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Review

Epidemics of Antimicrobial Resistance in Conflict Areas: Representative Recent Examples from the Middle East and Ukraine: The Time for Action Is Now

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Abstract

Antimicrobial resistance (AMR) has become a pressing global health concern, and its impact is magnified in the setting of armed conflict. Wars undermine health systems by disrupting infection prevention and control, damaging water and sanitation infrastructure, limiting access to diagnostics, and driving unregulated use of antimicrobials. Infections of war wounds typically follow a temporal pattern: gram-positive organisms dominate the early phase, whereas gram-negative pathogens increasingly complicate care in the following days. Reports consistently describe high rates of methicillin-resistant *Staphylococcus aureus* (MRSA), while among gram-negative bacteria, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* are the principal multidrug-resistant agents. In the Eastern Mediterranean Region, resistance levels are among the highest recorded worldwide, with carbapenem-resistant *A. baumannii* and extended-spectrum β -lactamase (ESBL)-producing Enterobacterales being especially common. In Ukraine, recent analyses highlight the predominance of metallo- β -lactamases, particularly NDM in Enterobacterales and *P. aeruginosa*, and OXA-23/-72 in *A. baumannii*. Forced displacement on an unprecedented scale further accelerates the cross-border spread of resistant strains. Surveillance, however, remains patchy: laboratory capacity is frequently impaired, and available studies are heterogeneous in methods and quality, limiting accurate assessment of the burden. This review brings together evidence from recent conflicts in the Middle East and Ukraine, examining resistance trends, underlying drivers, and their implications for clinical practice. Addressing AMR in conflict requires immediate, pragmatic steps: restoration of infection control and water systems, targeted screening of high-risk patients, context-specific antimicrobial stewardship, and the development of lean but standardized surveillance systems suited to resource-limited and insecure environments.

Keywords: antimicrobial resistance; Middle East; Ukraine; conflict; war-related infections

Introduction

Antimicrobial resistance (AMR) has been identified as a global public health problem with implications extending beyond health into social and economic domains. Recent estimates indicate that more than one million deaths were attributable to AMR in 2019 [1]. The economic burden on healthcare systems due to infections by resistant pathogens may reach thousands of dollars per case [2,3], while projections suggest that global gross domestic product (GDP) could shrink significantly, potentially pushing 28 million people into poverty by 2050, according to World Bank estimates [4]. The 2024 WHO Bacterial Priority Pathogens List classifies Enterobacterales resistant to third-generation cephalosporins, Enterobacterales and *Acinetobacter baumannii* resistant to carbapenems (CRAB), as “critical” pathogens, given their limited treatment options and high associated morbidity and mortality [5].

The burden of AMR is aggravated in conflict areas where political instability, economic collapse, and environmental destruction undermine healthcare systems [6]. Historically, during World War II, most of the patients experienced nosocomial infections, revealing the importance of infection prevention and control [7]. AMR, potentially driven by heavy metals used in weaponry, was hypothesized as early as World War II [8]. The widespread introduction of penicillin, followed by its combination with other antibiotic classes, contributed to the emergence of resistant pathogens, a trend that became more evident during the Vietnam War [7]. However, AMR was most clearly highlighted during and following the Iraq wars of the 1980s, where evidence supported an increasing proportion of resistant gram-negative pathogens during the period 1981-1988 of the Iran-Iraq war [9]. This review article describes the epidemiology and emergence of AMR in recent conflict zones of the Middle East and Ukraine.

Epidemiology of Resistant Pathogens: The Examples of the Recent Conflicts in the Middle East and Ukraine

Indicative data of the epidemiology of MDR pathogens in areas of conflict are presented in Table 1.

