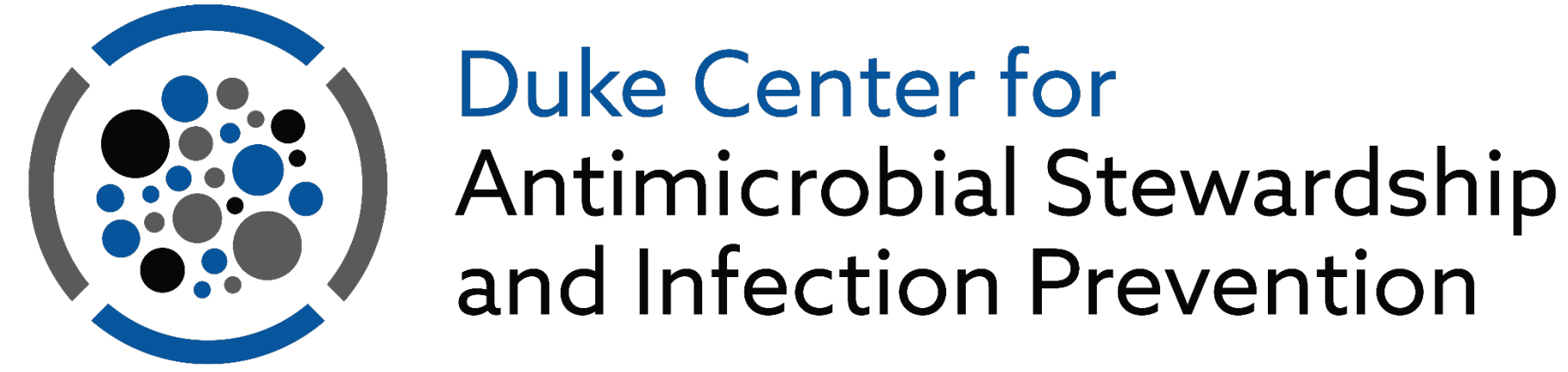


Investigating Urinalysis Criteria that Predict UTI: Impact of age, sex, and urine culture thresholds

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Introduction

- Clinicians and laboratories routinely use urinalysis (UA) results to determine if urine cultures and/or antimicrobials are indicated for patients with suspected urinary tract infection (UTI).
- Some patients with lower colony count UTIs (especially in outpatient settings) may be missed if urinalysis thresholds are not optimized.
- Yet, the performance of UA parameters and common clinical thresholds for action are not well defined. Our objectives were to
 - compare the performance of different UA parameters in predicting UTI
 - assess the performance of pyuria based age, sex and urine culture thresholds

Methods

- Design and Setting:** We performed a retrospective cohort study of adult inpatient non-catheterized patients with paired UA and urine cultures (within 24hrs) encounters from 2017-2019 in 5 hospitals (1 academic, 4 community) in NC, VA, GA.
- Definitions:** Patients were classified as having UTI, asymptomatic bacteriuria, or 'not UTI' based on IDSA guidelines using signs/symptoms and microbiology data.
- Analysis:** We evaluated the performance of relevant UA parameters in predicting UTI by assessing sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV). We also combined 18 different UA criteria and used receiver operating characteristic curves to identify the top 5 performing models for predicting UTI.

What we learned: Combination of UA parameters can predict UTI, but UA performance varies based on age, sex, and urine culture thresholds.

Table 1: Primary outcome (UTI) stratified based on age, sex, urine culture thresholds (n, %)

Category	Not UTI	ASB	UTI
	Mixed + Negative cultures	Positive culture cut off $\geq 100,000$ cfu*	
All patients (N=3392)	1614 (47.6)	704 (20.8)	723 (21.3)
Females (N=2021)	803 (39.7)	489 (24.2)	501 (24.8)
Males (N=1371)	811 (59.2)	215 (15.7)	222 (16.2)
≥ 65 years (N=1916)	788 (41.1)	472 (24.6)	447 (23.3)
Sensitivity Analysis: Bacterial Cut-offs lowered, n, %			
	Mixed + Negative cultures	Positive culture cut off ≥ 1000 cfu	
All patients (N=3392)	1614 (47.6)	903 (26.6)	875 (25.8)

