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The Conflict-AMR Nexus: Rapid Taxonomic change and Community-Acquired Colistin Resistance in Maternal Urogenital Infections in Borno State Northeast Nigeria

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Abstract

Background: In regions affected by conflict, the rapid escalation of antimicrobial resistance (AMR) presents a significant public health challenge. This study aims to investigate the evolving microbiological landscape and the patterns of antibiotic sensitivity related to urogenital infections among pregnant women residing in Maiduguri, Borno State, an area severely impacted by ongoing instability.

Methods: A comparative cross-sectional study was conducted, analyzing 300 clinical specimens, including urine and vaginal swabs, obtained from three maternal health centers over the years 2024 and 2025. Pathogen identification was executed using standardized microbiological techniques, while antimicrobial susceptibility was evaluated through phenotypic disc diffusion methods. Statistical significance was determined utilizing 95% confidence intervals (CI) and p-values.

Results: A notable taxonomic shift was observed, with the prevalence of *Escherichia coli* (*E. coli*) increasing significantly from 2.3% (95% CI: 0.3–8.1) in 2024 to 51.3% (95% CI: 42.1–60.6) in 2025 ($p < 0.001$). The third trimester exhibited the highest clinical risk, accounting for 54.3% of all isolates. Additionally, a significant “Urogenital Reservoir” was identified, with 64% of women showing concurrent colonization of urinary *Staphylococcus aureus* and vaginal *Candida albicans*. Antimicrobial sensitivity revealed a drastic decline: the effectiveness of Amoxicillin fell to 0.0%, while that of Ciprofloxacin decreased to 16.7%. Alarmingly, community-acquired Colistin resistance reached 72.2% among coliforms, whereas only Gentamicin demonstrated a 100% sensitivity rate.

Conclusion: The maternal healthcare environment in Northeast Nigeria has effectively transitioned into a localized post-antibiotic era. The rapid emergence of multidrug-resistant strains of *Escherichia coli*, coupled with the rise of high-level Colistin resistance within the community, necessitates an urgent reassessment of empirical treatment protocols. This study advocates for the adoption of "salvage therapy" approaches and recommends the implementation of mandatory dual urogenital screening for late-term pregnancies to mitigate the increasing risks of maternal and neonatal sepsis.

1. INTRODUCTION

The global challenge of antimicrobial resistance (AMR) is particularly acute in fragile and conflict-affected regions [1]. In these contexts, the deterioration of healthcare systems and the reduction of regulatory oversight create a conducive environment for the emergence of multidrug-resistant (MDR) pathogens [2]. In Northeast Nigeria, especially in Borno State, a prolonged insurgency spanning over a decade has significantly undermined healthcare governance in the region, resulting in unrestricted access to antibiotics and an over-reliance on empirical treatments that are increasingly proving ineffective [3].

For pregnant women, who are physiologically susceptible to urogenital infections, the declining efficacy of antibiotics represents a substantial risk to both maternal and neonatal health [4].

Urinary tract infections (UTIs) and related genital tract colonization are among the most common medical issues encountered during pregnancy [5]. If inadequately addressed, these infections can swiftly progress to serious complications such as pyelonephritis, preterm labor, and maternal sepsis [6]. Historically, *Escherichia coli* and *Klebsiella pneumoniae* have been the principal uropathogens targeted by first-line beta-lactam antibiotics; however, recent clinical findings from Maiduguri reveal a notable shift in the types of microbes that are prevalent, along with their associated resistance patterns [7].

The complexity of these infections is further exacerbated by the interaction between bacterial pathogens and fungal species such as *Candida albicans*. Emerging evidence suggests that the vaginal vault may serve as a protected "reservoir," wherein mixed-species biofilms promote horizontal gene transfer and shield bacteria from the host's immune responses, thereby rendering traditional antibiotics such as Amoxicillin largely ineffective [8, 9]. In humanitarian settings like Borno, the absence of routine culture-based diagnostics results in many pregnant women receiving "standard" first-line treatments that may already lack efficacy within the community [10].

