Scoping Review on Management of Nephrostomy – and Double J-Stent – Associated Infections

Uma Scoping Review para Identificar a Melhor Gestão das Infeções Associadas à Nefrostomia e ao Cateter Duplo J

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Abstract

Catheter-associated urinary tract infections (CA-UTIs) refer to infections related to indwelling urinary catheters and are the main cause of hospital-acquired urinary tract infections. Most literature, including the European Urological Association (EAU) Urological Infections Guidelines, defines CA-UTIs as infections specifically associated with urethral catheters, excluding catheter-associated infections related to percutaneous nephrostomies and double-J stents. As a result, there are limited guidelines for managing these types of infections, namely, on determining when to change or remove the catheter. This is probably due to the scarcity of information, the lack of uniformization in terminology (bacteriuria *versus* infection) and the low evidence of available studies.

This scoping review seeks to map the available evidence on infections associated with percutaneous nephrostomies (PN-UTIs) and double-J stents (DJ-UTIs). The review aims to address if studies provide a clear definition of asymptomatic bacteriuria and stent-associated infections; what are the most common pathogens associated with PN- and DJ-UTIs, and what recommendations are outlined in the literature for managing these infections.

We performed this scoping review according to the PRISMA-ScR extension for scoping reviews. The search was made in the databases PubMed/MEDLINE, Scopus and Cochrane Library. We defined the following outcomes for analysis: type of stent, definition of bacteriuria and infection, urine and stent culture methods, pathogens, and information on treatment approach.

The search yielded 441 articles, narrowed to 12 based on eligibility, relevance, and currency. Most studies, aside from two systematic reviews, were prospective and retrospective observational cohorts with small sample sizes (median 204 patients) and evidence level 3c. Stent-related infections were defined using inconsistent clinical criteria, with asymptomatic bacteriuria often undefined. Common pathogens included *E. coli* (26%), *Enterococcus faecalis* (17%), and *Pseudomonas aeruginosa* (14%). Urine cultures are typically performed using midstream urine samples, while stent cultures are primarily conducted for research purposes. Treatment approaches in the literature are highly variable. The management of catheters for source control is a topic with limited discussion, and recommendations vary, including stent replacement either before or after starting empirical antibiotics. A standardized treatment protocol remains to be established.

Keywords: Nephrostomy; Scoping Review; Stents; Urinary Tract Infections

Resumo

As infeções do trato urinário associadas a cateteres (CA-UTI) são a principal causa de infeções adquiridas no hospital. A maior parte da literatura, incluindo as Diretrizes para as Infeções Urológicas da Associação Europeia de Urologia (EAU), define as CA-UTI como infeções especificamente associadas a cateteres uretrais, excluindo as infeções associadas a nefrostomias percutâneas e stents duplo-J. Consequentemente, existem orientações limitadas para a gestão deste tipo de infeções, nomeadamente para determinar quando mudar ou remover o cateter. Este facto deve-se provavelmente à escassez de informação, à falta de uniformização na terminologia (bacteriúria versus infeção) e à baixa evidência dos estudos disponíveis.

Esta scoping review procura mapear a evidência disponível sobre infeções associadas a nefrostomias percutâneas (PN-UTIs) e stents duplo-J (DJ-UTIs). A revisão tem como objetivo determinar se os estudos fornecem uma definição clara de bacteriúria assintomática e infeções associadas a stents; quais são os agentes patogénicos mais comuns, e que recomendações são delineadas na literatura para a gestão destas infeções.

Realizámos esta scoping review de acordo com a extensão PRISMA-ScR para scoping reviews. A pesquisa foi efetuada nas bases de dados PubMed/MEDLINE, Scopus e Cochrane Library. Definimos os seguintes resultados para análise: tipo de stent, definição de bacteriúria e infeção, métodos de cultura da urina e do stent, agentes patogénicos e informação sobre a abordagem de tratamento.

