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ORIGINAL RESEARCH

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Assessment of potentially unnecessary antibiotic use for suspected urinary tract infections in nursing homes using a simplified algorithm

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ABSTRACT

Background: Nursing home (NH) residents are frequently treated with antibiotics for urinary tract infections (UTIs), often due to overdiagnosis. The aim of this study was to evaluate the proportion of potentially unnecessary antibiotic use for suspected UTIs in NHs across eight European countries.

Research design and methods: Over a three-month period (February to April 2024), NH professionals recorded information on all antibiotic treatments for UTIs using a specific registration chart. Based on medical literature and the expertise of the project consortium members, the authors developed and endorsed by consensus a simplified algorithm to assess unnecessary antibiotic use in residents without indwelling catheters.

Results: The study, conducted across 110 NHs, included 2773 antibiotic-treated infections. Of these, 1158 (41.8%) were treated for UTIs. Among 975 UTI cases without catheters, 54.1% may have been unnecessarily treated. Over one-third involved nonspecific symptoms including poor general condition and changes in urine appearance, while specific urinary symptoms, such as incontinence (21.3%) and dysuria (20.8%), were less common. A trend toward greater, potentially unnecessary antibiotic use was observed when urine dipsticks were performed.

Conclusions: The findings reveal potentially unnecessary antibiotic use. Further algorithm validation is needed to enhance diagnostic criteria, reduce overuse, and improve UTI management in NHs.

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1. Introduction

Urinary tract infections (UTIs) are among the most common infections in nursing homes and are usually treated with antibiotics. However, diagnosing UTIs in this setting is challenging, and significant overdiagnosis has been reported, leading to overtreatment [1]. Three main factors might explain this overdiagnosis. First, it can be difficult to distinguish between asymptomatic bacteriuria and a UTI, especially given the high prevalence of asymptomatic bacteriuria among nursing home residents, which ranges from 25% to 50% in women and 15% to 40% in men [2–5]. Another diagnostic challenge is the high prevalence of nonspecific signs and symptoms among residents, which are more common than typical urinary symptoms, with mental status changes and fever being the most frequent, as described in some studies [6,7]. Lastly, the presence of a doctor in most nursing homes is limited to specific time frames, and nursing staff are responsible for assessing the different signs and symptoms and contacting doctors when they believe residents need antibiotics for their condition.

Inappropriate antibiotic treatment can exacerbate antibiotic resistance and increase the risk of adverse events for residents [8,9]. Studies have shown that multimorbid older individuals living

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in nursing homes are more likely to have a UTI caused by multi-resistant bacteria than those living in the community [10]. Moreover, the aging population in nursing homes has led to increased complexity, including higher rates of frailty [11]. This demographic change results in increased susceptibility to serious health problems and complications, especially infectious diseases, highlighting the need for improved antimicrobial stewardship programs and prevention measures for healthcare-associated infections.

As part of the European-funded project 'Improving Antibiotic Use in Long-Term Care Facilities by Infection Prevention and Control and Antibiotic Stewardship (IMAGINE),' we are conducting a before-and-after intervention quality control study in eight different countries aimed at improving antibiotic utilization and enhancing infection prevention and control elements in nursing homes, focusing mainly on UTIs [12]. We aimed to assess the proportion of potentially unnecessary antibiotic use based on the results collected from the initial registration, with comparisons made between the use and nonuse of urine dipstick testing.

2. Patients and methods

2.1. Design

This report represents the findings from the first registration of a prospective, non-randomized, before- and after intervention study (IMAGINE project) and the application and implementation of a simple UTI diagnosis algorithm for diagnosing UTI in nursing home residents without indwelling catheters developed for this project. The study is conducted in eight European countries: Denmark, Greece, Hungary, Lithuania, Poland, Slovakia, Slovenia, and Spain. Detailed information about the study method and intervention can be found in the study protocol [12]. In summary, an average of four nursing staff professionals from at least 10 nursing homes in each country were invited to participate in the registration of their clinical practices conducted between February and April 2024. A second registration is taking place after the intervention from February to April 2025.

The study was conducted in accordance with the protocol, the Declaration of Helsinki, the principles of Good Clinical Practice, The General Data Protection Regulation (EU) 2016/679 and the Human Research Act as well as other locally relevant regulations. Appropriate Regulatory/Ethical approval was sought in each of the countries taking part in the study, and all study procedures started after gaining approval on the basis of the master protocol, translated where necessary to local language. In Spain, the coordinating country, the study protocol was approved by the Ethics Committee of IDIAP Jordi Gol, Institute of Research in Primary Health Care (ref. 23/080-P).

