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Original Research

Empiric antibiotic use and de-escalation practices in community-acquired infections in adults: a retrospective observational study at a tertiary care hospital in UAE

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Abstract

Background: The increase in antimicrobial resistance (AMR) rates is a global burden, including the Middle East and Gulf Region. Gaining insight into antibiotic use patterns in the United Arab Emirates (UAE) is crucial for informing antimicrobial strategies, such as antibiotic de-escalation, which can play a key role in reducing AMR. **Methods:** This retrospective observational study collected data from a tertiary care hospital medical record. Eligible patients were adults admitted for management of Community Acquired Pneumonia (CAP), Urinary Tract Infections (UTI), or sepsis between January 2022 and December 2023. Patients' characteristics such as demographics, comorbidities and severity of infection on admission, treatment received during hospital stay and clinical outcomes were recorded in a suitably designed data collection form. The pattern of antibiotic prescription was analyzed and the rate of empiric broad-spectrum use was evaluated. Eligibility for de-escalation was assessed based on microbiological results. Data analysis was conducted using Stata/SE 12.0 For windows and Microsoft Excel for windows. **Results:** Data from 207 patients (median age 41) showed that 45.4% had CAP, 40.1% UTI, 14.5% sepsis. Overall, 96 patients (46.4%) had culture specimens obtained pre-treatment. Among CAP and sepsis patients, positive cultures were observed in only 8 cases. Conversely, in UTI patients, 32 cultures were positive, with 28 identifying E. coli as the pathogen, 12 of which were ESBL-producing strains. Broad-spectrum antibiotics were initiated in 70.5% of patients, with meropenem being the most commonly prescribed (57.9%). Of 27 de-escalation-eligible patients, 25.9% were successfully de-escalated. Broad-spectrum prescribing was associated with recent intravenous antibiotic exposure, admission to the Intensive care unit (ICU) and higher C-reactive protein (CRP) levels. The odds of prescribing a broad-spectrum antibiotic increase by 1% for each unit increase in CRP level. The interquartile range (IQR) for duration of hospitalization was 3- 5 days. Successful therapy was achieved in 197 cases. **Conclusion:** Broad-spectrum antibiotics were frequently initiated empirically, with meropenem being the most common choice. While microbiological data supported de-escalation in 27 cases, it occurred in only a quarter of these. Opportunities exist to optimize empiric therapy and promote antibiotic stewardship strategies such as de-escalation.

Keywords: Anti-Bacterial Agents, Antimicrobial stewardship, Community-Acquired Infections, Pneumonia, Sepsis, Urinary Tract Infection, United Arab Emirates

INTRODUCTION

The increase in antimicrobial resistance (AMR) rate is a global burden, including the Middle East and the Gulf Region, due to the high treatment cost and increased mortality rate[1,2]. By 2050, AMR could account for 10 million deaths annually, making it one of the leading causes of mortality, with an estimated economic impact of up to 100 trillion US dollars (USD)[3]. To address this, organizations such as the World Health Organization have endorsed a Global Action Plan on AMR, of its main objectives optimizing the use of antimicrobial medicines[4]. Despite the increased focus on AMR, the occurrence of multidrug-resistant (MDR) infections continues to rise[5,6]. This has led to a greater reliance on the routine empirical use of broad-spectrum antibiotics[6].

In 2015, the United Arab Emirates' (UAE) Ministry of Health and Prevention has adopted the Global Action Plan on AMR and established the UAE Higher Committee for AMR. Their main goal is to address AMR by different strategies and policies[2]. Of their main objectives: Strengthening the knowledge through surveillance and research, and Optimize the use of antimicrobial medicines in human and animal health.[2] The objective of combating AMR can be met in hospitals through the implementation of antimicrobial stewardship program (ASP). ASP programs involves de-escalation of antibiotics, a strategy of narrowing the spectrum of empiric antimicrobial therapy based on diagnostic data and clinical improvement, typically 2–3 days after initiating empirical antibiotics. This process, which includes resource-intensive activities like prospective audit and feedback, intravenous-to-oral switch, and antibiotic time-outs, plays a significant role in reducing AMR[1,4]. Data on antimicrobial consumption and use are crucial for identifying areas for improvement and implementing ASP interventions and strategies such as de-escalation. An old study from the gulf region published in 2015 has assessed the pattern on antibiotic use in Community-Acquired Pneumonia (CAP) and found that treatment of CAP was matching the guidelines. It enrolled 684 patients admitted with CAP between January 2009 to February 2011 from five gulf countries including UAE. Majority of patients (82.9%) were classified as having non-

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severe pneumonia. The majority of patients were treated with levofloxacin monotherapy (65.7%) or levofloxacin plus ceftriaxone combination therapy (6.4%). Broad-spectrum antibiotics such as piperacillin/tazobactam, gentamicin, amikacin or cefepime were minimally used with a rate lower than 6% cumulatively[7].

In comparison, in 2019 a study from Saudi Arabia examined the empiric antibiotic use patterns in treating CAP. Using data from 1672 adult CAP patients, the study found that the most commonly used antibiotics were levofloxacin (68.12%), ceftriaxone (37.7%), imipenem/cilastatin (32.5%), and azithromycin (20.6%). The authors mentioned that imipenem/cilastatin had high usage among patient not admitted to the Intensive Care Unit (ICU). Its usage reaching one-third of this group is alarming. The study highlighted the need for ongoing monitoring and auditing of antibiotic use, especially in non-ICU settings, to ensure adherence to both local and international CAP treatment guidelines[8]. This drastic change in antibiotic use pattern and the increased tendency of prescribing broad-spectrum antibiotics for non-ICU cases of CAP in the gulf region should be highlighted.

