Four-year analysis of antimicrobial resistance patterns in Iraq

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Abstract

Background: This is the first nationwide assessment of resistance patterns among WHO target pathogens in Iraq.

Aim: To analyse antimicrobial resistance patterns over 4 years in Iraq, based on data from the national surveillance system.

Methods: Using the WHONET software, we collected and analysed 238 973 clinical specimens from the 106 antimicrobial resistance surveillance sites across Iraq, for 2020–2023, from the Iraqi national surveillance system. The data were analysed using SPSS version 26.

Results: Resistance to carbapenem by *Acinetobacter baumannii* increased markedly, reaching 80% in 2023. Resistance to third-generation cephalosporins was notably high among *Acinetobacter baumannii* (88.5–92%) and *Escherichia coli* (88.0%) while methicillin-resistant *Staphylococcus aureus* was at 74.0%. Multidrug resistance and extensively drug-resistant profiles for *Acinetobacter* spp. and *Klebsiella pneumoniae* increased, particularly extensively drug-resistant *Acinetobacter* spp. (66%). Resistance to last-line reserve antibiotics, such as colistin and tigecycline, increased significantly in 2023, suggesting an increasing threat to the efficacy of these critical agents.

Conclusion: These findings indicate that several key pathogens in Iraq have surpassed the critical resistance thresholds, thus limiting the effectiveness of commonly used empirical therapies and narrowing treatment options. Strengthening antimicrobial stewardship and prescription practices is essential to curb resistance and protect the efficacy of treatment regimens.

Keywords: antimicrobial resistance, antibiotic, antimicrobial surveillance, bacteria, antimicrobial stewardship, Iraq

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Introduction

Antimicrobial resistance (AMR) is a growing threat globally, leading to longer hospital stays, higher treatment costs and increased mortality. It disrupts routine care and strains health systems. WHO warns that AMR could cause 10 million deaths annually by 2050 if left unchecked (*1*). The 2024 annual statistical report of the Iraqi Ministry of Health (MOH) ranks bacterial infections as the seventh leading cause of mortality nationwide (*2*). And WHO statistics shows that Iraq has reached an alarming level of bacterial resistance across its health care settings (*3*).

In Iraq, infections caused by resistant strains of bacteria such as *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* have been linked to high mortality rates (*4–6*). A 2022 WHO report ranks Iraq fifth among 86 countries in methicillin-resistant *Staphylococcus aureus* (MRSA) prevalence (*7*). These infections are harder and costlier to treat. National studies report high rates of antibiotic-resistant *Acinetobacter baumannii*, especially in hospital and military settings across Iraq (*8–10*).

The WHO Access, Watch and Reserve (AWaRe) classification groups antibiotics into 3 categories: Access for first-line use, Watch for limited use due to resistance risk and Reserve as last resort options for severe, drug-resistant infections (*1*). Unfortunately, an Iraqi study revealed widespread colistin (reserve antibiotic) resistance among *A. baumannii* isolates from Baghdad, driven by mobile genetic elements (*11*).

AMR is fuelled by inappropriate prescriptions, self-medication and antibiotic use for livestock (*12,13*). Poor infection prevention and control facilitates the spread of resistant microbial strains in communities and health care settings (*14*). In Iraq, most physicians in public hospitals and pharmacists in community pharmacies prescribe antibiotics frequently and empirically without relying on culture and sensitivity tests (*12,15,16*). A review of 37 Iraqi studies found widespread antibiotic misuse, with pharmacists often dispensing without prescriptions. Residues in meat and water constitute environmental risks. Although there are regulations, implementation remains limited (*17*).

Antimicrobial surveillance helps detect resistance, guides treatment and improves outcomes. Studies on AMR trends inform public health policies and support infection control as well as optimisation and targeting of resource allocation for interventions (*18*). Effective AMR management depends on strong surveillance and reliable data. Timely resistance insights guide treatment, curb misuse and improve outcomes, while quality control ensures accurate monitoring and targeting of public health interventions (*3*).

Established in 2019, the Iraqi National Coordination Center (NCC) and Reference Laboratory leads AMR surveillance efforts through sites that monitor resistance and support timely public health actions. Data from the centre have been reported to the Global Antimicrobial Resistance and Use Surveillance System (GLASS) since inception, aiding resistance tracking (*18*).

Although several studies have explored bacterial profiles associated with AMR in Iraq, most of them were conducted in single sites or limited to individual provinces (*6,8,9,11,15*). This is the first nationwide study to profile WHO-designated indicator bacteria in Iraq using national surveillance data. The findings highlight the role of standardised surveillance in guiding therapy, shaping policy and detecting outbreaks, in alignment with the United Nations Sustainable Development Goals (SDGs). The study objective was to identify antimicrobial resistance patterns in Iraq over a period of 4 years, based on the national surveillance system.

Methods

This retrospective study used AMR data collected through the national surveillance system administered by the Department of Antimicrobial Resistance, Directorate of Public Health, Iraqi Ministry of Health. WHONET software was used to facilitate the systematic collection, monitoring and reporting of AMR data at the national level. The software was used to collate national AMR data from 106 sites in 19 directorates across 16 out of the 18 provinces in Iraq in 2023. Each surveillance site (hospital) had 2 focal persons for AMR activities—a pharmacist and a laboratory bacteriologist—who had been trained by MOH and WHO. Clinical specimens were collected from hospital patients, and data on resistant bacteria were recorded using the software. These data are submitted monthly to the national coordinating centre for aggregation and analysis.

