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Retrospective Cohort Study on Patients with Urinary Tract Infections in a Multidisciplinary Hospital in Romania

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Abstract: Urinary tract infections (UTI) are a significant health concern, particularly among the elderly, often leading to hospitalization. A comprehensive study conducted at the "Dr. Carol Davila" Central Military Emergency University Hospital in Bucharest analyzed 948 adult patients hospitalized for symptomatic UTI. The findings revealed that the majority of admitted patients were elderly, presenting with high comorbidity rates and severe dependence. The study also identified common risk factors for multidrug-resistant pathogens, with one-third of patients hospitalized within 30 days preceding their current admission. The research uncovered several independent predictors of prolonged hospital stay, including the degree of dependence and comorbidity, female sex, obesity, and the presence of bacteremia. These findings underscore the changing landscape of UTI epidemiology and presentation in hospitalized patients. This study emphasizes the need for improved management strategies, particularly in areas such as urinary incontinence care, judicious use of catheterization, and preventive measures. As the elderly population continues to grow, healthcare providers must adapt their approaches to effectively address the evolving challenges associated with UTIs in this vulnerable population.

Keywords: urinary tract infections; adults; etiology; risk factors

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1. Introduction

Urinary tract infections represent a significant global health concern, affecting millions of individuals across all age groups and sexes. [1] The prevalence of UTIs is staggering, with more than 150 million cases reported annually worldwide. [1,2] This high incidence rate translates to substantial healthcare costs and considerable morbidity, underscoring the need for effective preventive and treatment strategies. [1–3]

UTIs encompass a wide range of clinical manifestations, from relatively mild conditions such as cystitis to more severe complications such as pyelonephritis and renal abscesses. In extreme cases, particularly among immunocompromised individuals, UTIs can progress to life-threatening sepsis, which highlights the potential severity of these infections. [2,3]

The clinical presentation of UTIs is notably diverse, reflecting the complex interplay between host factors and pathogenic characteristics. Symptoms can vary widely in nature and intensity, ranging from mild discomfort to debilitating pain. [2] Common manifestations include dysuria, urinary urgency and frequency, lower abdominal cramping, and systemic symptoms, such as fever, chills, and fatigue. [2,3] More severe cases may present with flank pain, nausea, vomiting, or changes in mental status. Heterogeneity in symptom presentation is further complicated by individual risk factors and overall health status, making accurate diagnosis and appropriate management crucial.

[2–4] Typically, patients seek medical attention within three days of symptom onset, although this timeline can be extended, especially in cases of recurrent UTIs in women, where symptom severity may be more pronounced and persistent. [3,4]

Urinary tract infections (UTI) are a significant health concern, particularly among the elderly population. These infections are caused by a diverse array of microorganisms, with uropathogenic *Escherichia coli* being the most common culprit. [4] Other frequently isolated pathogens include *Klebsiella pneumoniae*, E*nterococcus faecalis, Enterobacter species, Pseudomonas aeruginosa, Staphylococcus aureus,* and *Candida species*. [2–4] The development of clinically relevant UTI is influenced by both host-specific and pathogen-specific risk factors. [2,3] Host factors such as diabetes, obesity, history of UTI, use of indwelling catheters, and pre-existing urinary lithiasis can increase susceptibility. Pathogen factors, including adhesins, increased survivability against host defenses, escape mechanisms, invasiveness, biofilm formation, and antibiotic resistance, contribute to the infection's severity and persistence. [3,4]

The clinical presentation of UTI can vary widely, ranging from asymptomatic bacteriuria to severe septic shock. UTI are classified as either uncomplicated or complicated, depending on the presence of anatomical or functional abnormalities in the urinary tract. [2–4]

Diagnosis typically involves a combination of patient history, clinical features, urine biochemical analysis, and urine culture. However, empirical antibiotic treatment is often initiated before culture results are available, which can take up to 48 hours. This practice, while necessary for symptomatic relief, can contribute to adverse effects such as colitis and increased antibiotic resistance. [3–5]

