

Diagnostic Accuracy of Code-Based Algorithms to Identify Urinary Tract Infection in U.S. Administrative Claims Databases

Stephen P Fortin¹, Jeroen Geurtsen², Michal Sarnecki³, Joachim Doua³, Jamie Colasurdo¹, Joel Swerdel¹
¹Janssen R&D, LLC, USA; ²Janssen Vaccines & Prevention, ³ Netherlands; Janssen Vaccines, EU

Background

- Urinary tract infections (UTI) are one of the most common infections in the United States and worldwide
- Nearly half of women experience a UTI during their lifetime
- Limited research exists assessed the diagnostic accuracy of code-based algorithms to identify UTI, and prior research is limited to studies performed at a single center or among pediatric patients, which may lack generalizability

Study Objectives: To evaluate the performance characteristics of 10 code-based algorithms to identify UTI among adult patients contained in 3 large U.S. administrative claims databases

Methods

Study Design: Descriptive study

Data Source: Data were from 3 large U.S. administrative claims databases:

- IBM® MarketScan® Multi-State Medicaid Database (MDCD)
- IBM® MarketScan® Medicare Supplemental and Coordination of Benefits Database (MDCR)
- IBM® MarketScan® Commercial Claims and Encounters Database (CCAE)

Study Population: We identified all patients observed on between January 1, 2010 to December 31, 2019 (MDCD) and January 1, 2010 to October 31, 2020 (MDCR and CCAE). Analyses were restricted to patients aged ≥18 years in MDCD and CCAE, and ≥66 years in MDCR.

Code-Based Algorithms: A total of 10 code-based algorithms (listed below) were developed based on a systematic literature review and clinical subject matter expert input.

Abbreviation Description

DX	UTI Dx
PDX	Primary UTI Dx
2DX	UTI Dx with ≥1 additional UTI Dx in 7 days
DX+A	UTI Dx with antibiotic for UTI in 7 days
DX+UA	UTI Dx with UA/UCX in 3 days
3DX	UTI Dx with ≥2 additional UTI Dx in 7 days
2DX+A	UTI Dx with ≥1 additional UTI Dx & antibiotic for UTI in 7 days
2DX+UA	UTI Dx with ≥1 additional UTI Dx in 7 days & UA/UCX in 3 days
3DX+A	UTI Dx with ≥2 additional UTI Dx & antibiotic for UTI in 7 days
3DX+UA	UTI Dx with ≥2 additional UTI Dx in 7 days & UA/UCX in 3 days

Dx: diagnosis; UA: urinalysis; UCX: urine culture

Statistical Analysis

- The PheValuator tool was used to develop diagnostic predictive models and probabilistic gold standards for UTI
- The probabilistic gold standards were used to evaluate the performance characteristics of code-based algorithms

Methods

Performance Characteristics

- *Sensitivity*
- *Positive predictive value (PPV)*
- *Specificity*
- *Negative predictive value (NPV)*
- *F1 score*: harmonic mean of PPV and sensitivity

Results

Table 1. Number of patients meeting the study criteria, covariates included in the probabilistic gold standard, and estimated prevalence of UTI in each database

Database	Number patients meeting study criteria (N)	Number covariates included in probabilistic gold standard	Estimated prevalence of UTI
MDCD	2,950,641	14,230	41.4%
MDCR	1,831,405	11,613	48.6%
CCAE	2,294,929	15,274	21.6%

