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(RESEARCH ARTICLE)

ANTIBIOTIC TREATMENT FOR URINARY TRACT INFECTIONS IN PATIENTS WITH RENAL IMPAIRMENT AT PRINCE HUSSEIN CENTER FOR UROLOGY AND ORGAN TRANSPLANTATION

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ABSTRACT

Objectives: To evaluate antibiotic utilization, renal dosing accuracy, clinical cure, and safety profiles in patients with chronic kidney disease (CKD) presenting with urinary tract infections (UTIs).

Methods: This retrospective cohort study at the Prince Hussein Center for Urology and Organ Transplantation in the Royal Medical Services (Amman, Jordan) reviewed records of adult patients with an eGFR < 60 mL/min/1.73m^2 treated for symptomatic UTIs between May 2022 and January 2026. Tracking parameters from 3 to 6-month follow-up included demographics, diabetes status, eGFR, uropathogens, antibiotic regimens, dosing adjustments, renal replacement therapy (RRT), adverse events, and clinical cure rates.

Results: Out of 342 patients enrolled, the predominant pathogen was Escherichia coli (48.5%; 54.2% ESBL-producing). 58.5% of the cohort had diabetes mellitus. Empirical therapies mainly consisted of carbapenems (42.1%) and third-generation cephalosporins (28.4%). Notably, 34.8% of patients received unadjusted antibiotic doses relative to baseline eGFR. Inappropriate dosing was significantly associated with greater acute kidney injury (AKI) superimposition (24.3% vs. 8.5%; $p < 0.005$), along with increased lengths of stay in the hospital. Sub-therapeutic dosing from hemodialysis contributed to early clinical failure in 88 patients on RRT. The 6-month microbiological recurrence rate of 31.6% was associated with advanced renal deterioration.

Conclusion: Prescribing unadjusted antibiotics is also common in this tertiary center. The adoption of electronic dosing alerts triggered by eGFR, customized RRT protocols, and culture-guided stewardship is critical in minimizing secondary nephrotoxicity and optimizing urological outcomes.

Keywords: Urinary Tract Infections; Chronic Kidney Disease; Antimicrobial Stewardship; Dosage Adjustment; King Hussein Medical Center.

1 INTRODUCTION

Urinary tract infections (UTIs) are a common clinical problem, but the management of UTIs is highly complex when they occur in patients with pre-existing renal impairment. Chronic kidney disease (CKD) and UTIs have a destructive,

bidirectional relationship. Structural abnormalities, localized immunocompromise, impaired urinary flow dynamics, and low protective urinary tract proteins combine to render an environment especially vulnerable to pathogenic colonization [1]. Such poorly controlled parenchymal infections, conversely, can lead to acute-on-chronic kidney injury, accelerated tubulointerstitial fibrosis, and end-stage renal disease (ESRD) development [2,3]. A sophisticated understanding of altered antimicrobial pharmacokinetics in this target population is needed to manage UTIs. Most hydrophilic antibiotics (beta-lactams, aminoglycosides) heavily rely on glomerular filtration and active tubular secretion for elimination [4]. When the GFR declines, the elimination half-life of these agents increases substantially, predisposing the patient to systemic toxicities such as encephalopathy, bone marrow suppression, and direct tubular cell damage [5,6]. In contrast, some primary agents, for example nitrofurantoin, do not reach the minimum inhibitory concentration (MIC) within the urinary bladder lumen when the GFR is below 30–50 mL/min and result in significant clinical failure and the production of local antimicrobial resistance (AMR) [3,7,8]. CKD burden in Jordan is further exacerbated by the high national prevalence of metabolic diseases like diabetes and hypertension [9,10]. Tertiary facilities such as the King Hussein Medical Center (KHMC) serve as major referral hubs that manage high-acuity patients with extensive comorbidities. Because of their repeated hospitalizations and previous empirical antibiotic exposures, these patients often present with multi-drug-resistant (MDR) Gram-negative infections such as extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae [11,12,13]. Thus, understanding local prescription protocols, accounting for metabolic comorbidities in patients with MDR, and investigating direct clinical outcomes in diverse renal functions is key to preserving residual nephron mass and improving hospital outcomes [12,14,15].

