UROSEPSIS AS A CLINICAL CHALLENGE: DIAGNOSIS, TREATMENT, AND MEDICAL PERSPECTIVES

Urosepsa jako wyzwanie kliniczne: diagnostyka, leczenie i perspektywy medyczne

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Abstract

Urinary tract infections are among the most common bacterial diseases in adults and, in some cases, may lead to the development of urosepsis, defined as a septic syndrome originating from the urinary tract. In civilian healthcare settings, urosepsis is generally straightforward to recognise and manage; however, military medicine presents additional challenges, such as delayed evacuation, limited diagnostic capabilities, and restricted therapeutic resources. The aim of this study was to analyse the epidemiology, diagnostic criteria, and therapeutic strategies in urosepsis, based on a literature review of PubMed, Scopus, and Web of Science databases (2019–2025), as well as current international guidelines (Sepsis-3, Surviving Sepsis Campaign, European Association of Urology). Particular emphasis was placed on rapid diagnostic methods, simplified risk-assessment tools, and treatment procedures feasible, for example, in field hospitals. Urosepsis is the most common septic syndrome in urology, which accounts for approximately 25% of all sepsis episodes. Under field conditions, the use of simplified clinical criteria (fever, hypotension, altered mental status) and bedside tests (urinalysis, basic inflammatory markers) is of primary importance, as complex clinical scoring systems such as SOFA or qSOFA are often impractical. Management requires immediate initiation of empirical antibiotic therapy, fluid resuscitation, early administration of vasopressors, and rapid removal of the source of infection. Early recognition using simple criteria, prompt initiation of empirical treatment, and adaptation of therapeutic procedures to field conditions are critical for improving patient outcomes.

Streszczenie

Zakażenia układu moczowego należą do najczęstszych chorób bakteryjnych u dorosłych, a w części przypadków mogą prowadzić do rozwoju urosepsy, definiowanej jako zespół septyczny wywodzący się z układu moczowego. W warunkach cywilnych urosepsa jest stosunkowo łatwa do rozpoznania i leczenia, jednak w medycynie wojskowej pojawiają się dodatkowe wyzwania, takie jak opóźniona ewakuacja, utrudniony dostęp do diagnostyki oraz ograniczone zasoby terapeutyczne. Celem pracy była analiza epidemiologii, kryteriów rozpoznania oraz strategii terapeutycznych stosowanych w urosepsie, którą przeprowadzono na podstawie przeglądu piśmiennictwa z baz PubMed, Scopus i Web of Science (2019–2025) oraz aktualnych wytycznych międzynarodowych (Sepsis-3, Surviving Sepsis Campaign, European Association of Urology). Szczególną uwagę zwrócono na szybkie metody diagnostyczne, uproszczone narzędzia oceny ryzyka oraz procedury terapeutyczne możliwe do wdrożenia na przykład w szpitalach polowych. Urosepsa jest najczęstszą postacią sepsy w urologii, odpowiada za około 25% przypadków sepsy. W warunkach polowych kluczowe znaczenie ma stosowanie uproszczonych kryteriów klinicznych (gorączka, hipotensja, zaburzenia świadomości) oraz badań przyłóżkowych (analiza moczu, podstawowe markery zapalne), gdyż rozbudowane kliniczne skale SOFA i qSOFA są często niepraktyczne. Leczenie obejmuje natychmiastowe wdrożenie antybiotykoterapii empirycznej, resuscytację płynową, wczesne zastosowanie leków wazopresyjnych i szybkie usunięcie źródła zakażenia. Wczesne rozpoznanie, oparte na prostych kryteriach, natychmiastowe wdrożenie leczenia empirycznego oraz dostosowanie procedur terapeutycznych do warunków polowych mają kluczowe znaczenie dla poprawy rokowania.

