

Urinary Tract Infections Caused by Gram-Positive Bacteria in Patients Younger than 19 Years: Prediction Analysis in a 13-year Hospital-Based Cohort

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BACKGROUND

- Urinary tract infection (UTI) is one of the common pediatric bacterial infections.
- Gram positive (GP) pathogens, in contrast to gram negative (GN) bacilli such as *E. coli*, are less accounted for pediatric UTI.

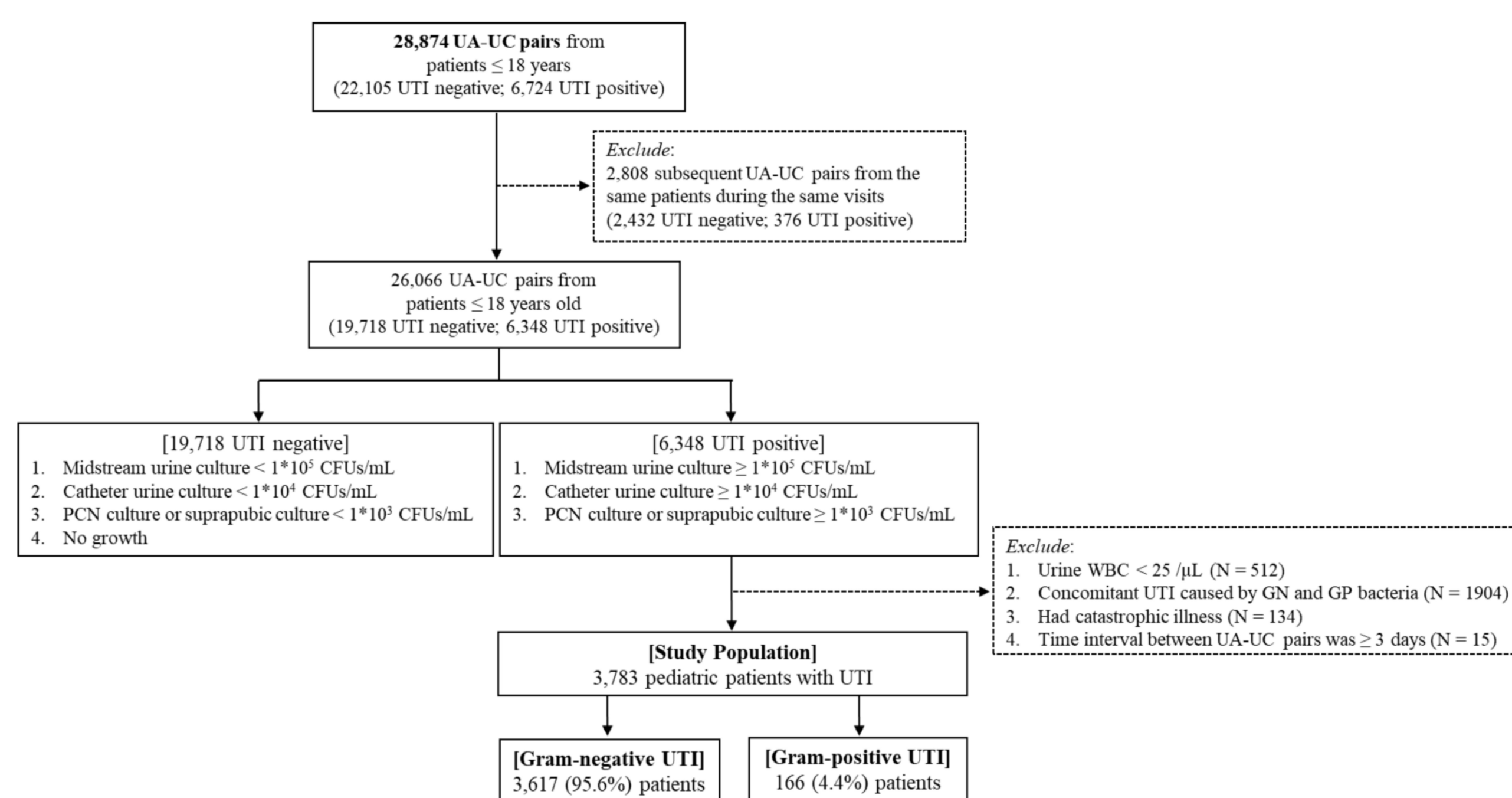
STUDY AIMS

- Identify predictors to enable clinicians to detect GP uropathogens from mostly causative GN bacteria in children with UTI.

