 6]

Table 9 illustrates CBS performance gains in Cameroon

Table 9. CBS Performance Compared to Facility-Only Surveillance: Example of Cameroon

Indicator	Facility-Only Surveillance	Facility + CBS	Difference
Weekly reporting completeness	51%	89%	+38 percentage points
Alerts generated per 100,000 population	6	42	7× higher
Outbreaks detected before 5 cases	12%	58%	+46 percentage points
Time from first case to alert (median)	7 days	2 days	5 days faster
Cost per outbreak averted	Not calculable	\$1,200	Cost-effective

Source: Cameroon CBS pilot evaluation (2023–2024) [5, 23]

Community-Based Surveillance (CBS) is the "Ears and Eyes" of the System

A comprehensive comparison between passive and active IDSR models is presented in Table 10.

Table 10. Comparison between Passive IDSR and Active IDSR

Metric	Passive IDSR	Active IDSR	Difference	Advised choice
Outbreak detection delay (median)	12 days	4 days	8 days faster	☐ Active
Weekly reporting completeness	48%	87%	+39 pts	☐ Active
Alerts investigated within 48 hours	22%	79%	+57 pts	☐ Active
Outbreaks contained within 4 weeks	34%	81%	+47 pts	☐ Active
Community awareness of reporting	12%	68%	+56 pts	☐ Active
Health worker competency (1–10)	4.1	8.3	+4.2 pts	☐ Active
Cost per true alert detected	\$240	\$85	65% lower	☐ Active
Cross-border info sharing	Sporadic	Systematic	Qualitative	☐ Active
Alerts generated per 100k population	6	42	7 × higher	☐ Active
Outbreaks detected before 5 cases	12%	58%	+46 pts	☐ Active
Time from alert to sample transport	8 days	2 days	6 days faster	☐ Active
Health worker reporting time (hours/week)	18 hrs	6 hrs	12 hrs saved	☐ Active

Data sources: [5, 6, 8, 15]

Active case finding consistently outperformed passive surveillance, detecting 10–15 times more cases per 1,000 persons screened and reducing outbreak size by up to 75% through earlier intervention [5, 6]. CBS also significantly strengthened surveillance performance in Cameroon, increasing weekly reporting completeness, alert generation, and early outbreak detection while reducing reporting delays [5]. Comparative analysis between passive and active IDSR models shows that active approaches improve detection speed, investigation timeliness, community awareness, and cost-effectiveness, reinforcing the value of proactive surveillance strategies [5, 6].

Challenges Limiting Surveillance Performance in Central Africa

Across Central Africa, six systemic challenges persistently undermine surveillance resilience, each with feasible, context-appropriate solutions [3, 4].

Workforce Deficit: Fifty-eight percent of districts regionally lack a dedicated surveillance officer. In Chad and CAR, only 18–22% of districts have such staff, with individual officers overseeing up to 51 health facilities. Training coverage in the past 12 months is below 10% in the most fragile settings [4]. Feasible solution: Community surveillance supervisors (12-month certificate)

costing \$3,000 per person per year, one-fifth the cost of a degree-holding officer. A DRC pilot increased reporting completeness from 31% to 67% within six months [6].

Laboratory Fragmentation: Rural districts experience sample transport delays of 10–21 days; 58% of district laboratories do not report results into IDSR; and stockouts occur 3.2 months annually [4]. *Feasible solution:* Motorcycle courier networks with GPS tracking. A Cameroon pilot reduced transport time from 14 to 4 days and increased confirmation rates from 34% to 71% at \$4.50 per sample [5].

Information System Fragmentation: Health workers complete seven separate reporting forms weekly, consuming nine hours, 3.5 hours of which is redundant data entry. Duplication is highest for COVID-19 (70% overlap with IDSR) and polio (45%) [4]. *Feasible solution:* A single integrated IDSR platform. A DRC pilot consolidated five vertical forms into one module, reducing reporting time from nine to 5.5 hours weekly and cutting data errors from 18% to 7% [6].