Not UTI: Negative or mixed urine culture based on above criteria with no lower or upper urinary tract symptoms
Asymptomatic Bacteriuria (ASB): Positive urine culture but no lower or upper urinary tract symptoms
UTI: Positive urine culture based on criteria above plus dysuria, urgency, frequency, suprapubic/flank pain or tenderness OR two clinical criteria (fever + hypotension) without other cause OR one clinical criterion + one urologic criterion
Clinical criteria: fever/rigors/hypotension/hypothermia/shock/nausea vomiting/confusion/leukocytosis.
Urologic Criteria: urologic procedure causing mucosal bleeding, urologic obstruction, e.g., stones or active malignancy; retention or incontinence; urologic trauma causing hematuria (catheter trauma; stent placement, etc)
 *Low threshold urine cultures counts not included in UTI or ASB definitions, but included in counts and sensitivity analysis

Table 2: Performance of Individual Urinalysis (UA) Parameters in Predicting UTI (all patients, 3392)

UA Parameter	Sensitivity	Specificity	PPV	NPV
Leukocyte esterase				
\geq Trace	0.90	0.49	0.33	0.95
$\geq 1+$	0.88	0.50	0.33	0.94
$\geq 2+$	0.21	0.80	0.23	0.79
WBC count/hpf				
≥ 5	0.92	0.43	0.32	0.95
≥ 10	0.84	0.55	0.35	0.92
≥ 20	0.70	0.66	0.37	0.89
Nitrite				
Positive	0.48	0.83	0.43	0.86
Bacteria count/hpf,				
5-50	0.20	0.77	0.20	0.77
> 50	0.72	0.71	0.41	0.90
Yeast count/hpf				
Positive	0.07	0.94	0.23	0.80

Table 3 Complete Performance Estimates for the 5 Models with the Best Area Under the Receiver Operating Characteristic Curve (AUROC) Performance

Model	Test Rule	AUROC	Sensitivity	NPV
Model 6, N=3230	≥ 20 WBCs or Nitrite	0.7093	0.83	0.92
Model 1, N=3347	$>$ Trace LE or Nitrite	0.7069	0.94	0.97
Model 5, N=3231	≥ 10 WBCs or Nitrite	0.7061	0.91	0.95
Model 2, N=3347	$\geq 1+$ LE or Nitrite	0.7039	0.93	0.96
Model 9, N=3206	$\geq 2+$ LE or ≥ 20 WBCs or Nitrite	0.6865	0.91	0.95

Table 4: Performance of Pyuria (>10 WBCs/hpf) on urinalysis in Predicting UTI based on age, sex, and urine culture thresholds

	Sensitivity	Specificity	PPV	NPV
Females <65 yrs	0.80	0.57	0.38	0.90
Females ≥ 65 yrs	0.81	0.45	0.34	0.87
Males <65 yrs	0.82	0.67	0.25	0.97
Males ≥ 65 yrs	0.95	0.59	0.38	0.98
$<100,000$ cfu/ml	0.80	0.57	0.40	0.89

Results

- Of 219,338 encounters, 3392 charts were included and reviewed, 723 (21.3%) patients met criteria for UTI.
- Females and older adults had a higher incidence of UTIs and ASB ($P < 0.05$; Table 1).
- Absence of pyuria (or leukocyte esterase) had a high NPV for UTI (Table 2).
- Combined UA parameters performed better than pyuria alone with regards to NPV and AUROC, specifically models 1, 2 and 5 (Table 3).
- UA parameters used in these models performed differently based on age, sex, and urine culture thresholds, with limited utility in older women and patients with lower colony count UTIs (Table 4).

Conclusions

- Combined UA parameters were better at predicting UTI, but performance of UA parameters differs based on age, sex, and urine culture thresholds.
- Our approach highlights the need to move away from a one-size fits all approach to using population specific UA cut-offs for patients with UTI symptoms.

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