METHODS

- This retrospective cohort study identified 26,066 paired urinalysis and urine culture obtained from the pediatric patients during 2003-2016.
- Of patients with UTI meeting our criteria, we included children with first-time UTI and classified them into GP-UTI and GN-UTI (Figure 1).
- Demographic, clinical and laboratory data were collected into analysis.
- We built a multivariable logistic regression model to predict the GP-UTI.
- The model performance was examined by using calibration and discrimination plots.
- We demonstrated a nomogram to predict GP-UTI that could be feasible in the clinical practice.

Figure 1. Flowchart of the Selection Process of the Study Population (N = 3,783 patients).



RESULTS

- Of 3,783 children with first-time UTIs, 166 (4.4%) were infected by GP and 3,617 (95.6%) by GN bacteria.
- The top 3 pathogens for GP uropathogens were vancomycin-resistant (VR) *E. faecalis*, *S. saprophyticus*, and coagulase-negative *Staphylococcus*. VR *E. faecalis* ranked first among children < 2 years old.
- Significant risk factors associated with GP-UTI in the multivariable analysis were: age \geq 24 months [odds ratio (OR) 3.40, 95% confidence interval (CI) 1.40-8.26], serum white blood cell (WBC) (compared to $\geq 14.4 \times 10^3 /\mu\text{L}$) [OR 2.18, 95% CI 1.26-3.77], hemoglobin (compared to $< 11.3 \text{ g/dL}$) [OR 1.89, 95% CI 1.04-3.45], negative urine leukocyte esterase [OR 3.12, 95% CI 1.83-5.33], negative urine nitrite [OR 4.14, 95% CI 1.88-9.14] and urine WBC (compared to $\geq 420 /\mu\text{L}$) [OR 2.16, 95% CI: 1.09, 4.26] (Table 1).

Table 1. Multivariable Prediction Model for Pediatric Urinary Tract Infections Caused by Gram-Positive Bacteria.