Urinary tract infection is a prevalent condition among older adults and presents unique challenges for diagnosis and management. [4,5] The difficulty in differentiating between symptomatic and asymptomatic bacteriuria is particularly pronounced in this population, especially among those residing in long-term care facilities. [5,6] This is primarily due to the atypical presentation of symptoms in older adults, who often lack the localized genitourinary symptoms that are commonly observed in younger patients. [6] Although consensus guidelines have been developed to aid clinicians in diagnosing and treating UTI, the absence of a universally accepted, evidence-based approach to diagnosis remains a significant issue in the field. [5,6]

Life expectancy is increasing, and the number of older adults is growing significantly. Currently, individuals over 65 years of age make up one-sixth of the total population, but account for one-third of outpatient visits. [6] This demographic shift has important implications for healthcare systems as older adults are more susceptible to bacterial infections, which can lead to increased morbidity, mortality, and hospital admissions. [6,7] Among these, urinary tract infections are the most prevalent among older adults. Urinary tract infections, if left untreated, can progress to sepsis. [7]

The complexity of accurately diagnosing UTI in this population underscores the need for further research to improve the diagnostic accuracy and develop more targeted treatment strategies. [6,7] This review aims to provide a comprehensive overview of UTI in older adults, covering their prevalence and the challenges associated with diagnosis. [7,8] By addressing these key aspects, this review seeks to enhance the understanding and promote more effective care for older adults affected by these common urinary tract conditions. [8]

This study aims to analyze epidemiological, microbiological, therapeutic, and prognostic data in elderly hospitalized patients with UTI, focusing on identifying the impact of risk factors on patient outcomes. [7–9] This research is particularly relevant given the changing epidemiology of UTI, influenced by factors such as increased comorbidities, aging populations, polypharmacy, and increased instrumentation of the urinary tract. [8]

2. Materials and Methods

2.1. Study Design and Setting

This research study is a comprehensive analysis of adult patients admitted for symptomatic urinary tract infections (UTIs) at the "Dr. Carol Davila" Central Military Emergency University Hospital in Bucharest. The study focuses on a specific patient population treated in the Departments of Infectious Diseases over a three-year period from January 2021 to December 2023. By conducting a single-centre observational cohort analysis, the researchers aim to gather detailed information about the characteristics and potential risk factors associated with UTI in this healthcare setting.

The study's design as an observational cohort analysis allows for the examination of clinical data, providing valuable insights into the management and outcomes of UTI in a hospital environment. The hospital's electronic database served as the primary source for data collection in this study.

The three-year duration of the study enables the researchers to identify trends and patterns in UTI cases over time, potentially revealing changes in patient demographics, causative pathogens, or treatment efficacy. The study protocol was approved by the Hospital Ethics Committee, being assessed under the internal registration code No. 718/29.08.2024.

"Dr. Carol Davila" Central Military Emergency University Hospital is a university hospital of 700 beds providing health care in Bucharest Romania.

2.2. Study Population

From January 2021 through December 2023, a total of 948 patients who experienced UTI were admitted at "Dr. Carol Davila" Central Military Emergency University Hospital in Bucharest. The study population included only adult patients.

2.3. Definitions and Variables

The study focused on patients presenting with symptoms of urinary tract infections (UTI) at the emergency department or other hospital wards. Inclusion criteria encompassed individuals with clinical presentations consistent with cystitis, prostatitis, pyelonephritis, or urinary sepsis, and those with microbiologically confirmed UTI. The definition of a confirmed UTI was based on the significant isolation of microorganisms in urine samples. Patients provided informed consent for data access and were followed prospectively for a six-month period.

