



## Narrative review

## Diagnosing probable urinary tract infections in nursing home residents without indwelling catheters: a narrative review

Carl Llor <sup>1,2,3,\*</sup>, Ana Moragas <sup>2,3,4</sup>, Georg Ruppe <sup>5</sup>, Jesper Lykkegaard <sup>1</sup>, Malene Plejdrup Hansen <sup>1,6</sup>, Valeria S. Antsupova <sup>7</sup>, Jette Nygaard Jensen <sup>7</sup>, Anna Marie Theut <sup>7</sup>, Davorina Petek <sup>8</sup>, Nina Sodja <sup>8</sup>, Anna Kowalczyk <sup>9</sup>, Lars Bjerrum <sup>10</sup> on behalf of IMAGINE study group\*

<sup>1</sup> Department of Public Health, Research Unit of General Practice, University of Southern Denmark, Odense, Denmark

<sup>2</sup> Primary Care Research Institute Jordi Gol, Institut d'Investigació en Atenció Primària (IDIAP), Barcelona, Spain

<sup>3</sup> CIBER Enfermedades Infecciosas, Instituto de Salud Carlos III, Madrid, Spain

<sup>4</sup> Department of General Pathology, University Rovira i Virgili, Tarragona, Spain

<sup>5</sup> Austrian Interdisciplinary Platform on Ageing/Österreichische Plattform für Interdisziplinäre Altersfragen (OEPIA), Vienna, Austria

<sup>6</sup> Center for General Practice, Aalborg University, Aalborg, Denmark

<sup>7</sup> Department of Clinical Microbiology, Copenhagen University Hospital, Herlev and Gentofte, Denmark

<sup>8</sup> Department of Family Medicine, University of Ljubljana, Ljubljana, Slovenia

<sup>9</sup> Centre for Family and Community Medicine, the Faculty of Health Sciences, Medical University of Lodz, Lodz, Poland

<sup>10</sup> Department of Public Health, Section and Research Unit of General Practice, University of Copenhagen, Copenhagen, Denmark

## ARTICLE INFO

## Article history:

Received 13 July 2024

Received in revised form

18 August 2024

Accepted 22 August 2024

Available online 30 August 2024

Editor: L. Leibovici

## Keywords:

Antibiotic prescribing

Bacteriuria

Frail elderly

Nursing homes

Signs and symptoms

Urinalysis

Urinary tract infection

## ABSTRACT

**Background:** Overdiagnosis of urinary tract infections (UTIs) is one of the most common reasons for the unnecessary use of antibiotics in nursing homes, increasing the risk of missing serious conditions. Various decision tools and algorithms aim to aid in UTI diagnosis and the initiation of antibiotic therapy for residents. However, due to the lack of a clear reference standard, these tools vary widely and can be complex, with some requiring urine testing. As part of the European-funded IMAGINE project, aimed at improving antibiotic use for UTIs in nursing home residents, we have reviewed the recommendations. **Objectives:** This review provides a comprehensive summary of the more relevant tools and algorithms aimed at identifying true UTIs among residents living in nursing homes and discusses the challenges in using these algorithms based on updated research.

**Sources:** The discussion is based on a relevant medical literature search and synthesis of the findings and published tools to provide an overview of the current state of improving the diagnosis of UTIs in nursing homes.

**Content:** The following topics are covered: prevalence of asymptomatic bacteriuria, diagnostic challenges, clinical criteria, urinary testing, and algorithms to be implemented in nursing home facilities.

**Implications:** Diagnosing UTIs in residents is challenging due to the high prevalence of asymptomatic bacteriuria and nonspecific urinary tract signs and symptoms among those with suspected UTIs. The fear of missing a UTI and the perceived antibiotic demands from residents and relatives might lead to overdiagnosis of this common condition. Despite their widespread use, urine dipsticks should not be recommended for geriatric patients. Patients who do not meet the minimum diagnostic criteria for UTIs should be evaluated for alternative conditions. Adherence to a simple algorithm can prevent unnecessary antibiotic courses without compromising resident safety. **Carl Llor, Clin Microbiol Infect 2024;30:1523**

© 2024 The Author(s). Published by Elsevier Ltd on behalf of European Society of Clinical Microbiology and Infectious Diseases. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

\* Corresponding author. Carl Llor, Department of Public Health, Research Unit of General Practice, University of Southern Denmark, Campusvej 55, 5230 Odense, Denmark.

E-mail address: [cllor@health.sdu.dk](mailto:cllor@health.sdu.dk) (C. Llor).

\* The full list of collaborators IMAGINE study group are listed in Acknowledgements section

## Introduction

The ageing population and healthcare strain in the European Union have led to an increase in patient care in long-term care facilities [1]. Nursing home residents frequently present severe infections, particularly urinary tract infections (UTIs), due to multiple comorbidities and frailty [2]. A 1-day point prevalence survey found that 4.9% of residents in 3,052 facilities across 24 European countries were receiving antimicrobials, with significant inappropriate use varying widely [3]. The urinary tract was the most common site for antimicrobial prescriptions, accounting for nearly 50% of cases, and at least 60% of the prescriptions for UTIs were inappropriate [3]. This contributes to the development of multidrug-resistant uropathogens, resulting in fewer therapeutic options, often requiring parenteral administration. Other studies have also observed this high rate of inappropriate antibiotic use among nursing home residents [4,5].

