RES-114

Artificial Intelligence-Based Prediction of Antibiotic Susceptibility in Urinary Pathogens Isolated from Women Aged 12 to 74 in Primary Care

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Background Cystitis is one of the most common urinary tract infections (UTIs) encountered in outpatient care, particularly among women. Appropriate first-line antibiotic therapy is essential to reduce treatment failures and limit the emergence of antimicrobial resistance. This study aims to evaluate an artificial intelligence (AI) module in predicting the antibiotic susceptibility of urinary pathogens isolated from women aged 12 to 74 years in primary care settings in the Occitania region of France. The predictions are compared with current clinical and microbiology guidelines (SPILF 2017, HAS 2019 and CA-SFM 2023).

Methods

AI Tools: Predi-ATB V11.4.1, developed to predict bacterial susceptibility based on species, sample type, patient sex, age, and sample origin (community, hospital, nursing home, dialysis, etc.).

A total of **22,990 antibiograms** with from **urinary samples of women aged 12 to 74 years** in community medicine were analyzed.

11 commonly prescribed antibiotics for UTIs: fosfomycin (FOS), pivmecillinam (MEC), nitrofurantoin (FT), amoxicillin (AMX), trimethoprim (TMP), ciprofloxacin (CIP), cefixime (CFM) ceftriaxone (CRO), cotrimoxazole (SXT), co-amoxiclav (AMC), and levofloxacin (LEV).

The bacterial species studied included:

Gram-negative bacilli (GNB): *Escherichia coli* (ECO, KP, n= 19,796), *Klebsiella pneumoniae* (n = 1,918), *Proteus mirabilis* (PMIR, n = 723), *Citrobacter koseri* (CKOS, n= 492), *Pseudomonas aeruginosa* (PAER, n = 61)

Gram-positive cocci (GPC): *Staphylococcus saprophyticus* (SSAP, n = 1,173), *Enterococcus faecalis* (EFCA, n = 482), *Streptococcus agalactiae* (STB, n = 569).

Comparison of AI Models

Figure 1 : **Predi-ATB V11.4.1 --> Classification tree vs Random Forest and Neural Net**

Criteria	Classification Tree	Random Forest	Neural Network
Interpretability	++++	++	+
Performance	++	+++	+++
Robustness	++	+++	+++
Complexity	+	++	++++
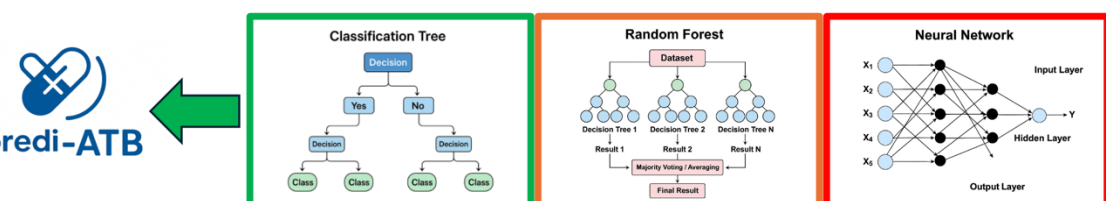
The **choice of a classification tree model** is natural, as its performance is comparable to or equal to that of Random Forest or Neural Networks, while being less complex and **more interpretable**, making it well-suited for **medical applications**.

Figure 2 : **AUC for classification tree prédiction in** UTI women aged 12 to 74 years in primary care settings with Predi-ATB V11.4.1

	AMX	AMC	CFM	CRO	CIP	LEV	SXT	MEC	TMP	FOS	FT
ECO	0,573	0,860	0,960	0,976	0,926	0,941	0,806	0,942	0,773	0,986	0,997
KP	0	0,934	0,951	0,956	0,950	0,968	0,806		0,904	0,673	0,604
PMIR	0,643	0,888	0,990	0,999	0,928	0,935	0,813		0,742	0,790	0
CKOS	0	1	0,998	0,998	1	1	1		1	1	0,998
PAER	0	0	0	0	0,984	0,967	0	0	0		0
SSAP	0,983	0,983	0	0,984		0,999	0,998	0		0	1
EFCA	1	1	0	0		0,983	0,963	0	0		0,994
STB	1	1		1		0,977	0,998				0,955

Results

For Acute Cystitis (Uncomplicate or with Risk of Complications)

Predicted susceptibility rates for first-line antibiotics were as follows:

Fosfomycin: 95.1% for GNB; not tested for GPC.

Pivmecillinam: 85.4% overall (94.7% for GNB; 0% for GPC according to CA-SFM).

Nitrofurantoin: 93.7% overall (93.4% for GNB; 99.0% for GPC)

Amoxicillin: 56.6% overall (51.4% for GNB; 70–98.9% for GPC depending on *S.saprophyticus* classification).

**Trimethoprim:** 78.6% for GNB; not tested for GPC.

For Enterobacteriaceae and cystitis, AI-based predictions are consistent with current French guidelines (SPILF 2017).

However, **for GPC and *P. aeruginosa*, AI-based predictions could help refine** empirical antibiotic selection pending future guideline updates.

Additional epidemiological data are needed for non-*E.coli* species, particularly regarding first-line agents such as pivmecillinam and fosfomycin.

Conclusion

In the future, **predictive antibiograms tailored to sample type and applicable across species** could enhance management infection as **UTI in women aged 12 to 74 years.**
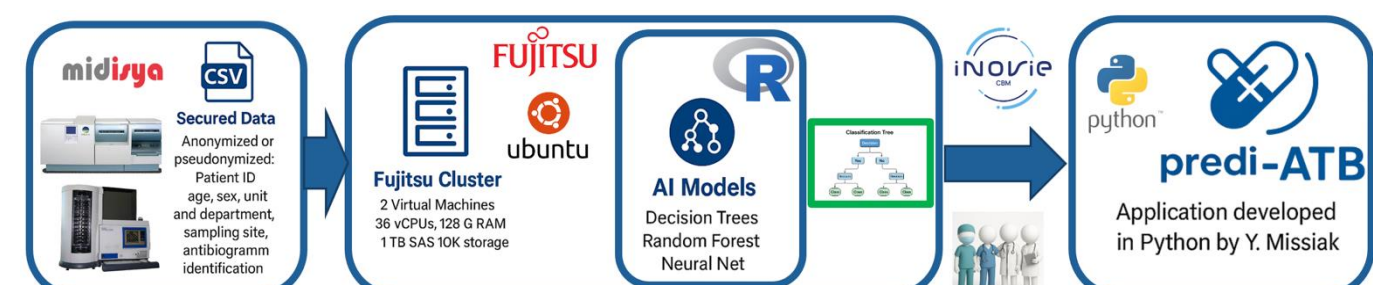
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Data Privacy Method:
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Conflict of interests:
No conflict of interest