The research protocol involved collecting a comprehensive set of data points. These included basic demographic information, pre-hospitalization residency, and admission and discharge dates. The study also examined individual comorbidities such as pre-existing urinary tract abnormalities, diabetes, obesity, cardiovascular diseases, chronic renal disease, active oncological illnesses, HIV status, and malnutrition. Additionally, predisposing risk factors for UTIs were identified, including urinary tract obstructions, vesicoureteral reflux, urinary tract lithiasis, benign prostate hyperplasia, bladder cancer, presence of catheters or foreign materials in the urinary tract, history of UTI, and sexually transmitted diseases. Clinical, analytical, and microbiological data at admission were meticulously recorded, encompassing sepsis criteria, vital signs, laboratory results, and culture findings. The study also tracked recurrence, need for rehospitalization, and 6-month survival as indicators of frailty following a UTI episode.

2.4. Statistical Analysis

The statistical analysis was performed using Mann-Whitney U tests to assess differences in clinical and demographic variables, as well as incidence rates between groups. This non-parametric test was chosen as it does not assume normal distribution of the data, making it suitable for comparing two independent groups when the dependent variable is either ordinal or continuous. The Mann-Whitney U test ranks all the values from both groups together and then evaluates whether the ranks for one group are significantly different from the other.

The significance level was established at P < 0.05, indicating that results with a p-value below this threshold were considered statistically significant. This commonly used threshold suggests a 5% chance of incorrectly rejecting the null hypothesis. All statistical analyses were conducted using SPSS software version 26.

3. Results

The study included a substantial cohort of 948 patients with notable sex distribution. Female patients constituted the majority, accounting for 597 individuals (62.9%), whereas male patients numbered 351 (37.1%). The average age of the participants was 74.32 years, with a standard deviation of 15.9 years, indicating a predominantly elderly population with some variation in the age range.

Analysis of UTI revealed distinct patterns of origin. A significant proportion of 741 cases (78.1%) were classified as community-acquired infections, suggesting that these UTIs were contracted outside healthcare settings, possibly in patients' homes or communities. Conversely, 207 cases (21.9%) were identified as healthcare-associated infections, implying that they were likely to be acquired during or shortly after interactions with healthcare facilities or services. This distribution highlights the importance of considering both community and healthcare settings in UTI prevention and management.

The most prevalent comorbidities observed in the study population were hypertension (61.9%), cardiovascular disease (25.4%), chronic renal disease (25%), diabetes mellitus (21.7%), and nephrolithiasis (19.9%). One hundred thirty-one patients presented with active neoplasia (13.8%). Of these, 41% were prostate tumors, followed by gynecological neoplasia (21.6%), and colon cancer (14%). Among all patients, 301 (31.7%) had a history of hospitalization within the preceding 30 days, and 52 (5.4%) were HIV-positive. Detailed information is presented in Table 1.

Table 1. Comorbidities.

Parameter	Total UTI n(%) N= 948
Chronic renal disease	237 (25)
Hypertension	587 (61.9)
Urinary tract obstruction	65 (6.8)
Nephrolithiasis	189 (19.9)
Malignancies	131 (13.8)
Heart failure	101(10.6)
Stroke	154(16.2)
Diabetes mellitus	206 (21.7)
HIV	52 (5.4)
Malnutrition	115 (12.1)
Cardiovascular disease	241 (25.4)
Hypertrophic prostate disease	146 (15.4)
Hospitalization 30 days prior	301 (31.7)

At the time of admission, one hundred sixty-five patients met the sepsis criteria, of which five (3%) presented with septic shock. Tachycardia was the most frequently altered vital sign (50.6%).

While the mean body temperature was elevated (38.7 °C), fever exceeding 39°C was observed in only 15.2% of patients. Acute kidney injury (28.6%) and hypotension (47.6%) occurred frequently. All patients exhibited abnormal urine sediment, with significant leukocyturia (87.7%) being the most prevalent abnormal marker, followed by hematuria (43.3%), and positive nitrites (32.1%). Blood analysis revealed elevated C-reactive protein levels and leukocytosis in 88.7% and 83.4% of the patients, respectively. Further details regarding the clinical and analytical parameters are provided in Table 2.

Table 2. Clinical characteristics.