We analysed archived data for 2020–2023 to assess AMR trends based on the WHO GLASS framework. Clinical specimens were cultured on media appropriate to type (e.g. blood, MacConkey, chocolate, or cystine-lactose-electrolyte-deficient CLED agar), incubated at 35–37°C for 18–24 hours, and examined for colony morphology and gram stain. Bacterial identification was done using biochemical methods, manual disk diffusion or automated systems (VITEK 2/Render), depending on available laboratory resources (*19*).

Following identification, antimicrobial susceptibility testing (AST) was conducted and the results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) breakpoints, with isolates categorized as susceptible (S), intermediate (I) or resistant (R). Results were recorded in the respective laboratory information systems and transmitted to the national AMR surveillance platform.

Inclusion and exclusion criteria

Only bacterial isolates with complete AST data were included in the study. Eligible specimens were required to originate from human clinical sources, such as blood, urine, respiratory tract, or wound. Bacterial culture isolates collected from all AMR surveillance sites across Iraq were analysed. Samples were obtained from patients attending health facilities, including inpatients and outpatients. All age groups were included. Data collection forms with incomplete information were excluded from the analysis. To prevent duplication, repeated isolates from the same patient were removed, and only the first bacterial isolate per patient was considered.

Ethics considerations

The study proposal was approved by the Ethical Committee at the University of Baghdad College of Pharmacy, Iraq. All data were anonymised, with patient identifiers removed to ensure confidentiality.

Statistical analysis

All the data were deidentified prior to analysis and imputed into Excel sheets, including organism names, dates of isolation, antibiotic agents, and corresponding susceptibility results. The dataset was subsequently cleaned to remove duplicate entries, incomplete records and implausible values. Descriptive statistics, including percentages of resistance, were computed using the SPSS version 26. Resistance prevalence was calculated as the proportion of resistant isolates among the total number tested for each antimicrobial agent. These rates were analysed to detect resistance patterns and temporal variations during the study period (2020–2023). Because the focus was on resistance percentages rather than inferential comparisons, descriptive statistics were sufficient. Figures were generated using Microsoft Excel.

Results

This study analysed 238 973 clinical specimens collected from patients attending hospitals during 4 consecutive years: 131 420 in 2023; 79 556 in 2022; 20 830 in 2021; and 7167 in 2020.

Antimicrobial surveillance sites in Iraq

Between 2020 and 2023, Iraq witnessed a substantial expansion in AMR surveillance capacity, with the number of public surveillance sites increasing from 22 in 2020 to 106 across 19 health directorates and 16 provinces by 2023. This expansion included the establishment of new public surveillance sites alongside the introduction of private laboratories into the national monitoring network. The inclusion of Erbil in 2023 with 7 public sites marked a notable extension in the northern region.

MRSA and Escherichia coli resistance to 3rd generation cephalosporins

Overall, resistance to third generation cephalosporins among *Escherichia coli* decreased, from 94.7% in 2020 to 85.5% in 2021 and 84% in 2022, before increasing to 88% in 2023. Methicillin-resistant *Staphylococcus aureus* showed more pronounced fluctuations, with resistance decreasing from 95.5% in 2020 to 84.6% in 2021, increasing to 87% in 2022, and then decreasing sharply to 74% in 2023 (Figure 1).

Acinetobacter, Klebsiella Pneumonia *and* Pseudomonas Aeruginosa *resistance to carbapenem*

Acinetobacter baumannii showed a progressive increase in carbapenem resistance, from 66% to 80% between 2020 and 2023. *Klebsiella pneumoniae* exhibited a variable trend, with resistance decreasing from 64.3% in 2020 to 51.6% in 2021, then gradually increasing to 61.8% by 2023. In contrast, *Pseudomonas aeruginosa* maintained relatively stable resistance rates, decreasing slightly to 50% in 2021 and increasing to 54% in 2023 (Figure 2).

Multiple drug resistance, extensive drug resistance and pan-drug resistance

Between 2020 and 2023, multidrug-resistance by *Acinetobacter* spp. increased from 71% to 78%, while MDR *Klebsiella pneumoniae* peaked at 65% in 2021 before decreasing to 58%. MDR *Escherichia coli* and *Enterococcus faecium* fluctuated modestly (38–47% and 34–40%, respectively), and MDR *Pseudomonas aeruginosa* and *Staphylococcus aureus* remained stable. Extensively drug-resistant (XDR) *Acinetobacter* spp. increased to 66%, whereas XDR *Klebsiella pneumoniae* decreased from 45% to 35%. Possible pan-drug resistant (PDR) strains were rare, with *Acinetobacter* spp. increasing from 4% to 8%; other species showed minimal change (Figure 3).