Data from Iraq, Iran, Afghanistan

Retrospective data from Iran (1981, 1985, 1987), based on blood, cerebrospinal fluid, stool, and pus cultures, demonstrated a steady predominance of gram-negative pathogens, with increasing resistance to multiple antibiotic classes [9]. *E. coli* and *Klebsiella* spp. were the most frequent urinary pathogens, while *Enterobacter* emerged as a major cause of central nervous system infection, together with *Pseudomonas* and *Acinetobacter*. Over the same period, gram-negative bacteremia showed a rising trend [9]. Although gram-negative organisms were identified in a study from 1987 evaluating war injury data from 1983-4 and after, they were not yet widely recognized as dominant contributors to war-related infections at the time [10]. Additional Iranian data from head wound, bone, and brain tissue infections identified *Acinetobacter* spp. and staphylococci among the most common pathogens [10].

In more recent conflicts, AMR epidemiology has been better characterized. A retrospective analysis of open tibial fractures from wounded U.S. military personnel from Iran or Afghanistan, between March 2003 and September 2006, revealed gram-negative organisms (mostly *Acinetobacter*, *Enterobacter* spp., and *P. aeruginosa*) as the main cause of infection, while staphylococci were primarily associated with recurrent infections [11]. A study from a tertiary U.S. military hospital in Baghdad (August 2003–July 2004) analyzed blood, wound, sputum, and urine cultures from both U.S. personnel and Iraqi civilians. Coagulase-negative staphylococci (CNS) were the most frequent isolates, followed by gram-negative pathogens (*K. pneumoniae*, *A. baumannii*, *P. aeruginosa*, *E. coli*) [12]. Resistant gram-negative organisms were more common among Iraqi patients, raising concerns about nosocomial transmission to American military personnel. Despite broad resistance, gram-negative isolates generally remained susceptible to amikacin and, particularly, carbapenems [12]. The proportion of MRSA among *S. aureus* was reported as high as 68%. Supporting this, Kaspar et al. found evidence of nosocomial acquisition of MDR pathogens in evacuated patients, based on serial screening cultures demonstrating increased colonization after transfer from Iraq to the U.S. [13].

Reports from the Iraq war in the 2000s consistently identified resistant *A. baumannii* as a major pathogen in injured personnel, both in wounds and the bloodstream [14,15]. In a retrospective analysis of Iraqi and American patients admitted to the U.S. Navy Hospital Ship (March–April 2003), *A. baumannii* was the leading cause of injury-related infections, followed by *E. coli* and *Pseudomonas* spp. More than 80% of *Acinetobacter* isolates were susceptible only to imipenem. The pathogen was recorded as the major cause of injury-related infections, followed by *E. coli* and *Pseudomonas* spp. in a retrospective analysis from Iraqi and American patients admitted to the U.S. Navy Hospital Ship during the period March–April 2003 [16]. More than 80% of *Acinetobacter* spp. isolates were susceptible only to imipenem [16]. Studying *A. baumannii* bacteremia in one of these reports revealed

that 62% of cases occurred within the first 48 hours after hospital admission [15]; 35% of the isolates were susceptible only to imipenem, while 4% were pan-drug-resistant [15]. According to Turton et al., the identification of common strains of *A. baumannii* in both U.S. and U.K. casualties when returning to their home countries suggests in acquisition in Iraq [14]. This underscores the risk that resistant pathogens originating in conflict zones can spread internationally if infection prevention and control measures are inadequate, highlighting the urgent need for robust AMR surveillance and global biosecurity strategies in conflict-affected regions.

Data from Syria

In Syria, surveillance data were sparse before the 2011 conflict, generally relying on single-center studies with small sample sizes and methodological limitations [17]. A retrospective analysis of data from the Médecins Sans Frontières (MSF) surgical project in Jordan, that admitted Syrian patients, with war-related injuries and suspected infections, described the microbiologic profile based on intraoperative specimens [18] (Table 1). In that series, an MDR pathogen was isolated in 69% of confirmed infection cases. MRSA was identified in 42% of staphylococcal isolates. Overall, gram-negative bacteria predominated (56% vs. 44% gram-positive), with *P. aeruginosa* and *E. coli* leading, followed by *A. baumannii*. [18]. Characteristically, most of the patients were late presenters (median 5 to > 6 months).

A separate study of Syrian refugees in Jordan with post-traumatic infections (20% of whom had osteomyelitis; more than half had metal implants) mainly used deep wound swabs. Gram-negative bacteria were isolated in 97% of the cases; 66% were MDR, and approximately 37% exhibited carbapenem-resistance [19] (Table 1).

