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Original Article

BLADDER score: evaluating a tool to support urinary diagnostic and antibiotic stewardship in hospitalized adults

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Abstract

Objective: Antibiotic overuse for asymptomatic bacteriuria is common in older adults and can lead to harmful outcomes including antimicrobial resistance. Our objective was to evaluate the impact of a simple scoring tool on urine culturing and antibiotic prescribing for adults with presumed urinary tract infections (UTI).

Design: Quasi-experimental study using interrupted time series with segmented regression to evaluate urine culturing and urinary antibiotic use and length of stay (LOS), acute care transfers, and mortality 18 months before and 16 months after the intervention.

Setting: 134-bed complex continuing care and rehabilitation hospital in Ontario, Canada.

Participants: Nurses, nurse practitioners, physicians, and other healthcare professionals.

Intervention: A multifaceted intervention focusing on a 6-item mnemonic scoring tool called the BLADDER score was developed based on existing minimum criteria for prescribing antibiotics in patients with presumed UTI. The BLADDER score was combined with ward- and prescriber-level feedback and education.

Results: Before the intervention, the mean rate of urine culturing was 12.47 cultures per 1,000 patient days; after the intervention, the rate was 7.92 cultures per 1,000 patient days (IRR 0.87; 95% CI, 0.67–1.12). Urinary antibiotic use declined after the intervention from a mean of 40.55 DDD per 1,000 patient days before and 25.96 DDD per 1,000 patient days after the intervention (IRR 0.68; 95% CI, 0.59–0.79). There was no change in mean patient LOS, acute care transfers, or mortality.

Conclusions: The BLADDER score may be a safe and effective tool to support improved diagnostic and antimicrobial stewardship to reduce unnecessary treatment for asymptomatic bacteriuria.

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Background

Antimicrobial resistance (AMR) is a significant threat to global health. Misuse of antimicrobials hastens AMR and increases the risk of harm including adverse effects and *Clostridioides difficile* infection, particularly for older adults.[1] One of the most common reasons for antibiotic prescribing in older adults is for presumed urinary tract infections (UTI). Antimicrobial use is commonly inappropriate in such situations, ranging from 32% to 93% of prescriptions for suspected UTI deemed unnecessary.[2] Nonspecific symptoms are often mistakenly attributed to UTI in older adults. Asymptomatic bacteriuria is very common, estimated at up to 50% of non-catheterized older adults. Positive urine cultures often falsely reinforce preexisting suspicions of UTI. This can lead to a harmful medical cascade of urine culturing, antibiotic prescribing, and then adverse effects of antibiotic use.[3] Further, there is a risk of "premature diagnostic closure," in which other possible diagnoses are not considered due to initial anchoring on a suspicion of UTI.[4]

Although it is important to ensure adequate and early treatment of true symptomatic UTI in older adults, tools are needed to help clinicians decide in which low-risk patients we can avoid sending urine for culture and instead shift investigation and management to other possible diagnoses (eg, dehydration, medication-induced confusion, etc.). Preventing unnecessary urine culturing in the first place can help minimize antibiotic use because positive cultures are often difficult to ignore and often result in antibiotic therapy in the absence of symptoms. In fact, upstream diagnostic stewardship (reducing unnecessary testing) may be more effective at reducing unnecessary treatment of asymptomatic bacteriuria, compared to

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downstream antimicrobial stewardship (reducing unnecessary treatment) once urine culture is already reported to the treating clinician.[5]

Given the prevalence of antibiotic overuse for presumed UTI and the complexity of this problem driven by many behavioral and clinical factors, a variety of strategies are needed.[6] One novel approach to behavior change, "boosting," a more transparent and competency-focused alternative to "nudging," aims to improve clinician decision-making by empowering and respecting human capacity to make the right decision.[7] Our objective was to implement a simple boosting tool called the BLADDER score and to evaluate its impact on urine culturing and antibiotic prescribing for adults with presumed UTI.

Methods

Study design and setting

This was a single-center, quasi-experimental study focused on older adults in a 134-bed complex continuing care and rehabilitation hospital in Ontario, Canada. The hospital provides a range of services for patients transferred from acute care including low- and high-intensity rehabilitation, shorter-term complex medical management, and end-of-life care. There is funding for 0.1 full-time equivalent (FTE) board-certified infectious diseases pharmacist designated to antimicrobial stewardship and is supported by a nurse practitioner with an interest in antimicrobial stewardship as well as an interprofessional antimicrobial stewardship committee. Antimicrobial stewardship efforts are focused on monthly appropriateness point prevalence audits of all patients on antibiotics, provider peer comparison audit and feedback reports, guidelines, and pharmacist and nurse education. The hospital uses a hybrid of paper and electronic medical record, where medication prescriptions and urine culture orders are currently written on a paper chart.

