The value of intraoperative point-of-care urinalysis to predict positive urine cultures and symptomatic postoperative infections during cystoscopic procedures for pediatric patients

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KEY MESSAGES

- An "either-positive" dipstick rule (leukocyte esterase ≥trace OR nitrite positive) during pediatric cystoscopy achieved a 97.4% negative predictive value and was the sole independent predictor of positive urine cultures.
- Applying this rule could have eliminated 62.9% of intraoperative cultures while missing only one infection (2.6% of uncultured cases).
- A dipstick-guided protocol promises to curb unnecessary lab tests and empiric antibiotics — supporting antimicrobial stewardship — although prospective, multicenter validation is needed.

ABSTRACT

Introduction: We aimed to evaluate intraoperative point-of-care urinalysis (UA) for predicting positive urine cultures and postoperative urinary tract infections (UTIs) in children undergoing cystoscopy, and to assess its potential to reduce unnecessary cultures and antibiotics.
Methods: In this retrospective cohort at a tertiary pediatric urology center (August 2023 to April 2024), 62 cystoscopy cases with paired dipstick UA and quantitative culture were analyzed after excluding recent antibiotic use or incomplete data. Dipstick markers —leukocyte esterase and nitrite — were evaluated alone and combined ("either-positive" vs. "both-positive"). Positive culture was defined as $\geq 10^5$ CFU/mL; postoperative UTI required fever, clinical signs, and a positive culture within seven days. Diagnostic accuracy was assessed by ROC curves and χ^2 tests. A multivariable logistic regression adjusted for age, sex, procedure, laterality, and

clinical condition. A retrospective quality improvement (QI) model estimated reductions in culture orders and empiric antibiotics.
Results: Thirty-nine patients (62.9%) were dipstick-negative by the "either-positive" rule; one had a positive culture (negative predictive value [NPV] 97.4%; 95% confidence interval [CI] 86.5–99.9). Of 23 dipstick-positive patients, 13 (56.5%) had positive cultures. In multivariable analysis, "either-positive" dipstick was the sole predictor of culture positivity (odds ratio [OR] 330.2, 95% CI 30.5–3 574.1, p=0.003). QI modeling indicated that restricting cultures to the 23 dipstick-positive specimens would have averted 39 of 62 cultures (62.9%), at the expense of missing one infection (2.6% of uncultured cases).
Conclusions: Intraoperative dipstick UA reliably identifies pediatric cystoscopy patients at low risk for postoperative UTI, offering a rapid, cost-effective tool to enhance antimicrobial stewardship and reduce laboratory utilization. This single-center, retrospective study with a modest sample and low event rate may limit generalizability; prospective, multicenter validation is warranted.

INTRODUCTION

Urinary tract infection (UTI) remains an important, if relatively uncommon, source of postoperative morbidity in children undergoing cystoscopic interventions (1, 2). In fact, a recent unpublished Pareto analysis of our institutional pediatric hospital morbidity data revealed that one of the highest emergency department return rates requiring management was due to symptomatic UTIs following cystoscopic procedures (3). These procedures included cystoscopy with botulinum toxin injection, laser lithotripsy of urolithiasis, ureteral stenting, ureteric injections for vesicoureteral reflux, puncture of ureterocoeles, and posterior urethral valve ablation. These patients were asymptomatic and infection-free preoperatively. To mitigate this risk, our center administers a single preoperative dose of intravenous antibiotic 30–60 minutes prior to instrumentation (typically cefazolin 30 mg/kg IV, maximum 2 g; in β-lactam allergy, clindamycin 10 mg/kg IV [max 900 mg] +/- gentamicin 5–7 mg/kg IV), sends an intraoperative urine specimen for culture, and considers targeted postoperative antibiotics only when clinically indicated in keeping with antimicrobial stewardship principles (1, 4). An intravenous line is placed as part of routine anesthetic care (often after mask induction in children), ensuring the dose is administered within 30–60 minutes before cystoscopic instrumentation.
Current guidelines from the American Urological Association recommend against routine postoperative antimicrobial continuation, limiting prophylaxis to a one-time preoperative dose at most (1). At the same time, the Infectious Diseases Society of America advises against screening for or treating asymptomatic bacteriuria in children outside high-risk scenarios (5). Despite these recommendations, practice patterns remain heterogeneous, as many pediatric urologists still obtain preoperative or intraoperative urine cultures "just in case," leading to low-yield testing and unnecessary antibiotic exposure (6, 7).