Additional microbiological data indicate variable rates of ESBL producers in Syria. Estimates range from 26% [20] to 52% in *E. coli* urine isolates in community and hospital settings [21,22]. In 3 hospitals in Aleppo, the proportion of MDR *E. coli* reached 63% [22]. Prior exposure to third-generation cephalosporin and quinolones, along with hospitalization and use of a urine catheter, were recognized as risk factors for a subsequent infection by ESBL *E. coli* [22]. Another report showed that 66% of ESBL producers (including *E. coli* and *K. pneumoniae*) exhibited a ciprofloxacin-resistance phenotype [23]. Relevant data for *P. aeruginosa* isolated in urinary and respiratory samples in a hospital setting, revealed high resistance rates; for example, susceptibility to ciprofloxacin, gentamicin, amikacin, ceftazidime, and ceftazidime was approximately 29.2%, 27%, 42.8%, 21.7%, and 28.6%, respectively [24]. The overall percentage of MDR *P. aeruginosa* was 54% [24]. Nonetheless, relatively good susceptibility rates to imipenem (56.1%) and meropenem (59.1%) were recorded [24].

Data retrieved from host countries (in refugee camps or treating hospitals) further inform the MDR epidemiology during the civil war (Table 1). In two Israeli hospitals admitting Syrian civilians, the proportion of MDR pathogens was 66% in children and 47% in adults [25]. Among the 28 adult patients with MDR isolates, 5 had carbapenem-resistant Enterobacteriaceae (2 harboring NDM), 11 had MRSA, 5 had *A. baumannii*, and 7 had ESBL producers [25]. Relevant data for children revealed that 20 among 21 cases with MDR Gram (-) pathogens were ESBL producers [25]. The first report of CRAB producing only NDM was isolated from wounded civilians in Lebanon in 2012 [26]. In one Israeli screening of 107 Syrian injured or ill children, 83% had carriage of MDR organisms; 9% carried CRE (7/10 NDM, 3/10 OXA-48), 3% VRE, 5% MRSA, 7% MDR *A. baumannii*, and 78% ESBL (95% *E. coli*) [27]. CRE and MDR *A. baumannii* were only susceptible to colistin [27]. Nineteen percent of these patients later developed MDR infections (mostly ESBL); importantly, 58% of those infections were caused by the same species as their carriage isolates [27].

Data from Lebanon

Lebanon has experienced recurrent conflicts since 1975, beginning with the civil war (1975–1978) and later the war with Israel. In parallel, as with other neighboring countries, the health system has also been burdened with caring for displaced populations, particularly during the U.S.-led “War on Terror” [7]. Between 1975 and 1984, data from more than 1,000 patients (civilians and military

personnel) with head and neck war-related injuries showed an infection rate of 12%. *S. aureus* was the most prevalent pathogen, followed by *P. aeruginosa* and *E. coli* [28]. Sepsis was reported as the second leading cause of death after hemorrhage, responsible for 2.1% of fatalities [29].

Since 1984 and up to 2006, there is a lack of publishing data. During the war with Israel, prospective data from 350 trauma patients (2006–2012), all treated with surgical debridement and antibiotics, indicated an infection rate of ~20%. *P. aeruginosa* was the leading pathogen (30.5%), followed by other gram-negative organisms (52.5%; including *Acinetobacter* spp., *E. coli*, *Klebsiella* spp., *Proteus*, and *Enterobacter* spp.), and gram-positive pathogens (17%; including CNS and *Enterococcus* spp.) [30]. In 2012, NDM-1-producing *K. pneumoniae* and *E. coli* were reported for the first time in Lebanon, in patients admitted from Iraq [31]; during that period, it was the first time that carbapenem-resistant strains of *A.baumannii* expressing the bla_{NDM-1} gene were isolated from wounded civilians of the Syrian war [26]. Between 2009–2012, the molecular analysis of *A.baumannii* detected bla_{OXA-23} and bla_{OXA-24} for the first time in the country [32]. From 2011 to 2013, among 116 isolates of *A.baumannii* retrieved from wounded Lebanese and Syrian war patients, 60% had a carbapenem-resistant phenotype [33]; bla_{OXA-23} was the predominant mechanism (found in 65 from 70 isolates), while 5 isolates were NDM-1 producers [33].