Keywords: sepsis; urinary tract infections; urosepsis; SOFA; qSOFA

Słowa kluczowe: sepsa; zakażenia układu moczowego; urosepsa; SOFA; qSOFA

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Introduction

Urosepsis is defined as a severe form of urinary tract infection in which the infection disseminates into the bloodstream, leading to sepsis, septic shock, and ultimately multi-organ failure. Sepsis, as defined by the Sepsis-3 criteria, is a critical condition in which infection triggers an abnormal host response that results in organ failure and poses a threat to life [1]. Urosepsis is characterised by a primary infectious focus within the urinary tract, which distinguishes it from other sepsis aetiologies [2].

In everyday clinical practice, urinary tract infections rank among the most common infectious diseases, and one of their serious complications is urosepsis, which accounts for approximately 25% of all sepsis episodes [3]. Reported case fatality rates range from 20% to 40% and may be even higher once septic shock develops [3]. Notably, each hour of delay in initiating effective targeted antimicrobial therapy increases mortality risk by approximately 7–8%.

Urosepsis is primarily regarded as a complication of acute pyelonephritis. In line with Sepsis-3 guidance, current practice emphasises the objective assessment of organ dysfunction using the Sequential Organ Failure Assessment (SOFA) or quick SOFA (qSOFA) scores, which facilitates more accurate risk stratification and timely therapeutic decision-making [1]. Scoring systems such as SOFA and qSOFA are not intended as diagnostic criteria but rather as prognostic tools designed to assess disease severity and mortality risk.

Urosepsis occurs predominantly in older adults and in individuals with comorbidities such as diabetes, chronic kidney disease, or immunosuppression. Additional major risk factors include urinary outflow obstruction, nephrolithiasis, and benign prostatic hyperplasia [2, 4]. Field conditions, limited access to specialist care, and constraints on medical evacuation further increase the risk and complexity of urosepsis management in military populations [4].

From a military medicine perspective, episodes of urosepsis may necessitate medical evacuation from the operation theatre, directly affecting unit readiness. Prevention and early intervention depend on training medical personnel to recognise sepsis promptly and on implementing the “first-hour bundle”, which encompasses rapid initiation of appropriate antimicrobials and haemodynamic/supportive measures [5, 6].

In summary, urosepsis remains one of the most serious complications of urinary tract infections. Its high mortality rate, rapid clinical progression, and potential for multi-organ involvement pose substantial diagnostic and therapeutic challenges. The literature underscores the need for further research into biomarkers that support early recognition and effective adjunctive therapies [5, 6].

Epidemiology and clinical significance

The epidemiology of urosepsis is a critical area of clinical and public health research, as it represents one of the most frequently encountered and aggressive forms of sepsis originating from urinary tract infections. Urosepsis accounts for approximately 25% of all sepsis cases, with reported mortality rates ranging from 20% to 40%, depending on the study population and the severity of disease at presentation [7, 8]. Differences in the epidemiological profile between community-acquired and hospital-acquired infections are illustrated in Figure 1.

In the general population, higher incidence rates are observed in older adults, particularly women, owing to their increased susceptibility to urinary tract infections. Additional risk factors include urolithiasis, urinary outflow obstruction, bladder catheterisation, immunosuppression, and chronic comorbidities, such as diabetes mellitus [7].

In hospital settings, antimicrobial resistance poses an escalating challenge, especially among *Enterobacterales* strains producing extended-spectrum beta-lactamases (ESBLs) and multidrug-resistant *Pseudomonas aeruginosa*. Rising prevalence of these pathogens complicates therapeutic management and is associated with poorer outcomes in patients with urosepsis [8].

The chart illustrates differences in incidence, mortality, pathogen spectrum, and antibiotic resistance. Hospital-acquired urosepsis is characterised by substantially higher incidence (approximately 70% vs. 30%), greater mortality (40% vs. 20%), more frequent involvement of multidrug-resistant organisms (80% vs. 40%), and a markedly higher rate of antibiotic resistance (90% vs. 30%) compared with community-acquired infections. These findings highlight the need for distinct diagnostic and therapeutic strategies depending on the site of infection onset, which is particularly relevant in field conditions where treatment options are limited.