Establishing reliable guidelines is essential for evaluating inappropriate antibiotic administration in UTIs. However, diagnosing UTIs in nursing home residents poses significant challenges. As part of the European-funded IMAGINE project, a nonrandomized, before-after intervention and implementation study aimed at standardizing infection prevention efforts, particularly targeting UTIs and antibiotic misuse in nursing homes in eight different European countries [6], we have reviewed the recommendations. Consequently, we conducted the present narrative review of tools, algorithms, consensus statements, and guidelines to ascertain the minimum criteria for diagnosing UTI and for initiating antibiotic therapy. Using a clear, straightforward algorithm can assist nursing staff to make more accurate diagnoses and reduce unnecessary antibiotic use. If the minimum criteria for infection are not met, other potential diagnoses should be explored. Relatives and caregivers often urge nursing staff to request urine testing or administering an antibiotic when a resident's condition deteriorates, frequently citing past experiences where antibiotics led to an improvement in the resident's condition [7]. Moreover, nursing home staff may fear missing a UTI, but concentrating on a UTI diagnosis without corresponding symptoms can delay the identification of other serious conditions [8].

## Diagnosing a urinary tract infection in a nursing home resident

Overdiagnosis of UTIs, which results in the overuse of antibiotics, is widespread in nursing homes. Diagnosing a genuine UTI in functionally declined older persons is particularly challenging for two main reasons [9]. First, the prevalence of asymptomatic bacteriuria—the presence of bacteria in the urine without noticeable symptoms—is high. It is identified by finding a specific bacterial species in quantitative counts  $\geq 10^5$  CFU/mL [10,11]. Although rare in younger populations, the prevalence of asymptomatic bacteriuria is higher among noncatheterized residents in long-term care facilities, ranging from 25% to 50% in women and 15% to 40% in men [2,12–14]. However, less than 2% have a true UTI [15,16]. Residents with indwelling catheters are at least twice as likely to develop a UTI and are also at a higher risk for asymptomatic bacteriuria.

Pyuria is defined as more than 10 white blood cells per high-power field in urinalysis. Unlike younger populations, in which pyuria is generally absent in those not infected, the prevalence of pyuria among long-term care residents is very high. Asymptomatic bacteriuria is associated with pyuria in more than 90% of cases [13]. Pyuria can arise from various conditions besides UTIs, such as intra-abdominal infections, pneumonia, inflammatory conditions, renal diseases, malignancies, and the use of certain medications commonly used by older people, such as analgesics and proton

pump inhibitors [17,18]. In the absence of acute urinary symptoms, this colonization state has a benign natural history and may even be protective against symptomatic UTI [19]. Treatment of asymptomatic bacteriuria in older people in a reduced health state confers no benefit and may even be harmful [20]. Therefore, clinical guidelines of organizations, such as the European Association of Urology Infectious and the Diseases Society of America, advise against treating asymptomatic bacteriuria with antibiotics in this group of patients [10,21].

Another diagnostic challenge is the high prevalence of nonspecific signs and symptoms among nursing home residents, which is greater than that of typical urinary symptoms, as described in some prospective and cross-sectional studies, with changes in mental status and fever being the most frequent [22,23]. Moreover, nearly one-third of geriatric patients with bacteraemia have a urinary source of infection but do not present typical urinary symptoms [24], which could be attributed to factors such as the presence of urinary catheters or cognitive impairment related to dementia or delirium. Moreover, multimorbid older patients may experience chronic urinary symptoms involving incontinence, nocturia, and urgency unrelated to UTI, further complicating the diagnosis. Three systematic reviews investigated the link between delirium and UTIs in mostly noninstitutionalized older adults and found that delirium was more common in patients with UTIs than in those without infections. However, all the studies included in these reviews had significant methodological flaws with potential for bias [25–27]. Moreover, in a review of nonspecific signs and symptoms, Rowe et al. [28] found that behavioural changes not related to delirium, functional decline, falls, and anorexia were not associated with a greater likelihood of infection in residents of nursing homes.

The problem is the lack of a definitive reference standard for diagnosing a true UTI in this age population. The only diagnostic test that confirms symptomatic UTI is a positive blood culture with the same isolate grown from blood and urine [29]. In addition, a negative urine culture obtained before commenced antibiotic therapy excludes a diagnosis of UTI. However, taking urine and blood samples for culture in all residents with suspected UTIs seems unrealistic and unviable.

Guidelines designed for diagnosing younger individuals in better health conditions often rely on the presence of urinary tract symptoms, but this alone is not sensitive enough to accurately diagnose many frail older adults [2]. A diagnosis of UTI in acutely unwell older patients may be incorrect in a high percentage of cases and can lead to inappropriate antibiotic exposure and delays in establishing a correct diagnosis. Table 1 describes the different types of signs and symptoms used for diagnosing UTI.