Population

The focus of our intervention was clinicians, particularly nurses, nurse practitioners, and physicians. However, no specific enrollment was required as this was a pragmatic hospitalwide quality initiative.

Interventions

We report our intervention in alignment with the template for intervention description and replication (TIDieR) checklist.[8] We devised a novel tool, the BLADDER score, to simplify existing consensus-based criteria (Loeb criteria) which specify a minimum set of signs and symptoms to initiate antibiotics in long-term care (LTC) residents without indwelling urinary catheters.[9] There is regional familiarity with the Loeb criteria as an algorithm based on these criteria is used widely across LTC homes in the province, as recommended by the provincial public health agency. Indwelling urinary catheter use is relatively infrequent (<15%) in our population; hence the tool was developed to address non-catheterized patients, the main population from which urine cultures are sent. The BLADDER score was developed as a "boost" to prompt more appropriate urine culturing in patients with presumed UTI. The aim was to ensure a reflective pause before ordering a urine culture and/or initiating antibiotics. Each of the letters BLADDER in the score represents a possible symptom representative of UTI (B, blood in urine; L, loss of urinary control or incontinence; A, abdominal or flank pain; D, dysuria or pain on urination; E, elevated temperature or fever; R, repeated urination or frequency) (see Figure 1). When patients are evaluated for possible UTI, 1 point is given for each letter in the algorithm (all symptoms receive a score of 1 except dysuria which is 2 points). A score of 2 or more should prompt a urine culture, whereas a score below 2 suggests careful monitoring and investigation for other etiologies to explain their symptoms rather than a urine culture.

Intervention planning

A Master of Applied Gerontology student (SA) performed several point prevalence audits based on a convenience sample of patients who received urine cultures across the hospital during a 16-week practicum rotation from May to August 2022. Each of the 4 hospital wards was audited for the proportion of urine cultures that met the BLADDER score criteria (score of 2 or more). A total of 31 urine cultures were audited, and 16 of them met the appropriateness criteria (52% appropriate). A brief, case-based 5–15-minute huddle script outlining the new initiative was developed. A hospital-wide email bulletin was disseminated in July 2022 announcing the BLADDER score, promoting its use, and encouraging score documentation in the patient's paper health record for any patient with a suspected UTI. The scoring tool was discussed at the Antimicrobial Stewardship Subcommittee, Pharmacy and Therapeutics Committee, and Medical Advisory Committee. Copies of the BLADDER score were printed and posted in conspicuous areas in each of the nursing wards. Although there was a widespread endorsement, it was reinforced that the BLADDER score is meant to be a tool in conjunction with the overall assessment of the patient and as such does not replace clinical judgment.

Materials and clinician and patient engagement

There were 2 case-based "huddles" for each of the 4 hospital wards, discussing the BLADDER score starting in July 2022 and continuing during the intervention period. The main target audience was nursing and allied health providers (eg, therapists) who are often the first point of contact to request urine cultures. Either the antimicrobial stewardship pharmacist (BL) or the antimicrobial stewardship nurse practitioner (JW) and gerontology student (SA) led the huddle discussions. During the first set of huddles, auditing results for the unit were provided, emphasizing using and documenting the BLADDER to improve their score. Thereafter, during the intervention period, monthly antibiotic point prevalence audits included an assessment of BLADDER score adherence. Where sufficient data were available, provider-specific BLADDER score percentage adherence was provided in peer comparison reports provided periodically during the study period in December 2022 and May 2023.

An educational patient-focused handout was developed in August 2022 based on input from patient partners. This 1-page document provided information on asymptomatic bacteriuria, appropriate indications for urine culturing, and the harms of antibiotic overuse (Supplement).