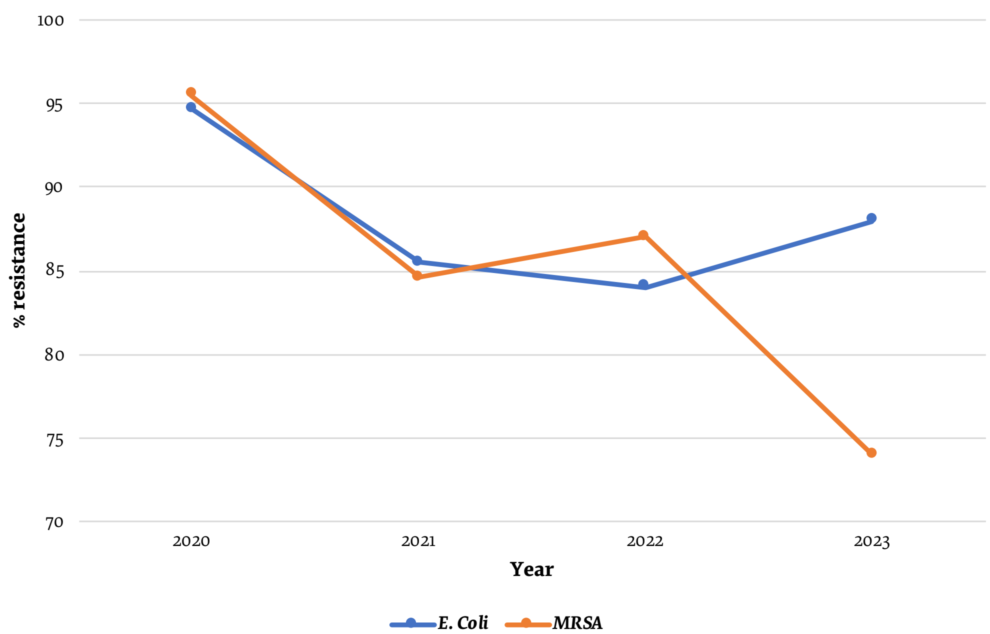
Resistance of Acinetobacter baumannii *to common antibiotics*

Resistance patterns of *Acinetobacter baumannii* from 2020 to 2023 was persistently high across multiple antibiotic classes. By 2023, resistance exceeded 80% for cefotaxime (91.9%), ampicillin/sulbactam (92.0%), ceftriaxone (88.5%), ceftazidime (84.1%), ciprofloxacin (81.8%), cefepime (81.6%), imipenem (80.6%), and meropenem (80.5%). Aminoglycosides such as gentamicin (76.5%) and amikacin (62.0%) showed considerable resistance, while levofloxacin and trimethoprim/sulfamethoxazole followed similar trends, reaching 75.6% and 70.1%, respectively, in 2023 (Table 1).

Resistance trend to 3 available reserve antibiotics

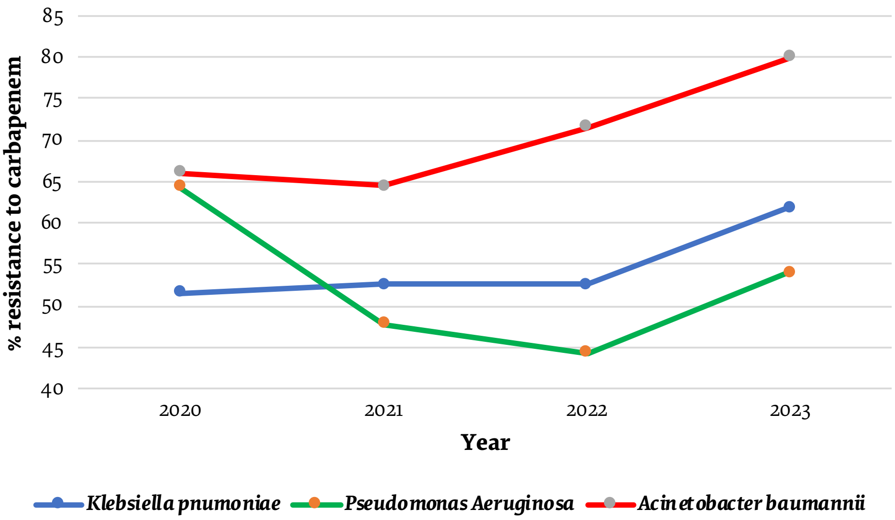
From 2020 to 2023, there were notable shifts in the overall resistance to reserve antibiotics. Resistance to colistin remained stable at 23.8% between 2020 and 2022, followed by a sharp increase to 44% in 2023. Tigecycline resistance hovered around 10.4% through the first 3 years, then more than doubled to 23.5% in 2023. In contrast, linezolid resistance showed relative stability, ranging from 9.4% to 11.7% during the same period (Figure 4).

Figure 1 Percentage infection with methicillin-resistant *Staphylococcus aureus* or *Escherichia coli* resistant to 3rd generation cephalosporin



The 2 metrics are indicators for the United Nations Sustainable Developments Goals

Figure 2 Percentage resistance of 3 indicator bacteria (*Acinetobacter*, *Klebsiella pneumonia* and *Pseudomonas aeruginosa*) to carbapenem



Discussion

Antimicrobial surveillance sites

This is the first nationwide study on WHO-designated indicator bacteria in Iraq, based on thousands of clinical specimens from the national AMR surveillance system. Between 2020 and 2023, AMR centres were launched in 16 of 18 provinces, enabling data transmission to the Ministry of Health via WHONET. By 2023, surveillance had covered 90 public hospitals and 16 private laboratories, reflecting Iraq's increasing efforts to strengthen AMR monitoring and epidemiologic infrastructure. Because only isolates with complete AST data were included, the dataset reflects testing performed using standardised methods across all contributing laboratories, which helps reduce inter-laboratory variability and limit the influence of external confounders on the observed resistance patterns.