More recent data from the International Committee of the Red Cross (ICRC) Weapon Traumatology Training Center in Lebanon (2016–2019) analyzed specimens from 672 patients with war-related injuries, including skin and soft tissue samples and bone biopsies. These data mix patients from Lebanon, Syria, Palestine, and Yemen [34]. *S.aureus* was the most common pathogen (49.1%), followed by Enterobacterales (28.5%), *P. aeruginosa* (13.2%), Enterococci spp. (3.2%), and *A.baumannii* (2%) [34]. More than half of the isolates were MDR (n=186); the highest proportion of multi-drug resistance was observed in Enterobacterales and *S. aureus* (n=83, 44.6% of the total MDR, for each one) followed by *P.aeruginosa* (7.6%) [34]. MRSA accounted for 48.5% of the total *S.aureus* strains and was more likely to be isolated in bone samples [34]. Resistance rates in Enterobacterales were high: >50% resistant to third- and fourth-generation cephalosporins and piperacillin-tazobactam, while resistance to imipenem (4%) and meropenem (10.1%) remained low [34]. Ciprofloxacin resistance was >40%, and trimethoprim-sulfamethoxazole resistance ~60% [34]. For *P. aeruginosa*, resistance rates were 24% to aminoglycosides, 17.4% to ceftazidime, 26.1% to cefepime, 21.7% to piperacillin-tazobactam, and 19.6% to aztreonam. Carbapenem resistance ranged from 14.7% (imipenem) to 23.9% (meropenem)(34).

Data from the Occupied Territories of Palestine

The Gaza Strip has experienced prolonged conflict and blockade, resulting in chronic shortages of food, medicine, energy, and healthcare access [35]. Although the West Bank maintains a network with Jordan for medical support and healthcare access, both territories suffer from an under-resourced healthcare system [35] with limited staff and equipment [36]. These conditions contributed to the emergence of AMR even before the escalation of hostilities in October 2023 [35]. A systematic review of AMR in the occupied Palestinian territories (West Bank, East Jerusalem, and Gaza) reported overall rates of ~27% for both MRSA and ESBL-producing organisms in human samples [35]. Among ESBL producers, ~6% displayed carbapenem resistance, *E. coli* ESBL prevalence increased over time, and ~8% of *Acinetobacter* isolates were carbapenem-resistant (*A. baumannii*, CRAB) [35].

In Gaza, a decade ago, a cross-sectional study of clinical, environmental, and air samples showed carbapenem resistance in 12.1% of gram-negative isolates, particularly from intensive care units; *Klebsiella* spp. was the most frequent carbapenem-resistant Enterobacterales [37]. More recently in 2022, a cross-sectional study showed the presence of *Pseudomonas* spp. in more than half of the water samples from primary healthcare settings in Gaza, with high resistance to imipenem and piperacillin; the NDM gene was detected in over a quarter of them [38]. Contaminated water supplies may therefore act as reservoirs for resistant pathogens and contribute to community AMR spread.

Clinical data highlight a substantial MDR burden. In osteomyelitis cases, MRSA accounted for 65% of *S. aureus* isolates; 30% of gram-negatives were ESBL producers, and ~25% of Enterobacterales

were carbapenem-resistant(36). At Al-Nasser Pediatric Hospital (2021), ESBL-producing gram-negatives were identified in ~59% of isolates (mainly from urine, followed by pus, blood, and sputum), exceeding earlier reports [39,40]. The same study recorded for the first time in the Gaza Strip the presence of *bla*_{KPC-2} in *K. pneumoniae* from the pediatric population [39].

