

## Deceptive Urine Studies and Inappropriate Antibiotic Use in Geriatric Psychiatry: The Impact of Bundled Interventions

### Abstract

**Background:** Indiscriminate orders for urinalysis and urine cultures (UC) drive inappropriate antibiotic treatment (Abx), especially in older adults with mental health disorders. Lack of data regarding the prevalence of and treatment for infections in acute geriatric psychiatric units (GPU) motivated us to initiate this project. **Aim:** Our goal was to improve urine test utilization and reduce unnecessary Abx for asymptomatic bacteriuria (ASB) and contaminated UC. **Methods:** This retrospective review and prospective evaluation of bundled interventions was conducted in a 22-bed GPU in a community-based teaching hospital. Four hundred twenty-seven (427) patient records were reviewed for Abx and indication and 157 patients were assessed for the impact of bundled interventions. **Results:** Near 27% received Abx, primarily for a misdiagnosed urinary tract infection. Only 20% met clinical criteria; 80% were unnecessarily treated for ASB or contaminated cultures. Over two-thirds of the Abx consisted of fluoroquinolones or trimethoprim-sulfamethoxazole, neither of which are recommended due to adverse events and/or resistance. The impact of bundled interventions was marginally effective. **Conclusion:** Urinalysis and UC are indiscriminately ordered in older adults, resulting in inappropriate Abx with non-recommended agents. Urinalysis should not be a requirement for admission in asymptomatic patients given the high prevalence of ASB and pyuria in older adults. There is an opportunity for more collaboration within referring networks to standardize best practice.

**Keywords:** Antimicrobial stewardship, asymptomatic bacteriuria, harm, older adults, testing stewardship

### Introduction

Antibiotics are commonly used in older adults, particularly in inpatient settings. The Centers for Disease Control and Prevention reports that 30%–50% of antibiotic use (AU) is unnecessary in acute care hospitals in the United States.<sup>[1]</sup> Inappropriate AU increases morbidity, antibiotic resistance, mortality, and cost of care. Diagnosing infections in older adults can be challenging, as classic signs of infection may be absent and nonspecific symptoms or functional decline may predominate. Cognitive deficits and delirium may limit clinical assessment. As part of our expanding antimicrobial stewardship initiatives, we identified the need to improve both urinalysis (UA) and urine culture (UC) utilization, as well as AU on our inpatient geriatric psychiatry unit (GPU). UA is commonly ordered but can be misleading unless interpreted with caution. A UA without leukocyte esterase (LE) or microscopic pyuria has

a strong negative predictive value for a urinary tract infection (UTI). LE signals the presence of leukocytes, and positive nitrites are indicative of the presence of bacteria from the family *Enterobacteriaceae*.<sup>[2]</sup> However, these results are not specific for UTI because these findings are extremely common in older adults. Among residents residing in long-term care, asymptomatic bacteriuria (ASB) is present in 25%–50% of women and 15%–40% of men.<sup>[3]</sup> There is no benefit to treating ASB in this population, even in the presence of pyuria, which does not differentiate ASB from a UTI.<sup>[3]</sup> Up to 90% of elderly institutionalized patients will have pyuria.<sup>[2]</sup> The American Geriatric Society and the Society for Postacute Care and Long-Term Care Medicine discourage treatment of bacteriuria unless specific urinary tract symptoms are present.<sup>[4,5]</sup> We hypothesized that overutilization of a required UA for GPU admission contributed to the overdiagnosis of UTI and accounted for unnecessary AU. This led us to assess

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**Table 1: Symptoms of urinary tract infection and recommended trigger for urine studies. Any one sign or symptom, unless otherwise specified**

No catheter	Indwelling catheter
<input type="checkbox"/> Acute dysuria	<input type="checkbox"/> Fever (>38°C or 100.4°F)
<input type="checkbox"/> Fever (>38°C or 100.4°F) and another symptom	
Gross hematuria	<input type="checkbox"/> Suprapubic pain
Urinary incontinence <sup>a</sup>	<input type="checkbox"/> Flank tenderness
Urgency <sup>a</sup>	<input type="checkbox"/> Rigors
Frequency <sup>a</sup>	<input type="checkbox"/> Acute hematuria
Suprapubic pain	<input type="checkbox"/> Unexplained mental status change or delirium
Flank tenderness	<input type="checkbox"/> Malaise or lethargy without another cause
<input type="checkbox"/> In the absence of fever, two of the above symptoms	<input type="checkbox"/> Septic shock, without an established source
<input type="checkbox"/> Septic shock, without an established source	

<sup>a</sup>New or increased

the prevalence of and treatment for infections in our GPU and then evaluate bundled interventions targeting improvement for the diagnosis and treatment of UTI.