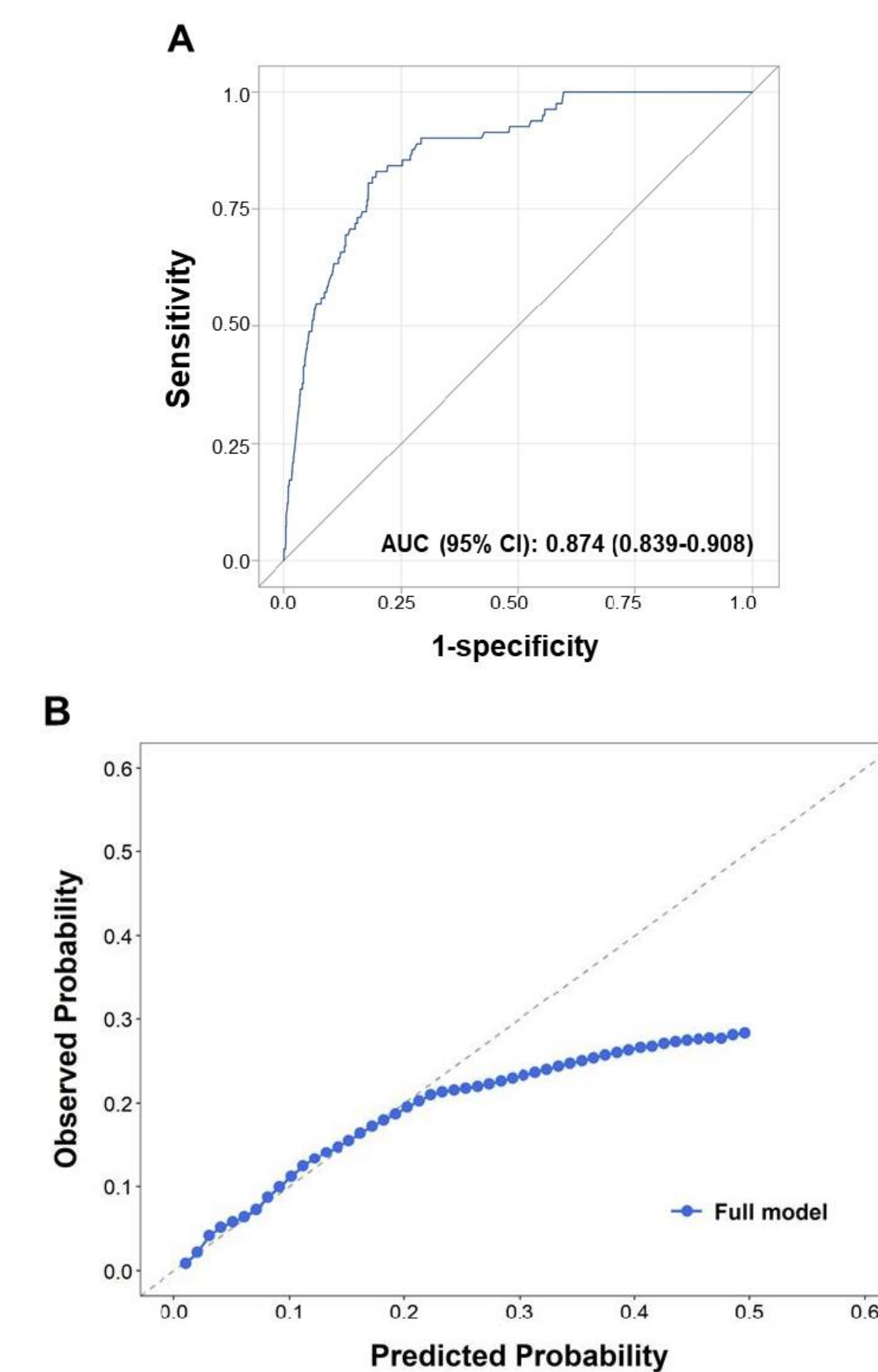
Variable	Crude		Multivariable		P-value
	OR	(95% CI)	OR	(95% CI)	
Age at UA order ≥ 24 months	5.90	(4.19, 8.31)	3.40	(1.40, 8.26)	0.007
Boy	0.54	(0.40, 0.75)	1.44	(0.84, 2.48)	0.183
Sample obtained from catheter, PCN, or suprapubic	4.54	(3.24, 6.36)	1.32	(0.58, 3.03)	0.506
No prior antibiotic use	2.43	(1.39, 4.24)	2.62	(0.90, 7.60)	0.076
No prior Foley catheterization	4.15	(2.61, 6.59)	1.26	(0.64, 2.48)	0.509
Serum biochemical profiles					
WBC (compared to ≥ 14.4)	3.96	(2.46, 6.38)	2.18	(1.26, 3.77)	0.005
CRP (compared to ≥ 3.6)	2.47	(1.53, 4.00)	1.56	(0.92, 2.66)	0.099
Hemoglobin (compared to < 11.3)	4.54	(2.74, 7.5)	1.89	(1.04, 3.45)	0.038
Urinalysis					
Bacteria +	0.35	(0.25, 0.50)	1.03	(0.60, 1.79)	0.902
Leukocyte esterase -	5.11	(3.58, 7.29)	3.12	(1.83, 5.33)	< 0.001
Nitrite -	8.15	(4.51, 14.73)	4.14	(1.88, 9.14)	< 0.001
WBC (compared to ≥ 420)	3.45	(2.39, 4.96)	2.16	(1.09, 4.26)	0.027
RBC (compared to ≥ 22)	1.38	(1.01, 1.88)	1.49	(0.87, 2.56)	0.144
C-statistic			0.874	(0.839, 0.908)	

Abbreviations: CI, confidence interval; CRP, c-reactive protein; OR, odds ratio; PCN, percutaneous nephrostomy; RBC, red blood cell; UA, urinalysis; WBC, white blood cell.

RESULTS cont.

- This model had good discrimination (C-statistic 0.874; 95% CI 0.839-0.908) and calibration performance (Figure 2).

Figure 2. Discrimination Plot (A) and Calibration Plot (B) of the Prediction Model for Pediatric Urinary Tract Infections Caused by Gram-Positive Bacteria.