A pesquisa revelou 441 artigos, reduzidos a 12 com base na elegibilidade, relevância e atualidade. A maioria dos estudos, à exceção de duas revisões sistemáticas, eram coortes observa-

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cionais prospetivos e retrospetivos com amostras de pequena dimensão (mediana de 204 doentes) e nível de evidência 3c. As infeções relacionadas com stents foram definidas utilizando critérios clínicos inconsistentes, com bacteriúria assintomática frequentemente indefinida. Os agentes patogénicos mais comuns incluíram E. coli (26%), Enterococcus faecalis (17%) e Pseudomonas aeruginosa (14%). As culturas de urina foram normalmente efetuadas utilizando amostras de urina do jato médio, enquanto as culturas de stent são realizadas principalmente para fins de investigação. As abordagens de tratamento na literatura são altamente variáveis. A gestão de cateteres para controlo da fonte de infeção é um tópico com discussão limitada, e as recomendações variam, incluindo a substituição do stent antes ou depois de iniciar antibióticos empíricos. Continua a ser necessário estabelecer um protocolo de tratamento normalizado.

Palavras-chave: Catéteres; Infeções do Sistema Urinário; Nefrostomia; Scoping Review

Introduction

Urinary infections related to catheters are mentioned in most research and clinical guidelines, including those from the European Association of Urology (EAU) and the Centers for Disease Control and Prevention (CDC), as infections associated with indwelling urethral catheters, specifically Foley catheters (CA-UTIs). These guidelines offer comprehensive strategies for preventing, diagnosing, and treating CA-UTIs.[1,2] However, they typically exclude other types of urinary catheters, such as percutaneous nephrostomies (PN) and double-J (DJ) stents, even though these devices pose a considerable risk of infection.[3]

Some effort has already been made to characterize infections associated with percutaneous nephrostomies (PN-UTIs) and double-J stents (DJ-UTIs). A 2020 systematic review encompassing 26 studies investigated potential PN- and DJ-UTIs risk factors. Duration of ureteral stent, diabetes mellitus, female gender, chronic renal failure, diabetic nephropathy, and cancer were found to increase the risk of asymptomatic bacteriuria (ABU) and ureteral stent colonization. However, none of these factors demonstrated a statistically significant association with the development of symptomatic UTIs.[3] The causal relationship between ABU and symptomatic UTI in this patient population remains to be established.[4] The absence of definitive conclusions in this study can be attributed to two factors: the substantial heterogeneity in the criteria used across the literature to distinguish symptomatic UTIs from asymptomatic bacteriuria (ABU), and the inclusion of studies with low levels of evidence, marked by significant methodological variability and correspondingly different results.[3]

Due to the scarcity of high-quality evidence, DJ- and PN-UTIs remain poorly defined. Consequently, in contrast to other well-studied urological infections, no standardized treatment guidelines currently exist for their management. One clinical challenge in treating these infections is implementing the source control strategy, focused on identifying and eliminating the source of infection to prevent continued microbial contamination of otherwise sterile tissues, organs, or body cavities.[5] It is well accepted as a key element in the management of sepsis and septic shock.[6] Due to the resistance of bacteria in biofilm to antibiotics, bacteria can adhere, colonize, and survive on indwelling medical devices even when antimicrobial drugs are in use.[7,8] A common example of source control is infections associated with central venous catheters (CVC), which guidelines state that CVCs are considered a source of infection and shall be removed.[9] Source control principles also apply to infections of the genitourinary tract: it is well accepted that CA-UTIs require removal of the catheter[1,2]; in case of obstructive pyelonephritis, decompression is required; and drainage is necessary for kidney or pelvic abscesses.[5] PN and DJ stents can also be a source of bacterial adhesion and colonization[10-14]; however, no specific guidelines exist on how to manage these stents in the case of infection.

With the rising concern regarding antibiotic resistance,[15] effective treatment strategies for patients with systemic infections are a priority area of study. Considering the gaps in knowledge regarding PN- and DJ-UTIs, a scoping review was undertaken, with the following research questions:

1) How are ABU, PN-UTIs, and DJ-UTIs defined in the literature?
2) Which pathogens are most commonly associated with PN--UTIs and DJ-UTIs (excluding ABU)?
3) What management recommendations for PN-UTIs and DJ--UTIs, namely for diagnosis and treatment, are provided in the literature?