## Materials and Methods

This retrospective review and prospective quality improvement initiative were conducted in our 22-bed GPU in a community-based teaching hospital, covered by four geriatric psychiatrists, one hospitalist, and one nurse practitioner. Baseline data (phase 1) were collected for patients hospitalized from February 1, 2016, to January 31, 2017. The medication administration record was reviewed to assess for AU. If antibiotic therapy was administered, the Epic electronic record and paper documents from referring facilities were scrutinized to determine whether a patient met criteria established by the Antimicrobial Stewardship Team (AST) for UTI [Table 1]. Allergies, renal function, empiric antibiotics, dose, culture and susceptibility (C and S) results, and duration of AU were recorded.

A positive UC was defined as equal to or greater than 100,000 colonies of bacteria per ml. Recovery of >2 species was considered contamination. ASB was defined as a positive UC without symptoms or signs of a UTI. Nitrofurantoin was considered appropriate empiric therapy for UTI in a patient with at least a creatinine clearance of 40 mL/min based on the annual antibiogram and recommendations from the AST. Appropriate AU was defined as the selection of an antibiotic recommended by the Infectious Diseases Society of America for cystitis and demonstrating more than 85% *Escherichia coli* susceptibility according to the cumulative hospital antibiogram.<sup>[6]</sup> For the purpose of this study, UTI was referred to uncomplicated disease.

Bundled interventions were subsequently implemented (phase 2), consisting of an in-person education on testing and treatment for UTI to GPU providers (August 14, 2017), removing the requirement for an admission UA which was communicated to emergency medicine (EM) leadership (September 6, 2017), and clinical decision support during physician order entry, requiring

documentation of symptoms to order a UC (October 1, 2017). UA, UC, and AU appropriateness were determined for patients who received at least four doses of an antibiotic for UTI. Pre-(discharged 7/3/17–8/14/17) and postintervention (admitted 10/2/17 and discharged prior to 1/17/18) periods were compared. The study was reviewed by IRB (Institutional Review Board) and considered as quality improvement.

## Results

In phase 1, among 427 patients, 131 were identified as having received an antibiotic. Sixteen patients were excluded from the analysis; 14 never received an antibiotic, and 2 received only topical therapy. One hundred and fifteen individuals (27%) were included in the study population. Half of the antibiotics were prescribed on the GPU, 19% in the emergency department (ED), 24% by a primary care physician, long-term care provider, or a provider from another hospital unit; 7% had different antibiotics prescribed by the ED and GPU. The majority of patients received a single antibiotic (81%), 17% received two different antibiotics, and 3.5% received parenteral antibiotics.

The most common diagnosis was UTI (53%), followed by skin and soft-tissue infection (26%) and pneumonia (10%).<sup>[6]</sup> Among 61 patients who were diagnosed with UTI, the majority were Caucasian (85%), female (79%), 70% were more than 71 years old, 61% were living in long-term care, 34% independently, and 5% in assisted-living facilities. Since UTI accounted for the overwhelming majority of infections, this condition became our focus. Only 12 of 61 patients (20%) diagnosed with UTI met the criteria [Table 2]. More than half of the positive cultures, involving 13 patients, were due to ASB, and 26% of patients had a contaminated culture (CC). Nearly 80% of empiric AU was inappropriate, primarily consisting of fluoroquinolones, sulfonamides, and beta-lactams. Nitrofurantoin was initiated in only eight patients. The dose of the antibiotic was appropriate in all but 2 patients, and 36% of patients were on antibiotics

**Table 2: Results of 58 urine cultures among 61 patients diagnosed with a urinary tract infection**

	Number (percentage of patients)
Positive culture*	25 (43)
UTI	12 (21)
Asymptomatic bacteriuria and pyuria	6 (10)
Asymptomatic bacteriuria	7 (12)
Contamination†	15 (26)
No growth	10 (17)

\*Equal to or >100,000 colonies of bacteria/mL, †>2 species of bacteria cultured. UTI: Urinary tract infection

**Table 3 Impact of bundled interventions on urinalysis, urine cultures, and inappropriate antibiotic therapy for urinary tract infection**

	Preintervention period (%)	Postintervention period* (%)
Number of patients	48	109
UA ordered	38 (79.2)	79 (72.5)
UA in asymptomatic patients	19 (50)	50 (63.3)
Urine cultures	15 (31.3)	25 (22.9)
Inappropriate antibiotic therapy	4 (8.3)	7 (6.4)
Contaminated specimens	6 (40)	12 (48)
Asymptomatic bacteriuria	4 (26.7)	6 (24)
Urinary tract infection	1 (6.7)	2 (8)

\*Postintervention period: No significant differences were observed between the pre and postintervention periods. UA: Urinalysis

for <3 days. Among 26 patients (22.6%) who presented with altered mental status and received antibiotics, 18 (69.2%) were misdiagnosed and treated for a UTI. Two of these patients were diagnosed and treated but were not cultured. Only three of these individuals had an indwelling catheter.