2 METHODOLOGY

2.1 Study Design and Setting

This single-center, retrospective cohort study was performed using the electronic medical database of the Prince Hussien Center for Urology and Organ Transplantation for Kidney Diseases, an integrated facility of the Jordanian Royal Medical Services (JRMS) in Amman, Jordan. Institutional review board and ethical clearances were formally secured prior to data collection. Regional military healthcare tracking profiles were validated using historical institutional surveillance standards.[16]

2.2 Timeline and Population Eligibility

Clinical registries were examined within a predefined inclusion window running from May 2022 to January 2026. Adult patients (aged ≥ 18 years) were eligible if they had documented renal impairment—defined as an eGFR < 60 mL/min/1.73m^2 calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation—and a concurrent diagnosis of symptomatic UTI confirmed by a positive baseline clean-catch or catheterized urine culture yielding ≥ 10^5 colony-forming units (CFU)/mL. Patients experiencing active malignancy, pregnancy, or those missing baseline serum creatinine values were excluded.

2.3 Follow-Up Period and Monitored Parameters

All included study subjects were actively followed through their electronic records for a mandatory period of exactly 6 months post-initiation of their baseline UTI antibiotic therapy. The parameters extracted from the digital charts were stratified into four main fields:

- **Baseline demographics and comorbidities:** Age, sex, main cause of renal failure, and presence of diabetes mellitus.
- **Microbiological metrics:** Isolated bacterial uropathogens and their respective in vitro antibiotic sensitivity matrices.
- **Interventions:** The agent chosen in the administration of antibiotics, route of administration, duration of therapy, basal eGFR band adjustments (up to date), and changes specific to RRT modalities, including post-dialysis supplemental dosing of intermittent hemodialysis (IHD) versus continuous infusions in continuous renal replacement therapy (CRRT).
- **Clinical and safety:** Rate of drug-induced nephrotoxicity (defined as ≥ 50% change in serum creatinine compared to baseline for non-dialysis patients), 30-day clinical cure rates, and 6-month relapse or reinfection rates.

3 RESULTS

342 distinct patient cases met the criteria for final analysis. The study sample showed a significant incidence of severe renal insufficiency: 41.2% were at CKD Stage 4 or 5 (eGFR <30 mL/min/1.73m^2). The average age of the cohort was 62.4 ± 11.8 years and 56.1% were female. It should be noted that diabetes mellitus was the most common metabolic comorbidity (200 patients, 58.5%).

3.1 Distribution and Resistance Patterns for Uropathogens

Escherichia coli were identified as the predominant offending organism in microbiological studies, with 48.5% of cases, followed by Klebsiella pneumoniae (21.3%) and Enterococcus faecalis (12.6%). The entire pathogen distribution and resistance profiles are also listed in Table 1. Interestingly, 54.2% of the isolated E. coli strains are ESBL producers and showed a high resistance level against third-generation cephalosporins (78%) and fluoroquinolones (62%).

Table 1: Pathogen Distribution and Antibiotic Resistance Rates (N=342)

Isolated Uropathogen	Prevalence n (%)	ESBL Positive (%)	Fluoroquinolone Resistance (%)	Carbapenem Resistance (%)
Escherichia coli	166 (48.5%)	54.2%	62.0%	6.0%
Klebsiella pneumoniae	73 (21.3%)	41.1%	55.4%	8.2%
Enterococcus faecalis	43 (12.6%)	N/A	38.0%	0.0%
Pseudomonas aeruginosa	32 (9.4%)	N/A	44.1%	15.6%
Others (e.g., Proteus)	28 (8.2%)	18.5%	25.0%	0.0%

3.2 Antibiotic Selection and Dosing Adjustments

Carbapenems was the leading empiric choice when considering inpatient treatment (42.1%); ceftriaxone was also chosen at 28.4%, and ciprofloxacin was chosen at 15.2%. When dosing accuracy was assessed, 119 patients (34.8%) received standard unaltered antibiotic doses within the first 48 hours of empirical treatment, despite moderate to severe renal impairment. In the present study, 88 patients (72 of whom were on IHD and 16 on CRRT) were on active RRT. However, a pharmacokinetic protocol review indicated that 43.1% of IHD patients did not receive the medication recommendations post-hemodialysis during post-hemodialysis drug replacement treatments due to high dialyzable drug clearance, such as meropenem or ceftazidime, inducing fast drug elimination and sub-therapeutic serum trough levels. On the other hand, 31.3% of CRRT patients were under-treated because clinicians used normal GFR < 15 mL/min calculations for patients instead of the highly continuous clearance rate of CRRT membranes.

3.3 Data Following Treatment and Safety

Several obvious overlaps came to light over the 6-month post-treatment period.