Methods

This review was performed according to the PRISMA-ScR extension for scoping reviews.[16]

The main eligibility criterion was articles describing and assessing infection (not colonization or ABU) in patients with DJs and PNs. We considered infection as the presence of symptoms (fever and urinary tract symptoms) with a positive urine culture.[3] The inclusion and exclusion criteria are summarized in Table 1.

The search was made in PubMed/MEDLINE, Scopus, and Cochrane Library in August 2023.

Search strategies were drafted and refined through team discussion. We used the following search items: “nephrostomy”, “double J stent”, “ureteral stent”, and “infection”, searching in Title in the first three items, and Title/Abstract in the last. In the Scopus database, we also limited the search to articles written in the eligible languages and limited the subject to “medicine”.

Articles were eligible for first review if the eligibility criteria were met through title and abstract analysis by two independent au-

Table 1 – Inclusion and exclusion criteria of the scoping review.

Inclusion criteria	Exclusion criteria
Population: patients older than 18 years with PN- or DJ-UTIs	Population: renal transplant recipients
Language: English, Spanish, Portuguese, German	Commentaries, letters, and reviews
Reviews: only if information/ /expert opinion on treatment	

thors. The first selection of articles was done through *Rayyan*® software, and the final selected articles were exported to a shared online database. The second stage included a full-text screening of the selected articles. Studies that did not meet the inclusion criteria were excluded, and disagreements between the reviewers were resolved through discussion or with the input of a third reviewer.

After the final article selection, we created a data-charting form for exporting information for the scoping review. Two reviewers independently charted data from each eligible article. Any disagreements were resolved through discussion between the two reviewers or further adjudication by a third reviewer.

The items analyzed and exported from the selected articles were: definition of ABU and infection, urine and stent culture methods, pathogens, and treatment approach (choice of antibiotics and management of the PN or DJ stent).

Results

After duplicates were removed, 441 citations were identified from searches of electronic databases. Based on the title and abstract, 411 citations were excluded, with 30 full-text articles to be retrieved and assessed for eligibility. Of these, two were reviews with no information regarding treatment, 12 articles had information only about ABU, and four articles used the same definition for ABU and infection. The remaining 12 studies were considered eligible for the review. As explained in the methods section, the two reviews were included only to extract information on management and treatment. The final results of the search are presented in Fig. 1.

The selected studies, with the design, country, and type of stent are presented in Table 2. The mean sample size of the included studies was 204 patients.

Definition of ABU and infection

Only three of the 12 selected studies defined ABU as a positive urine culture with more than 10^5 colony-forming units (CFU)/mL in