During phase 2 of the study, there were nonsignificant decreases in UA and UC utilization following the bundled interventions [Table 3]. Based on a review of data available from a report detailing criteria for ordering a UC, a reason for “request of admitting service” continued to be selected among EM providers, as other facilities in our psychiatric referral network required a UA for medical clearance.

Nonetheless, there was a 23% decrease in inappropriate AU for UTI, although it did not reach statistical significance due to the short observation period. CC and ASB remain far more common than UTI [Table 3]. One patient with urinary symptoms did not have a UA during the postintervention period, but no patient experienced an adverse effect from a delay in treatment.

## Discussion

Less than 3% of all admissions to our GPU in 1 year had a UTI. More than half of the positive UC was not clinically

warranted. CC and ASB were more common than UTI (26% and 22%, respectively). The overuse of UA without clinical indications has been reported among medical patients.<sup>[7]</sup> In an ED, 84% of patients who had a UA lacked symptoms of a UTI. A positive UA significantly increased orders for culture and antibiotic therapy in asymptomatic patients ( $P < 0.001$ ).<sup>[7]</sup> In another ED study, a positive UA and UC, but not signs or symptoms of a UTI, were significantly associated with an antibiotic prescription.<sup>[8]</sup> Interestingly, urine testing was done significantly more frequently for nonspecific reasons among older adults.<sup>[8]</sup> In our study, 80% of patients were overdiagnosed with UTI. This exceeds a report indicating that UTI is incorrectly diagnosed in 45% of patients older than 75 years residing in nursing homes.<sup>[9]</sup> Lack of appreciation for the high prevalence of ASB and pyuria in older adults, inattention to clinical signs and symptoms supporting a UTI, overuse of UA, suboptimal urine collection techniques, and patient characteristics, including delirium, dementia, and impaired communication, contribute to diagnostic error.

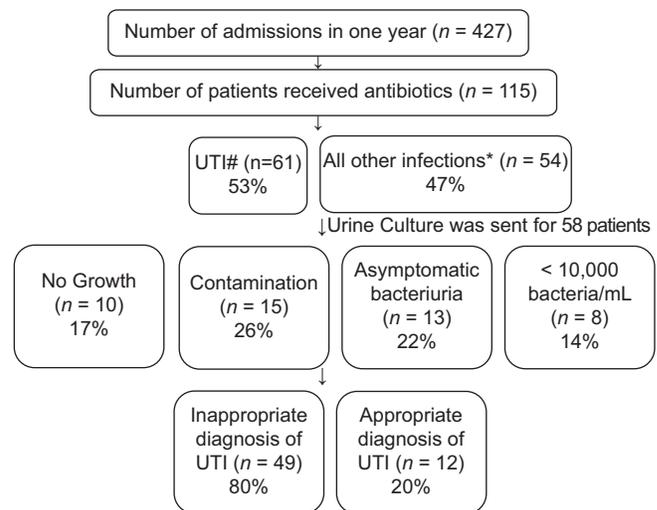
There is guidance from professional societies and experts to avoid using altered mental status as a symptom of UTI since it is not specific for this diagnosis.<sup>[10]</sup> Das *et al.*, demonstrated that a change in mental status should not prompt antibiotic therapy for a UTI in noncatheterized nursing home residents.<sup>[11]</sup> The diagnosis of a UTI requires the presence of genitourinary symptoms.<sup>[12]</sup> Older adults with infection at any site may present with confusion, decline in functioning, and anorexia; fever may be absent.<sup>[12]</sup> A diagnosis of UTI without careful assessment for infections at other sites and noninfectious causes for delirium can result in diagnostic error. The negative predictive value is nearly 100% if a UA is negative for LE and nitrite.<sup>[13]</sup> However, since pyuria is so prevalent in older adults, the pretest probability for an abnormal UA is extremely high, resulting in cognitive bias, false reassurance, and the potential for diagnostic error.<sup>[14]</sup> Therefore, a required screening UA for medical clearance is misguided, as it drives the ordering of UC and results in antibiotic overprescribing for ASB and CC. Suboptimal attention to proper specimen collection yielded a 26% contamination rate in our study and even a higher rate following the bundled interventions (48%). Correct midstream clean-catch technique was used in only 6% of patients who voided without assistance, and the majority received no instruction on specimen collection in an ED study reporting on pitfalls in urine testing and interpretation.<sup>[8]</sup> There needs to be a concerted effort to educate patients and ensure adherence to aseptic technique when collecting urine specimens. Older adults often require assistance. In-and-out bladder catheterization to minimize contamination can improve the diagnosis and management of patients when a UC is indicated. Notably, a straight catheter specimen is considered positive when greater or equal to 1000 bacteria per mL are cultured, irrespective of the number of species.<sup>[2]</sup>

