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Title

Machine learning prediction of urine cultures in primary care

Priority 1 (Research Category)

Big Data

Presenters

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Abstract

Context: Antibiotics for suspected urinary tract infection (UTI) is appropriate only when an infection is present. Urine culture is definitive but takes >1 day to result. A machine learning urine culture predictor was recently devised for Emergency Department (ED) patients but requires use of urine microscopy ("NeedMicro" predictor), which is not routinely available in primary care (PC). Objective: To adapt this predictor to use only features available in primary care and determine if predictive accuracy generalizes to the primary care setting. We call this the "NoMicro" predictor. Study Design and Analysis: Multicenter, retrospective, observational, cross-sectional analysis. Machine learning predictors were trained using extreme gradient boosting, artificial neural networks, and random forests. Models were trained on the ED dataset and were evaluated on both the ED dataset (internal validation) and the PC dataset (external validation). Setting: United States (US) academic medical centers emergency department and family medicine clinic. Population Studied: 80387 (ED, previously described) and 472 (PC, newly curated) US adults. Instrument: Physicians performed retrospective chart review. The primary outcome extracted was pathogenic urine culture growing ≥100,000 colony forming units. Predictor variables included age; gender; dipstick urinalysis nitrites, leukocytes, clarity, glucose, protein, and blood; dysuria; abdominal pain; and history of UTI. Outcome Measures: Predictor overall discriminative performance (receiver operating characteristic area under the curve, ROC-AUC), performance statistics (e.g., sensitivity, negative predictive value, etc.), and calibration. Results: The "NoMicro" model performs similarly to the "NeedMicro" model in internal validation on the ED dataset: NoMicro ROC-AUC 0.862 (95% CI: 0.856-0.869) vs. NeedMicro 0.877 (95% CI: 0.871-0.884). External validation on the primary care dataset also yielded high performance (NoMicro ROC-AUC 0.850 [95% CI: 0.808-0.889]), despite being trained on Emergency Department data. Simulation of a hypothetical, retrospective clinical trial suggests the NoMicro model could be used to avoid antibiotic overuse by safely withhold antibiotics in low-risk patients. Conclusions: The hypothesis that the NoMicro predictor generalizes to both PC and ED contexts is supported. Prospective trials to determine the real-world impact of using the NoMicro model to reduce antibiotic overuse are appropriate.