Insecurity and Access Constraints: In eastern DRC, reporting completeness drops from 78% in stable zones to 19% in active conflict zones and below 5% in no-go areas. An estimated 12–18 outbreaks are missed annually per conflict zone [6]. *Feasible solution:* Remote SMS hotlines and community informants. CAR received 34% of alerts from inaccessible areas via hotlines; DRC maintained 64% reporting during a three-month conflict using trained informants, at \$2,000–5,000 per zone [9].

Financing Gaps: Government allocations cover only 8–34% of surveillance costs; donor dependence reaches 92% in CAR and 88% in Chad [16]. Annual funding gaps exceed \$12 million in DRC. Consequences include 40% of EBS sites inactive in Cameroon and reporting falling below 50% for six months annually in Chad [4]. *Feasible solution:* Mandatory

domestic budget lines for surveillance plus Pandemic Fund access. Twelve districts in Cameroon allocated \$500–1,500 each, improving reporting completeness by 18 percentage points [5].

Data Quality Deficits: Regional completeness (58% vs. 95% target), timeliness (52% vs. 90%), and laboratory confirmation accuracy (44% vs. 90%) all fall far below IHR standards [4]. False zero reporting occurs in 38% of districts. *Feasible solution:* Automated data validation rules in DHIS2-IDSR. Gabon reduced implausible reports from 22% to 6% within four months at zero software cost [7].

In summary, the five highest-priority challenges—workforce, laboratory, information systems, insecurity, and financing—can be addressed through low-cost, scalable interventions that together could transform surveillance performance across the region within 12–24 months [3].

Country Experiences and Innovations Demonstrating Resilience

Despite shared challenges, several Central African countries have developed adaptive strategies and innovations that demonstrate surveillance resilience in practice. These experiences offer scalable models for the region [5–10].

Cameroon: Integrated digital IDSR at scale. Cameroon achieved the region's most comprehensive digital transformation, rolling out DHIS2-based IDSR to 60% of districts by 2024. The team integrated event-based surveillance alongside indicator-based reporting and trained community volunteers in 45 high-risk health zones. Results: Weekly reporting timeliness increased from 41% to 67%; alert verification time dropped from five days to under 24 hours; and 34% of outbreaks were first detected at community level. The country also operationalized a One Health platform that detected an anthrax outbreak ten

days before human cases appeared by monitoring livestock mortality [5, 25].

Democratic Republic of the Congo: Resilience under humanitarian stress. Despite active conflict affecting eastern provinces, DRC piloted innovative approaches to maintain surveillance functions. Community-based surveillance was deployed in 15 high-risk health zones, training local volunteers to report via encrypted SMS. Rapid response teams were reconfigured as active surveillance extenders, conducting routine patrols rather than waiting for alerts. Results: During active conflict, zones with community volunteers maintained 55% reporting completeness compared to 12% in zones without. Each active RRT investigated 18 alerts monthly (up from 2 in the passive model) and collected 45 samples per month during routine patrols [6, 23].

Gabon: Laboratory integration and digital dashboards. Gabon achieved the region's strongest laboratory-to-IDSRS linkage, with 72% of districts connected to functional sample transport networks and 68% of laboratories routinely reporting into the surveillance system. We deployed a real-time digital dashboard at national and regional levels. Results: Average sample transport time was 2–4 days, the fastest in Central Africa; 78% of suspected outbreaks were laboratory-confirmed within seven days; and automated validation rules reduced implausible reports from 22% to 6% within four months [7].

Lake Chad basin (Cameroon-Chad-Nigeria): Cross-border surveillance success. This tri-country initiative represents the region's only fully functional cross-border surveillance mechanism. The initiative adopted harmonized case definitions for six priority diseases, established shared alert thresholds, and routinely conducted joint outbreak investigations. Results: Mpox detection delay decreased from 14 to 5 days; monthly cross-border alerts increased from 1 to 14; and four

joint investigations were conducted in 2023–2024, a new regional capability [8, 24].

Central African Republic: Remote surveillance in conflict zones. Facing the region's most severe access constraints, CAR innovated with SMS and voice hotlines that allowed community members to report health events from areas where surveillance staff could not travel. Results: During 2023, 34% of all alerts originated from remote hotlines in inaccessible zones, detecting outbreaks that would otherwise have been missed entirely [9].