While numerous studies have documented the prevalence of UTIs in Nigeria, there exists a limited number of examinations that investigate the rapid escalation of resistance in conflict-affected regions [11]. Most contemporary research offers a static perspective on resistance patterns, failing to illustrate the dynamic nature of the clinical environment over the span of a single year [12]. A significant knowledge gap remains regarding the simultaneous colonization of the urinary and genital tracts and the implications of this "urogenital interaction" on the effectiveness of empirical maternal treatment in the Sahel [13].

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This study utilized a temporal, multi-site comparative cross-sectional approach carried out from January 2024 to December 2025. The research was conducted in Maiduguri, the capital city of Borno State, Nigeria, a region known for its ongoing socio-political challenges. Data collection took place primarily at three key maternal health facilities: the University of Maiduguri Teaching Hospital (UMTH), the State Specialist Hospital, and several Maternal and Child Health (MCH) centers, which included Maryam Abacha Women and Children's Hospital, Umaru Shehu Clinic, Pompomari Clinic, Nursing Home, Yerwa Clinic, and Nakowa Specialist Clinic. These locations were deliberately chosen to ensure a representative sample from the urban population, including internally displaced persons (IDPs) in need of maternal healthcare services in the city.

2.2 Participant Eligibility and Cohort Synthesis

The research included pregnant women participating in regular antenatal clinics (ANC). The participants were divided into three analytical cohorts:

2.2.1. The 2024 Baseline Cohort (n=87): Women in this group were tested for both asymptomatic and symptomatic urinary tract infections (UTIs) to determine initial resistance patterns.

2.2.2. The 2025 Pyelonephritis Cohort (n=113): This cohort consisted of women showing clinical symptoms of an upper urinary tract infection, such as a fever of 38°C, flank pain, and substantial bacteriuria.

2.2.3. The 2025 Genital Reservoir Cohort: A subgroup from the 2025 population underwent screening for concurrent colonization of the genital tract to explore bacterial-fungal interactions.

Exclusion Criteria: Individuals who had started antibiotic treatment within 14 days before enrollment or those with existing renal structural abnormalities were excluded to reduce bias in resistance pattern reporting.

2.3 Clinical Sample Collection and Processing

To ensure diagnostic precision and limit contamination, standardized procedures for sample collection were followed at all sites:

2.3.1 Urinary Samples: Midstream "clean-catch" urine (10–20 mL) was gathered in sterile containers [24, 25].

2.3.2 Genital Samples: High Vaginal Swabs (HVS) were collected with sterile swab sticks by trained clinical staff to maintain the integrity of the microbial profile [25, 26].

Samples were transported under cold chain conditions and processed at the Department of Medical Laboratory Science, University of Maiduguri, within two hours of collection [25, 27].

2.4 Laboratory Analysis and Pathogen Identification

2.4.1 Bacteriological Analysis

Samples were cultivated on Blood Agar, MacConkey Agar, and Cysteine Lactose Electrolyte Deficient (CLED) agar. Significant bacteriuria was defined as a colony count of 10^5 CFU/mL. Isolates were recognized through Gram staining and a standardized series of biochemical tests, which included Catalase, Coagulase, Indole, urease, gas production, H_2S, Citrate tests, and sugar fermentation [19, 20].

2.4.2 Mycological Analysis (2025)

Genital swabs were cultured on Sabouraud Dextrose Agar (SDA) supplemented with antibiotics to inhibit bacterial overgrowth. Identification of *Candida* species was conducted using germ tube tests and morphological assessment on Cornmeal Agar [21, 22].

2.5 Antimicrobial Susceptibility Testing (AST)

AST was performed using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar. The choice of antibiotic discs (including Amoxicillin, Gentamicin, Ciprofloxacin, and Colistin) was based on regional availability and the latest Nigerian clinical guidelines. Results were classified as Sensitive, Intermediate, or Resistant, adhering to the Clinical and Laboratory Standards Institute (CLSI) 2024/2025 criteria [23].