While the previous studies examined the utilization patterns of antibiotics among hospitalized patients coming from the community, another study conducted in Oman examined de-escalation practices. This study has also looked at the prescription patterns. It was a retrospective study and it included hospitalized patients with Urinary Tract Infection (UTI). The study encompassed 91 patients with a confirmed bacterial isolate in their urine culture. The most frequently prescribed antibiotics were ceftriaxone (34.1%), meropenem (23.1%), and piperacillin/tazobactam (19.8%). *Escherichia coli* (*E. coli*) was the most commonly isolated pathogen, found in 47.3% of cases followed by *Klebsiella pneumonia* in 19.8%. Unfortunately, the study did not specify the rate of extended-spectrum β-lactamases (ESBLs) producing bacteria, but it mentioned that among the study population 48.4% had an MDR bacteria isolated in urine. The overall de-escalation rate was 29.7%. Factors contributing to the failure to de-escalate included previous hospital admission and antibiotic use during the preceding 90 days, recurrent UTIs, sepsis, ICU admission, concomitant infection, appropriate antibiotic use, and delayed reporting of culture results. The study also found that de-escalation was associated with reduced hospital length of stay. While the data highlights areas for potential improvement in de-escalation practices, further large-scale studies are needed to better understand the barriers to successful de-escalation[9].

In the UAE, as in many parts of the world, there is limited data on antibiotic prescribing patterns for community-onset infections in tertiary care settings. More comprehensive data is required to inform future practices. This study aims to address this knowledge gap by examining antibiotic use patterns in community-onset infections specifically, sepsis, CAP and UTI at a tertiary care hospital in the UAE. By focusing on the antibiotic use patterns, the rate of broad-spectrum antibiotic use, and the frequency of de-escalation, this research seeks to provide valuable insights that can inform future antimicrobial stewardship efforts in the region.

METHODS

This study is a retrospective study performed at a tertiary care hospital in UAE to analyze antibiotic use patterns in adult patients admitted from the community for management of CAP, UTI and sepsis between Jan 2022 to Dec 2023.

There is a lack of consensus in defining broad-spectrum antibiotics. For instance, one study defined broad-spectrum antibiotics for CAP as agents covering MRSA or Pseudomonas, excluding fluoroquinolones due to their recommendation as monotherapy for CAP[10]. Another study defined broad-spectrum antibiotics as those covering Gram-positive and negative bacteria, with or without anaerobic coverage[11]. In this study, we defined broad-spectrum antibiotics as including meropenem, ertapenem, imipenem/cilastatin, piperacillin/tazobactam, vancomycin, teicoplanin, and amikacin. This classification considers the wide spectrum of activity of these antibiotics against multiple bacterial species, including multidrug-resistant bacteria and the hospital medication formulary.

In this study, de-escalation is based on culture and sensitivity results and is defined as changing an initially broad-spectrum antibiotic regimen to a narrower spectrum regimen. This definition is supported by several studies[12]. The study included adult patients admitted from the community for the management of CAP, UTI or sepsis and were receiving intravenous (IV) antibiotics. Patients admitted for less than 24 hours, who were transferred from other healthcare facilities were excluded. Only the first admission is included for patients with multiple admissions. The study employed a universal sampling method, enrolling all patients who meet the study criteria.

An appropriate data collection form was developed and validated by pilot testing on ten patients who were not included in the study. Ethical approval was obtained from the Institutional Review Board of the hospital. Patient consent was waived as the study involves collection of data retrospectively from the medical records review. Data were extracted from the electronic medical record (EMR) based on diagnosis using the ICD-10 code system.

Logistic regression analysis was used with broad-spectrum antibiotic use as the outcome variable and diagnosis, comorbidities, previous MDR infection in the past year, previous hospitalization, history of travel, history of IV or oral antibiotic use, ICU admission, lab values as predictors. Descriptive statistics was used to report data at baseline for the two groups, group who were started empirically on broad spectrum antibiotic and a group that did not. Patient demographics and baseline characteristics were compared between the 2 groups. Continuous variables were assessed for normality and compared using the Student t test or Mann-Whitney U test, as appropriate. Categorical variables were reported as frequencies and percentages, with differences between the 2 groups analyzed using the X2 test. The significance level (alpha)

was set at 0.05. All data were analyzed using Stata/SE 12.0 For windows and Microsoft Excel for windows.

RESULTS

A total of 456 patients' medical records were extracted from the EMR using the diagnosis code of sepsis, pneumonia, UTI between January 2022 and December 2023. Of which 249 (54.6%) were excluded after applying the study's inclusion and exclusion criteria. The final study cohort comprised 207 patients, with the majority admitted for management of CAP (n = 94, 45.4%). UTI accounted for the second largest group (n = 83, 40.1%), followed by sepsis cases (n = 30, 14.5%). Concert diagram of the study is presented as Figure 1.

Patients' age ranged from 18 to 93 years with a median age of 41 years and 52.6% (n=109) of them were females. The study population was divided into two groups based on what type of antibiotics they were initially treated with. Among the 207 included patients, 61 (29.5%) were started on non-broad-spectrum antibiotics and 146 (70.5%) were started on broad-spectrum antibiotics. The demographic data for both groups were similar at baseline. Common comorbidities among the patient population included diabetes mellitus (31.88%), hypertension (30.92%), myocardial infarction (7.73%), and moderate to severe chronic kidney disease (7.25%). Patients' characteristics are detailed in Table 1, showing no significant differences in comorbidity prevalence between those treated with broad-spectrum and non-broad-spectrum antibiotics.