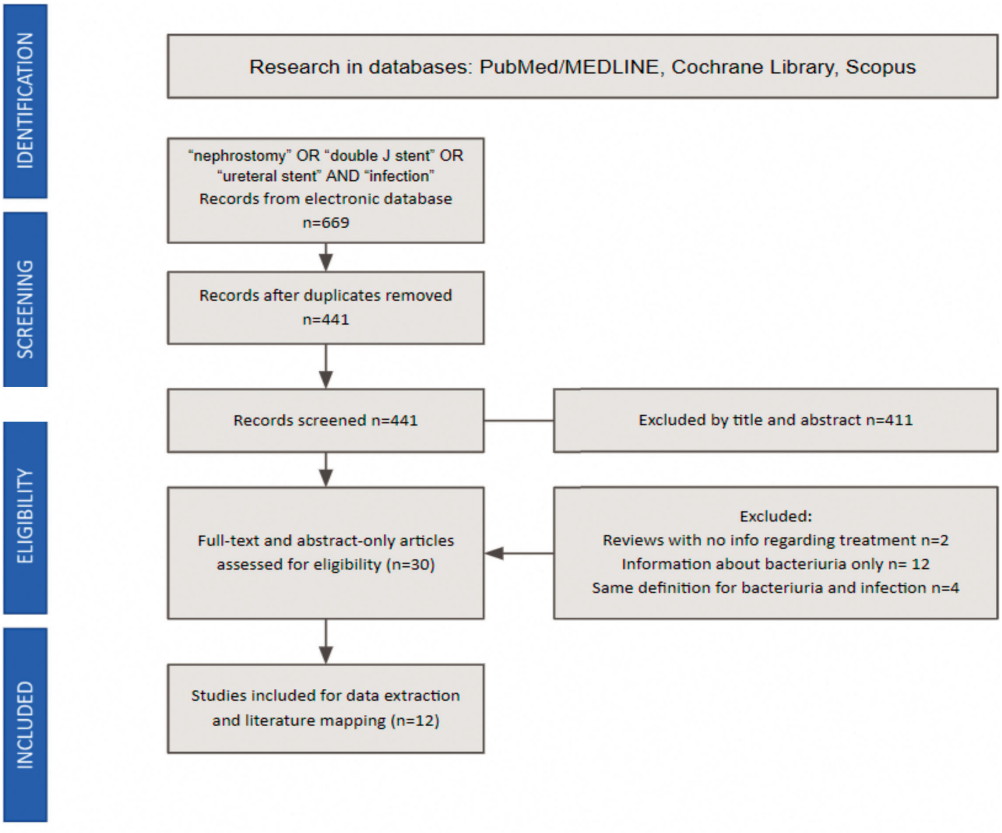

Figure 1 – PRISMA Flow Diagram for selection of sources of evidence.

Table 2 – Information on bacteriuria and infection.

Article		Stent	Information about bacteriuria		Information about infection	
Authors	Year		Defined?	Definition	Defined?	Definition
Li *et al*	2023	DJ	No	–	Yes	Fever > 37.5°C, urinary tract symptoms (UTS), bacteriuria ≥10^5 CFU/mL.
Kim *et al*	2023	DJ	Yes	Bacteriuria ≥10^5 CFU/mL from two consecutive urine culture samples, without symptoms.	Yes	Fever, UTS, bacteriuria ≥10^5 CFU/mL.
Bailly *et al*	2023	DJ	No	–	Yes	Fever, bacteriuria ≥10^5 CFU/m, without another etiology of fever.
Jiang *et al*	2020	DJ	No	–	Yes	Fever > 38 ºC, UTS, bacteriuria ≥10^5 CFU/mL.
Kozyrakis *et al*	2018	DJ	No	–	No	-
Souhail *et al*	2020	DJ	No	–	Yes	UTS, bacteriuria ≥10^5 CFU/mL.
Vallée *et al*	2021	DJ	–	–	–	-
Mert *et al*	2023	PN	No	–	Yes	UTS, bacteriuria ≥10^4 CFU/mL.
Szvalb *et al*	2019	PN	No	–	Yes	UTS, bacteriuria ≥10^4 CFU/mL.
Maramara *et al*	2018	PN	Yes	Bacteriuria ≥10^5 CFU/mL without symptoms.	Yes	Fever >38ºC, UTS, bacteriuria ≥10^5 CFU/mL.
Bahu *et al*	2013	PN	Yes	Bacteriuria ≥10^5 CFU/mL without symptoms.	Yes	Fever >38ºC, UTS, bacteriuria ≥10^5 CFU/mL.
Siddiq *et al*	2012	PN	No	Bacteriuria ≥10^2 CFU/mL without symptoms.		UTS, bacteriúria ≥10^2 CFU/mL

an aseptically collected specimen in the absence of signs and symptoms.[17-19] In eight articles, the ABU definition was absent. Regarding the definition of PN- and DJ-UTIs, most of the articles (n=9) defined these infections but used slightly different criteria. The majority defined these infections through a conjunction of symptoms like fever (higher than 37.5ºC[20] or higher than 38ºC[18,19,21,22]), dysuria or flank pain,[17-19,21,23-25] and a positive urine culture with a bacteriuria threshold that was defined differently, namely as the presence of ≥10^4 or ≥10^5 CFU/mL of a bacterial species isolated from midstream clean urine, as can be seen in Table 2.