Outcomes

The main outcomes were the number of urine cultures sent per 1,000 patient days, volume of urinary antibiotics (ciprofloxacin, nitrofurantoin, trimethoprim-sulfamethoxazole, fosfomycin) measured in defined daily doses (DDDs) per 1,000 patient days, and proportion of all antibiotic DDDs that were urinary. We also evaluated urine culture percent positivity throughout the study period. Secondary measures included total systemic antibiotic

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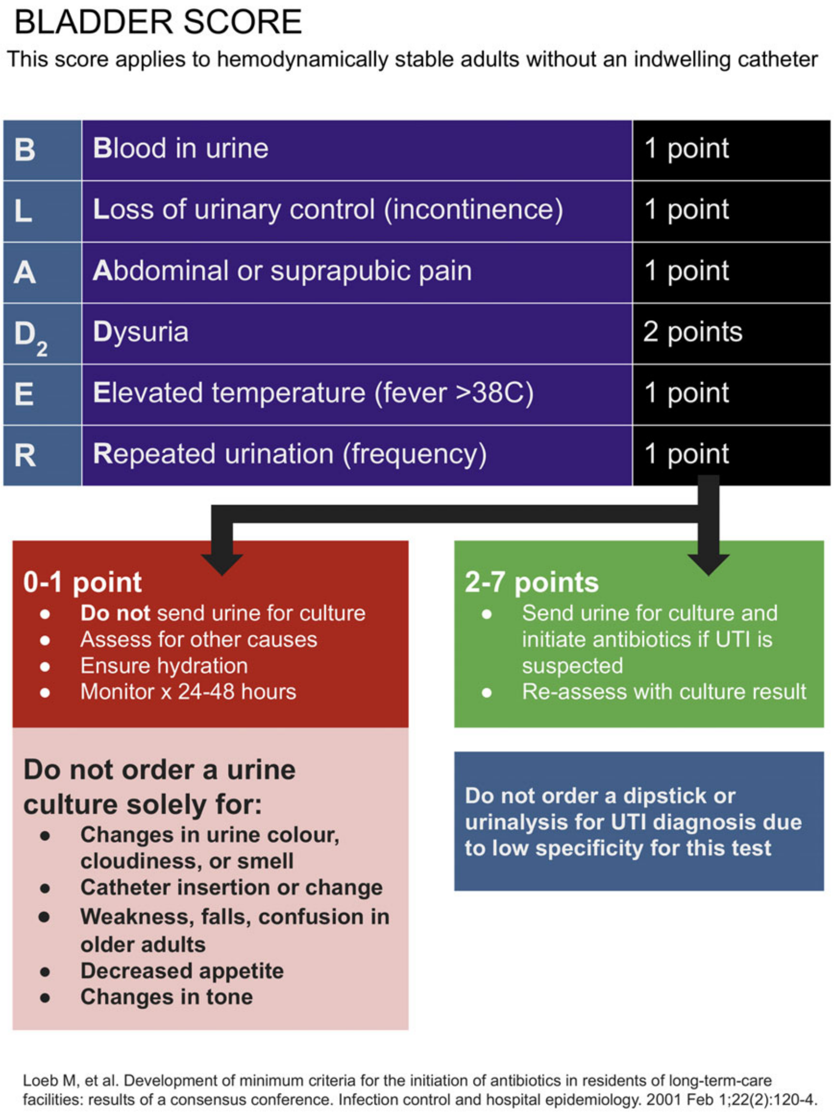

Figure 1. BLADDER score tool.

DDDs per 1,000 patient days (World Health Organization ATC Classification J01).[10] We included a negative tracer of non-urinary antibiotics (clindamycin, cloxacillin, daptomycin, fidaxomicin, macrolides, metronidazole, linezolid, moxifloxacin, penicillin, tetracyclines, vancomycin antibiotic DDDs per 1,000 patient days) which we expected would not be affected by the intervention.

To assess balancing measures, patient outcomes included mean monthly length of stay (LOS), transfers to acute care hospital, and in-hospital mortality.

Analysis

We employed an interrupted time series (ITS) analysis with segmented regression to assess the association of the intervention with the rates of urine culturing, antibiotic use, and patient outcomes. We evaluated outcomes over a 34-month period, 18 months before and 16 months after the intervention. The start month of the intervention was selected to be July 2022 given the huddles, meetings, and announcements began in that month. To model the incidence rate of urine culturing, antibiotic DDDs, acute care transfers, and mortality, we used Poisson regression due to the count nature of the data. The analysis included a pre- and postintervention comparison with an adjustment for patient volume (logarithm of patient days).[11] To report the association of the intervention on the outcomes, we reported incidence rate ratios (IRRs) with 95% confidence intervals. To model LOS, we used linear regression. Proportions were evaluated using binomial regression with a logit link. Based on the nature of the intervention, the model for each outcome assessed for change in level while accounting for the preintervention slope.[11] Due to the multipronged nature of the intervention with different strategies occurring at different times, a sensitivity analysis was performed to censor the intervention rollout phase which removes the period 2 months before and after the July 2022 start date. This censored period coincides with the period of student involvement in the project and reduces bias from the Hawthorne effect (audits) prior to the intervention and incorporates a potential for a lagged impact of the intervention. Analyses were carried out in R version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria).