Figure 1. Performance characteristics in MDCD

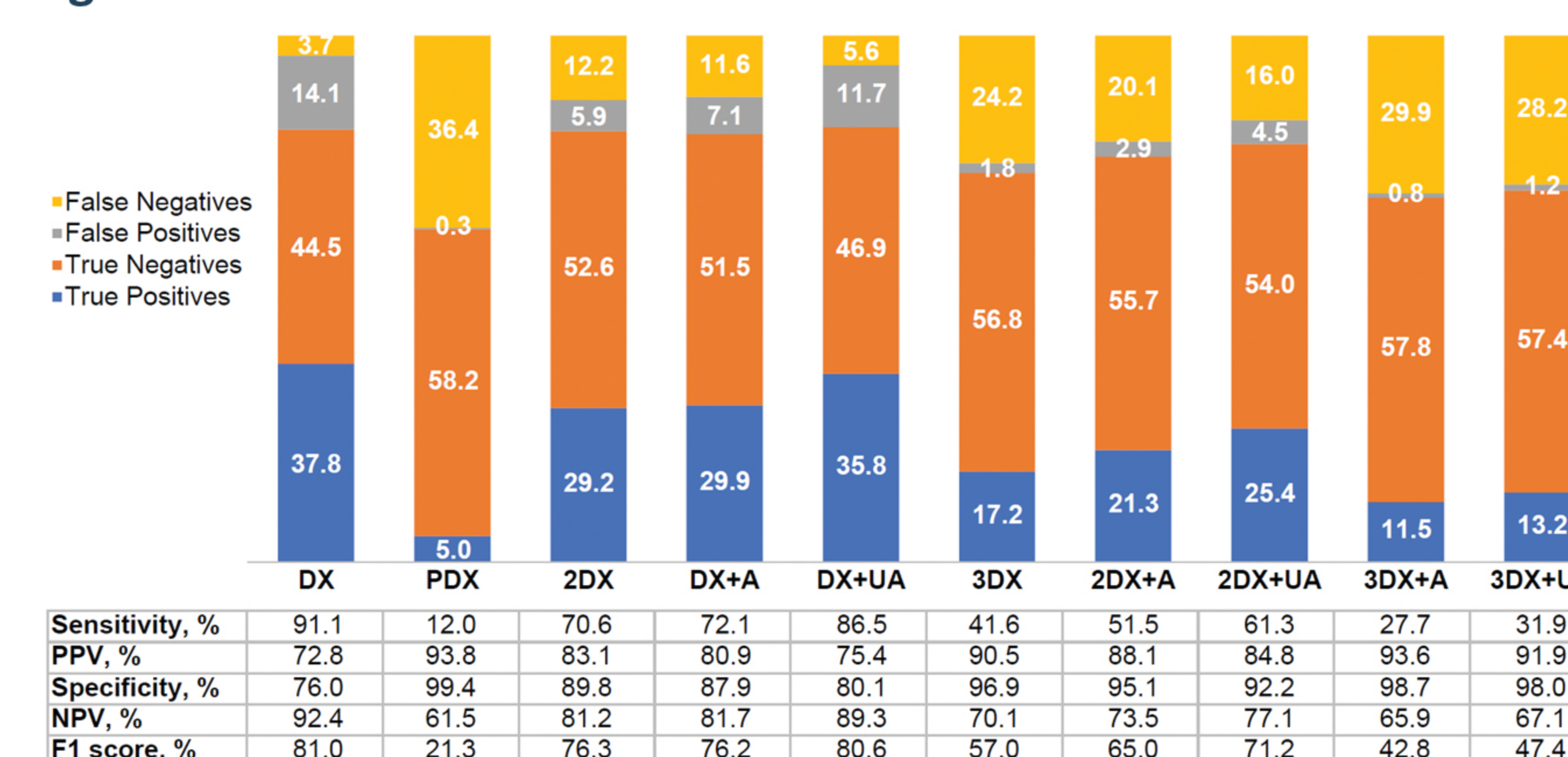