2.2. Information collected

Each nursing staff member in all the participating nursing homes was asked to fill out a specific template whenever a new resident began an antibiotic regimen during the three-month study period. The data were registered according to the methodology of the Audit Project Odense (APO), which follows a prospective self-registry methodology in which a simple reporting chart is used [13]. Nursing staff professionals collected information on all the common infections treated with antibiotic, registering the age and gender of the patient, type of infection for which the antibiotic was used, risk factors for UTI, the presence of new or worsened preexisting nonspecific signs and symptoms (fever, chills, confusion, poor general condition, behavior change, loss of appetite, reduced fluid intake, or no general symptoms), the presence of specific urinary signs and symptoms (dysuria, urgency, frequency, urinary incontinence, flank pain, low abdominal or pelvic pain, blood in urine, foul-smelling urine, cloudy urine, or no specific symptoms), urine testing performed, the antibiotic given, and the duration of the antibiotic course administered.

2.3. Context analysis study

A preliminary study was conducted to identify potential areas for improvement in nursing homes across the eight participating countries. This study involved a context analysis, which included interviews with healthcare professionals working in nursing homes. The interviews focused on infection prevention and control practices, as well as antibiotic management. The analysis helped identify gaps in information that needed to be addressed during the multifaceted intervention. Supplementary Table S1 provides a summary of this analysis conducted at the beginning of the project. The results indicated that nursing care is generally provided consistently across the eight participating countries, although doctor involvement varies significantly. The context analysis revealed that the percentage of nursing homes with clinical guidelines for the appropriate management of UTIs was low across the different countries. Additionally, the interviews showed that algorithms for better diagnosing UTIs in residents were not being used.

Following participatory action research, nursing home staff highlighted the need for various tools to address areas for improvement. One of the main goals of the IMAGINE project intervention was the co-creation of a toolbox to improve daily practice in nursing homes. Nurses and nursing staff, including helpers and assistants, are the primary healthcare professionals in contact with residents and play a key role in diagnosing UTIs. One of the tools developed was designed to assist in improving the diagnosis of UTIs.

2.4. Creation of a simplified algorithm for better diagnosis of UTIs in nursing homes

Many consensus guidelines, algorithms, and recommendations aim to establish the minimum criteria that nursing home residents should meet before considering a diagnosis of UTI for which antibiotics should be initiated. However, most of these tools are not easy to follow, as they tend to be complicated [14–19]. The use of laboratory evidence of UTI as the gold standard, most of these algorithms show low sensitivities (30% or lower), specificities of 79% or higher, and positive predictive values between 50% and 60% [20]. Based on published evidence, we initially created an algorithm aimed at assessing potentially unnecessary antibiotic use before and after the intervention. However, it evolved into a tool for diagnosing UTIs when we

discovered that the nursing staff was not using any algorithm for UTI diagnosis. The algorithm was designed as a simple tool to help diagnose UTIs, gather information on symptoms, follow-up with patients, and determine when to contact a doctor.

After reviewing the medical literature and available tools, two of the authors developed a simplified algorithm for residents without indwelling catheters, which was then reviewed and commented on by all the authors of this manuscript. We aimed to simplify existing algorithms to create a ready-to-use version, adapting the algorithms proposed by the revised Loeb criteria [15] and those of van Buul et al. [17]. This quality indicator was developed through iterative collaboration with experts within the consortium. The guiding principle during the revision process was to keep the algorithm simpler than existing tools in the medical literature, most of which are based on Delphi analysis, and to make it practical for daily use in nursing homes. This iterative process took approximately six months and was discussed during dedicated time slots in our monthly meetings with the entire consortium. We also held specific online meetings with a group of representatives from each participating country, formed for this purpose, to facilitate further discussion. The final algorithm was approved by all the authors (Figure 1). Supplementary Figure S1 shows an example of this tool provided during the intervention. We calculated potentially unnecessary antibiotic use, defined as the utilization of antibiotics when they were not required based on information from the registration chart.

2.5. Data analysis

Descriptive analysis of the results was carried out. We conducted a descriptive analysis of the results and used chi-square tests to assess the statistical differences in potentially unnecessary antibiotic use and the performance of urine dipstick tests. The data were analyzed with the Stata v17 statistical program. Statistical significance was considered with $p < 0.05$.