Point-of-care urinalysis (dipstick testing for leukocyte esterase and nitrite) provides a rapid and cost-effective method for triaging patients intraoperatively. In adult study cohorts, a negative dipstick has demonstrated high negative predictive value (~90%) for postoperative infectious complications, suggesting that routine preoperative cultures may be safely omitted in dipstick-negative patients (8-10). Intraoperative urinalysis (UA) can serve as a decision-making tool to guide the ordering of selective cultures and targeted antibiotic use in pediatric urology procedures, aligning real-time clinical assessment with stewardship principles (11). Motivated by quality-improvement goals and antimicrobial stewardship, we evaluated whether intraoperative dipstick urinalysis could safely triage culture ordering and postoperative antibiotic use in pediatric cystoscopy, with the aim of informing protocol refinement at our institution. In this study, we evaluate the diagnostic accuracy of intraoperative dipstick urinalysis and model its potential impact on culture ordering and stewardship in our pediatric cystoscopy population.

METHODS

We conducted a retrospective cohort study following a Pareto analysis that identified post-cystoscopy symptomatic UTIs as the leading cause of morbidity requiring emergency visits or readmissions in 2020–2021. After institutional review board approval (REB# 1000076091/1000077457), we identified 325 pediatric cystoscopy cases performed from August 2023 to April 2024. Patients receiving systemic antibiotics within 72 hours before surgery date or those lacking complete culture data were excluded. A total of 62 (19.1%) had both intraoperative point of care- UA dipstick and urine culture obtained at the start of the procedure. Dipstick UA was performed using the Clinitek Status+® Analyzer (Canada, Siemens Healthineers), with results for leukocyte esterase and nitrite recorded as negative or graded from trace to 3+. A composite dipstick score was defined as "either positive" (leukocyte esterase ≥ trace or nitrite positive) or "both positive" (leukocyte esterase ≥ trace and nitrite positive). Urine cultures were processed per standard laboratory protocols, with $\geq 10^5$ CFU/mL considered positive. Postoperative febrile symptomatic urinary tract infection (UTI) was our prespecified primary outcome, defined by fever > 38 °C, at least one clinical sign (dysuria, urgency, flank pain), and a positive urine culture within 7 days of the procedure. We focused on febrile UTIs to capture clearly clinically significant infections and minimize misclassification from transient instrument-related irritative symptoms, which are common after cystoscopy and may not represent true infection. As a descriptive secondary analysis, we also report afebrile culture-positive episodes (i.e., asymptomatic bacteriuria or afebrile irritative symptoms with positive culture).

Statistical analysis

Descriptive statistics summarized patient demographics and procedural characteristics. Continuous variables are reported as means ± standard deviations and categorical variables as counts and percentages. Receiver operating characteristic (ROC) curves assessed the diagnostic performance of dipstick markers, with areas under the curve (AUC) compared via DeLong's test; the optimal cut-off was chosen by Youden's index. Univariate associations between dipstick results and culture positivity were evaluated using χ^2 tests. We then constructed a multivariable logistic regression model using backward stepwise likelihood ratio method to identify predictors of positive urine culture results; variables entered into the model including age, sex, procedure code, laterality (unilateral vs bilateral), clinical condition, and binary indicators for either or both tests being positive component to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Model fit was assessed by –2 log-likelihood and Nagelkerke R^2, and classification performance (sensitivity, specificity, overall accuracy) was calculated. Statistical analyses were performed in SPSS v27 (IBM Corp.) (12), with two-sided $p < 0.05$ considered significant.

Quality improvement assessment

To evaluate the potential impact on laboratory utilization and antibiotic stewardship, we applied the "either positive" and "both positive" dipstick rule retrospectively as the sole criterion for ordering intraoperative cultures. We calculated the proportion of cultures that would have been spared and the number of positive cases that would have been missed. Similarly, we estimated the reduction in empiric antibiotic prescriptions by assuming treatment was initiated only for patients with a positive dipstick result. While assessing the data gathered on actual empiric treatment given and UTI development in the analyzed cohort.