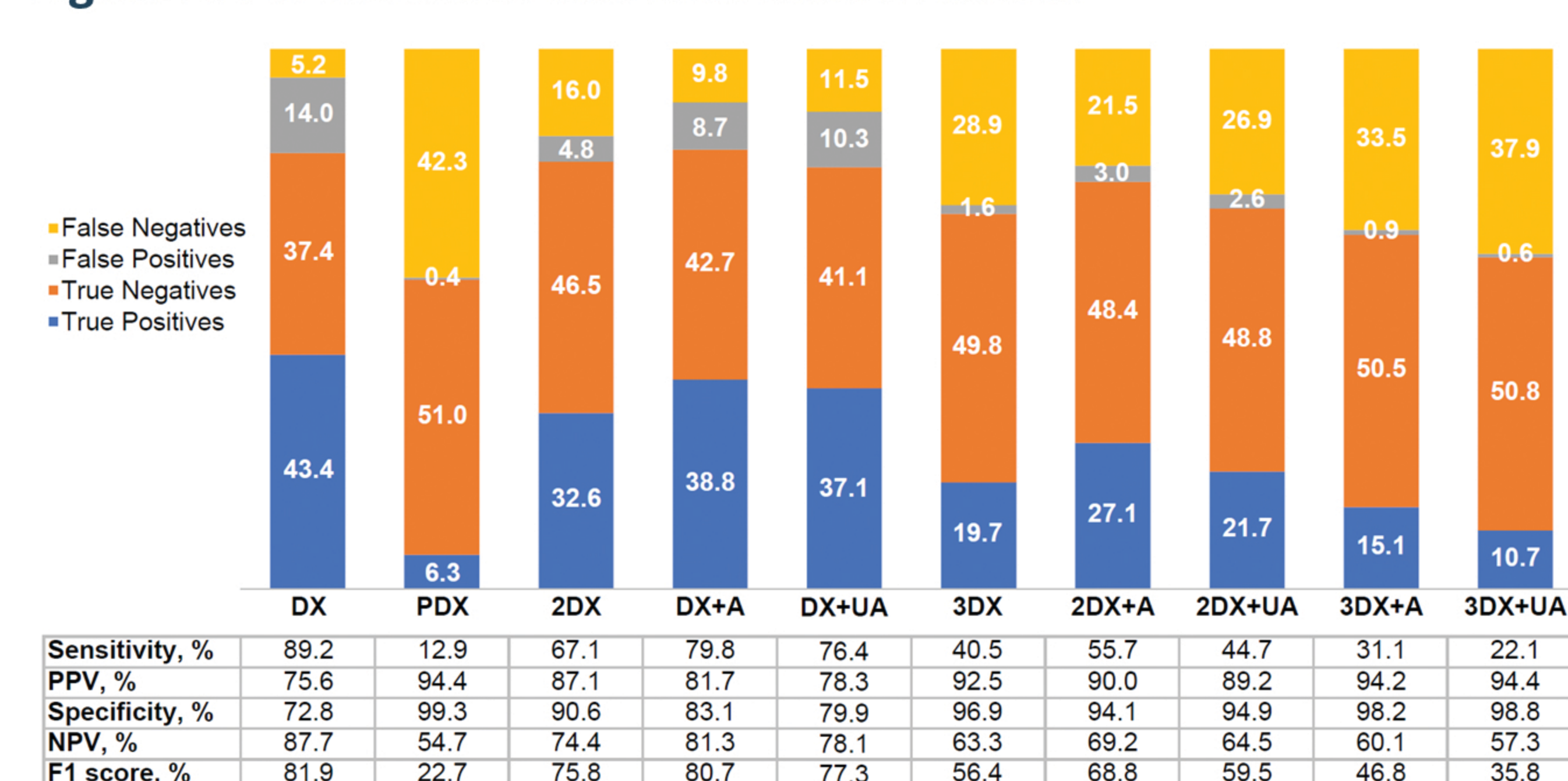
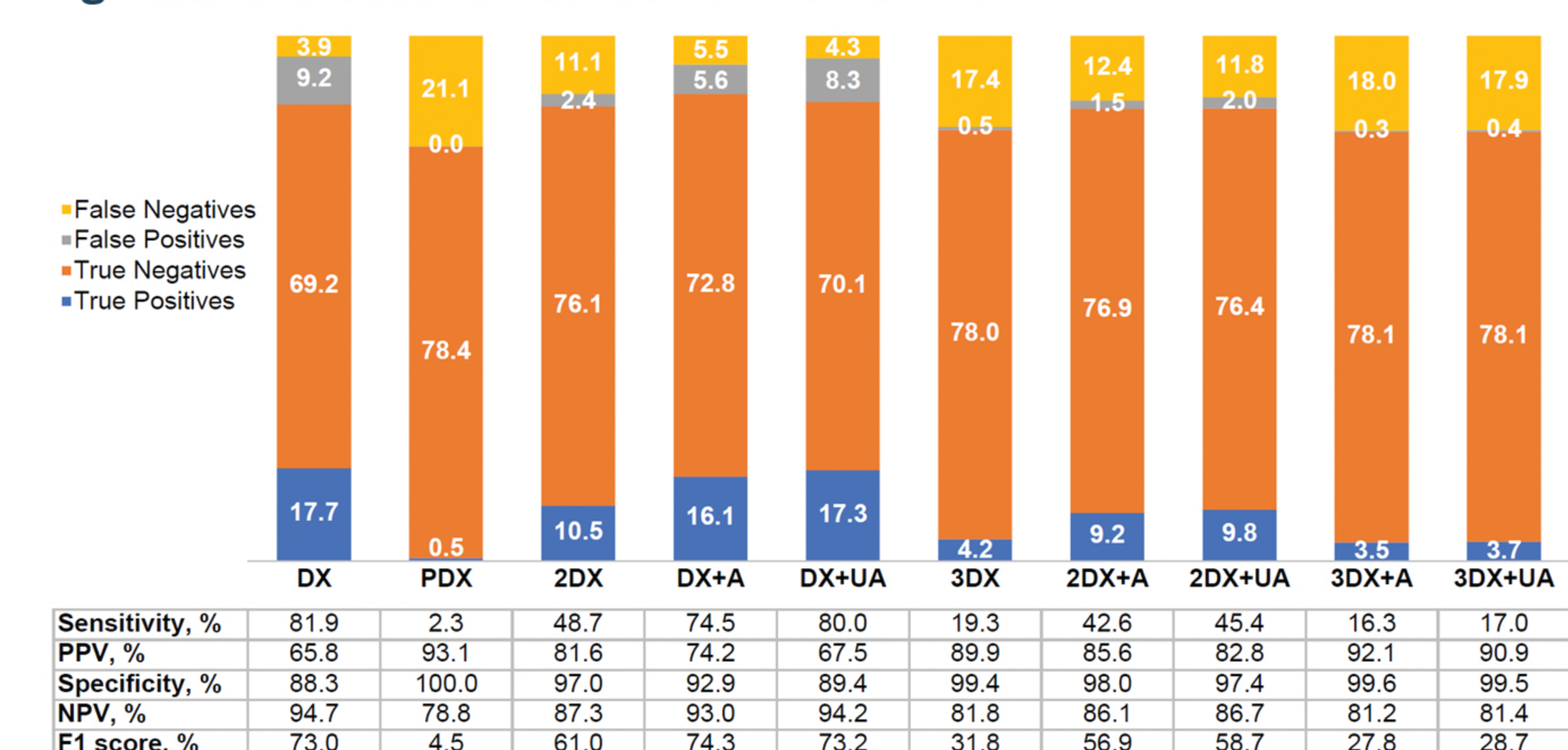