2.6 Statistical Framework and Ethics

Data analysis was conducted using SPSS version 26.0. To examine the relationships between socio-demographic factors (age, parity, and trimester) and the infection prevalence, the Pearson Chi-square test was applied. A p-value of less than 0.05 was deemed statistically significant. Ethical approval was obtained from the Borno State Ministry of Health and the institutional boards involved in this research. All participants provided informed verbal consent.

3. RESULTS

3.1 Study Population and Comparative Prevalence

A total of 300 pregnant women participated in the study analysis. The application of 95% Confidence Intervals (CI) reveals a significant increase in the regional infection burden over the study period. The non-overlapping confidence intervals from the 2024 baseline to the 2025 crisis cohort provide solid statistical proof of a noteworthy rise in urogenital infections, with prevalence nearly doubling in a single year.

Table 1: Cumulative Positivity Rates with 95% Confidence Intervals

Research Arm	Number (n)	Total Positives	Prevalence (%)	95% CI
Cohort A (2024 Baseline)	**87**	**40**	**46.0%**	**[35.3% – 56.7%]**
Cohort B (2025 Crisis)	**113**	**107**	**94.7%**	**[90.6% – 98.8%]**
Cohort C (2025 Reservoir)	**100**	**100**	**100.0%**	**[96.4% – 100.0%]**
TOTAL	**300**	**247**	**82.3%**	**[78.0% – 86.6%]**

3.2 Spatial Distribution of Pathogens by Healthcare Facility

● Analyzing pathogen distribution within the primary maternal health facilities in Maiduguri shows a widespread, city-wide transmission of resistant strains rather than localized outbreaks. This spatial data forms an essential basis for understanding the "Conflict-AMR Nexus" affecting the region at present.

● Primary Care as an Infection Reservoir: The prevalence of pathogens was highest at Maternal and Child Health (MCH) Clinics, which reported an incidence rate of 42.1% (95% CI: 35.9%–48.2%). This result is significant as it indicates that the community-based population is already experiencing a considerable infection burden before they seek urgent care at tertiary centers.

● The *S. aureus* Paradox: *Staphylococcus aureus* was identified as the most common isolate across all healthcare facilities, achieving its peak concentration at local MCH Clinics (n=51). This finding starkly contrasts with global trends where *E. coli* is usually recognized as the primary uropathogen, revealing a unique microbial profile in Borno.

● Tertiary vs. Primary Dynamics: Although the University of Maiduguri Teaching Hospital (UMTH) (31.2%) and State Specialist Hospital (SSH) (26.7%) serve as referral centers for critical cases, the high occurrence of *E. coli* displacement observed in these facilities likely reflects the accumulation of the most treatment-resistant strains in the urban area.

● Uniform Pathogen Profiles: The identification of *E. coli*, *S. aureus*, *Klebsiella*, and *C. albicans* across all levels of care—from primary clinics to tertiary hospitals—illustrates a consistent microbial risk. This ecological uniformity highlights the need for standardized diagnostic and treatment protocols for expectant mothers throughout the entire metropolitan healthcare network.

Table 2: Facility-Specific Pathogen Distribution (N=247 isolates)

Healthcare Facility	*E. coli*	*S. aureus*	*Klebsiella* species	*C. albicans*	Prevalence [95% CI]
UMTH (Tertiary)	23	27	9	18	31.2% [25.4%–36.9%]
SSH (Secondary)	21	22	7	16	26.7% [21.2%–32.3%]
MCH / Clinics	31	51	6	16	42.1% [35.9%–48.2%]
TOTAL (Isolates)	**75**	**100**	**22**	**50**	**100% (N=247)**

Abbreviations: UMTH=University of Maiduguri Teaching Hospital; SSH=State Specialist Hospital; MCH=Maternal and Children Hospitals; *E.=Escherichia; S=Staphylococcus; C.=Candida*

3.3 Demographic Risk and Trimester-Specific Density

- The Age Vulnerability Peak: The prevalence of pathogens displayed a non-linear trend according to age, with a significant peak in the 21–25 years age group at 34.8% (95% CI: 28.9%–40.7%). This demographic represents the optimal years for childbearing in the area. Notably, the prevalence rates for the younger (15–20 years) and older (>30 years) age groups were nearly identical at 19%, indicating a specific period of heightened risk for young adults.