## Usefulness of urine testing in nursing home residents

Requesting urine cultures in the absence of a minimum number of UTI symptoms often leads to the detection of asymptomatic bacteriuria, resulting in unnecessary antibiotic treatment [30]. Studies conducted in nursing homes reveal that only a small percentage of urine samples collected meet the minimum symptom criteria for culturing, and up to 80% of residents with asymptomatic bacteriuria undergo unnecessary urine testing [31]. A recent survey found that over 70% of general practitioners prescribe antibiotics for asymptomatic bacteriuria, with 90% mistakenly believing the patient has a UTI [32]. Urinalysis, commonly used for UTI diagnosis through pyuria detection [33], is not recommended in long-term care residents due to the high prevalence of pyuria.

Urine dipsticks are still commonly used for the diagnosis of UTI in most countries as they are quick, cheap, and noninvasive tools. These dipsticks test for leukocyte esterase—indicative of

**Table 1**  
Signs and symptoms related to urinary tract infection

Type of criteria	Signs and symptoms
Lower urinary tract signs and symptoms	Dysuria Urinary frequency Urinary urgency Urinary incontinence Suprapubic pain or low abdominal pain Pain, swelling or tenderness of the testes, epididymis, or prostate
Upper urinary tract signs and symptoms	Flank pain or renal angle tenderness
Systemic signs and symptoms	Fever (temperature $\geq 38^{\circ}\text{C}$ ) Shaking chills White blood cell count $\geq 12 \times 10^9/\text{L}$ (if available) C-reactive protein levels $\geq 50 \text{ mg/L}$ (if available)
Worsened mental or functional status	Acute confusion Acutely changed behaviour (delirium, agitation, and apathy) Acute general malaise Loss of appetite (also vomiting and nausea)
Impaired urine characteristics <sup>a</sup>	Reduced fluid intake Foul-smelling urine Gross haematuria Cloudy urine
Potential testing	Urine dipstick: leukocyte esterase and nitrites Urinalysis: flow cytometry for quantification of pyuria Dipslide: positivity or negativity Culture: urine culture <sup>b</sup> and blood culture

<sup>a</sup> Not considered in the common algorithms, only gross haematuria is included in the Loeb minimum criteria.

<sup>b</sup> A urine culture should only be ordered if the resident has a recurrent urinary tract infection, a suspected serious infection without specific urinary symptoms, or if antibiotic treatment needs to be guided by antibiotic susceptibilities.

pyuria—and urinary nitrites formed by coliform bacteria reducing nitrates in the urine. The dipstick has different test characteristics depending on the population studied and the clinical presentation of the patient. In a review of six studies aimed at assessing the validity of urine dipsticks for diagnosing UTIs in older patients in both nursing homes and hospital settings, Eriksen and Bing-Jonsson [34] found a sensitivity—positive for leukocyte esterase, nitrite, or both—for determining a positive urine culture ranging from 72% to 100%, a specificity of 20% to 70%, a negative predictive value of 85% to 100%, and a positive predictive value of 31% to 93%, with most studies reporting values below 50% [34]. Ducharme et al. [35] also found that 61% of patients with a positive urine dipstick test did not have bacteriuria according to urine culture. In a more recent study conducted in nursing homes, which was not included in this meta-analysis, Latour et al. [36] found a 14% positive predictive value among residents with suspected UTI. This issue is further complicated among institutionalized women with incontinence, where the prevalence of pyuria is even higher [15].

Consequently, the impact of the high negative predictive value of urine dipsticks on appropriate antibiotic use is minimal when compared with the extensive low-value care resulting from their poor positive predictive value [6]. In addition, it is important to recognize that published performance characteristics are based on urine culture cutoffs of  $>10^5$  CFU/ml. However, symptomatic infections with lower colony counts may not be detected during urinalysis, reducing the negative predictive value [37,38].

There is a common belief among nurses and doctors that a positive urine dipstick supports a UTI diagnosis. However, they often do not consider Bayesian reasoning or understand pretest probabilities, sensitivity, and specificity of tests, which frequently results in the prescription of an antibiotic [39–41]. This power of a positive result mentality often leads to cognitive bias, especially when pyuria is present without typical urinary signs or symptoms [42–44]. This has also been confirmed in qualitative studies when questioning health care professionals in nursing homes [45]. Furthermore, a prospective study of older patients in the emergency department found that positive urinalysis results were associated with an increased

probability of undergoing urine culture without an appropriate indication [46].

Public Health England no longer recommends urine dipsticks for the diagnostic work-up of UTIs in older patients, whether in the community or in nursing homes, regardless of whether they are catheterized or not [47]. This approach is increasingly being adopted by other countries as well. Because of the high prevalence of pyuria and asymptomatic bacteriuria, both urine culture and dipstick tests have limited diagnostic value in older people. Moreover, obtaining urine samples can be challenging due to urinary incontinence, cognitive impairment, contamination, or previous antibiotic use. Consequently, urine dipsticks should not be used in nursing homes. A quality control study called ‘to dip or not to dip’ conducted across nursing homes in the United Kingdom, aimed at decreasing the inappropriate diagnosis of UTIs, strongly discouraged the use of dipsticks. This led to a significant reduction in dipstick use, from 72% before to 12% after the intervention, resulting in a 56% reduction in antibiotic prescriptions for suspected UTIs [48].