RESULTS

Cohort characteristics

In this cohort of 62 patients who underwent both point-of-care urinalysis (POCT) and standard urine culture, 14 specimens (22.6%) were culture-positive and 48 (77.4%) were culture-negative, with no exclusions for incomplete data. Within 7 days post-procedure, 9 children met criteria for febrile UTI, while 5 additional culture-positive episodes were afebrile and were managed expectantly as asymptomatic bacteriuria or transient irritative symptoms. The mean age of the population was balanced between culture-positive and culture-negative groups, and there were no significant differences in sex distribution, procedure code, laterality, or underlying clinical condition, indicating a representative sample for evaluating POCT performance (TABLE 1). Leukocyte esterase showed higher sensitivity (78.6%) than nitrites (57.1%), while nitrites had higher specificity (89.6%). Using "either positive" test increased sensitivity to 92.9% and NPV to 97.4%, making it effective for ruling out infection. In contrast, "both positive" tests yielded the highest specificity (95.8%) and PPV (75.0%), useful for confirming infection. Accuracy was similar across all methods (82.3%–83.9%). These results highlight the value of combining tests based on clinical priorities (Table 2). No dipstick-negative patient developed a febrile UTI. ROC curve analysis corroborated these findings: leukocyte positivity achieved an AUC of 0.820 (95% CI, 0.682–0.958; $p < 0.001$), nitrite positivity an AUC of 0.734 (95% CI, 0.565–0.902; $p = 0.008$), and the "either positive" criterion an AUC of 0.860 (95% CI, 0.754–0.966; $p < 0.001$). The "both positive" approach yielded a lower AUC of 0.693 (95% CI, 0.514–0.873; $p = 0.029$), highlighting the trade-off between sensitivity and specificity inherent in combining markers (Figure 1).

In the multivariable logistic regression analysis evaluating predictors of positive urine culture, stepwise backward elimination identified "either positive" as a significant predictor. This variable remained consistently significant across multiple modeling steps (e.g., Step 5: OR = 33.27, 95% CI: 3.24–341.60, $p = .003$) (Supplementary Table 1). Other regression-adjusted variables, including age, sex, procedure code, condition, and laterality, were not statistically significant in the final model. Model performance improved significantly through the steps, with the final classification accuracy reaching 90.3%, sensitivity of 78.6%, and specificity of 93.8%. The model explained 61.4% of the variance (Nagelkerke R^2) and demonstrated strong predictive capacity, indicating that the presence of either a positive result was a strong independent predictor of positive culture growth.

Quality improvement impact

Applying a POCT-guided testing algorithm—reserving cultures for specimens with either leukocyte or nitrite positivity—could have averted 39 of 62 cultures (62.9%), at the cost of missing a single infection (2.9% of uncultured specimens). Using an "either-positive" threshold to trigger treatment is superior, as it captured all 9 symptomatic UTIs (100% sensitivity). In contrast, only 3 of 37 asymptomatic bacteriuria cases (8.1%) were inappropriately treated, versus the "both-positive" rule which would have missed 4 true UTIs (treating only 5/9 symptomatic; 55.6% sensitivity) and had a higher overtreatment rate (5/45; 11.1%) (Table 3).

DISCUSSION

Our study demonstrates that intraoperative dipstick urinalysis, assessing leukocyte esterase and nitrite, provides a rapid and reliable method for ruling out bacteriuria in pediatric cystoscopy patients. In our cohort, no child with a negative dipstick result developed a postoperative UTI, while "either positive" yielded a 97% negative predictive value. This also enables the omission of approximately 63% of routine urine cultures. This strategy may also reduce empiric antibiotic prescriptions, balancing laboratory efficiency with patient safety and aligning with antimicrobial stewardship goals.

Our results support a growing consensus that routine urine cultures in asymptomatic pediatric urology patients offer little clinical benefit and increase unnecessary health resource utilization. Hettel et al. (2017) found that only 8% of asymptomatic children undergoing vesicoureteral reflux surgery had positive preoperative cultures, none of whom were symptom-free, and that such cultures did not influence postoperative outcomes (13). Son et al. (2024) similarly demonstrated that documented UTIs before ureteral reimplantation predict higher postoperative infection and sepsis rates, underscoring the importance of treating true infections while avoiding blanket screening (6).

Evidence from other endoscopic procedures reinforces these findings. In urodynamic studies, Snow-Lisy et al. (2017) reported a 1.4% UTI rate despite high pre-procedure bacteriuria rates, and a prospective quality-improvement protocol by Shannon et al. (2023)) showed that restricting cultures based on dipstick results safely reduced routine cultures by two-thirds with no increase in infections (14, 15). Similarly, Bachtel et al. (2023) found that treating asymptomatic bacteriuria before intradetrusor botulinum toxin injections did not reduce postoperative UTIs (2). This suggests that for most pediatric patients, routine preoperative cultures and antibiotics are low-value practices.