The Charlson comorbidity index median was zero with an interquartile range (IQR) between 0 and 2, there was no significant difference between both groups. Similarly, the qSOFA score for 67% of the study cohort was zero and no significant difference between the groups. However, the white blood cell (WBC) count was significantly higher among those who received broad-spectrum antibiotics (12.04 × 109 cell/L ± 7.92) compared to those who received non-broad-spectrum arm (9.63 × 109 cell/L ± 3.79) (P = 0.023). The inflammatory mediator C-reactive protein (CRP) was significantly more elevated in the broad-spectrum group (149.93 mg/dL ± 102) compared to the other group (69.24 mg/dL ± 80.5) (P= 0.0000).

Procalcitonin (PCT) levels were only measured among 65

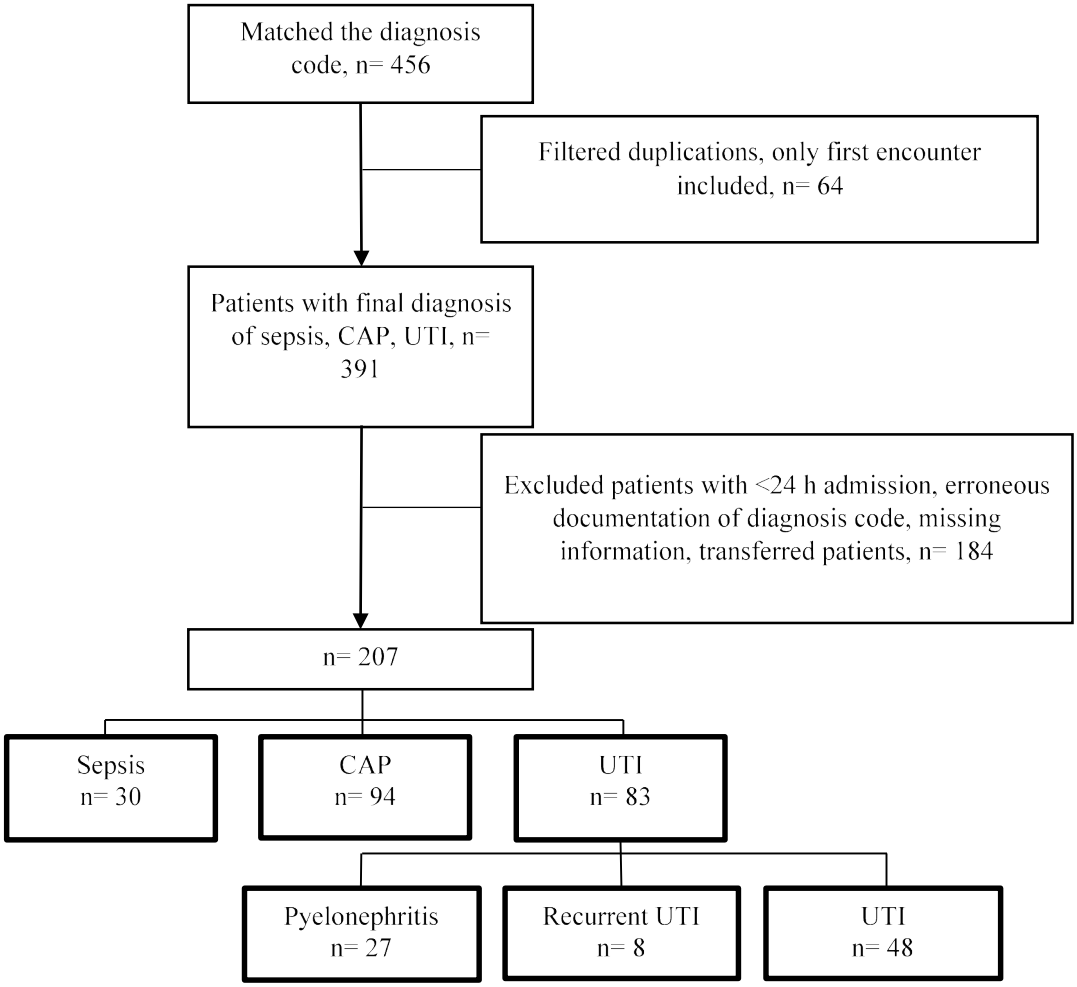

Figure 1. Concert Diagram of the Study Population

Table 1. Characteristics of Study Population

Parameter	**Study Population**	**Non-Broad Spectrum**	**Broad Spectrum**	**p-value**
Total Number (%)	207	61 (29.5%)	146 (70.5%)	
Age, years, median [IQR]	41 [33-55]	37 [31-54]	41 [35-56]	0.073
Female, no. (%)	109 (52.6%)	34 (55.7%)	75 (51.4%)	0.566
Weight, median [IQR]	75 [66-89]	78 [67.6-91.25]	74.7 [65.8-87.5]	0.172
Comorbidities, no. (%)				
Myocardial Infarction	16 (7.73%)	3 (4.92%)	13 (8.90%)	0.328
Congestive heart failure	3 (1.45%)	2 (3.28%)	1 (0.68%)	0.155
Peripheral Vascular Disease	6 (2.90%)	1 (1.64%)	5 (3.42%)	0.485
Stroke	3 (1.45%)	0	3 (2.05%)	0.259
Dementia	2 (0.97%)	0	2 (1.37%)	0.358
Pulmonary disease	15 (7.25%)	5 (8.20%)	10 (6.85%)	0.733
Connective tissue disease	1 (0.48%)	0	1 (0.68%)	0.517
Peptic ulcer	4 (1.93%)	1 (1.64%)	3 (2.05%)	0.843
Liver disease mild-mod	4 (1.93%)	2 (3.28%)	2 (1.37%)	0.363
DM	66 (31.88%)	20 (32.79%)	46 (31.51%)	0.857
Hemiplegia	1 (0.48%)	0	1 (0.68%)	0.517
Moderate to severe CKD	15 (7.25%)	2 (3.28%)	13 (8.90%)	0.155
Solid tumor	4 (1.93%)	2 (3.28%)	2 (1.37%)	0.363
Hypertension	64 (30.92%)	14 (22.95%)	50 (34.25%)	0.109
Mild Immunosuppression	7 (3.38%)	2 (3.28%)	5 (3.42%)	0.958
Severe Immunosuppression	3 (1.45%)	1 (1.64%)	2 (1.37%)	0.882
Charlson comorbidity index, median (IQR)	0 (0-2)	0 (0-0)	0 (0-3)	0.163
qSOFA score on admission, median (IQR)	0 (0-1)	0 (0-0)	0 (0-1)	0.143
Vitals and Lab Values, mean ± SD				
Temperature, C°	37.48 ± 1.02	37.09 ± 0.65	37.64 ± 1.11	0.004
WBC, cell x10^9/L	11.34 ± 7.05	9.63 ± 3.79	12.04 ± 7.92	0.023
Platelets, cell x10^9/L	234.79 ± 89.37	222.02 ± 78.48	240.13 ± 93.28	0.3
Hemoglobin, g/dL	12.1 ± 1.95	12.57 ± 1.95	11.9 ± 1.92	0.025
Creatinine, mg/dL	1.43 ± 4.54	0.91 ± 0.86	1.64 ± 5.34	0.09
CRP, mg/L	127.4 ± 103	69.24 ± 80.5	149.93 ± 102	0
Heart Rate, bpm	93.22 ± 16.86	86.08 ± 15.93	96.2 ± 16.39	0.0001
Respiratory rate,	20.71 ± 3.4	20.44 ± 2.36	20.82 ± 3.76	0.789
SBP, mmHg	121.37 ± 20.68	119.69 ± 15.4	122.08 ± 22.53	0.783
Other Characteristics, No. (%)				
History of MDR in the past year	2 (0.97%)	1 (1.64%)	1 (0.68)	0.522
History of travel in the past 3 months	6 (2.90%)	1 (1.64%)	5 (3.42%)	0.485
Oral Antibiotic in previous 90 days	70 (33.82%)	20 (32.79%)	50 (34.25%)	0.84
Intravenous Antibiotics within 90 days	27 (13.04%)	3 (4.92%)	24 (16.44%)	0.025