Chad: Humanitarian surveillance windows. In security-compromised border districts, Chad piloted intensified data collection during ceasefires and humanitarian lulls. Results: A single ten-day lull in 2024 captured 78% of quarterly surveillance data, showing that even fragmented access can yield high-value data when windows are anticipated and staff are pre-positioned [10].

Congo: Early pilot of cross-border mechanisms. Though lagging on most IDSRS 3.0 components, Congo initiated a pilot cross-border surveillance project on the Sangha River with Cameroon and CAR. While still in early stages, this represents an important first step toward addressing one of the region's most persistent gaps [8].

Synthesis of lessons learned. Across these experiences, five cross-cutting enablers of resilience emerge: (1) digital integration reduces fragmentation and improves timeliness; (2) community engagement maintains functions where facilities cannot; (3) active RRTs extend surveillance reach into remote areas; (4) cross-border mechanisms require sustained facilitation but yield high returns; and (5) humanitarian adaptation—using SMS, hotlines, and surveillance windows—preserves data flow during crises. Countries that have invested in these enablers consistently outperform their neighbours on

detection delays, reporting completeness, and outbreak containment [3, 5-10].

Role of Governance, Multisectoral Coordination, and Collaboration Mechanisms in Building Resilient Systems

The analysis shows that governance quality and the strength of coordination mechanisms are among the most decisive factors shaping surveillance resilience across Central Africa [3]. Countries with structured national leadership and harmonized coordination platforms consistently demonstrate superior performance in timeliness, laboratory confirmation, and early detection. Cameroon and Gabon illustrate this pattern most clearly: Cameroon reduced alert verification from five days to under 24 hours through integrated national coordination, while Gabon confirmed 78% of suspected outbreaks within seven days due to strong laboratory governance and digital reporting systems [5, 7]. These examples highlight how coherent national governance directly enhances surveillance sensitivity and operational efficiency.

Regional and cross-border coordination mechanisms further amplify resilience, particularly in areas with high population mobility and shared ecological risks. The Lake Chad Basin initiative, the region's only fully functional cross-border surveillance mechanism, produced measurable improvements, including reducing Mpox detection delay from 14 to 5 days and increasing cross-border alerts from one to fourteen per month [8, 24]. The mechanism also facilitated four joint outbreak investigations, demonstrating the value of harmonized case definitions, shared thresholds, and routine information exchange. Early-stage pilots, such as the Congo–Cameroon–CAR collaboration along the Sangha River, signal emerging governance momentum in historically underserved border zones [8].

Multisectoral collaboration with the One Health platforms also contributes significantly to early warning and risk detection. Countries with operational One Health coordination, most notably Cameroon, reported more frequent zoonotic alerts and earlier detection of animal-to-human spillover events [5]. Cameroon's platform detected an anthrax outbreak ten days before human cases appeared, underscoring the operational value of integrating veterinary, environmental, and public health data streams [25]. In contrast, countries without functional One Health structures reported no advance warning for zoonotic threats, reinforcing the importance of multisectoral governance [4].

Community Engagement and Partner Coordination and Financing

Community engagement emerged as a critical governance modality in fragile and conflict-affected settings. Community-based surveillance (CBS) systems in the Democratic Republic of the Congo maintained 55% reporting completeness in conflict zones, compared to only 12% in areas without CBS, while remote hotlines in the Central African Republic generated 34% of all alerts from inaccessible areas [6, 9]. These findings demonstrate that governance models that formally integrate community actors can sustain surveillance functions even when state presence is limited.

Partner coordination and financing also shape system resilience. Although government allocations cover only 8–34% of surveillance costs and donor dependence remains high, aligned investments yield measurable improvements [16]. In Cameroon, modest district-level allocations of USD 500–1,500 increased reporting completeness by 18 percentage points [5]. Similarly, WHO facilitated coordination in the Ubangi River basin increased cross-border alerts from zero to 24 and enabled three joint investigations, illustrating the catalytic role of regional institutions [8].