Point-of-care intraoperative urinalysis (UA) emerges as a practical compromise between no testing and universally requesting cultures. This targeted approach aligns with the Choosing Wisely and IDSA guidelines, which advise against screening or treating asymptomatic bacteriuria in children (1, 5, 11). Clinically, these data advocate for a risk-adapted strategy:

perform urine testing and administer antibiotics only in symptomatic children or those with significant UTI histories, while employing intraoperative UA to guide decisions in low-risk patients. Such a protocol enhances antimicrobial stewardship by minimizing unnecessary antibiotic exposure and reduces costs associated with laboratory testing (2, 14). Cost-effectiveness is another advantage: dipstick tests cost mere pennies versus substantial laboratory and treatment costs of cultures and unnecessary antibiotics. By eliminating nearly half of routine urine cultures, institutions can reallocate resources more efficiently, as noted in adult endourology cohorts and pediatric quality-improvement initiatives (14, 16). Practice implications and protocol impact. Based on these data, our pediatric urology service is piloting an intraoperative, dipstick-guided algorithm: reserve urine culture for specimens with either leukocyte esterase or nitrite positivity, and consider targeted postoperative antibiotics only when clinically indicated. We will continue a single preoperative prophylactic dose per AUA guidance and will not initiate routine postoperative antibiotics. We plan prospective monitoring of post-cystoscopy UTI rates and balancing measures after implementation.

Limitations of this study include retrospective designs, single-center cohorts, and low event rates, which may limit statistical power and generalizability (2, 15). Furthermore, dipstick UA can miss non–nitrite-producing pathogens or yield false positives from contaminants. Additionally, our primary endpoint focused on febrile UTIs; afebrile culture-positive episodes were described but not included as outcome events. Prospective multicenter trials and development of refined risk-stratification tools are needed to validate intraoperative UA protocols and ensure their safety across diverse pediatric populations.

In conclusion, point-of-care intraoperative urinalysis using a combined leukocyte esterase/nitrite dipstick score reliably identifies pediatric cystoscopy patients at low risk for postoperative UTI, achieving a perfect negative predictive value and enabling safe omission of up to 55% of routine urine cultures without compromising patient outcomes. This targeted approach aligns with AUA and IDSA recommendations to limit antibiotic prophylaxis and avoid screening or treating asymptomatic bacteriuria in, and mirrors successful quality-improvement protocols in other endoscopic settings. By reserving urine cultures and antibiotic therapy for those with positive intraoperative urinalysis or clear clinical indications, clinicians can enhance antimicrobial stewardship, reduce healthcare costs, and improve patient experience. Future multicenter, prospective studies are warranted to validate these findings across diverse pediatric populations, refine risk-stratification tools, and explore integration of emerging rapid diagnostics to further optimize perioperative infection prevention in pediatric urology.

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FIGURES AND TABLES

Figure 1. Receiver operating curve (ROC) curve illustrating area under the curve (AUC) for point-of-care urinalysis indicators in predicting urine culture positive growth.