Parameter	Total UTI n(%) N= 948
Tachycardia	480 (50.6)
Fever	798 (84.1)
Sepsis	165 (17.4)
Haematuria	411 (43.3)
Elevated CRP	841 (88.7)
Leukocytosis	791 (83.4)
Hypotension	452(47.6)
Acute kidney injury	272 (28.6)
Positive urine nitrites	305 (32.1)
Leukocyturia	832 (87.7)
Neutrophilia	696 (73.4)

This study provides detailed information on antibiotic treatment and microbial etiology in patients with urinary tract infection. All patients received empiric antibiotic treatment, with an average time of 12.56 ($\pm$ 6.56) hours between presentation and antibiotic initiation. The mean time to appropriate antibiotic initiation was longer, at 24.43 ($\pm$ 31.28) hours. A significant proportion of 267 patients (28.1%) received oral and intravenous antibiotic therapy, while 289 patients (30.4%) changed their antibiotic regimen during treatment. In addition, 257 patients (27.1%) transitioned from intravenous to oral antibiotics. Microbiological analysis revealed that all the patients had positive urine cultures. *Escherichia coli* was the most prevalent pathogen, identified in 443 patients (46.7%), followed by *Klebsiella pneumoniae* in 113 patients (11.9%) and *Enterococcus faecalis* in 109 patients (11.4%). Other notable pathogens included *Pseudomonas aeruginosa* isolated from 82 patients (8.6%), *Streptococcus agalactiae* from 72 patients (7.5%), *Staphylococcus aureus* from 70 patients (7.3%), and *Candida auris* from 59 patients (6.2%). Interestingly, nine infections (0.9%) were caused by polymicrobes. Among the isolated pathogens, *Candida auris* exhibited the highest antimicrobial resistance. Blood cultures were performed in 121 patients (12.7%), with 51 positive results (42.1%). In 82.46% of cases, there was concordance between urinary and blood isolates, with *E. coli* being the most common organism in blood cultures (28.9%). The mean total hospital stay was 11.65 ($\pm$ 10.23) days. Presence of positive blood cultures, obesity, and female sex were proven to be independent predictors for longer hospital stay.

Risk factors identified in our cohort including several demographic and clinical characteristics. Female sex emerged as a significant risk factor, likely due to anatomical differences that make women more susceptible to UTI. Age also played a crucial role, with older individuals generally at higher

risk. Prolonged immobilization, often associated with extended bed rest or limited mobility, was another important factor, potentially leading to urinary stasis and increased bacterial growth.

Urinary tract anomalies, including structural abnormalities or congenital defects, were found to predispose individuals to UTI. Urinary incontinence and urinary tract obstruction were also identified as risk factors, both of which can interfere with normal urinary flow and increase the likelihood of bacterial colonization. Additionally, a history of hospital admission within the past 30 days was noted as a risk factor, possibly due to exposure to healthcare-associated pathogens or interventions that may have compromised the urinary tract's natural defenses. These findings highlight the multifactorial nature of UTI risk and underscore the importance of considering both patient-specific and healthcare-related factors in prevention and management strategies.

4. Discussion

This study highlights the complex nature of tract infections in hospitalized patients, particularly in the elderly population. The findings revealed that a significant proportion of patients admitted for UTIs are characterized by high comorbidity rates and severe dependence, indicating a vulnerable patient group. [9,10] The study also emphasized the prevalence of recent hospitalizations and antibiotic treatments among these patients, suggesting a potential link between healthcare exposure and UTI occurrence. [10] Furthermore, the presence of urinary tract abnormalities and permanent urinary catheters in a substantial number of patients underscores the importance of considering these factors during UTI management. [10,11]

These research findings have important implications for clinical practice, particularly in the context of antibiotic therapy. This study suggests that unadjusted empirical antibiotic treatment may be inadequate for these complex patient groups, potentially leading to treatment failure and increased morbidity and mortality. Additionally, the identification of factors such as dependence, comorbidity, obesity, female sex, and bacteremia as predictors of longer hospital stay provides valuable insights for healthcare providers. [12–14] These findings can inform more targeted and personalized approaches to UTI management, potentially improving patient outcomes and reducing the burden on the healthcare system.