Analysis of fecal and rectal carriage, which is thought as a way for transmission of resistance both in community and healthcare settings, revealed ESBL-producers in 37% of the samples (including specimens from community health centers and hospitals). The majority were *E.coli* (52.8%), followed by *K. pneumoniae* (39.1%), *Citrobacter freundii* (26.7%), *Proteus mirabilis* (2.8%), and *K. aerogenes* (2.1%) [41]. Notably, *K. pneumoniae* with an ESBL phenotype was also observed in the community, suggesting spread beyond healthcare settings [41]. The dominant resistant mechanisms were *bla*_{CTX-M}, followed by *bla*_{TEM} and *bla*_{SHV} [41]. A prospective study analyzing human samples from a pediatric and a tertiary hospital before October 2023 supported that 40% of the *K.pneumoniae* isolates from blood cultures had a carbapenem-resistant profile, with the vast majority producing metallo-β-lactamases (MBL), followed by a small proportion of OXA-48 [42].

Data from Ukraine

Ukraine has faced armed conflict since 2014, escalating dramatically after the 2022 Russian invasion [43]. From 2014–2020, data from war-injured patients in Eastern Ukraine military hospitals showed high carbapenem resistance: 67.9% of *A. baumannii* (class A/D β-lactamases), 55.6% of *P. aeruginosa* (class A/B/D β-lactamases, including RmtB4), 42.9% of *E. coli*, and 32.8% of *K. pneumoniae* (mostly class A/D β-lactamases, with rare *bla*_{NDM-1} [44]). Genomic analysis confirmed that *A. baumannii* and *P. aeruginosa* strains isolated pre- and post-2022 were genetically related, suggesting continuity of resistant lineages across a decade of conflict [43].

In 2022, samples from burn, wound, and fracture patients revealed meropenem resistance in 58% overall, including *Klebsiella* spp. (76%), *A. baumannii* (73%), *P. aeruginosa* (57%), and *Enterobacter* spp. (18%) [45]. Approximately half of the strains were resistant to ceftiderocol (78% of Enterobacterales, 38% of *P.aeruginosa*, 24% of *A.baumannii*) [45]. Resistance to newer β-lactam/β-lactamase inhibitor combinations was alarmingly high: ceftazidime-avibactam (80%), ceftolozane-tazobactam (95%), imipenem-relebactam (84%), and meropenem-vaborbactam (80%) [45].

A large 2023–2024 hospital dataset (>6800 isolates) confirmed high resistance rates: *K. pneumoniae* was most prevalent (>50% ESBL-positive, up to 60% carbapenem-resistant, and 28% pan-drug resistant). *Acinetobacter* spp. showed >75% carbapenem resistance and 37% pan-drug resistance, exceeding global averages [46]. Emerging mechanisms include MBL-producing *P. aeruginosa* with limited treatment options. In one series, 8/12 isolates produced MBLs (4 NDM only, 1 IMP only, 1 NDM/OXA-48, 1 NDM/IMP, 1 KPC/NDM). All remained colistin-susceptible; most were ceftiderocol-susceptible [47]. Similarly, wound-related *A. baumannii* isolates were 95% MDR, 17.6% XDR, and 76.5% carbapenem-resistant, mainly via *bla*_{OXA-23} and *bla*_{OXA-72} [48].

Surveillance from the Netherlands on Ukrainian patients (March–December 2022) identified *bla*_{NDM} as the main driver of resistance to last-resort drugs, including ceftazidime-avibactam, ceftolozane-tazobactam, imipenem-relebactam, and aminoglycosides [49]. A parallel study confirmed that dominant resistance mechanisms in Enterobacterales were NDM/OXA-48-like and NDM, with KPC less frequent. In *A. baumannii*, NDM and OXA-23-like were dominant, while in *P. aeruginosa* NDM was most common [50]. Early-onset infections (<7 days) were more often carbapenemase-positive, suggesting community/field acquisition, whereas later-onset cases likely reflected nosocomial spread [50].