Urine and stent culture method

Seven articles mention the technique used for stent or urine culture. In those discussing DJ-UTIs, nearly all authors reported using a second-stream urine culture.[17,20,21,26] Two of these studies also included stent cultures, specifically from the bladder portion of the DJ stent.[4,20] In contrast, articles addressing PN-UTIs did not describe the urine culture method, namely whether urine was collected before or after catheter replacement, or whether the catheter was changed or removed at all. This information in summarized in Table 3.

The article from Kozyrakis *et al,* was removed from this table, since the detailed description of pathogens was only done for bacteriuria. From the reported infections (n=11), seven were caused by multi-resistant bacteria strains, detected in stent cultures.

Pathogens related to PN- and DJ-UTIs

From the included studies in the final analysis, we compiled the available epidemiological data to summarize the average rate of different bacterial species found in urine cultures of patients with DJ- and PN-UTIs. A 10% cut-off for the average rate was retained to include microorganisms in Table 5.

Table 3 – Described urine and stent culture methods in the selected studies.

Authors	Year	Stent	Indication	Urine culture method	Infection rate	Stent culture method
Li *et al*	2023	DJ	All indications	2nd stream	100% (inclusion criteria)	Bladder segment after removal with ureteroscope
Kim *et al*	2023	DJ	All indications; Requiring indwelling stents and replaced ureteral stents more than once	2nd stream, before ureteral stent replacement	7.20%	Not done
Bailly *et al*	2023	DJ	All indications	Not described	7.24%	Not done
Jiang *et al*	2020	DJ	After PCNL	2nd stream	13.01%	Not done
Kozyrakis *et al*	2018	DJ	All indications	Not described	18% postoperatively	Bladder segment after removal with ureteroscope.
Souhail *et al*	2020	DJ	Obstructive pyelonephritis	2nd stream	infection in 6.3%, but only 69% UC of these were positive	Not done
Vallée *et al*	2021	DJ	*Review article*	Not described	–	–
Mert *et al*	2023	PN	Malignancy	Not described	100% (inclusion criteria)	Not done
Szvalb *et al*	2019	PN	Malignancy	Not described	14%	–
Maramara *et al*	2018	PN	All indications	Not described	20%	Not done
Bahu *et al*	2013	PN	Malignancy	Not described	14%	Not done
Siddiq *et al*	2012	PN	*Review article*	Drawing urine from the PN	–	–

Table 4 – Average of most frequently identified pathogens related to PN- and DJ-UTIs

Article	Main types of reported pathogens				
Authors	**Year**	***E. coli***	***Klebsiella pneumoniae***	***Enterococcus faecalis***	***P aeruginosa***
Li *et al*	2023	30.55%	16.66%	13.89%	11.11%
Kim *et al*	2023	22.72%	0	18.18%	13.63%
Bailly *et al*	2023	38%	9%	14.50%	9%
Mert *et al*	2020	4.0%	26.67%	1.70%	1.70%
Jiang *et al*	2018	47.82%	15.21%	19.56%	4.34%
Szvalb *et al*	2020	17%	0	23%	36%
Maramara *et al*	2021	14.29%	21.43%	28.57%	35.71%
Bahu *et al*	2013	21.05%	0%	21.05%	13.16%
Souhail *et al*	2019	38.46%	7.69%	15.38%	0
MEAN		**25.99%**	**10.74%**	**17.31%**	**13.85%**

Table 5 – Information on treatment approach, namely type of antibiotic and stent removal.