Admission in previous 90 days	16 (7.73%)	3 (4.92%)	13 (8.90%)	0.328
Surgery in previous 30 days	3 (1.45%)	0	3 (2.05%)	0.259
Admitted to ICU	30 (14.49%)	3 (4.92%)	27 (18.49%)	0.011

Abbreviations: CKD, Chronic Kidney Disease, ICU, Intensive Care Unit, IQR, Interquartile Range, MDR, Multi-Drug Resistant, SBP, Systolic Blood Pressure, SD, Standard Deviation, WBC, White Blood Cell.

patients of the study population (10.37 ng/mL ± 45.52), 53 of them belonged to the broad-spectrum group (12.67 ng/mL ± 50.21) and 12 to the non-broad-spectrum arm (0.22 ng/mL ± 0.26) and it was significantly higher in the broad-spectrum group (P = 0.000). Moreover, patients who received intravenous antibiotics in the preceding 90 days and patients admitted to ICU on the first day of admission were significantly higher in the broad-spectrum group, P = 0.025 and 0.011 respectively. Although haemoglobin, heart rate and temperature on admission shows a significant p value it is not clinically significant.

Overall, microbiologic culture specimens were obtained from 155 patients (74.9%) in the study cohort, with 96 patients (46.4%) having cultures collected prior to the initiation of empiric antibiotic therapy. Among CAP and sepsis patients, positive cultures were observed in only 8 cases. Most of patients with UTI had cultures done before receiving antibiotics 70% (58/83). Of the UTI patients, 32 cultures were positive, with 28 identifying *E. coli* as the pathogen, 12 of which were ESBL-producing strains. Figure 2 shows the identified bacteria among all the study population. Identification was based on microbiological culture results for all organisms, except for *Mycoplasma pneumoniae*, which was detected based on positive IgM serology. Broad-spectrum antibiotics were initiated in 70.5% (146/207) of patients, with meropenem being the most frequently prescribed antibiotic overall (57.9%, 120/207). Table 2 provides the frequency of antibiotics use according to indication. In pneumonia cases (n=94), Ceftriaxone (58.5%, 55/94) and levofloxacin (54.3%, 51/94) were the most prescribed antibiotics. There was a frequent use of macrolides (30.85%, 29/94), primarily clarithromycin (21.3%, 20/94) and azithromycin (9.6%, 9/94), for atypical pathogens coverage. The use of meropenem (47.9%, 45/94) was high, given that only 10.6% (10/94) of patients had a CURB-65 score above 2, indicating severe pneumonia. Additionally, Anti-MRSA was minimally used in this population (17%, 16/94).

In UTI patients (n=83), meropenem was the predominant choice (56.6%, 47/83), followed by ceftriaxone (19.3%, 16/83) and ciprofloxacin (12%, 10/83). Ertapenem (8.4%, 7/83) used approximately 5 times less than meropenem. In sepsis cases (n=30), meropenem (93.3%, 28/30) was used near universal. There was a frequent addition of levofloxacin (53.3%, 16/30) and teicoplanin (46.7%, 14/30) to cover a wide range of potential pathogens, including resistant gram-positive organisms. Antibiotics targeting MRSA were used in 50% (15/30) of sepsis patients. Across all diagnoses, the use of piperacillin/tazobactam was low (6.3%, 13/207). There was infrequent use of aminoglycosides like amikacin (2.4%, 5/207).