- The "Late-Term Explosion": There is an observable, gradual increase in prevalence as pregnancy advances. Only 11.7% of isolates were identified during the 1st trimester, but this figure surged to 54.3% (95% CI: 48.0%–60.5%) by the 3rd trimester. This nearly five-fold increase illustrates that the risk of

colonization is not consistent but instead intensifies as pregnancy comes to an end as shown in table 3 below.

Table 3: Pathogen Prevalence by Maternal Age and Gestation (N=247)

Characteristic	Isolates	Prevalence (%)	95% CI	Characteristic
Maternal Age				**Maternal Age**
15–20 Years	48	19.4%	[14.5% – 24.3%]	15–20 Years
21–25 Years	86	34.8%	[28.9% – 40.7%]	21–25 Years
26–30 Years	64	25.9%	[20.5% – 31.4%]	26–30 Years
>30 Years	49	19.8%	[14.9% – 24.8%]	>30 Years
Gestational Stage				**Gestational Stage**
1st Trimester	29	11.7%	[7.7% – 15.8%]	1st Trimester
2nd Trimester	84	34.0%	[28.1% – 39.9%]	2nd Trimester
3rd Trimester	134	54.3%	[48.0% – 60.5%]	3rd Trimester

3.4 The Urogenital Nexus: Taxonomic Displacement and Overlap

● The long-term comparison conducted between 2024 and 2025 reveals a significant alteration in the urinary microbial ecosystem of the region. This period was noted for a substantial rise in the dominance of *Escherichia coli*, alongside the development of complex multi-pathogen reservoirs.

● The *E. coli* Surge: The most striking finding from this analysis is the statistically significant growth of *Escherichia coli*. In 2024, *E. coli* was a minor isolate with a prevalence of only 2.3%. Nonetheless, this proportion skyrocketed to 51.3% in 2025 (95% CI: 42.1–60.6%), showcasing an approximate 25-fold increase in prevalence ($p < 0.001$).

● Pathogen Stability: Conversely, compared to the notable variations with *E. coli*, the incidence of *Staphylococcus aureus* remained fairly constant as a principal pathogen, increasing slightly from 29.9% to 34.5% ($p = 0.481$). Similarly, *Klebsiella* spp. exhibited a small, non-significant decline, dropping from 13.8% to 8.8% ($p = 0.245$).

● Cross-Kingdom Overlap: In addition to analyzing the prevalence of individual pathogens, a considerable clinical overlap was observed. Notably, 64% of the women presenting with urinary *S. aureus* were

simultaneously colonized with vaginal *C. albicans*. This heightened co-infection rate indicates the emergence of a "fungal-shielded" urogenital reservoir.

Table 4: Temporal Shift in Primary Pathogens (2024 vs. 2025)

Pathogen	2024 Prevalence [95% CI]	2025 Prevalence [95% CI]	p-value
E. coli	2.3% [0.3 – 8.1]	51.3% [42.1 – 60.6]	< 0.001
S. aureus	29.9% [20.5 – 40.6]	34.5% [25.7 – 43.3]	0.481
Klebsiella spp.	13.8% [7.3 – 22.8]	8.8% [4.3 – 15.6]	0.245
TOTAL	46.0% (n=40)	94.6% (n=107)	< 0.001

Abbreviations: *E. coli=Escherichia coli; S. aureus=Staphylococcus aureus; spp=species.*

3.5 Catastrophic Erosion of Antimicrobial Efficacy

● The therapeutic effectiveness of conventional antimicrobial agents saw an almost complete breakdown between the baseline evaluation in 2024 and the follow-up assessment in 2025. This swift decline in drug efficacy suggests that the Maiduguri metropolitan area has effectively entered a "localized post-antibiotic era" pertaining to maternal urogenital healthcare.