Overall, governance quality consistently predicts surveillance performance across the region [3]. Countries that have invested in integrated national coordination, multisectoral platforms, community engagement, and structured cross-border mechanisms outperform their neighbours on detection delays, reporting completeness, and outbreak containment [5-9]. Governance is therefore not a peripheral factor but a central determinant of surveillance resilience in Central Africa.

Forward-looking Roadmap for Scaling and Sustaining Resilient IDSR-based Surveillance Networks

The evidence synthesis across Central Africa highlights a clear set of strategic priorities that together form a practical roadmap for scaling and sustaining resilient IDSR-based surveillance systems [3]. Digital transformation emerges as the most powerful and scalable driver of improvement. Countries that adopted integrated digital IDSR platforms, such as Cameroon and Gabon, demonstrated substantial gains in reporting timeliness, data quality, and laboratory confirmation [5, 7]. These results indicate that expanding DHIS2 IDSR, automated validation rules, and real-time dashboards across the region would significantly reduce fragmentation and accelerate early warning [3].

Institutionalizing community-based and event-based surveillance is equally essential. Evidence from DRC, Cameroon, and CAR shows that CBS and EBS dramatically increase alert generation, shorten detection delays, and maintain surveillance functions in conflict-affected or inaccessible areas [5, 6, 9]. Scaling these approaches requires formal policy integration, standardized training, and simple mobile reporting tools [3].

Laboratory system strengthening remains a central pillar of the roadmap. Persistent delays in sample transport and confirmation undermine early detection, yet low-cost innovations—such as motorcycle courier

networks and integrated laboratory IDSR reporting—have proven highly effective and scalable [5, 7].

Cross-border coordination also emerges as a high-impact priority. The Lake Chad Basin mechanism demonstrates that structured cross-border governance reduces detection delays, increases information sharing, and enables joint investigations [8, 24]. Replicating this model in other high-risk border zones would address one of the region's most persistent surveillance gaps [8].

Discussion

The findings from this mixed-methods implementation analysis confirm that the 3rd Edition of the IDSR framework has catalysed measurable, though uneven, progress in surveillance system resilience across Central Africa [3]. While the updated guidance on event-based surveillance, digital integration, and community engagement has enabled tangible gains in several settings [1], persistent structural barriers—workforce shortages, laboratory fragmentation, insecurity, and financing gaps—continue to constrain performance in the most fragile contexts [4, 16]. This discussion synthesizes the main cross-cutting insights, compares them with evidence from other African regions, examines the practical meaning of "resilience" in Central Africa, and outlines strategic implications for policy and practice. Sustainable resilience will depend on expanding the surveillance workforce through tiered, cost-effective models, securing predictable domestic financing, and operationalizing One Health platforms for zoonotic early warning [3, 16].

Resilience as a Function of Adaptive Capacity, Not Just Resources

A core finding of this study is that resilient surveillance networks are distinguished less by total financial or technical resources and more by their ability to adapt under stress [14]. The comparison of high versus low resilience

settings (Table 2) shows that even relatively under resourced districts, such as those in Cameroon's CBS pilot or DRC's active RRT zones, achieved outbreak detection delays of 3–5 days and maintained >60% reporting completeness during crises [5, 6]. What enabled this performance was not an influx of external funding but rather a deliberate reconfiguration of existing assets: training community volunteers, repurposing rapid response teams for proactive case finding, and using simple SMS hotlines when paper reporting failed [9].

This aligns with the health system resilience literature, which emphasizes absorption, adaptation, and transformation as core dimensions [14, 11]. In Central Africa, absorption (maintaining functions with fewer resources) is evident in CAR's remote hotlines [9]; adaptation (using new methods to sustain performance) is seen in Chad's "surveillance windows" during ceasefires [10]; and transformation (fundamental redesign) is exemplified by Cameroon's integrated digital IDSR platform [5]. These findings suggest that resilience-building investments should prioritize adaptive capacity—training, community trust, and flexible data flows—over static infrastructure alone.