The limited use of narrow-spectrum antibiotics such as amoxicillin/clavulanic acid (0.5%, 1/207) and cefuroxime (1%, 2/207) across all infection types is noteworthy. The use of antibiotics targeting anaerobic bacteria, such as metronidazole, was relatively low (2.4%, 5/207). Moreover, many of the patients were prescribed two antibiotics simultaneously (46.4%). Most of these patients, accounting for 69 individuals, were admitted for the management of pneumonia. All the combinations included a beta-lactam plus coverage for atypical

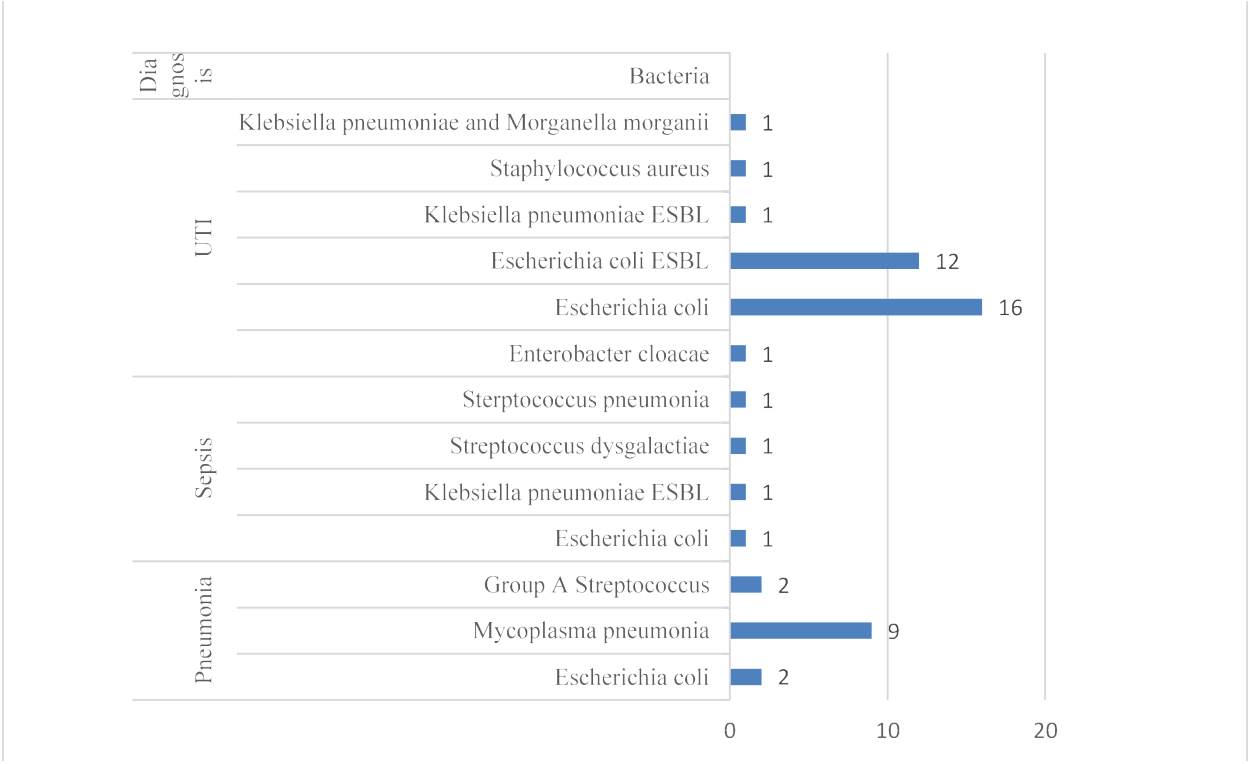

Figure 2. Identified Bacteria in the Study Population

Table 2. Frequency of Antibiotic Prescribing

Antibiotic	Diagnosis			
	Pneumonia	UTI	Sepsis	Grand Total
	N = 94	N = 83	N = 30	N = 207
Meropenem	45 (47.9%)	47 (56.6%)	28 (93.3%)	120 (58.0%)
Levofloxacin	51 (54.3%)	7 (8.4%)	16 (53.3%)	74 (35.7%)
Ceftriaxone	55 (58.5%)	16 (19.3%)	0 (0.0%)	71 (34.3%)
Teicoplanin	12 (12.8%)	0 (0.0%)	14 (46.7%)	26 (12.6%)
Clarithromycin	20 (21.3%)	0 (0.0%)	0 (0.0%)	20 (9.7%)
Piperacillin/Tazobactam	5 (5.3%)	5 (6.0%)	3 (10.0%)	13 (6.3%)
Ertapenem	3 (3.2%)	7 (8.4%)	1 (3.3%)	11 (5.3%)
Ciprofloxacin	0 (0.0%)	10 (12.0%)	1 (3.3%)	11 (5.3%)
Azithromycin	9 (9.6%)	0 (0.0%)	1 (3.3%)	10 (4.8%)
Imipenem/Cilastatin	0 (0.0%)	8 (9.6%)	0 (0.0%)	8 (3.9%)
Doxycycline	5 (5.3%)	0 (0.0%)	2 (6.7%)	7 (3.4%)
Metronidazole	2 (2.1%)	2 (2.4%)	1 (3.3%)	5 (2.4%)
Amikacin	0 (0.0%)	4 (4.8%)	1 (3.3%)	5 (2.4%)
Vancomycin	4 (4.3%)	0 (0.0%)	1 (3.3%)	5 (2.4%)
Cefuroxime	0 (0.0%)	2 (2.4%)	0 (0.0%)	2 (1.0%)
Fosfomycin	0 (0.0%)	2 (2.4%)	0 (0.0%)	2 (1.0%)
Amoxicillin/Clavulanic acid	1 (1.1%)	0 (0.0%)	0 (0.0%)	1 (0.5%)
Clindamycin	0 (0.0%)	0 (0.0%)	1 (3.3%)	1 (0.5%)
Tetracycline	1 (1.1%)	0 (0.0%)	0 (0.0%)	1 (0.5%)

bacteria (fluoroquinolones, macrolides, or doxycycline). Most of the patients who were prescribed a single antibiotic had UTIs. Only a few patients, totalling 25 (12.1%), were prescribed three or more antibiotics; these patients were distributed almost equally between those with sepsis and those with pneumonia. Details of concomitant antibiotic use are presented in Table 3.