3. Results

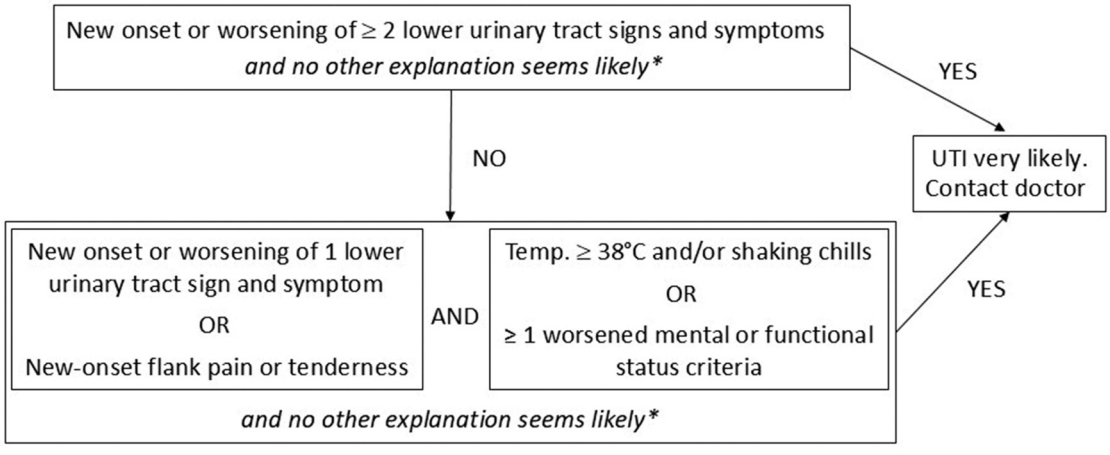
3.1. Characteristics of the residents

A total of 110 nursing homes were included in the first audit registration, with the number of facilities ranging from 9 in Greece to 18 in Hungary. A total of 2773 infections were treated with antibiotics in this first audit registration across eight countries, with numbers ranging from 66 in Greece to 761 in Slovenia. The mean age of the residents was 82.0 years (standard deviation 11.7 years), and 63.4% were women. A total of 269 residents (9.7%) had an indwelling urinary catheter, and 54.5% wore incontinence pads. A total of 1158 nursing home residents (41.8%) were treated with antibiotics for a UTI.

As shown in Figure 2, the most prevalent signs and symptoms among the cases included poor general condition, observed in 40.7% of the cases, followed by cloudy urine in 36.6%, foul-smelling urine in 36%, confusion in 32.6%, and behavior change in 29.3% of the cases. Notably, the incidence of urinary tract-specific signs and symptoms was relatively low, with urinary incontinence, dysuria, frequency, and urgency reported in 21.3%, 20.8%, 13.9%, and 7.6% of cases, respectively. Urine cultures were requested in 28.3% of suspected UTI cases.

3.2. Potentially unnecessary antibiotic use

Of the 975 antibiotic prescriptions in residents without indwelling urinary catheters, potentially unnecessary antibiotic use was observed in 527 (54.1%) of the cases with the use of the simplified algorithm, with considerable variation among countries, ranging from 37% in Slovakia to 61.2% in Slovenia. The percentage of potentially unnecessary antibiotic use according to the Buul algorithm was 56%, compared to 69.9% based on the Loeb minimum criteria (Table 1).



*If other reasons for the respective signs and symptoms can be excluded, particularly urinary retention, dehydration, side effects of medication, other infectious foci, or other diseases.

Figure 1. Simplified algorithm on minimum criteria for urinary tract infection in residents without indwelling catheter.