An important epidemiological aspect is the distinction between community-acquired and hospital-acquired urosepsis. In the former, *Escherichia coli* remains the predominant pathogen, whereas in nosocomial infections, multidrug-resistant organisms such as *Klebsiella pneumoniae* and *Enterococcus faecium* are more frequently isolated. The latter group is also associated with higher

mortality rates, largely due to more severe clinical courses and limited therapeutic options [7].

In military settings, urosepsis carries particular significance, as field conditions such as dehydration, limited hygiene, and delayed access to specialised medical care during combat missions substantially increase the risk of severe urinary tract infections. Under these circumstances, rapid recognition and prompt intervention are crucial and can significantly reduce mortality.

Current projections indicate a global increase in the burden of urosepsis, driven by a longer life expectancy, more frequent use of urological procedures, and a growing number of immunocompromised patients. From this perspective, the epidemiology of urosepsis has emerged not only as a medical issue but also as a major challenge for healthcare systems worldwide [4, 9].

Pathophysiology of urosepsis

Among the most dangerous outcomes of urinary tract infections is urosepsis, a condition characterised by intricate mechanisms involving impaired immune regulation, alterations in microcirculation, and endothelial damage. Sepsis begins with the presence of pathogens in the urinary tract that trigger a systemic inflammatory response once translocated into the bloodstream. A critical factor is the imbalance between pro-inflammatory and anti-inflammatory mechanisms, ultimately leading to tissue injury and multi-organ dysfunction (MODS) [1].

In this process, key functions are carried out by macrophages, monocytes, and neutrophils, which release pro-inflammatory mediators including TNF-α, IL-1β, and IL-6. Excessive production of these mediators can result in a "cytokine storm", causing endothelial injury, increased vascular permeability, and arterial hypotension. Subsequent microcirculatory disturbances, including pericyte and endothelial cell dysfunction, lead to tissue hypoxia, lactic acidosis, and ultimately, MODS [10, 11].

Certain uropathogens, such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterococcus faecalis*, can form biofilms that hinder host immune defences and reduce the efficacy of antimicrobial therapies. Moreover, urinary tract obstruction facilitates bacterial proliferation and increases the likelihood of progression to systemic infection [7, 12].

Clinically relevant biomarkers include serum lactate, a strong predictor of sepsis severity; procalcitonin (PCT); and C-reactive protein (CRP), which are widely used to assess infection activity and monitor treatment responses. Emerging markers such as presepsin and mid-regional pro-adrenomedullin show promise for future clinical application [13–15].

Overall, the pathophysiology of urosepsis is rooted in the complex interplay between pathogen virulence and the host immune response, leading to systemic organ dysfunction. A deeper understanding of these mechanisms is essential for improving early diagnosis and advancing the development of novel targeted therapies.

Importance of early diagnosis in urosepsis

The early diagnosis of urosepsis remains a critical determinant of effective treatment and mortality. Urosepsis is a severe clinical condition arising from urinary tract infection that leads to a systemic septic response, organ dysfunction, and a markedly increased mortality risk. The interval between symptom onset and the initiation of appropriate therapy is the primary prognostic factor, with each hour of delay in administering effective antibiotic treatment increasing mortality by approximately 7–8% [1, 6].