● Total Erosion of First-Line Defense: The most alarming finding is the complete loss of efficacy for Amoxicillin. While it demonstrated a 90.0% sensitivity rate in 2024, this figure plummeted to 0.0% sensitivity (95% CI: 0.0%–3.2%) in the 2025 cohort, indicating the total clinical obsolescence of the region's most frequently used first-line oral antibiotic.

● The Collapse of Fluoroquinolones: Ciprofloxacin, previously a reliable second-line treatment with a sensitivity rate of 85.0%, suffered a drastic reduction to 16.7%, indicating widespread clinical failure.

● The Colistin Crisis: Resistance to Colistin—historically regarded as a "drug of last resort"—is already significantly high, with only 27.8% sensitivity observed. This suggests that 72.2% of tested coliforms are resistant to last-line therapies, greatly restricting options for clinicians dealing with multi-drug resistant (MDR) sepsis.

● Lone Salvage Utility: Gentamicin remains the only drug in this study showing 100% sensitivity throughout both evaluation periods, thus ensuring consistent statistical confidence in its effectiveness for severe cases.

Table 5: Sensitivity Patterns and Clinical Status (2025 Cohort)

Antibiotic Agent	2024 Sens.	2025 Sens.	95% CI (2025)	Status
Amoxicillin	90.0%	0.0%	[0.0% – 3.2%]	Total Erosion
Ciprofloxacin	85.0%	16.7%	[8.1% – 25.2%]	Clinical Failure
Colistin	N/T	27.8%	[18.5% – 37.1%]	Emergent Crisis
Gentamicin	100%	100%	[96.7% – 100.0%]	Salvage Utility

Abbreviation: Sens.=Sensitives

4. DISCUSSION

4.1 The Rapid Evolution of the Urogenital Microbiome

The principal finding of this study is the considerable taxonomic shift observed over a twelve-month period. The increase in the prevalence of *Escherichia coli* from 2.3% in 2024 to 51.3% in 2025 indicates a significant ecological transformation that is infrequently documented in stable environments. Historically, *Staphylococcus aureus* has been recognized as a predominant uropathogen in North-East Nigeria [7]; however, the data presented in this study suggest that *Escherichia coli* is swiftly establishing itself as the principal causative agent of maternal urinary tract infections (UTIs) in this region. This trend corresponds with global statistics indicating that *Escherichia coli* accounts for the majority of community-acquired UTIs [4]. Nonetheless, the rapidity of this transition documented in Borno suggests a disruption of regional microbial stability. Notably, this alteration in microbial composition appears to be consistent throughout the metropolitan area. The significant prevalence recorded at primary Maternal and Child Health (MCH) clinics (42.1%), which surpasses that observed in tertiary care centers, affirms that these resistant strains are firmly established within the community rather than being confined to specialized clinical settings. This phenomenon is likely exacerbated by changes in hygiene and sanitation practices associated with displacement [3].

4.2 The "Late-Term Explosion" and Urogenital Reservoirs

In addition to the gestational stages, our analysis revealed that the age cohort of 21 to 25 years represent the period of greatest clinical vulnerability, exhibiting a prevalence of 34.8%. It is noteworthy that conventional demographic indicators, such as parity (the number of previous births), did not demonstrate statistical significance in relation to pathogen type ($p = 0.53$). This finding implies that the environmental pressures arising from the Borno conflict create a "universal risk" that transcends individual obstetric history. Our data indicate that the third trimester is characterized by the highest infection density, with a prevalence of 54.3%. This observation aligns with regional studies conducted across Sub-Saharan Africa [5], which attribute increased vulnerability during late gestation to physiological hydroureter and urinary stasis. Furthermore, our discovery of a concurrent "Urogenital Reservoir," in which 64% of women with urinary *Staphylococcus aureus* also harbored vaginal *Candida albicans*, introduces additional clinical complexity. Recent evidence suggests that the vaginal vault functions as a protected reservoir in which bacterial pathogens reside within fungal biofilms, potentially evading standard short-course antibiotic therapies and contributing to elevated recurrence rates [8].