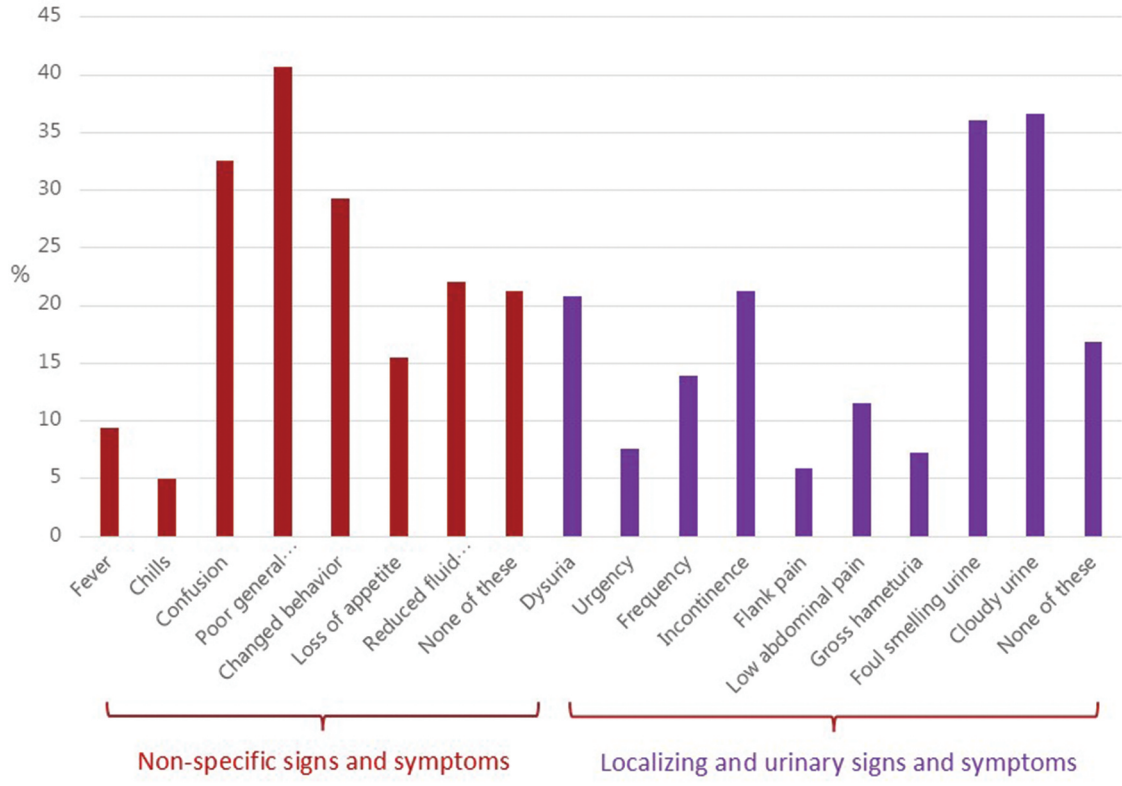


Figure 2. Presence of the different signs and symptoms among residents with suspected urinary tract infections treated with antibiotics in the participating nursing homes ($n = 1158$).

Table 1. Potentially unnecessary antibiotic use in residents without indwelling catheters, determined using different criteria.

		Loeb minimum criteria		Van Buul criteria		Simplified algorithm	
Country	Total number of UTIs	n	Mean	n	Mean	n	Mean
Denmark	164	123	75.0%	79	48.2%	73	44.5%
Greece	16	11	68.7%	10	62.5%	8	50.0%
Hungary	113	68	60.2%	53	46.9%	54	47.8%
Lithuania	27	16	59.2%	12	44.4%	12	44.4%
Poland	46	32	69.6%	24	52.2%	24	52.2%
Slovakia	46	25	54.3%	18	39.1%	17	37.0%
Slovenia	309	230	74.4%	198	64.1%	189	61.2%
Spain	254	177	69.7%	152	59.8%	150	59.1%
Total	975	682	69.9%	546	56.0%	527	54.1%

UTI=Urinary tract infection.

3.3. Urine dipsticks performed and association with potentially unnecessary antibiotic use

A urine dipstick test was performed in 708 cases in which a resident without an indwelling catheter was suspected of having a UTI, accounting for 72.6% of all cases. The percentage of dipstick use ranged from 28.3% in Slovakia to 92.9% in Spain (Table 2). Potentially unnecessary antibiotic use was identified in 394 cases in which a urine dipstick was used (55.6%), slightly higher than in cases in which dipstick testing was not performed (133 cases, 49.8%), with no statistically significant differences. Out of the 708 cases in which a dipstick was performed, the result was not reported in 34 patients. Among the remaining 674 cases in which the result was reported, potentially unnecessary antibiotic use was significantly higher among residents undergoing dipstick analysis (56.4% vs. 48.8%; $p \leq 0.05$). Positive results for leukocyte esterase and/or nitrites were reported in 659 cases (97.8% of all cases).

4. Discussion

The main finding of our study is that over half of the antibiotics given to residents without indwelling urinary catheters for suspected UTIs in 110 nursing homes in eight European countries were potentially unnecessary, ranging from 37% to 61.2% across countries. More than one-third of the cases treated for UTI presented with a poor general condition, cloudy urine, and foul-smelling urine. In contrast, common urinary tract signs and symptoms were present in less than one-quarter of the cases. The mean use of urine dipsticks was generally high, ranging from 28.3% to 92.9% across countries, with those using urine dipsticks being more prone to unnecessarily administer antibiotics.