The United Arab Emirates maintained a more extensive network of 317 surveillance sites, including 84 hospitals, 233 health centres or clinics and 45 microbiology laboratories distributed across all the 7 emirates (*20*). Iraq needs to expand its AMR surveillance network to a broader range of public and private health facilities, enabling comprehensive monitoring of resistance patterns and facilitating early detection of potential outbreaks.

Bacterial resistance to 3rd generation cephalosporins

Ceftriaxone is currently among the most commonly used empirical injectable antibiotics in Iraq (*21*). The 2023 surveillance report highlights persistently elevated resistance rates to third generation cephalosporins, with *Escherichia coli* exhibiting an alarming resistance prevalence of 88%. Similarly, a study conducted in the northern province of Duhok, which analysed 454 clinic specimens collected between 2017 and 2020, reported high levels of *Escherichia coli* resistance to multiple antibiotics, including third generation cephalosporins—cefepime (63.3%) and ceftriaxone (63.9%)—as well as ampicillin (88%) (*4*).

Our analysis revealed that *Acinetobacter baumannii* exhibited very high resistance rates to third generation cephalosporins—specifically cefotaxime (92%) and ceftriaxone (88.5%)—which remain among the most commonly administered empirical antibiotics in Iraq (*22*). These findings indicate the limited clinical efficacy of third generation cephalosporins. In addition to *Acinetobacter baumannii* resistance, a previous Iraqi study (2012) reported that several prevalent bacterial pathogens—including *Escherichia coli*, *Streptococcus* spp., *Klebsiella* spp., *Pseudomonas aeruginosa*, *Proteus* spp., and *Staphylococcus* spp.—exhibited resistance to third generation cephalosporins, with rates ranging from 52.6% to 100% (*23*). Therefore, the empirical use of cephalosporins in this context may offer limited clinical benefit while imposing a significant economic burden on the health system.

Bacterial resistance to carbapenem

Meropenem, a commonly prescribed watch antibiotic for MDR infections in Iraq, showed high resistance rates: *Acinetobacter* spp. (88%), *Klebsiella pneumoniae* (61.8%) and *Pseudomonas aeruginosa* (54%). A 2023 Baghdad study found *Escherichia coli* had 96% resistance to imipenem, indicating poor efficacy (*24*). Another study reported that 51.5% of *Pseudomonas aeruginosa* isolates from Baghdad hospitals were resistant to carbapenems, with meropenem resistance (50%) slightly higher than imipenem (39.7%) (*25*).

Several Iraqi studies have attributed the high rate of carbapenem resistance to widespread inappropriate antibiotic use, particularly empirical prescription

Figure 3 Multidrug resistance (A), extensive drug resistance (B) and pan-drug resistance (C) trends of 6 common bacteria, Iraq (2020–2023)