The Active Approach: Moving Beyond Passive IDSR Implementation

The results consistently demonstrate that an active approach—active case finding, community-based surveillance, event-based surveillance, and proactive rapid response teams—substantially outperforms passive, facility-only IDSR implementation [5, 6]. The magnitude of difference is striking: active strategies reduced outbreak detection delays by 8 days (from 12 to 4 days), increased weekly reporting completeness by 39 percentage points, and improved outbreak containment within 4 weeks from 34% to 81% [5] (Table 10).

These findings challenge the common assumption that resource-constrained settings

should prioritize passive surveillance as a baseline. On the contrary, the evidence from Central Africa indicates that active strategies are often more cost effective (85 per true alert detected vs 240 for passive) and more resilient under stress [5]. This aligns with broader regional analyses showing gradual but uneven improvements in IDSR performance indicators across the WHO African Region [20]. Furthermore, the original vision of IDSR as an integrated, action-oriented system—rather than a passive reporting mechanism—supports the active strategies documented here [21]. Community-based surveillance, in particular, proved essential in conflict-affected zones where health facilities were non-functional [6] (Table 5). This echoes recent evaluations from the WHO African Region that recommend CBS as a core component of IDSR 3.0 implementation in fragile settings [15].

Persistent Gaps: Workforce, Laboratories, and Insecurity

Despite promising innovations, the study confirms that six systemic challenges remain pervasive [4]. The workforce deficit—58% of districts regionally lacking a dedicated surveillance officer—is arguably the most binding constraint [4]. Without a designated person to collate, validate, and act on data, even well-designed digital tools and community networks underperform. The DRC pilot of community surveillance supervisors (12-month certificate) offers a scalable solution, but this model requires national policy endorsement and recurrent financing to move from pilot to routine practice [6].

Laboratory fragmentation continues to delay confirmation by 10–21 days in rural districts [4], directly undermining the IDSR objective of timely response. Gabon's achievement of 2–4-day sample transport times and 78% confirmation within 7 days demonstrates that rapid transport networks and laboratory IDSR integration are feasible even in the Central African context [7]. The motorcycle courier

model from Cameroon (\$4.50 per sample) is highly cost-effective and could be replicated across all countries with support from Africa CDC and WHO [5].

Insecurity remains a distinctive challenge for Central Africa relative to other regions [16]. The finding that reporting completeness drops from 78% to <20% in active conflict zones, and that an estimated 12–18 outbreaks are missed annually per conflict zone, underscores the need for dedicated humanitarian surveillance protocols [6]. CAR's remote SMS hotlines and DRC's trained community informants provide practical models that should be systematically integrated into national IDSR guidelines for insecure areas [9, 23].

Cross-Border Coordination: A Regional Imperative

The Lake Chad Basin mechanism stands out as the region's only fully functional cross-border surveillance system, reducing mpox detection delay from 14 to 5 days and enabling four joint investigations [8, 24]. This success contrasts sharply with the Ubangi, Sangha, and other border zones where coordination remains ad hoc or non-existent [8]. Given that Central Africa has some of the most porous borders and highest population mobility on the continent, the absence of systematic cross border surveillance represents a major health security gap [3].

The WHO facilitated Ubangi pilot, which increased cross border alerts from zero to 24 at a cost of \$200 per month, demonstrates that even minimal investment can yield returns [8]. Scaling such mechanisms to all high risk borders should be a top priority for regional bodies (ECCAS, WHO AFRO, Africa CDC), with dedicated funding from the Pandemic Fund and other instruments [17].

Governance and Multisectoral Coordination as Determinants

Objective 6 results clearly show that governance quality predicts surveillance

performance more consistently than any single technical input [3]. Countries with integrated national coordination (Cameroon, Gabon) outperform those with fragmented oversight [5, 7]. The One Health finding—Cameroon detected an anthrax outbreak 10 days before human cases appeared—compellingly illustrates multisectoral value [25], yet only three countries have functional One Health platforms [4]. Expanding One Health coordination to all Central African countries is not a niche environmental activity but a core early warning strategy [3].

Community engagement as a governance modality is particularly relevant for fragile settings. When community actors are formally integrated into surveillance governance, with training, supervision, and feedback loops, they maintain functions that the state cannot [6, 9]. This finding supports the growing consensus that resilience requires distributed governance, not centralized command and control [14].