The Centers for Disease Control and Prevention recommends nursing staff to evaluate feedback on antibiotic management performance following a protocol in nursing homes [21]. Our study was aimed at evaluating the proportion of

Table 2. Use of urine dipsticks reported in the registration charts across the participating countries.

		Urine dipstick performed		Urine dipstick performed with specific results for LE and nitrites		Urine dipstick performed with positive LE and/or nitrites results	
Country	Total number of UTIs	n	Mean	n	Mean	n	Mean
Denmark	164	107	65.2%	87	53.0%	85	51.8%
Greece	16	5	31.2%	4	25.0%	4	25.0%
Hungary	113	60	53.1%	59	52.2%	56	49.6%
Lithuania	27	10	37.0%	7	25.9%	5	18.5%
Poland	46	19	41.3%	19	41.3%	19	41.3%
Slovakia	46	13	28.3%	8	17.4%	8	17.4%
Slovenia	309	258	83.5%	254	82.2%	248	80.3%
Spain	254	236	92.9%	236	92.9%	234	92.2%
Total	975	708	72.6%	674	69.1%	659	67.6%

LE=Leukocyte-esterase; UTI=Urinary tract infection.

potentially unnecessary antibiotic use in these settings. Initially, we developed a simplified algorithm, which was consensually approved by our group as part of the IMAGINE project, to assess potentially inappropriate antibiotic use both before and after the intervention. However, it subsequently evolved into a diagnostic tool for UTIs upon discovering that nursing staff were not using any standardized algorithm for diagnosis. In this first registration, we observed a low presence of typical urinary tract signs and symptoms, such as dysuria, frequency, urgency, or suprapubic pain. The most prevalent symptoms were confusion, foul-smelling urine, and cloudy urine. This aligns with other studies, in which changes in urine characteristics and changes in mental status were more prevalent than the typical urinary signs [6,7]. However, this misattribution of these nonspecific signs and symptoms to UTIs is widespread in nursing homes. This is mainly due to the fact that many professionals still consider a UTI in cases of sudden cognitive decline, despite unclear evidence for this. Notwithstanding, some residents without specific signs and symptoms can also develop sepsis. In a recent study, nearly one-third of older patients with bacteremia had a urinary source of infection but did not present with typical urinary symptoms [22]. Not only does the fear of missing a serious infection, but also the perceived or direct demands for antibiotic use from residents and relatives who believe antibiotics might be effective for residents who present new-onset or worsened delirium, confusion or fever, mostly recalling that they seemed effective in previous situations, contribute to the overdiagnosis and overtreatment of suspected UTIs among nursing home residents [23].

The main reason why overdiagnosis of UTIs is so common in nursing homes is the lack of a definitive gold standard [24]. 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 due to sepsis. The criteria most used were developed by Loeb et al. [15], who introduced a minimum set of clinical guidelines for empirically starting antibiotics for UTIs, known as the Loeb minimum criteria. Further studies using Delphi consensus analyses have sought to identify signs and symptoms indicating UTIs in older adults, aiming to create decision-making tools for diagnosis and antibiotic initiation [17–19]. Van Buul et al. [17]. developed a simple algorithm based on clinical criteria and urine dipstick results, ruling out UTIs if both leukocyte esterase and nitrites were negative. We compared our simplified algorithm with the two simplest tools published so far. Our algorithm resulted in a rate of potentially unnecessary antibiotic use of 54.1%, while the percentages with the van Buul and Loeb criteria were slightly higher, at 56% and 69.9%, respectively. The IMAGINE algorithm was the most conservative of the three tools analyzed in this study, prioritizing caution for treating suspected rather than confirmed UTIs. Despite this approach, more than half of the antibiotics used were unnecessary.