### Decision tools available for the empiric treatment of suspected UTIs

International infectious disease experts have recommended minimum criteria for initiating antibiotics in nursing home residents to balance the risk of antibiotic overuse with the risk of poor outcomes from sepsis. The first decision tool for defining UTIs and other infections in nursing homes was published by McGeer et al. [49] in 1991, primarily for infection surveillance. Recognizing the limitations of the criteria by McGeer, in 2001, Loeb et al. [50] introduced a minimum set of clinical criteria for empirically starting antibiotics for UTIs (Tables S1 and S2). The Loeb criteria led to a 25% reduction in antibiotic usage in a randomized trial based on a clinical algorithm also known as the revised Loeb criteria, without increasing the risk of hospitalization or mortality [51]. However, another study observed no reduction in antibiotic use [52].

In a prospective study evaluating nursing home residents with suspected UTIs versus the McGeer, Loeb, and revised Loeb

consensus-based criteria, using urine culture as the reference standard, the sensitivity ranged from 19% to 30% depending on the criteria used, with a specificity of 82–89%, a positive predictive value of 52–57%, and a negative predictive value of 59–61% [53]. Approximately half of the residents with urinary tract symptoms tested negative in cultures, despite high rates of asymptomatic bacteriuria, suggesting that symptoms alone were not reliable for diagnosing UTIs and new algorithms were necessary. To enhance the accuracy of diagnosing UTIs, the updated McGeer criteria necessitated a positive urine culture to confirm the diagnosis [54].

Several studies using Delphi consensus analyses have been undertaken to identify which signs and symptoms indicate UTI in older people (Fig. S1). These studies aimed to establish decision-making tools for diagnosing UTIs and initiating antibiotic treatment, with the inclusion of international expert panels. The simplest study was led by van Buul et al. [55], who devised a practical algorithm to determine when antibiotic therapy should be initiated for suspected UTIs. This algorithm relied solely on clinical criteria and the results of a urine dipstick test, which were used to rule out a UTI diagnosis if both leukocyte esterase and nitrites were negative, as also recommended in some reviews [56]. Other algorithms based on Delphi consensus analyses were published by Nace et al. [57] and more recently by Bilsen et al. [58], who developed a diagnostic algorithm for suspected UTIs across all age groups, including a specific algorithm for the elderly population. However, this required urinalysis and urine culture for all suspected cases.

### The diagnostic process in residents with suspected urinary tract infection needs to be simplified

Despite the availability of various tools, algorithms, Delphi-based consensus of expert opinion, and guidelines for suspecting UTIs, observational studies in nursing homes across different countries show that 30–80% of residents with asymptomatic bacteriuria receive antibiotics [4,5,31]. In addition, in six studies, Mylotte [59] recently found that antibiotic therapy was appropriately initiated using the Loeb minimum criteria in only 8–44% of residents with suspected UTI. Nursing staff has shown to have a central role in diagnosing UTI in nursing home residents. Nurses observe patients' conditions and symptoms on a daily basis, perform urine testing, and influence the initiation of antibiotics [60]. Consequently, it is important for health care providers, particularly nursing staff, to possess correct and solid knowledge on UTIs in the elderly, with clear instructions, to enable correct assessments.

The lack of a reference standard for diagnosing UTIs in nursing home residents makes it impossible to construct a perfect set of criteria for initiating antibiotic therapy. However, the evidence base regarding signs and symptoms (particularly those that are nonspecific) indicating the need for antibiotic therapy, needs improvement. Most research on this topic consists of observational trials, primarily retrospective studies. There is a clear need for well-designed randomized controlled trials to assess the impact of evaluation and treatment approaches for suspected UTIs when specific urinary tract symptoms are absent in nursing home residents.

This lack of rigorous studies has led and will lead to the publication of new consensus of expert opinion, which are usually complex and difficult to implement. However, collaboratively developed guidelines that prioritize simplicity, transparency, and rigorous evidence can provide numerous advantages. They can standardize practices, discourage the use of outdated and inefficient methods like dipsticks, and improve health care delivery efficiency. This approach might also help reduce antibiotic overuse, thereby conserving valuable resources. The classical minimal Loeb

criteria [50] and the algorithm proposed by van Buul et al. [55], represent two of the most straightforward algorithms published to date. Despite their simplicity, both algorithms have the potential for further simplification. Urinary dipstick analysis should not be recommended for anyone over the age of 65, whether institutionalized or not, with or without an indwelling catheter, and urine cultures should only be ordered in a few specific cases (Table 1).

### Conclusion

The misattribution of nonspecific signs and symptoms to infection, the fear of missing a UTI, perceived antibiotic demands from residents and relatives, along with the existence of various consensus guidelines and tools that are often inconsistent and difficult to implement, represent major barriers to improving the appropriateness of antibiotic use in nursing homes. Health care providers working with this group of vulnerable patients should be trained to use simple or easy-to-apply algorithms that primarily focus on clinical symptoms and the functional appearance of patients for diagnosing a UTI and making the decision for antibiotic treatment. Similarly, health care staff should also be encouraged to abstain from antibiotic treatment if the diagnosis of a UTI is based on invalid diagnostic tools, such as a positive dipstick result.