Standardised tools such as the SOFA score and the simplified qSOFA are employed to rapidly assess disease severity in urosepsis. Scoring systems such as SOFA and qSOFA do not serve as diagnostic tools in the strict sense; rather, they are intended solely for assessing the severity of organ dysfunction and forecasting the clinical

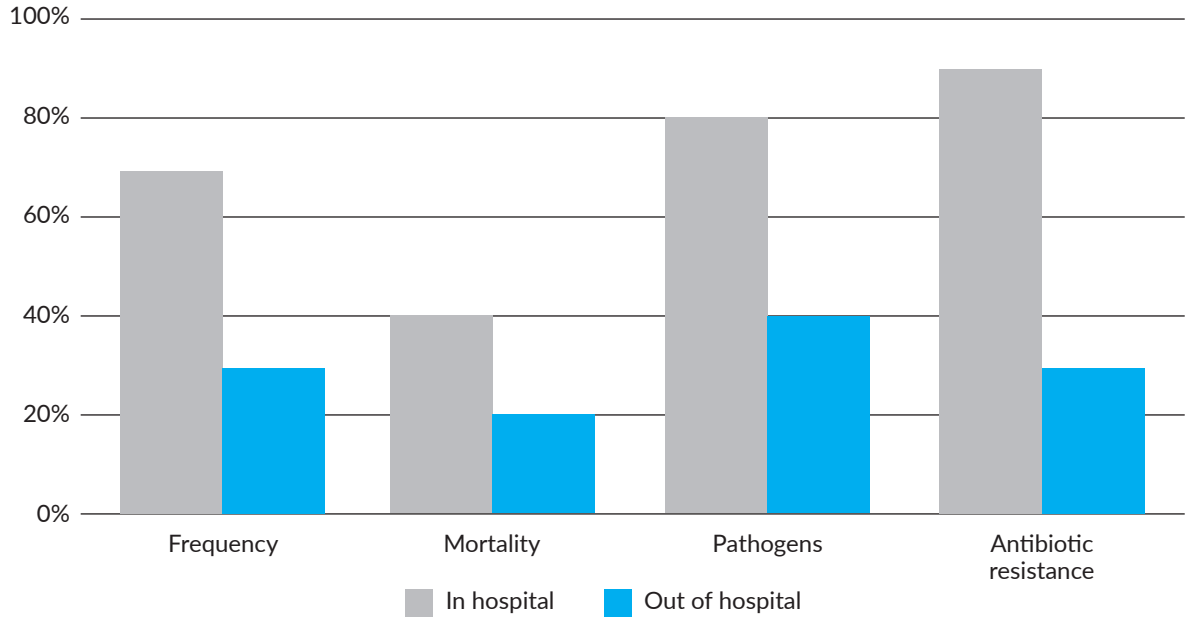

Figure 1. In-hospital and out-of-hospital differences in urosepsis [7, 8]

course. Their primary value lies in monitoring disease dynamics and identifying patients who require escalation of therapy, but they cannot substitute for sepsis diagnostic criteria. In military medicine, the diagnosis and management of urosepsis must be adapted to battlefield realities and limited access to specialised procedures. Simple assessment instruments, such as qSOFA, are of particular importance because they enable rapid identification of patients at risk of severe sepsis. When combined with physical examination and basic imaging such as point-of-care ultrasound (POCUS), these tools support early recognition and the initiation of life-saving interventions. In situations where full laboratory diagnostics are unavailable, therapeutic decisions must rely on the clinical picture and the immediate initiation of empirical antibiotics together with intensive supportive care. Implementing such a simplified protocol has the potential to improve prognosis and reduce mortality, even in field conditions. A practical battlefield approach involves a streamlined algorithm comprising: (1) rapid recognition of warning signs (fever, hypotension, altered mental status), (2) immediate initiation of empirical antibiotic therapy, (3) aggressive fluid resuscitation, and (4) evacuation to a referral centre if no improvement is observed [1, 4, 6].

These instruments facilitate the identification of patients at risk of severe sepsis who require urgent intervention. Owing to its simplicity and accessibility (evaluating respiratory rate, blood pressure, and mental status), qSOFA is particularly valuable in prehospital and military settings, where access to laboratory diagnostics may be limited [1].