In a mildly symptomatic patient, if the dipstick reveals LE or nitrite, or a microscopic exam shows >10 white blood cells (WBC) per high-power field (HPF), a properly collected specimen for culture should be obtained and empiric therapy delayed pending culture results.<sup>[12]</sup> If symptoms resolve, no treatment is needed, even in the presence of bacteriuria.<sup>[12]</sup> Following our bundled interventions, our organization implemented an option for a reflex UC when the microscopic exam demonstrates >10 WBC/HPF, but this may offer little benefit in older adults given the high prevalence of pyuria.<sup>[3]</sup> In order to improve urine testing utilization, it will be important to limit the ordering of reflex UC to only symptomatic patients.<sup>[15]</sup>

Unnecessary AU for misdiagnosed UTI was common. Physician preference and not patient characteristics was found to be a major influencing factor behind antibiotic prescriptions.<sup>[16]</sup> In our study, ciprofloxacin was the most prescribed antibiotic for UTI, but fluoroquinolones are not recommended due to resistance, an association with *Clostridioides difficile*, serious blood glucose alterations, psychiatric side effects (nervousness, disorientation, agitation, altered attention, memory impairment, and delirium), tendinopathy, QT prolongation, and aortic aneurysms.<sup>[17,18]</sup> Prophylactic use of antibiotics for UTI, empiric therapy without C and S in older adults, treatment of ASB, prolonged duration of treatment, and other broad-spectrum antibiotics are discouraged.<sup>[19]</sup>

Our bundled initiatives reduced UA, UC, and inappropriate AU. Extending these improvement activities to facilities in our psychiatric referral network is essential for a more coordinated and systematic process. When there is clinical uncertainty in stable patients, a cautious approach to diagnosis and treatment is felt to outweigh the risk of harm posed by overtreatment. Active monitoring, with a frequent assessment of vital signs, hydration, and criteria for contacting the provider for any deterioration, is recommended.<sup>[20]</sup> The potential for unintended consequences and harm exists in overdiagnosing UTI in older adults, particularly if there is not a thorough search for other etiologies to explain the patients' symptoms.<sup>[20]</sup> Every 8–9 UAs resulted in an inappropriate antibiotic prescription (49/415). Since 20% of patients experience at least 1 antibiotic adverse event, the number of patients harmed by a UA was 10. Indiscriminate urine studies have the potential to cause harm and result in low-value care.

Retrospective nature and reliance on documentation from a variety of providers to ascertain signs and symptoms of infection are the major limitations of this study. It was confined to a single-center and consisted of geriatric psychiatry patients, so results may not be generalizable.



**Figure 1: The requirement for urinalysis (UA) is associated with inappropriate antibiotic therapy in nearly 12% of the population (49/415). Every 8.5 (415/49) UA result in an inappropriate antibiotic prescription. Since 20% of patients' experience at least 1 antibiotic adverse event,<sup>[25]</sup> the number of patients harmed by indiscriminate UA is 10. Based on previously published data<sup>25</sup>, 2-3 patients would experience definitive harm. \*Other infections include skin & soft tissue infections, respiratory tract infections, *Clostridioides difficile*, gingivitis, tooth abscess, conjunctivitis, blepharitis, corneal scar, prophylactic antibiotic use, late latent syphilis, neurosyphilis. \*UTI- urinary tract infection**

## Conclusions

This study supports the need for improving the utilization of urine studies and AU. A routine UA should not be a required test for admission or medical clearance since it results in overdiagnosis and overtreatment of UTI. We encourage EM providers, geriatricians, and psychiatrists to collaborate with pharmacy, infectious diseases physicians, and laboratory medicine leads at their institution to improve diagnostic stewardship, agree on clinical criteria for diagnosing common infections, and ensure optimal AU is based on local susceptibility data. Indiscriminate orders for UA have the potential to cause harm and result in low-value care [Figure 1]. We recommend educating the psychiatrists and ED physicians on the criteria to diagnose UTI to prevent misdiagnosis and inappropriate use of antibiotics. Routine UA in asymptomatic patients should be discouraged as a criteria for admission in a GPU.

## Ethical clearance

The study was reviewed by IRB (Institutional Review Board) and considered as quality improvement.

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## Conflicts of interest

There are no conflicts of interest.

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