### Author contributions

C.L., A.M., and G.R. conceived the review idea, collected, and interpreted data. C.L. wrote the first manuscript draft. All authors contributed to manuscript writing, revision, and approved the final version of the manuscript.

### Transparency declaration

#### Potential conflict of interest

The authors declare that they have no conflicts of interest.

#### Financial report

Cofunded by the European Union's EU4H Programme, grant agreement number 101079838. The funding organization had no role in study design or concept or approval of manuscript. Views and opinions expressed are, however, those of the author(s) alone and do not necessarily reflect those of the European Union or European Health and Digital Executive Agency (HaDEA) and neither the European Union nor the granting authority can be held responsible for them.

### Acknowledgements

We would like to acknowledge the contribution of the other members of the IMAGINE project: Anders Bjerrum, Ana García-Sangenís, Daniela Modena, Ramon Monfà, and Rosa Morros Pedrós, from IDIAP; Athina Chalkidou and Tina Marloth, from the Department of Clinical Microbiology at Copenhagen University Hospital; Susanne Døssing Berntsen, Nina Camilla Døssing-Poulsen, Anders Munck, Jonas Kanstrup Olsen, and Asbjørn Tang Hall, from University of Southern Denmark; Beatriz González López-Valcárcel, Ana Squaglia, Marina Elistratova, and Laura Vallejo-Torres, from the University of Las Palmas; Marilena Anastasaki, Agapi Angelaki, Maria-Nefeli Karkana, Christos Lionis, Elena Petelos and Greta Tsoulchali, from University of Crete; András Balint, Ría Benkő, from Szeged University; Laura Álvarez, Sergi Briones, and Marta Ricart, from the Spanish Society of Family Medicine; Maciej Godycki-Cwirko, from the Medical University of Lodz; Jozef Glasa and



Helena Glasová, from the Slovak Medical University; and Lina Jaruseviciene and Ruta Radzeviciene, from Ltd Mano Seimos Gydytojas.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cmi.2024.08.020>.