In the evaluation of patients with suspected sepsis, the SOFA score demonstrates higher sensitivity (approximately 85%) compared with the qSOFA score (approximately 65%), making it more effective for detecting patients at risk of severe disease progression. Conversely, qSOFA exhibits greater specificity (80% vs. 70%), indicating that it is more reliable for ruling out false-positive cases. Importantly, both tools serve complementary roles: SOFA remains the standard for assessing sepsis severity in hospital and intensive care settings, while qSOFA, owing to its simplicity and higher specificity, is especially useful in prehospital environments and non-ICU wards [1].

The cornerstone of diagnosing and monitoring urosepsis is the rapid collection of biological samples (urine for analysis and culture; blood for microbiological testing) prior to the initiation of empirical antibiotic therapy [4]. Serum lactate concentration is considered a key prognostic biomarker, as elevated levels correlate with hypoperfusion and worse clinical outcomes [16, 17]. Additional biomarkers, including PCT and CRP, support the differentiation of bacterial infections and assist in monitoring treatment effectiveness [13, 16, 18].

Prompt detection of urinary tract obstruction is critical in urosepsis diagnostics. Ultrasonography of the urinary tract, particularly point-of-care ultrasound (POCUS), is a rapid and non-invasive method for identifying urinary retention and calculi, thereby preventing further clinical deterioration [19]. Computed tomography (CT) is recommended in cases with an ambiguous clinical presentation, especially when complications such as renal abscess or necrotising pyelonephritis are suspected, as CT enables superior visualisation of inflammatory changes and ischaemic areas within the renal parenchyma [19]. When urinary tract obstruction is identified as the underlying cause of sepsis, early urological intervention – such as percutaneous nephrostomy or placement of a JJ stent – may be required to decompress the collecting system and prevent further clinical decline [20, 21].

Within the framework of the "sepsis bundle," essential diagnostic and therapeutic measures should be performed within the first hour of recognition: microbiological sampling, assessment using SOFA/qSOFA, lactate measurement, initiation of empirical antibiotic therapy, and commencement of fluid resuscitation [6]. Early diagnosis is therefore an integral component of an effective therapeutic strategy.

In the military context, limited access to comprehensive diagnostics under field conditions poses a major challenge. Rapid and simple tools such as qSOFA and portable imaging modalities (POCUS), combined with adequate personnel training, are thus essential to minimise delays in recognition and intervention. A summary of key diagnostic and therapeutic approaches applicable in both civilian and field conditions is presented in Table 1.

The clinical management of urosepsis is critical for patient prognosis. Rapid identification and immediate treatment initiation significantly reduce mortality and limit the risk of multi-organ failure. Both the European Association of Urology guidelines [4] and the Surviving Sepsis Campaign unequivocally recommend a multidimensional approach including causal treatment (antibiotics and source control), life-supportive therapy, and continuous monitoring.

Therapeutic choices should depend on local resistance patterns, prior microbiological results, and the clinical condition of the patient. Carbapenems, third-generation cephalosporins, and fluoroquinolones are frequently used, while combination regimens are increasingly important in the context of increasing antimicrobial resistance [1, 4].

Supportive therapy must be initiated concurrently with causal treatment. The key element is aggressive crystalloid fluid resuscitation aimed at haemodynamic stabilisation, with close monitoring of cardiorespiratory parameters and hourly urine output. High-flow oxygen therapy or mechanical ventilation may be required in cases of severe respiratory failure [6].

Therefore, source control is essential. In urosepsis, this most often involves relief of urinary tract obstruction via JJ stent placement, percutaneous nephrostomy, or endoscopic urological intervention. The sooner the obstruction is removed, the greater the chance of eradicating the infection and reducing the risk of recurrence [4].