De-escalation eligibility was contingent upon the availability of culture and sensitivity reports. Among the 27 patients eligible for de-escalation, 22 of these had a UTI infection, 2 had CAP and 3 had sepsis. Successful implementation occurred in 25.9% (7/27) of cases. The time for de-escalation varied, with 4 cases achieving this within 48 hours and 3 cases within 72 hours. Antibiotic de-escalation flow chart is presented in Figure 3.

Table 3. Concomitant Antibiotic Use

Number of Antibiotics	Diagnosis	Count	Total Count
1 Antibiotic	Pneumonia	12	86 (41.5%)
	UTI	68	
	Sepsis	6	
2 Antibiotics	Pneumonia	69	96 (46.4%)
	UTI	15	
	Sepsis	12	
≥ 3 Antibiotics	Pneumonia	13	25 (12.1%)
	Sepsis	12	

A logistic regression model has examined a number of variables that makes the use of broad-spectrum antibiotics more likely. Of all the variables CRP was the only variable to be statistically significant. Suggesting that the odds of prescribing a broad-spectrum Antibiotic increase by 1% for each unit increase in CRP level (OR = 1.01, 95% CI = 1.005-1.015, P = 0.000). Other factors like previous IV or oral antibiotic use in the last 90 days, previous admission to hospital in the last 90 days, admission to ICU and severe immunosuppression did not have a significant effect on the likelihood of predicting the prescription of broad-spectrum antibiotic. While 95.2% of patients had their CRP levels measured upon admission, only 31.4% had their PCT levels assessed at admission. This discrepancy prevented PCT from being included as a variable in the logistic regression model. Detailed analysis of factors associated with prescribing broad-spectrum antibiotics are presented in Table 4.

The study reported that 95.1% (197/207) of pneumonia patients achieved successful therapy, defined as being clinically stable and reporting improved or complete resolution of symptoms at discharge. Of those 197 patients, 123 returned for a 1-week follow-up appointment and showed resolution of their infection, while 74 did not attend the follow-up. The IQR for duration of hospitalization was 3- 5 days. Majority of patients were discharged with antibiotics accounting for 95.7%. In-hospital mortality was zero. Clinical outcome of the study population is presented in Table 5.

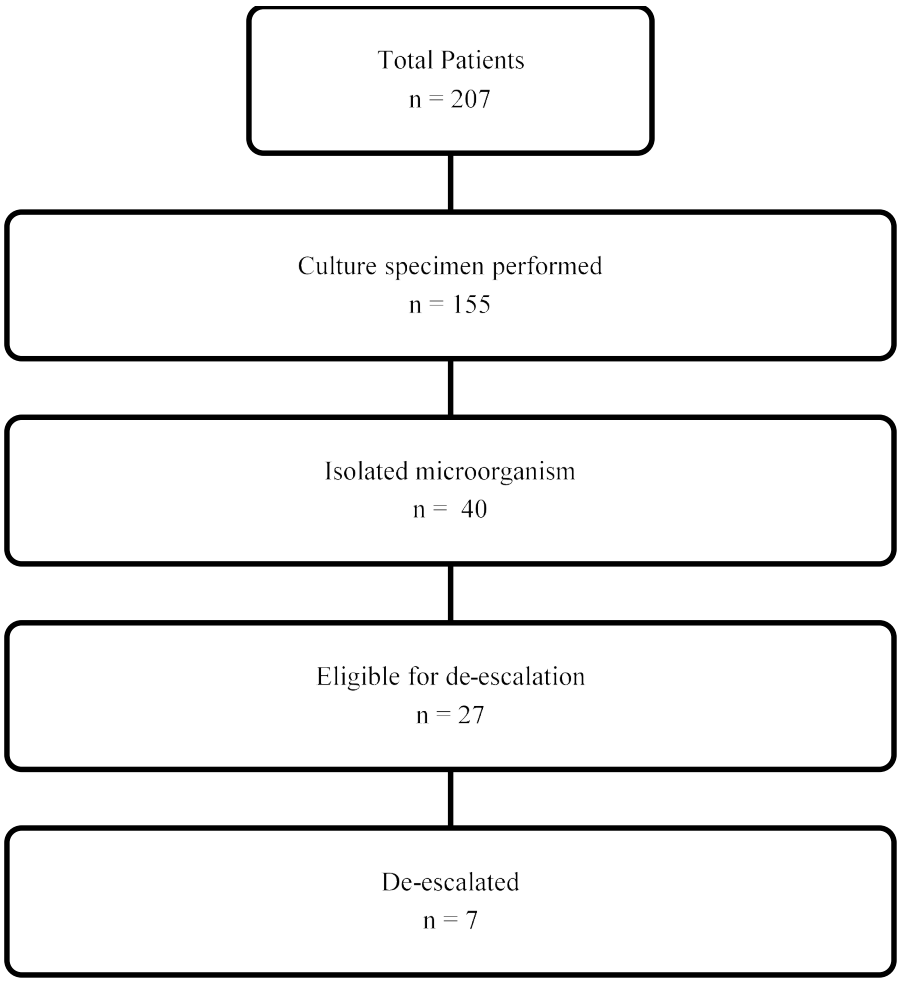

Figure 3. Antibiotic De-escalation Flow Diagram

Table 4. Logistic Regression Analysis of Factors Associated with Prescribing Broad-Spectrum Antibiotic