Article		Stent	Antibiotic	Stent removal/substitution
Authors	Year			
Li *et al*	2023	DJ	No info	All patients removed the stent
Kim *et al*	2023	DJ	Targeted	Some were taken out, and others remained
Bailly *et al*	2023	DJ	Empiric	Some were taken out, and others remained
Jiang *et al*	2020	DJ	Empiric	–
Kozyrakis *et al*	2018	DJ	Targeted	All patients removed the stent
Souhail *et al*	2020	DJ	Empiric	Some were taken out, and others remained
Vallée *et al*	2021	DJ	Empiric	–
Mert *et al*	2023	PN	Empiric	–
Szvalb *et al*	2019	PN	Empiric	Exchange of PN within four days of antibiotics
Maramara *et al*	2018	PN	Empiric	–
Bahu *et al*	2013	PN	No info	Some were taken out, and others remained
Siddiq *et al*	2012	PN	No info	Exchange PN before antibiotics

Treatment approach

The information on the treatment approach is summarized in Table 6. In two studies, the antibiotic therapy prescribed was already targeted, one because urine was collected for microbiological testing every time the patients electively changed the stent[17]; and another because all the patients had to remove the stent, and stent cultures were done for research purposes.[4]

Regarding managing the DJ stent, in two studies, all the patients removed it because it was no longer needed.[4,20] In four studies, some patients had DJ stent exchange. In the study by Kim

Table 6 – Information on treatment approach, namely, type of antibiotic and stent removal.

Article	Stent	Antibiotic	Stent removal/substitution
Authors			
Li *et al*	DJ	No info	All patients removed the stent
Kim *et al*	DJ	Targeted	Some were taken out, and others remained
Bailly *et al*	DJ	Empiric	Some were taken out, and others remained
Jiang *et al*	DJ	Empiric	–
Kozyrakis *et al*	DJ	Targeted	All patients removed the stent
Souhail *et al*	DJ	Empiric	Some were taken out, and others remained
Vallée *et al*	DJ	Empiric	–
Mert *et al*	PN	Empiric	–
Szvalb *et al*	PN	Empiric	Exchange PN within four days of antibiotics
Maramara *et al*	PN	Empiric	–
Bahu *et al*	PN	No info	Some were taken out, and others remained
Siddiq *et al*	PN	No info	Exchange PN before antibiotics

et al, of the 22 patients who developed a DJ-UTI (7.2% of the study population), 15 had their ureteral stents replaced with new stents. In these, the UTI symptoms resolved; in the remaining seven patients, ureteral stents were left in place, although they were treated with appropriate antibiotics. The symptoms related to the infection and the bacteriuria recurred in these patients (mean time to symptom recurrence: 10 days); subsequently, ureteral stents were replaced with new stents, and patients' symptoms were relieved.[17] In the study by Bailly *et al,* of the 48 patients with DJ-UTI (7.24% of the study population), six had their ureteral stent removed. In the remaining, symptoms relapsed in 13 (30.9%). The microorganism isolated during infection recurrence was the same as that identified in the previous infection for five patients (38%).[22] Additionally, in the study by Souhail *et al,* in three (23%) of the 13 cases with DJ-UTI (6.3% of the study population), the DJ stent was removed for source control.[23] None of these studies justify the precise criteria for exchanging the DJ stent. Regarding PN-UTIs, in the study by Bahu *et al,* of the 38 patients who developed an infection (19% of the study population), 22 patients underwent exchange or removal for source control. In this case, there was also no defined criterion by the authors for catheter exchange.[19]

In only two articles, the authors state how catheters should be managed in case of infection. In the study of Szvalb *et al,* PN catheter exchange within four days of PN-UTI diagnosis (p=0.048) and receiving concomitant antimicrobials at the time of PN catheter replacement (p=0.008) were independently associated with a decrease in risk of recurrent PN-UTI. Therefore, they defend that PNs should be exchanged once antimicrobial susceptibilities are made available and the patient receives concordant antibiotics, ideally in the first four days of the infection.[25] On the other hand, Siddiq *et al,* in their review article, state that once the diagnosis of PN-UTI is established, the catheter should be exchanged immediately to decrease the bacterial load, along with immediate initiation of empiric antibiotics.[27]