4.3 Catastrophic Decline of First-Line Therapies

The significant decrease to a sensitivity rate of 0.0% for Amoxicillin and an alarming 16.7% for Ciprofloxacin highlights a pivotal development that indicates a "post-antibiotic era" in maternal healthcare in Borno State. In contrast, studies conducted in stable southern regions of Nigeria report Amoxicillin sensitivity rates ranging from 20% to 30% [11]. The findings suggest that in conflict-affected areas, the decline in antibiotic efficacy is extensive. This deterioration renders the World Health Organization's (WHO) "AWaRe" group antibiotic recommendations largely irrelevant for this region [14]. Furthermore, the reliance on Ciprofloxacin as a secondary treatment is clinically impractical, reflecting the rise in fluoroquinolone resistance observed throughout the Sahel and South Asia [13].

4.4 The Colistin Crisis: A Global Alarm

The emergence of a 72.2% resistance rate to Colistin among coliform isolates represents the most concerning finding of this study. Colistin is categorized as a "Reserve" antibiotic, functioning as the ultimate line of defense [15]. The high prevalence of Colistin resistance within a community-based maternal population suggests a widespread and silent transmission of resistance genes, potentially correlated with the mcr-1 plasmid [16]. These findings directly challenge global antimicrobial stewardship policies, which operate under the assumption that "Reserve" antibiotics will remain effective in community settings. The data indicate that even last-resort medications are under immediate threat in "fragile and conflict-affected settings" (FCAS) [2].

4.5 Policy Implications and the Conflict-AMR Nexus

Current global stewardship policies are frequently grounded in data derived from stable environments. This research elucidates the "Conflict-AMR Nexus," wherein disrupted supply chains and inadequate diagnostic infrastructure exacerbate antibiotic resistance at rates substantially exceeding global averages [12]. Rescue Protocols: The 100% sensitivity of Gentamicin necessitates a strategic

reorientation in regional policy toward these "Salvage Therapies" [17]. Dual Screening: The increased incidence of bacterial-fungal co-colonization underlines the necessity for a policy adjustment that promotes simultaneous urinary and genital screening for all late-term patients, aimed at preventing neonatal sepsis [18]. Community-Level Intervention: Given that the highest density of pathogens was identified in Maternal and Child Health (MCH) clinics, there exists a critical need to decentralize diagnostic capabilities and distribute "salvage" antibiotics from tertiary care facilities to primary healthcare settings, thus facilitating timely interventions prior to the escalation of infections into maternal sepsis.

Conclusion

This study presents conclusive evidence of a significant alteration in the urogenital microbial landscape of Borno State, Northeast Nigeria, taking place between 2024 and 2025. The transition from a baseline predominantly characterized by *Staphylococcus* to a crisis involving multidrug-resistant *Escherichia coli*—evidenced by a total failure of first-line antibiotics such as Amoxicillin—indicates that the region has substantially entered a "localized post-antibiotic era." The identification of a high-density "Urogenital Reservoir" during the third trimester, in which bacterial pathogens appear to be protected by fungal biofilms, elucidates the heightened recurrence rates and increased clinical severity documented in the region. Of particular concern is the emergence of community-acquired resistance to Colistin, which serves as a global alert, suggesting that even the most limited "last-resort" antibiotics are diminishing in efficacy in fragile and conflict-affected environments. In the absence of immediate intervention, the intensifying "Conflict-AMR Nexus" poses a significant threat to the progress made over decades in reducing maternal and neonatal mortality rates in the Lake Chad Basin.

Limitations of the Study

This research contributes valuable insights into the urogenital crisis in Borno State; however, several limitations warrant consideration:

1- Absence of Molecular Characterization: The study employed phenotypic disc diffusion methods to identify antimicrobial resistance. Due to infrastructural limitations in the region, it was not feasible to conduct Polymerase Chain Reaction (PCR) or Whole Genome Sequencing (WGS) to confirm the presence of specific resistance genes, including the mcr-1 plasmid associated with Colistin and the *blaCTX-M* gene linked to ESBL-producing *E. coli*.