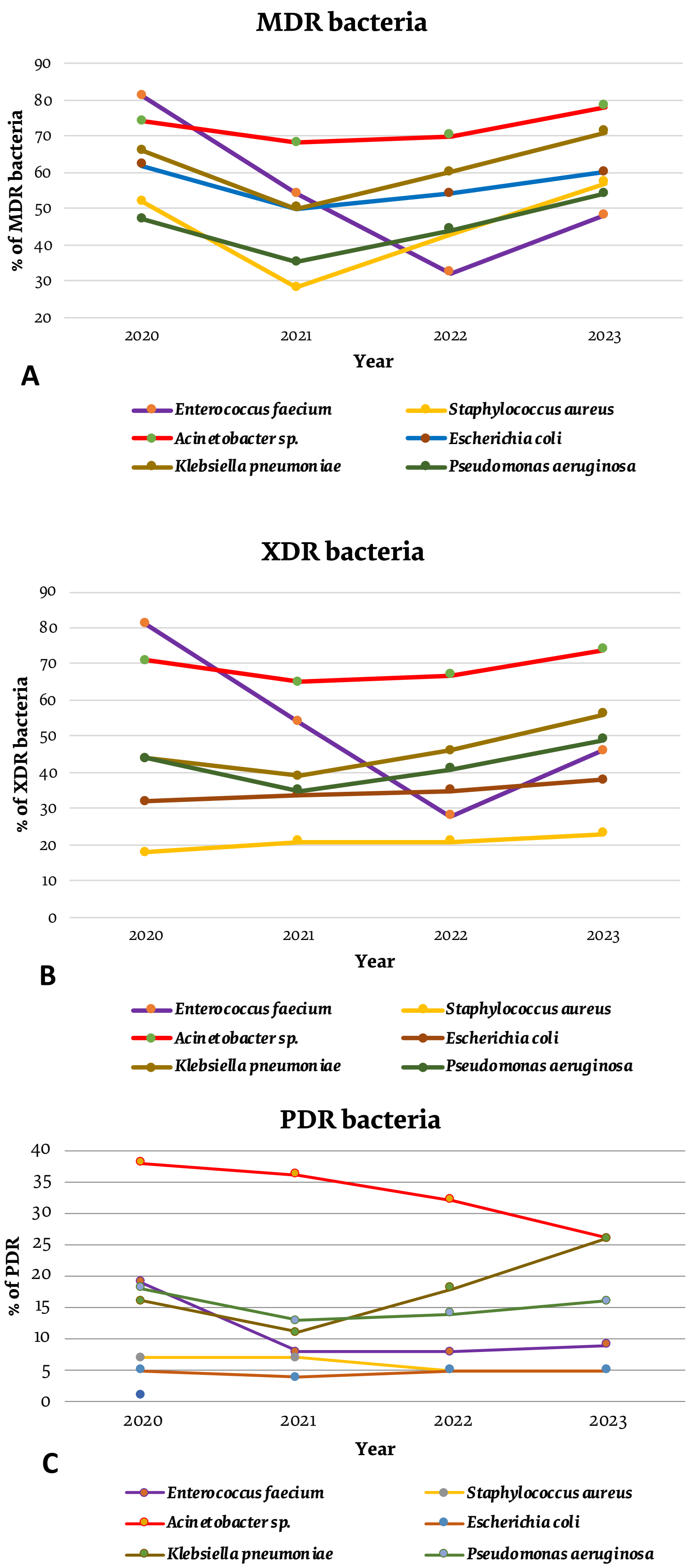


Table 1 Percentage resistance of *Acinetobacter baumannii* to common antibiotics, Iraq (2020–2023)

Antibiotic name	2020	2021	2022	2023
Ampicillin/Sulbactam	50.0	N/A	91.4	92.0
Cefotaxime	98.7	93.0	94.6	91.9
Ceftriaxone	95.2	79.8	89.8	88.5
Ceftazidime	86.4	83.2	81.4	84.1
Ciprofloxacin	N/A	68.2	77.6	81.8
Cefepime	79.2	75.5	79.4	81.6
Imipenem	74.9	68.3	72.8	80.6
Meropenem	79.1	66.9	74.8	80.5
Gentamicin	72.2	67.0	68.3	76.5
Levofloxacin	78.8	58.4	72.0	75.6
Trimethoprim/ Sulfamethoxazole	68.2	54.7	65.4	70.1
Amikacin	N/A	62.0	59.4	62.0

N/A= not applicable (not measured)

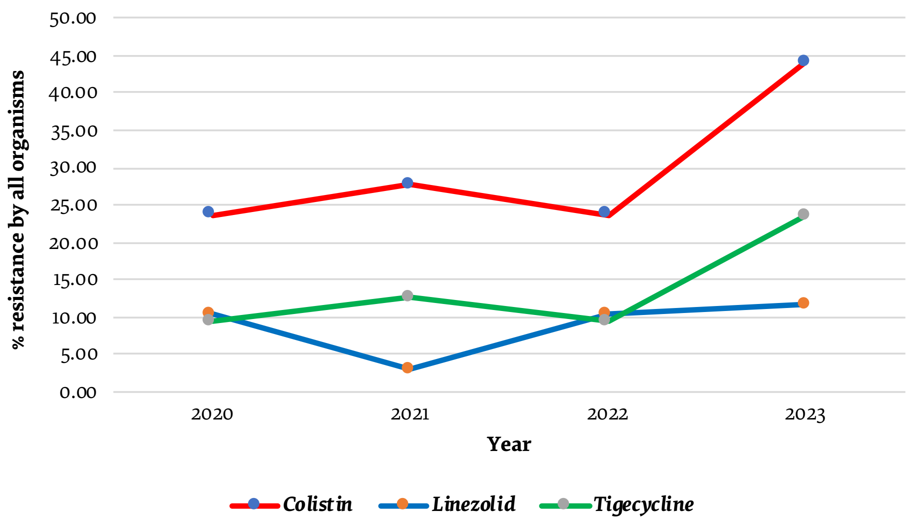
practices that bypass preliminary culture and sensitivity testing (26,27). A recent review of Iraqi studies highlights multiple official directives by the Ministry of Health to limit meropenem prescription until culture and sensitivity results are available (17). However, these antibiotic stewardship efforts face challenges in clinical practice; some physicians continue to prescribe meropenem empirically—particularly in urgent cases—because of the time required to obtain laboratory test results, which may be several days.

MDR, XDR and PDR of Escherichia coli and MRSA

This study applied WHO indicator 3.d.2, tracking resistance in *E. coli* to third generation cephalosporins and MRSA—2 common, fast-growing pathogens. Between 2020 and 2023, Iraq saw a general decrease in resistance levels. MDR bacteria resisted at least 1 drug in 3 or more classes; XDR resisted all but 1 or 2; PDR resisted all, leaving no effective treatments (28). Between 2020 and 2023, *Escherichia coli* showed consistently high MDR rates (50–62%), with possible XDR increasing from 32% to 38%, signalling increasing treatment challenges. PDR remained low (4–5%).

A Ramadi-based study of 120 urinary tract infection cases confirmed extensive resistance among uropathogenic *Escherichia coli* (UPEC) strains—over 90% to third generation cephalosporins and piperacillin, 82.9% to fluoroquinolones and up to 68.2% to aminoglycosides. Imipenem remained largely effective (7.3% resistance) (29).