Variables	Odds Ratio	Confidence Interval	P value
IV Antibiotics Use in the Last 90 days	1.91	0.387-9.424	0.427
Oral Antibiotic Use in the Last 90 days	1.22	0.572-2.592	0.608
Hospital Admission in the Last 90 days	1.38	0.248-7.640	0.715
Admission to the ICU	3.68	0.852-15.848	0.081
Elevated CRP Level	1.01	1.005-1.015	0
Severe Immunosuppression	0.07	0.003-1.387	0.08

Table 5. Clinical Outcomes

Clinical Outcomes	Number	Percentage
In-hospital mortality	0	0%
Successful therapy	197	95.20%
Reported worse symptoms on follow up appointment	1	0.50%
Re-admission within 30 days/ returned to the outpatient department with persistent symptoms	9	4.30%
Patient discharged with antibiotics	198	95.70%
Patient discharge without Antibiotics	9	4.30%

DISCUSSION

This study is among the first in the UAE to investigate antibiotic prescribing patterns in adult inpatients with community-onset pneumonia, UTI, and sepsis. It comprehensively evaluates the patterns of antibiotic therapy, the use of broad-spectrum antibiotics, and the potential for de-escalation.

The majority of the study population were admitted for management of CAP or UTI and only 14.5% of them were admitted for sepsis management. The study population was predominantly young to middle-aged (75% between 33-55 years old) with low Charlson comorbidity scores (0-2) and qSOFA scores (0-1) on admission. Among the study population, only 14.5% required ICU admission and among the *E-Coli* isolated from Urinary tract had 42.85% ESBLs. Although the majority of patients presented with favorable baseline characteristics — including younger age, low qSOFA scores, and low Charlson Comorbidity Index scores — empiric broad-spectrum antibiotics were initiated in 70.5% of cases.

Patients were divided into two groups: those who were started on broad-spectrum antibiotics empirically and those who were started on other antibiotics. Baseline characteristics were similar between groups, except for previous IV antibiotic use, CRP levels, WBC count and ICU admission. Suggesting that broad-spectrum antibiotics prescribing was associated with the previously mentioned factors. In pneumonia cases (n=94), the antibiotic choices include beta lactams and fluoroquinolones. Ceftriaxone (58.5%, 55/94) and levofloxacin (54.25%, 51/94) were the most prescribed antibiotics, aligning with recommended CAP therapy. The frequent use of macrolides (30.85%, 29/94), primarily clarithromycin (21.3%, 20/94) and azithromycin (9.6%, 9/94), suggests appropriate coverage for atypical pathogens. However, the use of meropenem (47.9%, 45/94) is particularly high, even though only 10.6% (10/94) of patients had a CURB-65 score above 2, indicating severe pneumonia.

The prevalence of pathogens causing CAP in the UAE is not much available. However, in the USA, individuals with CAP typically have a low prevalence of resistant pathogens. The EPIC study, a surveillance study of adults with CAP requiring hospitalization, enrolled 2,488 patients from five US hospitals. A bacterial or viral pathogen was detected in 853 (38%) patients, with fungal or mycobacterial pathogens identified in 17 (1%). The most common pathogens were human rhinovirus (9% of patients), influenza virus (6%), and Streptococcus pneumoniae (5%), while the incidence of MRSA was only 0.7%[13-15]. Similarly, a Veterans Affairs study found rates of *Pseudomonas* and MRSA to be less than 2% each[13]. These findings underscore the importance of judicious use of broad-spectrum antibiotics, especially considering that their use in CAP is associated with poorer outcomes and higher mortality[10,13].

The 2019 Infectious Diseases Society of America/ American Thoracic Society (IDSA/ATS) guidelines and the updated 2023 CAP clinical pathway advocates the initial use of broad-spectrum antibiotics in hospitalized adults with severe CAP and risk factors for multidrug-resistant organisms, such as hospitalization or parenteral antibiotic use within the past 90 days. The empiric use of anti-MRSA agent may be warranted if MRSA nasal colonization or prior respiratory infection is present. Similarly, anti-pseudomonal therapy should be considered for patients with prior *P. aeruginosa* isolation, advanced structural lung disease, history of *P. aeruginosa* colonization or infection within the past year. Conversely, for non-severe pneumonia without risk factors for MRSA or *P. aeruginosa* the use of a beta-lactam plus macrolide or respiratory fluoroquinolone alone is recommended. It is also recommended before starting broad-spectrum antibiotic to obtain cultures to allow de-escalation or confirmation of need for continued therapy[16,17].

There was a widespread use of carbapenems as initial empiric therapy in our study's UTI population, where carbapenems were initiated in 73% of cases. Meropenem was used around five times more often than ertapenem (47 vs. 7 patients, respectively) followed by ceftriaxone (19.2%, 16/83) and ciprofloxacin (12%, 10/83). This might be due to the lack of local antibiogram and the rising prevalence of ESBL-producing *Escherichia coli* and *Klebsiella pneumoniae* in the UAE, which increased from 32.5% and 26.5% in 2019 to 33% and 29% in 2022, respectively[18,19].