Discussion

Wound infections account for a significant proportion of war-related infections. Early after injury, gram-positive organisms tend to predominate; as time passes, gram-negative pathogens increasingly drive morbidity, in line with trauma microbiology from Middle Eastern conflicts [7]. According to data based on the WHO Global Antimicrobial Resistance and Use Surveillance System

(GLASS), the antimicrobial resistance in the Eastern Mediterranean Region is higher than the global average [51]. A meta-analysis focusing on GLASS Priority Pathogens exclusively in conflict zones of the Eastern Mediterranean Region showed that *S.aureus* was the predominant pathogen isolated [52]. Despite the heterogeneity and low quality of data, it is worth mentioning that the proportion of MRSA was 55.6% of the total *S.aureus* isolates; among gram-negative pathogens with carbapenem-resistance profile, the most prevalent was *A. baumannii* (60.3%), followed by *P.aeruginosa* and *K.pneumoniae* with a proportion of approximately 22% and 12%, respectively [52]. The recorded ceftriaxone resistance proportion for *E.coli* and *K. pneumoniae* was 76% and approximately 81%, respectively [52]. These figures align with country-level reports across Syria and Lebanon, and mirror the historically observed shift toward late, gram-negative, often device- or hospital-associated infections in protracted conflicts [7,17–34].

When conflict vs. non-conflict settings in the Middle East are compared, one synthesis suggested similarly high carbapenem resistance in *Acinetobacter* spp. in both contexts (78% vs. 72.7%) [53] underscoring the fact that AMR pressure is not confined to battlefields alone. However, data for *K. pneumoniae* were sparse; where available, carbapenem resistance was ~15% without a clear conflict effect, whereas ESBL prevalence was markedly higher in conflict zones (75.5% vs. 22.5%) [53]. Together with our regional summaries, this suggests that conflict amplifies transmission opportunities and selection pressures (overcrowding, antimicrobial overuse, disrupted IPC/WASH), particularly for ESBL and non-fermenters, even where baseline resistance is already high [6,52,53].

Human displacement is a critical accelerant. In the background of the new conflicts unravelling in Eastern Europe and the Middle East, the United Nations High Commissioner for Refugees (UNHCR) Global Trends Report for 2024 reported a growing trend of people forced to flee over the last decade [54]. For 2024, more than 120 million people were displaced, representing 1 human in every 64 worldwide, with the vast majority coming from low- and middle-income countries [54]. This intensification of human displacement could function as a catalyst for the rapid inter-regional spread of multidrug-resistant pathogens emerging from war zones to the host countries.

The Ukrainian data summarized are particularly concerning: high meropenem resistance across Enterobacterales and non-fermenters, substantial resistance to newer β -lactam/ β -lactamase inhibitor combinations, and MBL dominance (especially NDM) in Enterobacterales and *P. aeruginosa*, with OXA-23/72 in *A. baumannii* [43–50]. These patterns differ from many non-conflict European settings and complicate empiric therapy and infection control (45, 49, 50). European guidance has therefore weighed targeted screening and isolation when patients were recently hospitalized in Ukrainian facilities [55] consistent with evidence that prior hospitalization in Ukraine predicts carriage of carbapenemase-producing organisms [49].

Conflict-driven determinants are now well characterized: breakdown of hygiene and IPC; damage to water and sewage systems; interruptions in vaccination; workforce depletion and training gaps; and heavy, often empiric, broad-spectrum antibiotic use [6]. These factors promote both colonization and clinical infection by MDR organisms and make *mass-casualty* care particularly vulnerable to nosocomial transmission [56]. The Gaza findings exemplify several of these pathways: carbapenem-resistant gram-negatives in clinical and environmental samples [37], MDR *Pseudomonas* carrying NDM in primary-care water sources [38], high ESBL burdens in pediatric hospitals and community carriage [39–41], and MBL-mediated carbapenem resistance in bloodstream *K. pneumoniae* [42]. Such water- and infrastructure-linked reservoirs plausibly sustain community-healthcare transmission loops and widen the AMR footprint [36–41].

Yet the very environments that generate AMR also undermine surveillance. Conflict zones report fewer bloodstream infections per million inhabitants (a proxy for under-ascertainment) and conduct less systematic surveillance than non-conflict comparators [57]. However, the active surveillance with screening for MDR and consequently, contact isolation of patients is encouraged since evidence supports, for example, the decrease of carriage of *A.baumannii* or a stable proportion of MRSA by the implementation of such measures [58].