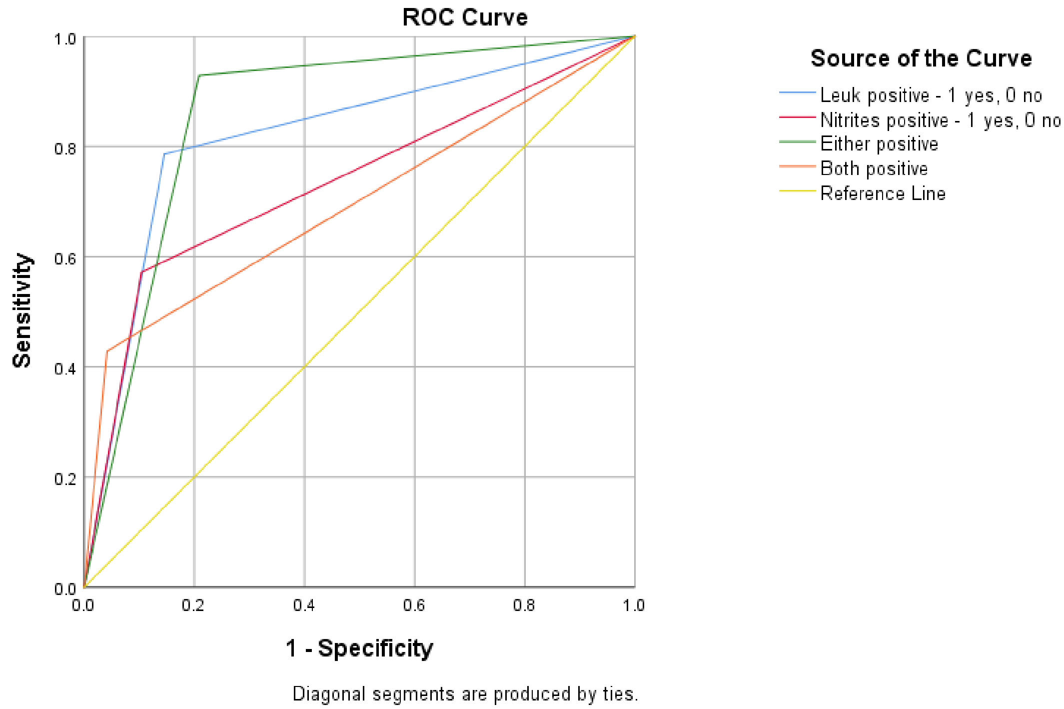

Table 1. Cohort summary and comparative characteristics of patients between UC-negative and UC-positive					
Variables		**UC-negative (n=48)**		**UC-positive (n=14)**	
Age in months		Mean 117 (SD 63.5)		Mean 113.64 (SD 73.94)	
		Count	**Column %**	**Count**	**Column %**
Sex	Female	18	37.5%	7	50.0%
	Male	30	62.5%	7	50.0%
Procedure category	Cystoscopy, retrograde pyelogram, ureteroscopy, stent insertion	23	47.9%	4	28.6%
	Cystoscopy, OnabotulinumtoxinA injection, or J stent removal or diagnostic cystoscopy	21	43.8%	10	71.4%
	Cystoscopy, dextranomer/hyaluronic acid copolymer injection	4	8.3%	0	0.0%
Laterality	Bladder only	16	33.3%	8	57.1%
	Unilateral	28	58.3%	5	35.7%
	Bilateral	4	8.3%	1	7.1%
Diagnosis	Urolithiasis (upper tract)	18	37.5%	2	14.3%
	Posterior urethral valves	5	10.4%	2	14.3%
	Ureteropelvic junction obstruction/ ureterovesical junction obstruction	7	14.6%	3	21.4%
	End-stage renal disease post-renal transplant	4	8.3%	1	7.1%
	Neurogenic bladder	10	20.8%	6	42.9%
	Vesicoureteral reflux	4	8.3%	0	0.0%
UA dipstick leukocytes	Negative	41	85.4%	3	21.4%
	Positive	7	14.6%	11	78.6%
UA dipstick nitrites	Negative	43	89.6%	6	42.9%
	Positive	5	10.4%	8	57.1%
Either UA dipstick indicator positive	Negative	38	79.2%	1	7.1%
	Positive	10	20.8%	13	92.9%
Both UA dipstick indicator positive	Negative	46	95.8%	8	57.1%
	Positive	2	4.2%	6	42.9%

Either positive=leukocyte esterase ≥trace or nitrite positive. Both positive=leukocyte esterase ≥trace and nitrite positive. Two "both-positive" likely reflects inflammatory pyuria or pre-specimen prophylaxis reducing culture yield despite positive dipstick chemistry. SD: standard deviation; UA: urinalysis; UC: urine culture.

Table 2. Diagnostic accuracy of intraoperative point-of-care urinalysis in predicting urine culture-positive growth

Test	TP	FP	TN	FN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Leukocyte positive	11	7	41	3	78.6	85.4	61.1	93.2	83.9
Nitrite positive	8	5	43	6	57.1	89.6	61.5	87.8	82.3
Either positive	13	10	38	1	92.9	79.2	56.5	97.4	82.3
Both positive	6	2	46	8	42.9	95.8	75.0	85.2	83.9

Either positive=leukocyte esterase ≥trace or nitrite positive. Both positive=leukocyte esterase ≥trace and nitrite positive. Two "both-positive" likely reflects inflammatory pyuria or pre-specimen prophylaxis reducing culture yield despite positive dipstick chemistry. FN: false-negative; FP: false-positive; NPP: negative predictive value; PPV: positive predictive value; TN true-negative; TP: true-positive.

Table 3. Summary of antibiotic usage among patients and urine culture results and eventual development of UTI

				UCS-negative	UCS-positive	
				Developed symptomatic UTI	Developed symptomatic UTI	
				None	No	Yes
				Count	Count	Count
Either positive	No	Treatment antibiotics started post-cystoscopy procedure	No	34	1	0
			Yes	3	0	0
	Yes	Treatment antibiotics started post-cystoscopy procedure	No	6	2	2
			Yes	4	9	0
Both positive	No	Treatment antibiotics started post-cystoscopy procedure	No	40	2	2
			Yes	5	4	0
	Yes	Treatment antibiotics started post-cystoscopy procedure	No	0	1	0
			Yes	2	5	0

UTI: urinary tract infection.