If hypotension persists after fluid therapy, vasopressor use (e.g. norepinephrine) is indicated. Metabolic monitoring of glucose, lactate, and electrolytes is also essential, with renal replacement therapy implemented if necessary. Therapy must be tailored to patient age,

Table 1. Diagnosis and management of urosepsis – comparison of civilian and military practice [1, 4, 6, 16, 22–24]

Stage of management	Civilian practice	Military / field practice
Diagnosis	Sepsis-3 criteria: infection + organ dysfunction (SOFA ≥2)	Clinical criteria: fever, tachycardia, tachypnoea, altered mental status; simplified qSOFA assessment
Laboratory diagnostics	Full laboratory panel: CBC, CRP, PCT, creatinine, blood and urine cultures	Urinalysis, CRP (where available), clinical evaluation; decisions often made without full diagnostics
Imaging	Ultrasound/Computed tomography to identify urinary tract obstruction	Point-of-care ultrasound or physical examination only
Antibiotic therapy	Broad-spectrum antibiotics according to local guidelines (European Association of Urology, Surviving Sepsis Campaign 2021)	Immediate empirical antibiotic treatment using agents available under field conditions (e.g. third-generation cephalosporins or carbapenems, where available)
Haemodynamic stabilisation	Early fluid resuscitation, blood pressure monitoring, vasopressor therapy (norepinephrine)	Intensive fluid therapy, basic monitoring; vasopressors where available (norepinephrine/alternatives in field hospitals)
Source control	Nephrostomy, JJ stent insertion, endoscopic or surgical procedures	Bladder catheterisation, nephrostomy (where feasible), evacuation to a higher-level facility
Follow-up care	Monitoring of biochemical parameters, fluid balance, organ function	Clinical observation, preparation for transfer to a referral centre
CBC – complete blood count; CRP – C-reactive protein; PCT – procalcitonin; SOFA – Sequential Organ Failure Assessment; qSOFA – quick Sequential Organ Failure Assessment		

comorbidities, and risk of antimicrobial resistance. Particular attention should be paid to elderly and immunosuppressed patients, in whom infections tend to progress rapidly and aggressively [6].

Effective management of urosepsis requires rapid diagnosis, immediate initiation of antibiotic therapy, haemodynamic support, timely source control, and individualised treatment strategies. Multidisciplinary collaboration (urology, intensive care, and microbiology) remains key to improving survival outcomes and reducing complications.

Although urosepsis is often described as one of the more common and clinically milder forms of sepsis, it remains a significant clinical challenge in both civilian and military medicine. Urinary tract infections, which are the usual source, rank among the most frequent infections in adults, and under combat conditions they may progress because of limited access to diagnostics and delays in therapeutic intervention. According to current epidemiologic data, early recognition and prompt initiation of treatment are critical determinants of patient outcomes.

Field diagnostics require simplification. Comprehensive scoring systems such as SOFA may be useful in facilities with full laboratory support; however, in military practice, greater emphasis is placed on the assessment of basic vital signs and readily available inflammatory markers. Simple tools such as urinalysis or CRP testing, combined with the assessment of clinical symptoms (fever, tachycardia, altered mental status), enable rapid decisions regarding the initiation of treatment and patient evacuation.

Therapeutic management should focus on the immediate administration of broad-spectrum antibiotics and haemodynamic stabilisation, in accordance with the Surviving Sepsis Campaign (2021) recommendations. Equally important is the prompt relief of urinary tract obstruction, which in many cases determines the success of therapy. In combat settings, the availability of simple urinary drainage procedures, such as catheterisation or nephrostomy, is critical, as is the ability to continue empirical therapy until evacuation can be undertaken.

From a military medical perspective, urosepsis may impair a soldier's ability to perform operational duties, even when its clinical course is relatively mild compared with other forms of sepsis. Its impact on physical performance and the potential for long-term complications (e.g. renal damage) justify considering it a significant health concern in military personnel.

The management of urosepsis requires different priorities depending on the operational setting. In civilian healthcare, comprehensive diagnostic assessment and guideline-based treatment (European Association of Urology) represent the standard of care. In military practice, however, the focus must be on rapid recognition based on clinical signs, immediate empirical treatment, and patient stabilisation prior to transport. An integrated approach that takes into account the unique aspects of military medicine may significantly reduce mortality and enhance operational readiness.

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