## References

- [1] European Commission. Long-term care needs in the EU on the rise, due to demographic change. EU Sci Hub 2024 [Internet]. Available from: [https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/long-term-care-needs-eu-rise-due-demographic-change-2024-02-02\\_en](https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/long-term-care-needs-eu-rise-due-demographic-change-2024-02-02_en) [cited 2024 Sep 12].
- [2] Woodford HJ, George J. Diagnosis and management of urinary infections in older people. *Clin Med (Lond)* 2011;11:80–3. <https://doi.org/10.7861/clinmedicine.11-1-80>.
- [3] Ricchizzi E, Latour K, Kärki T, Buttazzi R, Jans B, Moro ML, et al. Antimicrobial use in European long-term care facilities: results from the third point prevalence survey of healthcare-associated infections and antimicrobial use, 2016 to 2017. *Euro Surveill* 2018;23:1800394. <https://doi.org/10.2807/15607917.ES.2018.23.46.1800394>.
- [4] van Buul LW, Veenhuizen RB, Achterberg WP, Schellevis FG, Essink RT, de Greeff SC, et al. Antibiotic prescribing in Dutch nursing homes: how appropriate is it? *J Am Med Dir Assoc* 2015;16:229–37. <https://doi.org/10.1016/j.jamda.2014.10.003>.
- [5] Daneman N, Gruneir A, Newman A, Fischer HD, Bronskill SE, Rochon PA, et al. Antibiotic use in long-term care facilities. *J Antimicrob Chemother* 2011;66:2856–63. <https://doi.org/10.1093/jac/ckr395>.
- [6] García-Sangenis A, Modena D, Jensen JN, Chalkidou A, Antsupova VS, Marloth T, et al. Improving antibiotic use in nursing homes by infection prevention and control and antibiotic stewardship (IMAGINE): protocol for a before-and-after intervention and implementation study. *JMIR Res Protoc* [Preprint] 2024;13:e60099. Available from: <https://preprints.jmir.org/preprint/60099> [cited 2024 Sep 12].
- [7] Walker S, McGeer A, Simor AE, Armstrong-Evans M, Loeb M. Why are antibiotics prescribed for asymptomatic bacteriuria in institutionalized elderly people? A qualitative study of physicians' and nurses' perceptions. *CMAJ* 2000;163:273–7.
- [8] Piggott KL, Trimble J, Leis JA. Reducing unnecessary urine culture testing in residents of long term care facilities. *BMJ* 2023;382:e075566. <https://doi.org/10.1136/bmj-2023-075566>.
- [9] Nicolle LE. Urinary tract infections in the older adult. *Clin Geriatr Med* 2016;32:523–38. <https://doi.org/10.1016/j.cger.2016.03.002>.
- [10] Bonkat G, Bartoletti R, Bruyère F, Cai T, Geerlings SE, Köves B, et al. European Association of Urology Guidelines on Urological Infections: Summary of the 2024 Guidelines. *Eur Urol* 2024;86:27–41. <https://doi.org/10.1016/j.eururo.2024.03.035>.
- [11] Kouri TT, Hofmann W, Falbo R, Oyaert M, Schubert S, Gertsens JB, et al. The EFLM European urinalysis guideline 2023. *Clin Chem Lab Med* 2024;62:1653–786. <https://doi.org/10.1515/cclm-2024-0070>.
- [12] Baldassarre JS, Kaye D. Special problems of urinary tract infection in the elderly. *Med Clin N Am* 1991;75:375–90. [https://doi.org/10.1016/s0025-7125\(16\)30460-6](https://doi.org/10.1016/s0025-7125(16)30460-6).
- [13] Sundvall PD, Ulleryd P, Gunnarsson RK. Urine culture doubtful in determining etiology of diffuse symptoms among elderly individuals: a cross-sectional study of 32 nursing homes. *BMC Fam Pract* 2011;12:36. <https://doi.org/10.1186/1471-2296-12-36>.
- [14] Nicolle LE. Urinary infections in the elderly: symptomatic or asymptomatic? *Int J Antimicrob Agents* 1999;11:265–8. [https://doi.org/10.1016/s0924-8579\(99\)00028-x](https://doi.org/10.1016/s0924-8579(99)00028-x).
- [15] Biggel M, Heytens S, Latour K, Bruyndonckx R, Goossens H, Moons P. Asymptomatic bacteriuria in older adults: the most fragile women are prone to long-term colonization. *BMC Geriatr* 2019;19:170. <https://doi.org/10.1186/s12877-019-1181-4>.
- [16] Tsan L, Langberg R, Davis C, Phillips Y, Pierce J, Hojlo C, et al. Nursing home-associated infections in Department of Veterans Affairs community living centers. *Am J Infect Control* 2010;38:461–6. <https://doi.org/10.1016/j.ajic.2009.12.009>.
- [17] Hooker JB, Mold JW, Kumar S. Sterile pyuria in patients admitted to the hospital with infections outside of the urinary tract. *J Am Board Fam Med* 2014;27:97–103. <https://doi.org/10.3122/jabfm.2014.01.130084>.
- [18] Glen P, Prashar A, Hawary A. Sterile pyuria: a practical management guide. *Br J Gen Pract* 2016;66:e225–7. <https://doi.org/10.3399/bjgp16X684217>.
- [19] Cai T, Köves B, Johansen TE. Asymptomatic bacteriuria, to screen or not to screen - and when to treat? *Curr Opin Urol* 2017;27:107–11. <https://doi.org/10.1097/MOU.0000000000000368>.
- [20] Zalmanovici Trestioreanu AZ, Lador A, Sauerbrun-Cutler MT, Leibovici L. Antibiotics for asymptomatic bacteriuria. *Cochrane Database Syst Rev* 2015;4:CD009534. <https://doi.org/10.1002/14651858.CD009534.pub2>.
- [21] Nicolle LE, Gupta K, Bradley SF, Colgan R, DeMuri GP, Drekonja D, et al. Clinical practice guideline for the management of asymptomatic bacteriuria: 2019 update by the Infectious Diseases Society of America. *Clin Infect Dis* 2019;68:e83–110. <https://doi.org/10.1093/cid/ciz021>.
- [22] D'Agata E, Loeb MB, Mitchell SL. Challenges in assessing nursing home residents with advanced dementia for suspected urinary tract infections. *J Am Geriatr Soc* 2013;61:62–6. <https://doi.org/10.1111/jgs.12070>.