In sepsis cases (n=30), the near-universal use of meropenem (93.3%, 28/30) reflects an aggressive approach to broad-spectrum coverage in these critically ill patients. The frequent addition of levofloxacin (53.3%, 16/30) and teicoplanin (46.7%, 14/30) indicates a strategy aimed at covering a wide range of potential pathogens, including resistant gram-positive organisms. Generally, the trends of prescribing empiric antibiotics for suspected community-onset sepsis tends towards covering MRSA and *Pseudomonas*[20]. A recent cross-sectional study in the United States (US) assessed the annual rates of empiric anti-MRSA and/or antipseudomonal beta-lactam agent use and their appropriateness determined based on the clinical culture results on day 4 of admission. The study found that among 6 272 538 hospitalizations 65.1% received either anti-MRSA (42.5%) or anti-pseudomonal beta-lactam (57.4%) and 34.8% received both. Moreover, they found that the proportion of patients with suspected sepsis administered anti-MRSA or antipseudomonal therapy was increasing overtime. Even though broad-spectrum antibiotics is widely used in this condition, only in 7.3% of cases had resistant organisms being isolated[20]. In comparison, our study shows similar MRSA coverage (53.33%, 16/30), but with a higher use of antipseudomonal and carbapenem therapies (100%, 30/30), likely due to the rising prevalence of ESBL-producing *E. coli* and *Klebsiella pneumoniae* in the UAE.

Across all diagnoses, the use of piperacillin/tazobactam was surprisingly low (6.3%, 13/207). This underutilization of a common broad-spectrum alternative to carbapenems suggests a strong preference for meropenem, possibly due to its perceived broader coverage or its preference for treatment of severe infections. The infrequent use of aminoglycosides like amikacin (2.4%, 5/207) may reflect concerns about nephrotoxicity or a preference for beta-lactam antibiotics.

The limited use of amoxicillin/clavulanic acid (0.5%, 1/207) and

cefuroxime (1%, 2/207) across all infection types is noteworthy. This pattern suggests a potential underutilization of targeted therapy, even in cases where narrow-spectrum antibiotics might be appropriate based on local resistance patterns or patient-specific factors. In our analysis, we also examined the rate of de-escalation based on culture and sensitivity results. The de-escalation rate was 25.9% (7/27). Reassessing antibiotic therapy based on microbiologic culture and susceptibility testing supports antibiotic stewardship programs and is associated with improved outcomes in severe infections[21]. However, some patients in our study with pan-susceptible bacteria continued carbapenem therapy. Observational studies suggest that de-escalation of antibiotics is likely safe and effective for treating various types of infections[22,23]. The absence of rapid diagnostic tests and modern microbiological methods, which are critical for guiding appropriate antibiotic therapy, may have influenced the rate of antibiotic de-escalation and the overall appropriateness of antibiotic use. Rapid diagnostic testing for potential pathogens is considered indispensable for antibiotic stewardship programs, as it can decrease antibiotic use, reduce mortality, shorten hospital stays, and lower costs[21]. The lack of availability of modern diagnostic tests represents a significant barrier in low-resource settings. Most patients in our study did not undergo rapid diagnostics, possibly due to the high cost of these tests, insurance coverage issues, or challenges in making these diagnostics available. Moreover, the short duration of hospitalization which was between 3 to 5 days in 75% of the population might have contributed to the decreased rate of antibiotic de-escalation, as usually it takes at least 48 hours for culture and sensitivity results to be ready. Moreover, the relatively short duration of hospitalization explains the high rate of antibiotic prescription of discharge.

Although elevated CRP levels have slightly increased the likelihood of prescribing broad-spectrum antibiotics (OR = 1.01, 95% CI = 1.005-1.015, P = 0.000), it is crucial to emphasize that this practice needs to be revised. The C-reactive protein is a non-specific acute phase reactant which typically increases 4-6 hours after an inflammatory trigger, peaks at 36-50 hours and decrease rapidly with the resolution of inflammation. CRP is usually used to monitor the success of antibiotic therapy. A raised CRP does not indicate a serious bacterial infection however a CRP level that keeps rising or does not decrease after 48 hours of initiating antibiotic therapy suggest treatment failure[24,25]. Most study participants (95.2%) experienced successful treatment outcomes. Only 4.8% of patients were readmitted or returned to the outpatient department with persistent symptoms, highlighting the effectiveness of the treatment for this patient cohort.

This prescribing pattern, characterized by heavy reliance on broad-spectrum antibiotics, particularly carbapenems, can be explained by some challenges and limitations. Of the challenges is the diversity of the population in the country coming from around the world contributing to the introduction and circulation of resistant bacterial isolates[26]. In addition, the increased prevalence of ESBL producing isolates reported by local surveillance data[18,19]. Moreover, the resource limitation in the cost and availability of rapid diagnostic tools which push prescribers for using broad spectrum antibiotics. This highlights the need for robust antibiotic stewardship programs. Implementation of AMS programs could promote more judicious use of broad-spectrum antibiotics.

Evidence-based interventions that enhance judicious antimicrobial prescribing include: clinician education regarding appropriate antimicrobial selection, development and implementation of institution-specific prescribing guidelines, prospective audit with intervention and feedback mechanisms, antimicrobial-focused multidisciplinary ward rounds, formulary restrictions, preauthorization requirements for designated broad-spectrum agents, integration of rapid diagnostic testing, and systematic antimicrobial therapy reviews with appropriate de-escalation protocols[27]. These interventions align with achieving the goal of optimizing the use of antimicrobial medicines in humans, a core goal in WHO Global Action Plan on Antimicrobial Resistance[4].

This retrospective cohort study has some limitations that should be considered when interpreting the findings. The retrospective nature and the reliance on EMR data may have resulted in incomplete or inaccurate documentation of antibiotic use and de-escalation practices. The study was conducted at a single tertiary care hospital with a small sample size limiting the generalizability of the results.

CONCLUSION

The findings of the study reveal a high rate of broad-spectrum antibiotic use among the study population. This trend is likely influenced by the rising prevalence of ESBL-producing organisms in the region, resource-limited settings, and the absence of a local antibiogram. The study also highlights the low rate of antibiotic de-escalation. Thus, this study offers a critical baseline for understanding antibiotic use patterns in the UAE providing valuable information for future planning, especially in developing strategies to improve treatment protocols and better address the challenges posed by drug-resistant pathogens.

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