Healthcare providers aim to integrate recent, high-quality research findings into their daily practice. However, the vast volume of research literature, variability in published tools, and diverse clinical issues in geriatric medicine pose significant challenges. Despite all these tools, studies show that 30–80% of nursing home residents receive unnecessary antibiotics [25–27]. Mylotte recently found in six studies that antibiotic therapy was appropriately initiated using the Loeb minimum criteria in only 8–44% of residents with suspected UTIs [28]. Healthcare providers in long-term care facilities should be given clear instructions about when a UTI should be suspected. Nursing staff play a pivotal role in the diagnosis of UTIs in nursing home residents, as they monitor patients' conditions and symptoms daily, significantly influencing the initiation of antibiotic treatment [29]. Therefore, it is crucial for nursing staff to have accurate and comprehensive knowledge of UTIs in older adults, supported by clear guidelines to ensure correct clinical assessments. Collaboratively developed protocols, prioritizing simplicity, transparency, and evidence-based practice, offer several benefits. They standardize diagnostic procedures, discourage outdated methods, such as the use of urine dipsticks, and improve the overall efficiency of healthcare delivery [30]. The use of a simplified algorithm, which was ultimately designed to help nursing staff more accurately identify UTIs when the minimum criteria are met, might help reduce antibiotic overuse and conserve valuable resources. Whether this new simplified tool will be more widely used by nursing staff remains to be elucidated, and a validity study also needs to be performed.

In our study, the use of urine dipsticks led to a greater use of potentially unnecessary antibiotics, which was statistically significant when we excluded cases in which dipstick results were not recorded in the registration charts. Urine dipsticks were used in nearly two-thirds of the residents with suspected UTI cases, which might be influenced by factors such as ease of implementation, rapid results, and practical considerations

[31]. Additionally, traditional practices in each area may play a role, with a high variability in their use across countries, as noted in our study. The observation that most of the residents with suspected UTIs underwent dipstick analysis emphasizes the tendency among professionals to treat patients based on urine dipstick results even in the absence of specific symptoms. In addition, more than 97% of the dipstick test results were positive for leukocyte esterase, nitrites, or both. This indicates that nursing home professionals might rely on diagnostics too much, while not paying enough attention to patients' symptoms [32]. This high utilization of urine dipsticks is also mentioned in other European studies. In a recent study, Dutch researchers found that urine dipsticks were used in more than 80% of suspected UTI cases across 19 nursing homes in the country [33]. It is crucial to clearly communicate that dipsticks should not be used under any circumstances in nursing homes, in line with current recommendations from Public Health England and other relevant societies [34]. Unlike some common tools that may provide unclear guidance or even recommend the use of dipsticks, our straightforward algorithm firmly rejects their use.

The study has several limitations. Despite most front-line professionals in nursing homes being nurses, the responsibility for prescribing antibiotics lies with doctors. However, in many European countries, doctors in nursing homes are usually external professionals and are not present during nights and weekends, whereas nursing staff is always available. We anticipated that greater empowerment of nurses, along with continuous training, could lead to fewer UTI diagnoses and reduced antibiotic use. The nursing staff participated voluntarily, and as noted in some studies, volunteers may have a higher interest in quality improvement programs and research compared to the general professional population [35]. Additionally, the act of self-registering could potentially influence prescribing behavior. Our study also has some strengths. Importantly, we invited eight different countries in Europe to participate with more than 100 nursing homes, each with different backgrounds, nursing home organizations, and antibiotic utilization rates. This diversity allows for better extrapolation of the results. Completing the APO charts was straightforward, requiring participating nursing staff to merely check off criteria without writing, allowing them to maintain their usual routines during both registration periods.

5. Conclusions

This study reveals a high rate of potentially unnecessary antibiotic use among European nursing home residents, with considerable differences in urine testing procedures, indicating significant room for improvement. As stated in this study, the prevalence of general symptoms, which are less accurate for diagnosing UTIs, is high, whereas the prevalence of urinary tract symptoms and signs is not, making diagnosis more difficult. Enhanced diagnostic criteria are essential for nursing staff to effectively manage UTIs in nursing homes, particularly to reduce the indiscriminate use of antibiotics in residents who exhibit few urinary tract signs and symptoms. Effective diagnosis and treatment of UTIs will not only improve infection management within nursing homes but also contribute to the global effort to combat antimicrobial resistance.

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Data availability statement

The data that support the results of this study are available from the corresponding author upon reasonable request.

Declaration of interest

Jens Søndergaard declares being on an advisory board for Abbot rapid diagnostics, steering group for project sponsored by Roche Diagnostics, advisory board for AstraZeneca, advisory board for Novo Nordisk. None of these relevant for this study. The other authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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Peer reviewers on this manuscript have no relevant financial or other relationships to disclose