- [23] Juthani-Mehta M, Drickamer MA, Towle V, Zhang Y, Tinetti ME, Quagliarello VJ. Nursing home practitioner survey of diagnostic criteria for urinary tract infections. *J Am Geriatr Soc* 2005;53:1986–90. <https://doi.org/10.1111/j.1532-5415.2005.00470.x>.
- [24] Bai AD, Bonares MJ, Thrall S, Bell CM, Morris AM. Presence of urinary symptoms in bacteremic urinary tract infection: a retrospective cohort study of *Escherichia coli* bacteremia. *BMC Infect Dis* 2020;20:781. <https://doi.org/10.1186/s12879-020-05499-1>.
- [25] Mayne S, Bowden A, Sundvall PD, Gunnarsson R. The scientific evidence for a potential link between confusion and urinary tract infection in the elderly is still confusing – a systematic literature review. *BMC Geriatr* 2019;19:32. <https://doi.org/10.1186/s12877-019-1049-7>.
- [26] Balogun SA, Philbrick JT. Delirium, a symptom of UTI in the elderly: fact or fable? A systemic review. *Can Geriatr J* 2013;17:22–6. <https://doi.org/10.5770/cgj.17.90>.
- [27] Krinitski D, Kasina R, Klöppel S, Lenouvel E. Associations of delirium with urinary tract infections and asymptomatic bacteriuria in adults aged 65 and older: a systematic review and meta-analysis. *J Am Geriatr Soc* 2021;69:3312–23. <https://doi.org/10.1111/jgs.17418>.
- [28] Rowe TA, Jump RL, Andersen BM, Banach DB, Bryant KA, Doernberg SB, et al. Reliability of nonlocalizing signs and symptoms as indicators of the presence of infection in nursing-home residents. *Infect Control Hosp Epidemiol* 2022;43:417–26. <https://doi.org/10.1017/ice.2020.1282>.
- [29] Nicolle L. Urinary tract infection (UTI) in the nursing home patient [Internet]. Available from: 2019. <https://www.infectiousdiseasesadvisor.com/home/decision-support-in-medicine/infectious-diseases/urinary-tract-infection-uti-in-the-nursing-home-patient/> [cited 2024 Sep 12].
- [30] Nicolle LE, Mayhew WJ, Bryan L. Prospective randomized comparison of therapy and no therapy for asymptomatic bacteriuria in institutionalized elderly women. *Am J Med* 1987;83:27–33. [https://doi.org/10.1016/0002-9343\(87\)90493-1](https://doi.org/10.1016/0002-9343(87)90493-1).
- [31] Phillips CD, Adepoju O, Stone N, McMaughan Moudouni DK, Nwaiwu O, Zhao H, et al. Asymptomatic bacteriuria, antibiotic use, and suspected urinary tract infections in four nursing homes. *BMC Geriatr* 2012;12:73. <https://doi.org/10.1186/1471-2318-12-73>.
- [32] Baghdadi JD, Korenstein D, Pineles L, Scherer LD, Lydecker AD, Magder L, et al. Exploration of primary care clinician attitudes and cognitive characteristics associated with prescribing antibiotics for asymptomatic bacteriuria. *JAMA Netw Open* 2022;5:e2214268. <https://doi.org/10.1001/jamanetworkopen.2022.14268>.
- [33] Mody L, Juthani-Mehta M. Urinary tract infections in older women: a clinical review. *JAMA* 2014;311:844–54. <https://doi.org/10.1001/jama.2014.303>.
- [34] Eriksen SV, Bing-Jonsson PC. Can we trust urine dipsticks? Sykepleien 2016 [Internet]. Available from: <https://sykepleien.no/en/forskning/2017/01/can-we-trust-urine-dipsticks> [cited 2024 Sep 12].
- [35] Ducharme J, Neilson S, Ginn JL. Can urine cultures and reagent test strips be used to diagnose urinary tract infection in elderly emergency department patients without focal urinary symptoms? *CJEM* 2007;9:87–92. <https://doi.org/10.1017/s1481803500014846>.
- [36] Latour K, De Lepeleire J, Cattri B, Buntinx F. Nursing home residents with suspected urinary tract infections: a diagnostic accuracy study. *BMC Geriatr* 2022;22:187. <https://doi.org/10.1186/s12877-022-02866-2>.
- [37] Smith MA, Puckrin R, Lam PW, Lamb MJ, Simor AE, Leis JA. Association of increased colony-count threshold for urinary pathogens in hospitalized patients with antimicrobial treatment. *JAMA Intern Med* 2019;179:990–2. <https://doi.org/10.1001/jamainternmed.2019.0188>.
- [38] Sathiananthamoorthy S, Malone-Lee J, Gill K, Tymon A, Nguyen TK, Gurung S, et al. Reassessment of routine midstream culture in diagnosis of urinary tract infection. *J Clin Microbiol* 2019;57:e01452–18. <https://doi.org/10.1128/JCM.01452-18>.
- [39] Saukko PM, Oppenheim BA, Cooper M, Rousham EK. Gaps in communication between different staff groups and older adult patients foster unnecessary antibiotic prescribing for urinary tract infections in hospitals: a qualitative translation approach. *Antimicrob Resist Infect Control* 2019;8:130. <https://doi.org/10.1186/s13756-019-0587-2>.
- [40] O'Sullivan ED, Schofield SJ. Cognitive bias in clinical medicine. *J R Coll Physicians Edinb* 2018;48:225–32. <https://doi.org/10.4997/JRCPE.2018.306>.
- [41] Pettersson E, Vernby A, Mölstad S, Lundborg CS. Infections and antibiotic prescribing in Swedish nursing homes: a cross-sectional study. *Scand J Infect Dis* 2008;40:393–8. <https://doi.org/10.1080/00365540701745279>.
- [42] Langford BJ, Daneman N, Leung V, Langford DJ. Cognitive bias: how understanding its impact on antibiotic prescribing decisions can help advance antimicrobial stewardship. *JAC Antimicrob Resist* 2020;2:dlaa107. <https://doi.org/10.1093/jacamr/dlaa107>.
- [43] Joseph A. The diagnosis and management of UTI in >65s: to dipstick or not? The argument against dipsticks. *Infect Prev Pract* 2020;2:100063. <https://doi.org/10.1016/j.infpip.2020.100063>.
- [44] Trautner BW, Bhimani RD, Amspoker AB, Hysong SJ, Garza A, Kelly PA, et al. Development and validation of an algorithm to recalibrate mental models and