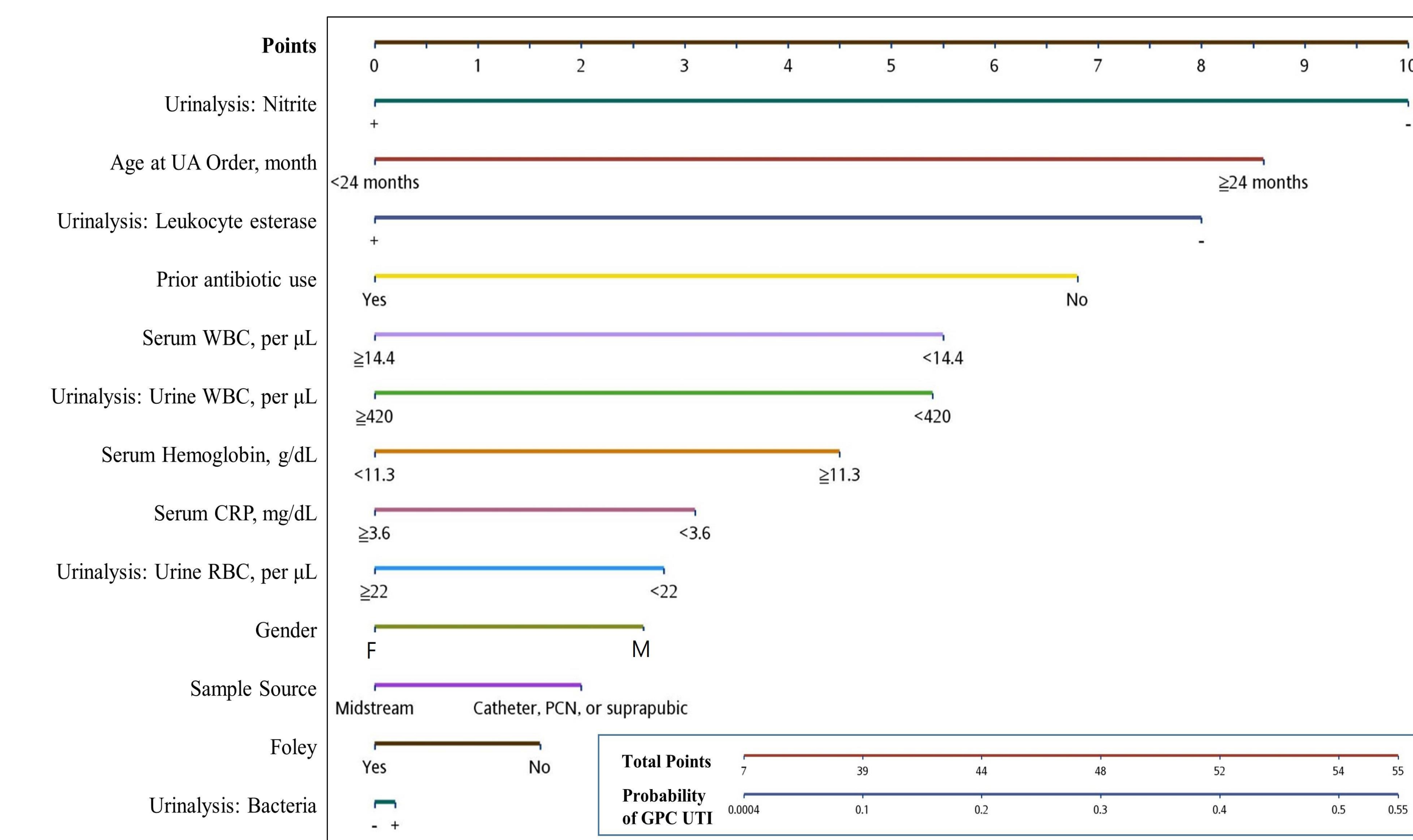
DISCUSSION

- VR *E. faecalis* is the leading GP uropathogen in the children less than two years of age which need notice of infection control.
- This is the first study to establish a prediction model for GP UTI in a pediatric population.
- Age older than 2 years, no prior antibiotic use, low blood and urine WBC count, high hemoglobin level, and absence of urine nitrite and leukocyte esterase are significant predictors of pediatric UTI caused by GP bacteria.
- Our proposed prediction model for GP UTI in children could help clinicians detect potential GP uropathogen and enable them to choose adequate antibiotic regimen early.
- Large prospective studies in the future should validate our findings.

RESULTS cont.

- By using our nomogram, physicians can estimate the probability of UTI that is caused by a GP pathogen, with a probability ranges from 0.04% to 55% (Figure 3).

Figure 3. Nomogram of the Prediction Model for Pediatric Urinary Tract Infections Caused by Gram-Positive Bacteria.



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