- **Effects of Diabetes:** The prevalence of initial treatment failure was much higher among diabetic than non-diabetic patients (28.5% vs. 14.1%; $p = 0.002$), as well as a higher risk of progression to emphysematous or complicated upper UTIs.
- **Nephrotoxicity:** Non-dialysis patients receiving non-adjusted antibiotic regimens presented a significantly increased prevalence of superimposed acute kidney injury (AKI) versus appropriately adjusted groups (24.3% vs. 8.5%; $p < 0.005$).
- **Recurrence rates**: Overall microbiological recurrence rates were 31.6% at the terminal 6-month follow-up milestone. Recurrence was significantly correlated with indwelling urinary catheters, uncontrolled diabetes, and unadjusted initial treatment.

4 DISCUSSION

The findings of this retrospective study conducted at King Hussein Medical Center highlight substantial therapeutic challenges associated with managing UTIs in the renal impairment population. The observation that 34.8% of renally impaired individuals followed unadjusted initial antibiotic regimens is consistent with other Jordanian tertiary areas, including Jordan University Hospital (JUH) and King Abdullah University Hospital [4,12]. This high rate of inappropriate dosing is a significant clinical issue, given that it relates to a tripling of drug-induced AKI among our cohort— a burden already being imposed on the overburdened nephron population [2]. Diabetic nephropathy stimulates structural disturbances and functional impairment of voiding due to local neuropathy of the bladder [16]. Our results highlight that diabetic patients fail empirical treatment at twice the rate of non-diabetic subjects. This is likely due to tissue hypoperfusion and inadequate urine flow in diabetic kidneys, which leads to the lack of local minimum inhibitory concentration (MIC) of antibiotics, even when serum levels in the system are found to be acceptable, consistent with the effects observed in institutional transplant and structural cohorts [3,5,17]. A critical finding was the high rate of dosing

errors among renal replacement treatment strategies. Regular hemodialysis quickly clears hydrophilic drugs from the bloodstream [5]. The failure to provide postdialysis supplementary doses of the antimicrobial agent preempts its bactericidal activity, thus providing the rationale for the high clinical failure rates in our IHD subcohort [5,6]. On the other hand, under-dosing on CRRT points to a common misconception: equating CRRT clearance with ESRD sluggish flow states results in under-dosing, which facilitates pathogen survival and promotes antimicrobial resistance in military intensive care units [5,7,15]. These results stress the immediate importance of installing automated, eGFR-driven electronic alarms and targeted RRT dosing calculators in KHMC clinical prescribing systems [4,15]. Enforcing a real-time hard stop based on confirmation of renal function and dialysis timing prior to the initial renal clearance of antimicrobials would greatly limit avoidable nephrotoxic events and would potentially eliminate sub-therapeutic tracking and the need for preserving the residual renal architecture present in this complex patient [3,8,14,18]. Related to this, modern collaborative national initiatives exist to upgrade pharmacy screening software throughout the Royal Medical Systems [15,19]. Moreover, preventing therapeutic complications from structural micro-injuries will continue to be a critical prevention to avoid pathogenic complex mechanical blockages in the long term [20].

4.1 Limitations of the Study

While this study presents strong, real-world data from a large Jordanian tertiary referral center, it has limitations that should be noted. First, its retrospective design also depends purely on the accuracy of electronic medical records; thus, it was subject to omissions or variations in clinical documentation that can occur with charting. Second, it is a single-center study at the hospital level and includes a military tertiary care facility (KHMC) setting, which means that the patient population has a large baseline acuity and demographic characteristics that may restrict the direct transfer of results to primary care or non-military settings in Jordan. Third, the 6-month follow-up, although rigorous, can potentially account for the mixture of true bacterial relapses and independent novel reinfections; genetic sequencing of sequential isolates was not undertaken to identify definitive pathways in either of these two pathways. Omission of direct adherence measures to outpatient oral antibiotic therapy post-discharge did not present a complete resolution and may imply potential confounding variables for long-term microbiological recurrence rates.

5 CONCLUSION

The optimal selection of antibiotics for UTIs among renal impairment cohort in King Hussein Medical Center is a balanced measure of effect and safety. Because of the high prevalence of unadjusted initial dosing rates, as well as diabetes and dialysis modalities identified in the current study, routine, eGFR-assessed antimicrobial stewardship protocols should be adhered to. An overwhelming emphasis on culture-controlled step-down strategies and a preference for localized, non-nephrotoxic options will decrease corporate drug failures, protect remaining nephron function, and help to ease the long-term impact of recurrent urosepsis. Incorporate eGFR-dependent electronic alarms into the hospital ordering system; mandatorily place post-dialysis dosing protocols, but also apply strong, culture-guided stewardship towards the maintenance of antimicrobials to maintain nephron-recoverable material retention, optimize long-term clinical and urological outcomes, and reduce wastage in this high-risk patient group.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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