- reduce diagnostic errors associated with catheter-associated bacteriuria. *BMC Med Inform Decis Mak* 2013;13:48. <https://doi.org/10.1186/1472-6947-13-48>.
- [45] Kuil SD, Schneeberger C, van Leth F, de Jong MD, Harting J. "A false sense of confidence". The perceived role of inflammatory point-of-care testing in managing urinary tract infections in Dutch nursing homes: a qualitative study. *BMC Geriatr* 2020;20:450. <https://doi.org/10.1186/s12877-020-01853-9>.
- [46] Yin P, Kiss A, Leis JA. Urinalysis orders among patients admitted to the general medicine service. *JAMA Intern Med* 2015;175:1711–3. <https://doi.org/10.1001/jamainternmed.2015.4036>.
- [47] England Public Health. Diagnosis of urinary tract infections. Quick reference materials for primary care for consultation and local adaptation. 2018 [Internet]. Available from: <https://www.gov.uk/government/publications/urinary-tract-infection-diagnosis> [cited 2024 Sep 12].
- [48] Joseph A, McGowan T, Weston V, Ogunbuyide O, Bird S, Gajree D, et al. "To dip or not to dip": a quality improvement project to improve the diagnosis and management of urinary tract infection in care homes. *Age Ageing* 2018;47:iii31–42. <https://doi.org/10.1093/ageing/afy126.46>.
- [49] McGeer A, Campbell B, Emori TG, Hierholzer WJ, Jackson MM, Nicolle LE, et al. Definitions of infection for surveillance in long-term care facilities. *Am J Infect Control* 1991;19:1–7. [https://doi.org/10.1016/0196-6553\(91\)90154-5](https://doi.org/10.1016/0196-6553(91)90154-5).
- [50] Loeb M, Bentley DW, Bradley S, Crossley K, Garibaldi R, Gantz N, et al. Development of minimum criteria for the initiation of antibiotics in residents of long-term-care facilities: results of a consensus conference. *Infect Control Hosp Epidemiol* 2001;22:120–4. <https://doi.org/10.1086/501875>.
- [51] Loeb M, Brazil K, Lohfeld L, McGeer A, Simor A, Stevenson K, et al. Effect of a multifaceted intervention on number of antimicrobial prescriptions for suspected urinary tract infections in residents of nursing homes: cluster randomized controlled trial. *BMJ* 2005;331:669. <https://doi.org/10.1136/bmj.38602.586343.55>.
- [52] Olsho LE, Bertrand RM, Edwards AS, Hadden LS, Morefield GB, Hurd D, et al. Does adherence to the Loeb minimum criteria reduce antibiotic prescribing rates in nursing homes? *J Am Med Dir Assoc* 2013;14:309.e1–7. <https://doi.org/10.1016/j.jamda.2013.01.002>.
- [53] Juthani-Mehta M, Tinetti M, Perrelli E, Towle V, Van Ness PH, Quagliarello V. Diagnostic accuracy of criteria for urinary tract infection in a cohort of nursing home residents. *J Am Geriatr Soc* 2007;55:1072–7. <https://doi.org/10.1111/j.1532-5415.2007.01217.x>.
- [54] Stone ND, Ashraf MS, Calder J, Crnich CJ, Crossley K, Drinka PJ, et al. Surveillance definitions of infections in long-term care facilities: revisiting the McGeer criteria. *Infect Control Hosp Epidemiol* 2012;33:965–77. <https://doi.org/10.1086/667743>.
- [55] van Buul LW, Vreeken HL, Bradley SF, Crnich CJ, Drinka PJ, Geerlings SE, et al. The development of a decision tool for the empiric treatment of suspected urinary tract infection in frail older adults: a Delphi consensus procedure. *J Am Med Dir Assoc* 2018;19:757–64. <https://doi.org/10.1016/j.jamda.2018.05.001>.
- [56] Devillé WL, Yzermans JC, van Duijn NP, Bezemer PD, van der Windt DA, Bouter LM. The urine dipstick test useful to rule out infections. A meta-analysis of the accuracy. *BMC Urol* 2004;4:4. <https://doi.org/10.1186/1471-2490-4-4>.
- [57] Nace DA, Perera SK, Hanlon JT, Saracco S, Anderson G, Schween S, et al. The Improving Outcomes of UTI management in long-term care project (IOU) consensus guidelines for the diagnosis of uncomplicated cystitis in nursing home residents. *J Am Med Dir Assoc* 2018;19:765–769.e3. <https://doi.org/10.1016/j.jamda.2018.05.030>.
- [58] Bilsen MP, Conroy SP, Schneeberger C, Platteeel TN, van Nieuwkoop C, Mody L, et al. A reference standard for urinary tract infection research: a multidisciplinary Delphi consensus study. *Lancet Infect Dis* 2024;24:e513–21. [https://doi.org/10.1016/S1473-3099\(23\)00778-8](https://doi.org/10.1016/S1473-3099(23)00778-8).
- [59] Mylotte JM. Determining the appropriateness of initiating antibiotic therapy in nursing home residents. *J Am Med Dir Assoc* 2023;24:1619–28. <https://doi.org/10.1016/j.jamda.2023.06.034>.
- [60] Eikelenboom-Boskamp A, van Loosbroek M, Lutke-Schipholt E, Nelissen-Vrancken M, Verkaaik M, Geels P, et al. A practice guide on antimicrobial stewardship in nursing homes. *Antimicrob Resist Infect Control* 2023;12:120. <https://doi.org/10.1186/s13756-023-01321-0>.