Author contributions

C.Llor, M.P.Hansen, J.Lykkegaard, J.N.Jensen, and A.Garcia-Sangenís contributed to the conception and design of the research. The methodology and analysis plan were constructed by M.P.Hansen, J.Lykkegaard, L.Vallejo-Torres, B.G.López-Valcárcel, J.N. Jensen, T. Marloth, M. Theut, V. Antsupova. M.P Hansen, J. Lykkegaard were responsible for the study design and analysis plan and carried out the data monitoring. C.Llor and A.Moragas devised a first algorithm. All authors substantially contributed to the design of the simplified algorithm used in this project. M.Elistratova performed the statistical analysis. L.Vallejo-Torres and B.G.López-Valcárcel contributed to the interpretation of data. C.Llor wrote the original draft. All authors substantially contributed to the conception and design of the article and interpreting the relevant literature and were involved in writing the article or revising it for intellectual content. All authors agreed on the submission of the manuscript to the journal and reviewed and agreed on all versions of the article before submission, during revision, the final version accepted for publication, and significant changes introduced at the proofing stage. All authors had access to the study data and took responsibility for the integrity of the data and accuracy of the data analysis.

References

Papers of special note have been highlighted as either of interest (•) or of considerable interest (••) to readers.

1. Hartman EAR, Groen WG, Heltveit-Olsen SR, et al. Decisions on antibiotic prescribing for suspected urinary tract infections in frail older adults: a qualitative study in four European countries. Age Ageing. 2022;51(6):afac134. doi: 10.1093/ageing/afac134
2. Woodford HJ, George J. Diagnosis and management of urinary infections in older people. Clin Med (Lond). 2011;11(1):80–83. doi: 10.7861/clinmedicine.11-1-80
3. Nace DA, Drinka PJ, Crnich CJ. Clinical uncertainties in the approach to long term care residents with possible urinary tract infection. J Am Med Dir Assoc. 2014;15(2):133–139. doi: 10.1016/j.jamda.2013.11.009
4. Nicolle LE. Urinary infections in the elderly: symptomatic or asymptomatic? Int J Antimicrob Agents. 1999;11(3–4):265–268. doi: 10.1016/s0924-8579(99)00028-x
5. Biggel M, Heytens S, Latour K, et al. Asymptomatic bacteriuria in older adults: the most fragile women are prone to long-term colonization. BMC Geriatr. 2019;19(1):170. doi: 10.1186/s12877-019-1181-4
6. 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(1):62–66. doi: 10.1111/jgs.12070
7. Juthani-Mehta M, Drickamer MA, Towle V, et al. Nursing home practitioner survey of diagnostic criteria for urinary tract infections. J Am Geriatr Soc. 2005;53(11):1986–1990. doi: 10.1111/j.1532-5415.2005.00470.x
8. van Buul LW, van der Steen JT, Veenhuizen RB, et al. Antibiotic use and resistance in long term care facilities. J Am Med Dir Assoc. 2012;13(6):568.e1–e13. doi: 10.1016/j.jamda.2012.04.004
9. Nicolle LE. Urinary tract infections in the older adult. Clin Geriatr Med. 2016;32(3):523–538. doi: 10.1016/j.cger.2016.03.002
10. Chung HS, Namgung M, Lee DH, et al. Comparison of antibiotic resistance rates and outcomes among older adult patients with urinary tract infections living in long- term care hospitals and the community. Geriatr Nurs. 2023;53:6–11. doi: 10.1016/j.gerinurse.2023.06.012
11. Carrasco-Ribelles LA, Cabrera-Bean M, Danés-Castells M, et al. Contribution of frailty to multimorbidity patterns and trajectories: longitudinal dynamic cohort study of aging people. JMIR Public Health Surveill. 2023;9:e45848. doi: 10.2196/45848
12. García-Sangenís A, Modena D, Jensen JN, 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. 2024;13:e60099. doi: 10.2196/60099
13. Plejdrup Hansen M, Lykkegaard J, Søndergaard J, et al. How to improve practice by means of the Audit Project Odense method. Br J Gen Pract. 2022;72(718):235–236. doi: 10.3399/bjgp22X719417
    - **Review article on the strengths and limitations of the Audit Project Odense method.**
14. McGeer A, Campbell B, Emori TG, et al. Definitions of infection for surveillance in long-term care facilities. Am J Infect Control. 1991;19(1):1–7. doi: 10.1016/0196-6553(91)90154-5
15. Loeb M, Bentley DW, Bradley S, 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(2):120–124. doi: 10.1086/501875