On the ground, problems include damaged facilities, unsafe transport of specimens, reagent stock-outs, and loss of skilled personnel [6]. Coverage gaps in GLASS and national systems are substantial: Gaza is under-represented relative to the West Bank; parts of Iraq and Syria have minimal or geographically skewed participation. For instance, in 2021, areas of Iraq were not included in the AMR strategy, while poor geographical representation was also observed in the case of Syria, where most of the data retrieved from the host countries, such as Lebanon or Jordan, that admitted refugees [59]. At the same time, the collapse of infrastructure jeopardizes access to surveillance sites [59]. Additional challenges are the lack of functional laboratories providing reliable diagnosis, as in the case of Afghanistan, where only 28% of the hospitals with operating laboratories, as well as the limited access to essential antibiotics, such as in the case of Iraq [59]. The result is fragmented, methodologically heterogeneous data—with small samples, inconsistent case definitions (including MDR/XDR), varied specimen sources (e.g., deep tissue vs. swabs), and unclear separation of colonization vs. infection—limiting comparability and trending [52,59].

Despite these limitations, several pragmatic implications emerge:

1. Early IPC & WASH restoration are core clinical interventions. Immediate investment in clean water, sanitation, cohorting, decontamination workflows, and basic surgical infection prevention can reduce late gram-negative burdens [6,56,59].
2. Targeted screening and isolation policies should be risk-based. For patients with recent hospitalization in high-AMR conflict settings (e.g., Ukraine), admission screening for CRE/CRAB and contact precautions are justified [49,50,55,58].
3. Antibiotic stewardship must be feasible and field-adapted. Given high ESBL/MBL prevalence and frequent resistance to newer β -lactam/ β -lactamase inhibitors in Ukrainian cohorts, empiric regimens and escalation pathways should be locally calibrated and rapidly revised as resistance data accrue [45,49,50,56].
4. Surveillance needs minimum viable standards. Even in austere settings, standardized case definitions, simple antibiogram reporting, sentinel blood-culture capacity, and referral networks can yield actionable data [57,59]. Where possible, it is important to harmonize MDR/XDR definitions and distinguish colonization vs. infection to enable cross-study comparison [52,57,59].
5. Environmental monitoring can be high-yield. Incorporating water system surveillance (e.g., for *Pseudomonas* and Enterobacterales carbapenemases) into humanitarian WASH assessments may identify remediable reservoirs [38,59].
6. Global health security link. Cross-border spread documented among repatriated casualties and refugees argues for joined-up AMR preparedness between origin and host countries—laboratory twinning, data sharing, and surge procurement for diagnostics and last-resort agents [14,49,55,59].

In conclusion, conflict acts as a force multiplier for AMR by amplifying transmission opportunities, selection pressure, and healthcare fragmentation. While current evidence is limited by heterogeneity, under-reporting, and variable methodology [52,57,59], the convergent signals—high MRSA, dominant CRAB, rising ESBL with CTX-M, and MBL-driven carbapenem resistance in key hubs—support immediate, context-appropriate action across IPC/WASH, stewardship, targeted screening, and lean surveillance systems [6,51–53,56,59]. Careful interpretation remains essential, but inaction while awaiting for perfect data risks entrenching patterns that will be far harder—and costlier—to reverse.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

Abbreviation List

AMR	antimicrobial resistance
CNS	coagulase-negative staphylococci
CRAB	<i>Acinetobacter baumannii</i> resistant to carbapenems
CRE	Carbapenem-resistant Enterobacterales
ECDC	European Centre for Disease Prevention and Control
ESBL	Extended-spectrum β -lactamase
GDP	global gross domestic product
GLASS	WHO Global Antimicrobial Resistance and Use Surveillance System
MBL	metallo- β -lactamase
MDR	multi-drug resistant
MSF	Médecins Sans Frontières
NDM	New Delhi metallo- β -lactamase (NDM),
VRE	Vancomycin-resistant Enterococci
UNHCR	United Nations High Commissioner for Refugees

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