Ethics

Given the project aimed to evaluate the impact of a hospital-wide quality improvement initiative, the research ethics board indicated that it does not require ethical approval.

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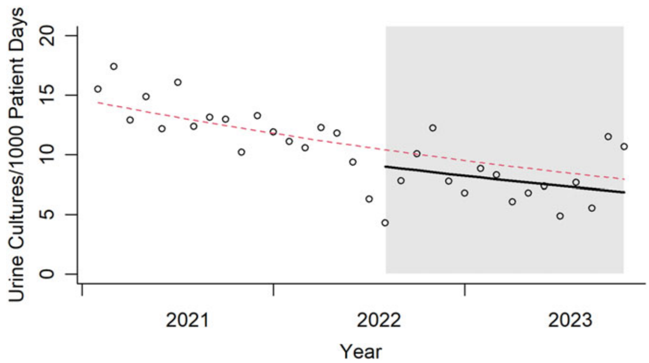

Figure 2. Urine culturing rate before and after BLADDER score. Red line represents the preintervention and predicted outcome without the intervention. Black line represents the actual model during the postintervention period.

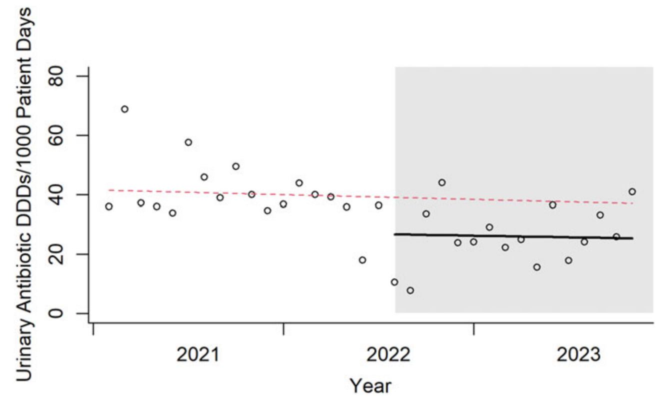

Figure 3. Urinary antibiotic use before and after BLADDER score. Red line represents the preintervention and predicted outcome during the study period without the intervention. Black line represents the actual model during the postintervention period. Urinary antibiotics included ciprofloxacin, nitrofurantoin, trimethoprim-sulfamethoxazole, and fosfomycin.

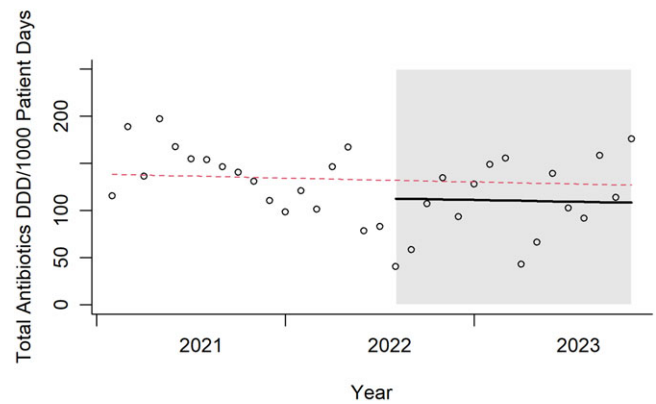

Figure 4. Total antibiotic use before and after BLADDER score. Red line represents the preintervention and predicted outcome during the study period without the intervention. Black line represents the actual model during the postintervention period.

Results

During the 34-month study period from January 2021 to October 2023, there were 2,715 patient discharges. The mean patient age was 76, and the mean LOS was 36 days. This represents a total of 97,178 eligible inpatient days.

Urine culturing

During the 34-month study period, there were 999 urine cultures performed over 97,178 inpatient days. Culture positivity was similar throughout the study period (preintervention 51.0%; postintervention 56.7%). There was already a declining trend of urine culturing prior to the intervention (0.14 less urine cultures per 1,000 patient days per month). Before the intervention, the mean rate of urine culturing was 12.47 cultures per 1,000 patient days; after the intervention, the rate was 7.92 cultures per 1,000 patient days (IRR 0.87; 95% CI, 0.67–1.12) (Figure 2). BLADDER score adherence was captured as part of routine antibiotic point prevalence audits from September 2022 to October 2023. During this period, 15 of 20 (75%) urine cultures were considered appropriate according to the scoring tool.