Figure 4 Resistance trend to 3 common reserve antibiotics by all organisms, Iraq (2020–2023)



These findings indicate the need for stronger stewardship and updated treatment protocols. *Staphylococcus aureus* showed a sharp increase in MDR from 28% in 2021 to 57% in 2023, with XDR steady at 21–23% and PDR low (5–7%). Despite worsening resistance, some treatment options remain.

Four Iraqi studies confirmed widespread resistance in *S. aureus* and coagulase-negative staphylococci. An Iraqi study analysing 200 blood samples collected from public and private hospitals between 2018 and 2019 identified *Staphylococcus aureus* as the causative agent in 14.4% of septicaemia cases (*30*). Another Iraqi study found *S. aureus* (10.36%) as the leading post-maxillofacial surgery pathogen, with over 65% resistance to key antibiotics. MDR MRSA strains showed >90% resistance to penicillin and 91.1% to erythromycin (*31*). Mohammed and colleagues evaluated 290 clinical samples upon hospital admission, reporting that *S. aureus* accounted for 22.4% of isolates, with 95.4% of strains resistant to oxacillin and methicillin—confirming widespread MRSA prevalence (*32*).

Awayid et al analysed MRSA strains from patients with skin, wound and burn infections between January and September 2020 and reported extreme multidrug resistance among MRSA isolates—exceeding 90% for both penicillin and erythromycin (*5*). Coagulase-negative *Staphylococcus* spp. showed resistance to most tested antibiotics, including levofloxacin, azithromycin and tetracyclines. In severe cases, meropenem was used with vancomycin or cephalosporins due to resistance to standard injectables (*15*).

These findings reveal widespread multidrug-resistant *Staphylococcus* spp. in Iraq and indicate an urgent need for stronger stewardship and targeted infection control.

MDR, XDR and PDR of Acinetobacter baumannii

During the 4 years of our study, *Acinetobacter* species showed the highest resistance in Iraq, with MDR rates of 74–78%, XDR reaching 74% in 2023 and PDR peaking at 38% in 2020 and remaining high at 26% in 2023. Multiple Iraqi studies have also reported the escalating MDR of *Acinetobacter baumannii*, particularly in hospital environments. Al-Samaree analysed isolates from Baghdad hospitals and found high resistance rates to several antibiotics, notably 94% to piperacillin, while colistin retained partial efficacy with 20% resistance—though emerging resistance was noted (*8*). A case of osteomyelitis caused by multidrug-resistant *Acinetobacter baumannii* was reported in an American military setting in Iraq. The infection was successfully treated with tigecycline, indicating the potential—yet underexplored—therapeutic role of this agent in managing bone infections (*9*).

Al-Kadmy and colleagues characterised *A. baumannii* isolates from hospital surfaces, revealing 100% resistance to gentamicin and ciprofloxacin, whereas colistin and tigecycline remained fully effective at that time. This study of 120 isolates in Baghdad found colistin resistance genes linked to mobile genetic elements, indicating caution in its use (*10*).

These findings align with national data identifying *Acinetobacter baumannii* as Iraq's most resistant pathogen and reinforces the need for culture and sensitivity testing before treatment.

Acinetobacter species remains an AMR threat in the region. A 2024 study in United Arab Emirates (UAE) analysed 17 564 isolates over 12 years and reported nearly 50% decrease in MDR and XDR rates between 2010 and 2021—contrasting Iraq's steady resistance levels. However, carbapenem-resistant strains (CRAB) still posed serious risks, linked to higher mortality, intensive care unit (ICU) admissions and longer hospital stays (*20*). The notable decrease in resistance levels among *Acinetobacter* spp. in the UAE suggests more effective antibiotic stewardship and dispensing practices than those observed in Iraq.

A study in Saudi Arabia found widespread environmental contamination by carbapenem-resistant *A. baumannii* in ICU, medical and surgical units. Many isolates were international clones, indicating the urgent need for strict hygiene and infection control (*33*). Another Saudi Arabia study analysed the incidence, outcomes and predictors of *A. baumannii* infections in 8 ICUs in 5 geographically diverse cities. The study found that infection rates were higher in university and military hospitals, especially those with larger bed capacity and more ICU isolation rooms. Notably, mechanically ventilated patients had a 10-fold increased risk of infection, highlighting the role of invasive procedures and hospital infrastructure in driving transmission (*34*). *Acinetobacter baumannii* poses a major threat across Iraq and the Middle East due to its high resistance to commonly used watch antibiotics.

Resistance trend to 3 available reserve antibiotics

Surveillance data show increasing resistance to Iraq's reserve antibiotics—colistin (44%) and tigecycline (23.5%)—indicating the urgent need for stricter stewardship to protect their effectiveness. In addition to its increasing resistance profile and high cost, numerous local, regional and global studies have documented serious adverse effects associated with colistin use, including respiratory failure, nephrotoxicity and acute renal failure (*35–38*). Therefore, colistin and other reserve antibiotics should be preserved as last-line treatments for MDR, XDR or possible PDR pathogens—such as *Acinetobacter baumannii*, and resistant strains of *Escherichia coli*.