Urinary tract infections associated with indwelling catheters represent a significant healthcare challenge, with estimates suggesting that they account for up to 80% of complicated UTI. [14,15] The use of these catheters has been identified as an independent risk factor for UTI and is associated with increased patient morbidity. [14–16] This association is particularly concerning given that many catheter insertions are deemed unnecessary, and it is estimated that nearly half of catheter-associated UTI could be prevented through improved catheter management and more judicious use. [16–19]

The severity of catheter-associated UTI is underscored by the fact that the majority of these infections are classified as severe or complicated, with over 17% of cases meeting the criteria for sepsis. Notably, more than 84% of the patients presented with fever upon admission, highlighting the acute nature of these infections. However, it is crucial to recognize that diagnosing UTI solely based on clinical presentation can lead to a high rate of misdiagnosis. [20–22] This emphasizes the need for comprehensive diagnostic approaches that combine clinical assessment with laboratory testing to ensure the accurate identification and appropriate treatment of catheter-associated UTI, ultimately improving patient outcomes and reducing the burden on healthcare systems. [22,23]

The selection of patients in our study was based on a combination of clinical and analytical criteria, ensuring a focused approach to identifying cases of infection. Patients admitted to the hospital presented with clear clinical signs of infection, accompanied by significant analytical indicators such as pyuria (presence of white blood cells in urine) and/or the detection of nitrites in urine samples. These criteria are commonly associated with urinary tract infections and provide a strong initial basis for diagnosis. [22–24] Importantly, other potential infectious causes were ruled out during admission, further strengthening the specificity of our patient cohort.

Notably, in many cases, the responsible physicians did not pursue additional cultures beyond the initial diagnostic tests. This decision is likely influenced by the positive clinical evolution observed in these patients. As patients showed signs of improvement and responded well to initial

treatments, the need for further microbiological confirmation may have been deemed unnecessary by attending physicians. This approach, while potentially limited in terms of comprehensive microbiological data, reflects common clinical practice in which treatment decisions are often guided by a combination of initial diagnostic results and subsequent clinical response. [25,26] However, this aspect of the study methodology should be considered when interpreting the results, as it may have implications for the completeness of the microbiological profile of our patient population.

The implications of this research extend beyond individual patient care, emphasizing its broader impact on public health and healthcare systems. Accurate diagnosis and appropriate treatment of tract infections are crucial not only for patient well-being, but also for combating the global threat of antibiotic resistance. [27,28] By highlighting the limitations of relying solely on nonspecific inflammatory markers, this study underscores the importance of evidence-based medicine in infectious disease management. These findings suggest that healthcare providers should adopt a more comprehensive approach to UTI diagnosis, incorporating urine cultures as a standard practice, especially in high-risk populations or severe cases requiring hospitalization. [27–29] Moreover, this study has significant implications for healthcare policies and resource allocation.

By advocating for more precise diagnostic methods and targeted antibiotic therapy, it presents an opportunity to optimize healthcare expenditures and improve overall patient outcomes. [29,30] The potential cost savings from reduced antibiotic use, shorter hospital stay, and fewer complications may be substantial. [30] Additionally, this approach aligns with antimicrobial stewardship programs, which aim to preserve the effectiveness of existing antibiotics by promoting judicious use. [29,30]

As healthcare systems worldwide grapple with rising costs and the challenge of antibiotic resistance, implementing the recommendations from this research could contribute to more sustainable and effective UTI management strategies, ultimately benefiting both individual patients and public health. [28–30]

Risk factors contributing to extended hospital stays were consistent across both the entire cohort and the subset of patients with confirmed urinary cultures. [31] The significant predictors of prolonged hospitalization included the presence of important comorbidities and patient dependence. [31] Notably, female sex and obesity also emerged as factors associated with longer hospital stay. These findings underscore the complex interplay between patient characteristics and clinical factors in determining the duration of hospital stay for tract tract infections. [31] This highlights the need for cautious interpretation of the results and emphasizes the importance of conducting other studies to further validate these findings and explore potential risk factors that may have been overlooked owing to sample size limitations. [31]