Antibiotic use outcomes

Urinary antibiotic use declined after the intervention from a mean of 40.55 DDD per 1,000 patient days before and 25.96 DDD per 1,000 patient days after the intervention (IRR 0.68; 95% CI, 0.59–0.79) (Figure 3). Total antibiotic use also declined after the intervention from 135.55 DDD per 1,000 patient days preintervention to 109.96 DDD per 1,000 patient days postintervention (IRR 0.85; 95% CI, 0.79–0.92) (Figure 4). Non-urinary antibiotic use did not significantly decline during the study period. Prior to the BLADDER score, the mean non-urinary antibiotic usage was 39.36 DDD per 1,000 patient days, and after, it was 29.73 DDD per 1,000 patient days (IRR 0.97; 95% CI, 0.84–1.11) (Figure S1). The proportion of all antibiotics that were urinary antibiotics declined during the intervention from 0.31 to 0.25 (OR 0.67; 95% CI, 0.56–0.81).

Patient outcomes

Patient LOS did not significantly change during the intervention (before: 38.17 days, after 34.69 days; difference +0.02 days; 95% CI, −7.33–+7.38 days) (Figure S2). Transfers to acute care remained unchanged (before: 2.77/1,000 patient days, after: 2.25/1,000 patient days; IRR 0.86; 95% CI, 0.52–1.43) (Figure S3). Mortality also remained unchanged (before: 1.40 deaths per 1,000 patient days, after: 1.62 deaths per 1,000 patient days; IRR 1.00; 95% CI, 0.51–1.94) (Figure S4).

Sensitivity analysis

Censoring the period of intervention rollout resulted in similar findings. The impact on urinary antibiotic prescribing was evident but less pronounced (IRR 0.81 (0.68–0.96)), compared to the primary analysis. Total antibiotic use did not appear to decline (IRR 0.96 (0.88–1.06)), whereas non-urinary antibiotic use declined (IRR 0.82 (0.69–0.98)), after the intervention. Similar to the primary analysis, the proportion of urinary antibiotic use of all antibiotic use declined after the intervention implementation (OR 0.77 (0.63–0.95)). There remained no impact on LOS, acute care transfers, or mortality.

Discussion

Implementation of the BLADDER score along with a multifaceted approach including education and audit and feedback was associated with a 32% reduction in urinary antibiotic prescribing in our rehabilitation hospital. Although there was no statistically significant decline in urine culturing, an overall trend in reduced

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urine culturing over time in addition to this novel tool may have contributed to this improvement in antibiotic use. There was no signal of unintended harm as inpatient LOS, acute care transfers, and mortality did not significantly change during the intervention.

Many large-scale multifaceted antimicrobial stewardship initiatives have focused on improving urine culturing in adults, most of which resulting in significant reductions in urine culturing and antibiotic prescribing.[5,12,13] The implementation of a scoring tool may be a useful adjunct to further explore in addition to other diagnostic stewardship strategies in hospitalized and LTC patients. Such a tool may be particularly useful as part of electronic health records as a trigger to consider more judicious culturing practices. Cognitive biases such as anchoring (fixating on certain diagnostic features early in the process) and commission bias (tendency toward action over inaction) are common in medicine, particularly antimicrobial prescribing. As such, tools to boost prescriber reflection and meta-cognition may be well-positioned to influence antimicrobial and diagnostic stewardship.[4]

Nudging involves modifying choice architecture to predictably alter decision-making[14] and has been gaining recent interest in health care.[15] However, it relies on existing cognitive biases and is sometimes considered nontransparent, and its effects are not expected to be sustained once the nudge is removed. Boosting, on the other hand, is a more active approach that aims to empower and sustain optimal decision-making, which requires some motivation on the part of the participant.[16] Boosting may be well-suited to antimicrobial stewardship where the aim is to improve clinician competency in antimicrobial use while respecting autonomy and acknowledging the need for nuanced individualized decision-making. Implementing and evaluating such boosts may be an area ripe for antimicrobial stewardship research.

Strengths of this study include the relatively long 34-month observation period and use of ITS analysis which reduces the risk of falsely attributing positive findings to an intervention, as it accounts for existing secular trends in the data. Some limitations to this work include the single-center design which may limit the generalizability and observational nature of our data which may include time-varying confounders. However, there appears to be a trend of reduced urine culturing prior to the intervention which would bias findings toward the null.

In conclusion, this study suggests that scoring tools may be a useful adjunct to support improved antimicrobial stewardship. The BLADDER score should be further evaluated in prospective studies to help reduce unnecessary urine culturing and mitigate the risk of harm to patients and the broader population.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2024.93.

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Competing interests. The authors have no competing interests to declare.

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