Tackling AMR requires a coordinated, multisectoral approach involving engagement between the healthcare, policy and public sectors. Priorities include responsible antimicrobial use, stronger surveillance, research for new treatments, and raising public awareness (*39*).

Study limitations

This study has several limitations. The study was limited to samples and culture results obtained from public health care settings, primarily government hospitals. The Ministry of Health provides AMR data as cumulative annual aggregates without disaggregation by individual reporting sites. This limited our ability to conduct sub-analyses confined to the original (2020) surveillance centres and may have limited the granularity of our findings. Site-specific variations in resistance patterns could not be assessed, which may affect the interpretation and generalisability of the results.

Conclusion

This 4-year national analysis provides the most comprehensive overview until date of antimicrobial resistance patterns in Iraq, and highlights several critical, data-supported concerns. *Acinetobacter baumannii* consistently showed the highest resistance burden, with carbapenem resistance reaching 80% and third generation cephalosporin resistance exceeding 88–92% by 2023. *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* showed substantial carbapenem resistance (61.8% and 54%, respectively), while *Escherichia coli* maintained persistently high resistance to third generation cephalosporins (88%). The MDR and XDR profiles further highlight the severity of resistance, particularly among *Acinetobacter* spp., where XDR levels increased to 66%. Alarmingly, resistance to reserve antibiotics increased sharply in 2023, with colistin resistance reaching 44% and tigecycline 23.5%. These findings collectively indicate that several key pathogens in Iraq have surpassed critical resistance thresholds, limiting the effectiveness of commonly used empirical therapies and narrowing treatment options. Continued investment in laboratory capacity, standardised AST practices and timely reporting will be essential to detect emerging resistance trends and guide evidence-based clinical and public health interventions.

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References

1. World Health Organization. AWaRe classification of antibiotics for evaluation and monitoring of use. 2023, WHO/MHP/HPS/EML/2023.04: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2023.04.
2. Ministry of Health. Annual statistical report. Baghdad: Department of Biostatistics, 2024. https://moh.gov.iq/.
3. World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS) report, 2022. Geneva: World Health Organization, 2022. https://www.who.int/publications/i/item/9789240062702.
4. Naqid I, et al. Antibiotic susceptibility pattern of Escherichia coli Isolated from various clinical samples in Duhok City, Kurdistan Region of Iraq. 2020;7:1–5. DOI: 10.5812/iji.103740.
5. Sami AH, Mohammad SQ. Prevalence and antibiotic resistance pattern of methicillin-resistant Staphylococcus aureus isolated from Iraqi hospitals. Archives of Razi Inst 2022;77(3):1147–1156. doi: 10.22092/ARI.2022.357391.2031.
6. Al-Metwali BZ, Shubbar HA. Assessing antimicrobial prescribing patterns and antimicrobial resistance in Dhi Qar Governorate hospitals; A retrospective study. Iraqi J Pharm Sci 2025;34(2):215–226. https://doi.org/10.31351/vol34iss2pp215-226.
7. World Health Organization. SDG 3.d.2: AMR infect MRSA. Geneva: World Health Organization, 2025. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/sdg-3.d.2-amr-infect-mrsa.
8. Al-Samaree M, Al-Khafaji Z. Antibiogram of Acinetobacter baumannii isolated from Baghdad Hospitals. Inter J Adv Res Biol Sci 2016;3(4):238-242.
9. Schafer JJ, Mangino JE. Multidrug-resistant Acinetobacter baumannii osteomyelitis from Iraq. Emerg Infect Dis 2008;14(3):512–514. http://s-o-i.org/1.15/ijarbs-2016-3-4-32.
10. Al-Kadmy IMS, et al. Molecular characterization of Acinetobacter baumannii isolated from Iraqi hospital environment. New Microbes New Infect 2018;21:51–57. DOI: 10.1016/j.nmni.2017.10.010.
11. Al-Kadmy IM et al. Prevalence of genes involved in colistin resistance in Acinetobacter baumannii: first report from Iraq. Micr Drug Res 2020;26(6):616–622. DOI: 10.1089/mdr.2019.0229.
12. Al-Jumaili AA, et al. Evaluating the dispensing of non-prescription antibiotics in Baghdad's community pharmacies: A public health concern. Maaen J Med Sci 2026;5:11–19. https://doi.org/10.55810/2789-9136.1090.