Regarding the choice of antibiotics, most authors defend choosing broad-spectrum antibiotics as empirical therapy. Included studies mostly report the use of ceftriaxone or cefotaxime,[18,22,23] piperacillin-tazobactam,[18,22-24] and ertapenem or meropenem.[18,22,24]

Discussion

Our findings highlight the challenges in establishing optimal recommendations for managing PN and DJ stents in patients with associated infections. The literature search for this review revealed that most studies focus on stent colonization and ABU, with few addressing stent-related infections. In fact, from the 30 studies selected for full-text review, 12 only mentioned ABU, and four articles used the same definition for ABU and PN- and DJ-UTIs.[12-14,28] This challenge is already addressed in the EAU Guidelines.[1] To address this issue, it would be essential to clearly define these infections, distinguishing them precisely from CA--UTIs, to allow for better comparison of study results. Only after stating the criteria for diagnosing PN- and DJ-UTIs will it be possible to understand their epidemiology, incidence, and risk factors. Concurrently, each hospital should monitor its local pathogen and antibiotic resistance patterns in stent-related infections and adapt recommendations accordingly to fit the local context, as is true for CA-UTIs.[15]

Regarding urine and stent cultures, collecting second-stream urine is considered an appropriate and widely accepted method for obtaining urine samples. In patients with DJ stents, culturing the stent would require catheter replacement each time, making second-stream urine collection the most practical option for guiding antibiotic therapy. However, challenges arise in both collecting and interpreting urine culture results. Many patients present with polymicrobial cultures, complicating effective antibiotic targeting.[3,7] Additionally, stent cultures may be more likely to identify the primary pathogenic microorganisms. In the study by Li *et al,* culture rates of pathogenic bacteria in DJ stents were significantly higher than those of urine.[20] More studies comparing both methods are needed to draw further conclusions.

Regarding antibiotic therapy, there is a trend toward the use of broad-spectrum antibiotics, like Piperacillin-tazobactam, as first empirical therapy. Regardless, we found many differences in clinical practice. Even within hospitals with the same antibiotic protocols, the choice of empirical antibiotic therapy was very heterogeneous.[23] This can be logically due to the lack of guidelines for the choice of antibiotherapy in these cases. However, differences in antibiotic prescription even for non-complicated UTIs (which have well-defined guidelines) are also commonly seen and reported in the literature.[29-31] One important strategy should be reporting local pathogen and resistance patterns, and defining corresponding protocols in each hospital or region. Antibiotic prescription by clinicians should be monitored.

Finally, managing PN or DJ stents for source control remains a matter of debate. Most included studies didn't provide any information regarding their criteria for stent exchange or removal (except when stent maintenance was no longer clinically indicated). Several potentially relevant factors may influence the decision to perform stent exchange, including the patient's clinical response to antibiotic therapy and individual patient characteristics. Additionally, the indication and timing of stent exchange, particularly whether it occurs after starting antibiotic treatment, may be a critical variable. Future research, ideally through multicenter prospective studies, is warranted to evaluate optimal antibiotic regimens and to compare clinical outcomes between early *versus* delayed stent exchange, as well as stent exchange versus stent maintenance.

Conclusion

This scoping review highlights inconsistencies in the diagnostic approaches of PN- and DJ-UTIs, namely in their definitions and urine or stent culture techniques. Clear differentiation between asymptomatic bacteriuria and true infection is essential to prevent unnecessary antibiotic use and to establish a reliable foundation for future clinical research. Monitoring local resistance patterns should be a priority to guide therapy. The role of stent exchange as a means of source control remains underexplored but appears to be a relevant factor in the management of these infections. Further prospective studies are needed to refine diagnostic criteria and optimize treatment strategies.

Awards and Previous Presentations: This work was already presented in the LXXXVII Congreso Nacional de Urología, in Palma de Mallorca, Spain, in June 2024.

Responsabilidades Éticas

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All authors contributed to the study design, manuscript writing, participated in the critical review of the intellectual content, and approved the final version to be published.

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