    - **The Loeb minimum criteria have been widely used to inform decisions regarding residents in long-term care facilities when care is needed.**
16. Stone ND, Ashraf MS, Calder J, et al. Surveillance definitions of infections in long-term care facilities: revisiting the McGeer criteria. Infect Control Hosp Epidemiol. 2012;33(10):965–977. doi: 10.1086/667743
17. van Buul LW, Vreeken HL, Bradley SF, 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(9):757–764. doi: 10.1016/j.jamda.2018.05.001
    - **An expert consensus study was developed in which the use of urine dipsticks was limited to negative results only.**
18. Nace DA, Perera SK, Hanlon JT, 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(9):765–769e3. doi: 10.1016/j.jamda.2018.05.030
19. Bilsen MP, Conroy SP, Schneeberger C, et al. A reference standard for urinary tract infection research: a multidisciplinary delphi consensus study. Lancet Infect Dis. 2024;24(8):e513–e521. doi: 10.1016/S1473-3099(23)00778-8
20. Juthani-Mehta M, Tinetti M, Perrelli E, et al. Diagnostic accuracy of criteria for urinary tract infection in a cohort of nursing home residents. J Am Geriatr Soc. 2007;55(7):1072–1077. doi: 10.1111/j.1532-5415.2007.01217.x
21. The core elements of antibiotic stewardship for nursing homes. Centers for Disease Control and Prevention website; 2015. Available from: http://www.cdc.org/longtermcare/index.html
22. Bai AD, Bonares MJ, Thrall S, et al. Presence of urinary symptoms in bacteremic urinary tract infection: a retrospective cohort study of Escherichia coli bacteremia. BMC Infect Dis. 2020;20:781. doi: 10.1186/s12879-020-05499-1
23. Piggott KL, Trimble J, Leis JA. Reducing unnecessary urine culture testing in residents of long term care facilities. BMJ. 2023;382:e075566. doi: 10.1136/bmj-2023-075566
24. Nicolle LE, Gupta K, Bradley SF, 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(10):e83–110. doi: 10.1093/cid/ciy1121
25. Daneman N, Gruneir A, Newman A, et al. Antibiotic use in long-term care facilities. J Antimicrob Chemother. 2011;66:2856–2863. doi: 10.1093/jac/dkr395
26. van Buul LW, Veenhuizen RB, Achterberg WP, et al. Antibiotic prescribing in Dutch nursing homes: how appropriate is it? J Am Med Dir Assoc. 2015;16(3):229–237. doi: 10.1016/j.jamda.2014.10.003
27. Phillips CD, Adepoju O, Stone N, et al. Asymptomatic bacteriuria, antibiotic use, and suspected urinary tract infections in four nursing homes. BMC Geriatr. 2012;12:73. doi: 10.1186/1471-2318-12-73
28. Mylotte JM. Determining the appropriateness of initiating antibiotic therapy in nursing home residents. J Am Med Dir Assoc. 2023;24:1619–1628. doi: 10.1016/j.jamda.2023.06.034
29. Eikelenboom-Boskamp A, van Loosbroek M, Lutke-Schipholt E, et al. A practice guide on antimicrobial stewardship in nursing homes. Antimicrob Resist Infect Control. 2023;12:120. doi: 10.1186/s13756-023-01321-0
30. Denegri S, Faure H. It's plain and simple: transparency is good for science and in the public interest. Trials. 2013;14:215. doi: 10.1186/1745-6215-14-215
31. Devillé WL, Yzermans JC, van Duijn NP, et al. The urine dipstick test useful to rule out infections: a meta-analysis of the accuracy. BMC Urol. 2004;4(1):4. doi: 10.1186/1471-2490-4-4
32. Langford BJ, Daneman N, Leung V, et al. Cognitive bias: how understanding its impact on antibiotic prescribing decisions can help advance antimicrobial stewardship. JAC Antimicrob Resist. 2020;2(4):dlaa107. doi: 10.1093/jacamr/dlaa107
    - **An interesting review of behavioral science on the importance of cognitive bias in decision-making, particularly when deciding whether to treat with antibiotics.**
33. Yeung GYC, Smalbrugge M, van Buul LW, et al. Urinary tract infection guideline adherence in a Dutch sentinel nursing home surveillance network. J Am Med Dir Assoc. 2024;25(7):105037. doi: 10.1016/j.jamda.2024.105037
34. England Public Health. Diagnosis of urinary tract infections. Quick reference materials for primary care for consultation and local adaptation; 2018 Available from: https://www.gov.uk/government/publications/urinary-tract-infection-diagnosis
35. Baker R, Robertson N, Farooqi A. Audit in general practice: factors influencing participation. BMJ. 1995;311(6996):31–34. doi: 10.1136/bmj.311.6996.31