Limitations

Several limitations should be acknowledged. First, the study relies on publicly available secondary data and published reports, which may overrepresent successful experiences and underrepresent failures or settings with no surveillance data at all [4]. Second, cross country comparisons are constrained by differences in data quality, completeness, and definitions; for example, "reporting timeliness" is calculated differently across national IDSR systems [4]. Third, the analysis captures a snapshot from 2018–2024, but surveillance system resilience is inherently dynamic, and recent improvements could reverse with funding cuts or escalating conflict [16]. Fourth, the study did not include primary data collection from health workers or community reporters, whose perspectives might reveal additional barriers or innovations. Finally, while the cost estimates presented are plausible, they are drawn from pilot projects and may not fully reflect the costs of regional scale up [5–7].

Implications for Policy and Practice

The findings carry several direct implications for national governments, regional bodies, and international partners [3].

First, national IDSR strategic plans should explicitly incorporate resilience benchmarks, not only timeliness and completeness in stable periods, but also performance indicators during crises [14]. Without such benchmarks, resilience remains an abstract goal rather than an actionable target.

Second, financing models must shift from episodic, donor driven projects to predictable domestic budget lines for surveillance [16]. Cameroon's experience, where district allocations of \$500–1,500 improved reporting completeness by 18 percentage points, suggests that even modest domestic resources can generate meaningful gains [5].

Third, the Pandemic Fund and other global financing instruments should prioritize cross border surveillance, community based systems, and laboratory transport networks—the three interventions with the highest demonstrated return on investment in Central Africa [8, 9, 17]. Funding for digital transformation should require integration (no new standalone vertical platforms) and support for automated validation rules to address data quality deficits [7].

Fourth, workforce strategies should adopt the tiered model demonstrated in DRC: degree holding surveillance officers at provincial level, community surveillance supervisors (12-month certificate) at district level, and trained community volunteers at village level [6]. This approach is affordable (\$3,000 per supervisor per year) and rapidly scalable.

Fifth, One Health coordination should be operationalized not as high level policy dialogue but as routine data sharing between human, animal, and environmental surveillance systems [25]. Cameroon's 10 day advance warning for anthrax provides a clear return on investment that ministries of finance and health can readily appreciate.

Conclusion

The 3rd Edition of IDSR has provided a technically robust and strategically relevant framework for strengthening surveillance in Central Africa. However, the framework alone does not guarantee resilience. This study demonstrates that active, adaptive, and community embedded implementation is what distinguishes high performing systems from those that continue to fail. The way forward is not to wait for conflict to end, for laboratory infrastructure to arrive, or for donor funding to increase. Rather, it is to systematically apply the low cost, scalable innovations already proven in the region: community surveillance supervisors, motorcycle courier networks, integrated digital platforms, SMS hotlines, and cross border coordination calls. With deliberate governance and sustained but modest investment, resilient surveillance networks are achievable across Central Africa within the next 24 months, and they will be the foundation for regional health security long into the future.

Recommendations

The following actionable recommendations are prioritized by feasibility and impact, drawn directly from proven innovations across Central Africa.

For National Governments

1. Institutionalize community-based surveillance (CBS). Train community surveillance supervisors for all districts lacking dedicated officers. Target: 80% CBS coverage in high-risk districts within 24 months [6, 23].
2. Adopt integrated digital IDSR platforms. Replace vertical reporting systems with a single DHIS2-IDSR module. Implement automated validation rules. Target: All districts digital within 36 months [5, 7].
3. Strengthen laboratory transport. Deploy motorcycle courier networks with GPS tracking (Cameroon: \$4.50/sample, reduced transport from 14 to 4 days).

- Target: Confirmation within 7 days for $\geq 70\%$ of outbreaks within 24 months [5, 7].
4. Establish domestic budget lines. Allocate minimum 5% of health budget to IDSR. Provide district-level flexible funds (\$500–1,500 annually). Target: No district without operational funding within 24 months [5, 16].
 5. Operationalize One Health platforms. Mandate weekly data sharing between human, animal, and environmental surveillance. Target: All countries have functional early warning systems within 24 months [25].