The high prevalence of previous UTI episodes in the patient cohort, with over 30% experiencing confirmed or suspected UTI in the month preceding admission, highlights the recurrent nature of these infections in vulnerable populations. However, the low rate of documented asymptomatic bacteriuria (5%) suggests potential gaps in screening or documentation practices. The microbial profile observed in this study aligns with established patterns, with *E. coli* being the predominant pathogen, followed by *K. pneumoniae* and *E. faecalis*. This finding reinforces the importance of tailoring empiric antibiotic therapy to effectively target common uropathogens. [32]

This study underscores the complex health status of patients with UTI, particularly in older populations. The significant association between severe dependence and prolonged hospital stay reaffirms the impact of frailty and comorbidities on patient outcomes. [33] This observation emphasizes the need for comprehensive geriatric assessments and targeted interventions to address the multifaceted needs of vulnerable patients. [31,32] Furthermore, it suggests that strategies aimed at improving functional status and reducing dependency might potentially lead to shorter hospital stays and better overall outcomes in older adults with UTI. [32]

The evolving landscape of urinary tract infections requiring hospitalization presents a significant challenge in contemporary healthcare. [31,32] Although the clinical presentation of these cases is undergoing notable changes, there is a dearth of up-to-date information to guide medical professionals. [32,33] The majority of the available evidence stems from case-control studies and retrospective cohort analyses, which, while informative, may not fully capture the current trends and

complexities of UTI cases necessitating inpatient care. [33] The scarcity of recent prospective cohort studies and the limited sample sizes of those that do exist further compounds the challenge of understanding and managing these evolving presentations. [33]

Our study addresses this knowledge gap by offering a comprehensive analysis of UTI cases requiring hospitalization. The strength of our approach lies in the application of multivariate regression techniques coupled with a variable selection process grounded in biological plausibility. This methodological rigor enhances the reliability and relevance of our findings, providing valuable insights into the changing patterns of UTI presentation in hospitalized patients. [34]

By focusing on biologically plausible variables, our study aimed to uncover meaningful associations and potential risk factors that can inform clinical decision-making and improve patient care strategies for this evolving patient population.

5. Conclusions

The changing landscape of urinary tract infections requiring hospitalization presents significant challenges for healthcare providers. As patients become older and frailer with increased comorbidities, the complexity of UTI cases has increased. These patients often present with severe or complicated infections accompanied by vague symptoms that can delay proper diagnosis and treatment initiation. This shift in epidemiology and presentation underscores the need for heightened awareness among healthcare professionals to promptly recognize and address UTI in vulnerable populations.

The identification of hypertension and nephrolithiasis as risk factors for UTI adds another layer of complexity to patient management. These comorbidities not only increase the likelihood of developing UTIs but may also complicate treatment. The vicious cycle created by UTI in elderly patients, where infections lead to increased frailty, which in turn increases susceptibility to future infections, highlights the importance of comprehensive care strategies. Although some risk factors may be inherent and unmodifiable, there is a pressing need to optimize the management of associated pathologies. This approach may include better control of hypertension, proactive management of nephrolithiasis, and implementation of preventive measures to reduce the incidence and severity of UTI in high-risk populations.

Limitations: The limitations of this study extend beyond its single-center, retrospective design. The potential for selection bias inherent in this approach may have influenced the patient cohort, potentially skewing the results towards a specific demographic or clinical profile. This could limit the generalizability of our findings to broader populations or healthcare settings. In addition, retrospective studies rely on previously collected data, which may be incomplete or inconsistent, potentially affecting the accuracy of the analysis. To address these limitations and strengthen the evidence base, future research should prioritize multicenter prospective studies. Such studies would allow for a more diverse patient population, thus reducing the impact of regional or institutional biases.

Conflicts of Interest: The authors declare no conflicts of interest.

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