13. Shubbar HA, Al-Metwali B. Exploring physicians' perspectives on antibiotic stewardship implementation: A qualitative investigation in Al-Nasiriyah Hospital. Al-Rafidain J Med Sci 2024;7:78–85. DOI: https://doi.org/10.54133/ajms.v7i2.1366.
14. Dadgostar P. Antimicrobial resistance: Implications and costs. Infect Drug Resist 2019;12:3903–3910. DOI: 10.2147/IDR.S234610.
15. Ali Azeez Al-Jumaili KKA, Eman Sadeq MAWLA, Al-Rekabi IMMMD. Irrational use of antibiotics in Iraqi public hospitals. Latin Amer J Pharm 2023;42(Special issue):178–183.
16. Kurmanji JM, et al. Quality indicators of antimicrobials prescribing in Iraq: A scoping review. Al-Rafidain J Med Sci 2024;7(1):221–226. DOI: https://doi.org/10.54133/ajms.v7i1.1227.
17. Al-Jumaili AA, Ahmed KK. A review of antibiotic misuse and bacterial resistance in Iraq. East Mediterr Health J 2024;30(10):663–670. https://doi.org/10.26719/2024.30.10.663.
18. Rana Abdulmahdi Nahi BAA, Tawfeeq AA. Annual report of Iraq antimicrobial resistance surveillance system. Baghdad: Ministry of Health, 2022.
19. Vandepitte J, Verhaegen JKE, Rohner P, Piot P, Heuck CC. Basic laboratory procedures in clinical bacteriology, 2nd edition ed. Geneva: World Health Organization, 2003. https://www.who.int/publications/i/item/9241545453.
20. Thomsen J, et al. Epidemiology and antimicrobial resistance trends of Acinetobacter species in the United Arab Emirates: a retrospective analysis of 12 years of national AMR surveillance data. Front Public Health 2023;11:1245131. DOI: 10.3389/fpubh.2023.1245131.
21. Al-Nema ZM. Trend of antibiotics usage in the intensive care unit in the Medical City in Baghdad. Iraqi J Pharm Sci 2016;25(1):50–58. DOI: 10.31351/vol25iss1pp50-58.
22. Al-Jumaili AA, et al. Antimicrobial utilization in an Iraqi province: a comprehensive evaluation of antibiotic source and cost. Int J Pharm Pract 2017;25(1):81–88. DOI: 10.1111/ijpp.12338.
23. Abdulghani S. The outcome of the misuse of 3rd generation cephalosporins in Fallujah City, West of Iraq. Al-Anbar Med J 2012;10:46–50. article_70905_f2099e4d302ec84b207c3139ef854819.pdf.
24. Abdulkareem MH, Mohammed NA. Multidrug resistance for some entero-bacterial cases from Al-Yarmouk Hospital. Rivista Ita Filo Anal Jr. 14(2):2023. https://rifanalitica.it/index.php/journal/article/view/475.
25. Kazem HAM, Muhammad SAS. Prevalence of Carbapenem resistant Pseudomonas aeruginosa at hospital in Baghdad, Iraq. Int J Adv Multidisc Res Stud. 2023;3(5):1414-1417.
26. Al-Jawadi H. An assessment study of using Meropenem Injection in Iraqi Hospitals. International J Pharm Sci Res 2017;2(5):14-17.
27. Hussin NA, Hussin AA. Patterns of inappropriate use of meropenem as antibacterial. Tikrit J Pharm Sci 2016;11(1):38–54. DOI: 10.25130/tjphs.2013.11.1.5.38.54.
28. Magiorakos AP, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect 2012;18(3):268–281. doi: 10.1111/j.1469-0691.2011.03570.x.
29. Abed AD, Mutter TY. Relationship between antimicrobial resistance and virulence factors in uropathogenic Escherichia coli isolates from Ramadi, Iraq: phenotype and genotype identification. Afr Health Sci 2023;23(3):486–496. doi: 10.4314/ahs.v23i3.56.
30. Abdullah SMZ. Common bacterial causes of Septicemia and their antibiotic susceptibility profile in Erbil, Iraq. Elect Res J Eng, Comp App Sci Vol 2 (2020).
31. Akram ZM, et al. Antimicrobial resistance of bacterial pathogens isolated from the infections of post maxillofacial surgery. J Med Life 2022;15(8):944–950. DOI: 10.25122/jml-2021-0149.
32. Mohammed KAS, et al. Spa typing of Staphylococcus aureus Isolated from Clinical Specimens from Outpatients in Iraq. Pol J Microbiol 2021;70(1):79–85. doi: 10.33073/pjm-2021-007.
33. Al-Hamad A, et al. Molecular characterization of clinical and environmental carbapenem resistant Acinetobacter baumannii isolates in a hospital of the Eastern Region of Saudi Arabia. J Infec Pub Health 2020;13(4):632–636. DOI: 10.1016/j.jiph.2019.08.013.
34. Kharaba A, et al. Incidence, outcomes, and predictors of Acinetobacter infection in Saudi Arabian critical care units. J Crit Care 2021;66:109–116. DOI: 10.1016/j.jcrc.2021.08.010.
35. Eljaaly K, et al. Colistin Nephrotoxicity: Meta-analysis of randomized controlled trials. Open Forum Infec Dis 2021;8(2). DOI: 10.1093/ofid/ofab026.
36. Moghnieh R, et al. The prevalence and risk factors of acute kidney injury during colistin therapy: A retrospective cohort study from Lebanon. Antibiotics 2023;12(7):1183. DOI: 10.3390/antibiotics12071183.
37. Algherbawe M, Wanis AW. Case report of acute type 2 respiratory failure secondary to Colistin. Iraq Med J 2019;3(3):78-80.
38. Ordooei Javan A, Shokouhi S, Sahraei Z. A review on colistin nephrotoxicity. Eur J Clin Pharmcol 2015;71(7):801–810. DOI: 10.1007/s00228-015-1865-4.
39. Ventola CL. The antibiotic resistance crisis: part 1: causes and threats. P t, 2015;40(4):277–283. PMCID: PMC4378521.