For Regional Bodies (OCEAC, WHO AFRO, Africa CDC)

1. Scale cross-border mechanisms. Replicate Lake Chad Basin model on Ubangi, Sangha, and Congo River borders. Establish monthly coordination calls. Target: Functional mechanisms on all major borders within 36 months [8, 24].
2. Establish a regional resilience fund. Pool resources from member states and donors to finance cross-border networks, laboratory transport, and training. Target: \$10 million seed capital within 12 months [17].
3. Deploy regional surveillance mentors. Provide on-site technical support to lagging countries. Target: Two mentors per country within 18 months [3, 15].

For International Partners & Donors

1. Prioritize three proven interventions. Direct 50% of new surveillance funding to: (a) cross-border mechanisms, (b) CBS with paid supervisors, (c) laboratory transport networks. No standalone vertical digital platforms [5, 6, 8].
2. Link funding to active implementation. Incentivize outcome-based metrics (reduced detection delays, conflict-zone completeness) over input-based reporting [3, 17].

3. Finance humanitarian adaptations. Support remote SMS hotlines, community informants, and pre-positioned supplies for conflict-affected zones. Target: All conflict districts have remote surveillance within 24 months [9, 10].
4. Require domestic counterpart financing. Provide matching funds conditional on government budget allocations for surveillance. Target: Reduce donor dependence from 70–90% to $\leq 50\%$ within 5 years [16].

For District & Facility Levels

1. Conduct weekly active case finding in high-risk areas (markets, schools, border crossings, displacement camps) [5, 6].
2. Engage community volunteers as formal surveillance partners with simple mobile reporting tools and regular feedback [6, 23].
3. Use data for action—review weekly, detect anomalies, trigger responses, and provide real-time feedback to reporting sites [5, 7].
4. Prepare crisis contingency plans including pre-identified remote reporting methods and pre-positioned supplies [9, 10].

Conflict of Interest

The authors declare no competing interests.

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Ethical Approval

Although the research did NOT involve humans or animals, it adhered to ethical standards for using public domain data and followed principles of transparency, integrity, and responsible reporting. All analyses respected country-level confidentiality and did not manipulate or misrepresent the data.

Informed Consent

This was not required as we did not deal with patients.

Author Contributions

All authors contributed significantly to this study. The roles and responsibilities were distributed as follows:

1. **Daniel YOTA** (Lead Author): developed the research concept, defined the objectives, and structured the methodology.
2. **Vatsiharizandry MANDROSOVOLOLONA**: contributed to the initial draft of the manuscript, to the field implementation and the data collection in the field with IHR national focal point.
3. **Christian Eric MASSIDI**: collaborated in extracting and analysing data from the WHO platform, applying statistical methods to identify trends and disparities across countries.
4. **Anderson LATT**: As Emergency Preparedness Team Lead, He played a supervisory role and participated in interpreting the findings, identifying thematic patterns.
5. **Tieble TRAORE**: As Emergency Preparedness member team, he contributed to the initial draft of the manuscript.
6. **Freddy Banza Mutoka** : He participated in interpreting the findings, identifying thematic patterns, and formulating strategic recommendations. He also provided high-level oversight, ensured alignment with regional priorities, and contributed to interpreting results.
7. **Allan MPAIRWE**: As Emergency Preparedness member team, he contributed to the initial draft of the manuscript.
8. **Hermann TCHIYANE**: He ensured alignment with IDSR priorities and contributed to interpreting results.
9. **Omer NJAJOU TCHIKAMGOUA (Supervisor)**: Oversees research design and implementation, provides strategic guidance, reviews manuscript drafts critically, and validates findings.
10. **Marie Roseline Darnycka BELIZAIRE (Supervisory role)** : provided strategic direction and expert guidance throughout the study, coordinated the research activities and offered substantial revisions to the manuscript before submission.
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 - Data curation – Christian Massidi, Tieble Traore, Hermann Tchiyane
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Data Availability

All data used in this study were obtained from the publicly accessible WHO platform. The analysis was performed independently, and interpretations relied solely on the reported data and documented methodologies. The authors have ensured transparency, reproducibility, and objectivity in presenting their findings.

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