Figure 2. Performance characteristics in MDCR



Results

Figure 3. Performance characteristics in CCAE



As shown in **Figures 1-3**, overall trends in performance characteristics were similar across data sources, and algorithms could be classified into one of two categories:

- High sensitivity algorithms
 - High PPV algorithms
- High sensitivity algorithms:**
- **DX:** Sensitivity and PPV greater than 81.9% and 65.8%, respectively, translating to high F1 scores (>73.0%)
 - **DX+A, DX+UA:** Improvements in PPV (>74.2%) alongside a small reduction in sensitivity (>72.1%) as compared to DX
- High PPV algorithms:**
- **PDX:** highest PPV (>93.1%) and lowest sensitivity (<12.9%) translating to a low F1 score (<22.7%)
 - **3DX, 3DX+A, 3DX+UA:** high PPV (>89.9%) and improved, albeit low, sensitivity (<41.6%)

In MDCR, algorithms requiring UA/UCX had decreased performance as compared to other algorithms

Conclusions

- Inherent tradeoff insensitivity and PPV across algorithms
- Recommend algorithms requiring single UTI diagnosis code in studies where sensitivity is critical (e.g., safety studies)
- Recommend algorithms requiring 3 UTI diagnosis codes over algorithms requiring primary UTI diagnosis code in studies where high PPV is important (e.g., comparative effectiveness studies)
- Algorithms requiring primary UTI diagnosis code suffer from poor sensitivity
- Additional requirement for antibiotics used in the treatment of UTI or the presence of a urinalysis/urine culture associated with a small increase in PPV and decrease in sensitivity, but performance may be dependent on data source characteristics