2- Geographic Specificity: Data collection was limited to healthcare facilities in Maiduguri. Although these institutions serve as primary referral centers, the results may not comprehensively reflect the microbial dynamics present in remote rural areas of Borno State, where access to antibiotics and the resulting selection pressures may differ significantly.

3- Cross-Sectional Design: The research utilized a cross-sectional design encompassing the years 2024 and 2025. A longitudinal approach that follows a cohort of women from the first to the third trimester would yield more conclusive evidence regarding the transition of pathobionts and the formation of a "reservoir."

4- Biological Sampling Constraints: The identification of the "Urogenital Reservoir" was based on concurrently positive cultures. Nonetheless, advanced biofilm imaging techniques, such as Scanning Electron Microscopy (SEM), were not employed to visualize the physical interactions between *C. albicans* and *S. aureus* in vivo.

Limitations of the Study

5-Methodological Constraints on Polymyxin Testing: Colistin resistance in this study was initially identified using phenotypic disc diffusion screening. While this method quickly indicated high-level resistance in resource-limited labs, CLSI and EUCAST guidelines point out that the poor diffusion of large polymyxin molecules in agar can create variability. Therefore, these findings reflect phenotypic colistin resistance rates, and future monitoring should involve broth microdilution (BMD) or colistin drop elution tests.

Recommendations

Immediate Revision of Empirical Guidelines: In light of the observed 0.0% sensitivity of Amoxicillin and the significantly high failure rate associated with Ciprofloxacin, regional health authorities must expeditiously remove these medications from the list of first-line empirical treatments for maternal urinary tract infections in Borno State.

Adoption of "Salvage Therapy" Protocols: In the absence of effective oral alternatives, it is essential to prioritize Gentamicin and certain fluoroquinolones, where warranted, as rescue therapies. This approach should be supported by rigorous diagnostic stewardship to preserve the remaining efficacy of these agents.

Mandatory Dual Screening in Late Gestation: To mitigate the impact of the "Urogenital Reservoir" phenomenon, clinical policies should evolve to mandate simultaneous urinary and vaginal screening for all women entering their third trimester. Treatment protocols must comprehensively address both bacterial and fungal components to ensure total clearance of infections.

Scaling Molecular Surveillance: International health organizations, including the World Health Organization and the Centers for Disease Control and Prevention, should prioritize the region for molecular surveillance efforts, specifically aimed at tracking the dissemination of the *mcr-1* gene and other mobile genetic elements that contribute to Colistin resistance.

Strengthening Fragile Supply Chains: It is crucial to implement policies that ensure the consistent availability of high-quality, non-degraded antibiotics in conflict-affected areas, thereby preventing the selection pressure that arises from the use of substandard or low-dose medications.

Declarations

Ethics Approval and Consent to Participate

This study adhered to the ethical standards of the Declaration of Helsinki, receiving approval from the Research and Ethics Committee of the Borno State Ministry of Health and participating institutions (Approval numbers: SHREC 81/2023, 58/2025, and SSH/GEN/611/vol.1). Due to socio-political instability, low literacy, and security issues in outpatient antenatal care in conflict zones, ethics committees permitted informed verbal consent prior to specimen collection. Information sheets were explained in participants' native languages (Hausa/Kanuri), and for minors under 18, consent was obtained from a parent or guardian present.

Availability of Data and Materials

The datasets produced and analyzed during this study (2024–2025 cohorts) are available from the corresponding author upon reasonable request. All initial laboratory results and antimicrobial susceptibility profiles are included in the results section of this paper.

Competing Interests

The authors declare that there are no competing interests, either financial or otherwise, related to the research conducted or the findings presented in this manuscript.

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Authors' Contributions

HBA initiated the study, oversaw the laboratory analyses, and drafted the manuscript. BIY and ML were responsible for sample collection, microbiological processing, and data entry for their respective cohorts. UM was involved in the statistical analysis and performed a literature review. All authors reviewed and approved the final version of the manuscript.

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