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Predicting Resistance of Commonly Used Antimicrobials in Urinary Tract Infections: A Decision Tree Analysis

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Abstract : Background: In general practice, many infections are treated empirically without microbiological confirmation. Understanding susceptibility of antimicrobials during empirical prescribing can be helpful to reduce inappropriate prescribing. This study aims to apply a prediction model using a decision tree approach to predict the antimicrobial resistance (AMR) of urinary tract infections (UTI) based on non-clinical features of patients over 65 years. Decision tree models are a novel idea to predict the outcome of AMR at an initial stage. Method: Data was extracted from the database of the microbiological laboratory of the University Hospitals Galway on all antimicrobial susceptibility testing (AST) of urine specimens from patients over the age of 65 from January 2011 to December 2014. The primary endpoint was resistance to common antimicrobials (Nitrofurantoin, trimethoprim, ciprofloxacin, co-amoxiclav and amoxicillin) used to treat UTI. A classification and regression tree (CART) model was generated with the outcome 'resistant infection'. The importance of each predictor (the number of previous samples, age, gender, location (nursing home, hospital, community) and causative agent) on antimicrobial resistance was estimated. Sensitivity, specificity, negative predictive (NPV) and positive predictive (PPV) values were used to evaluate the performance of the model. Seventy-five percent (75%) of the data were used as a training set and validation of the model was performed with the remaining 25% of the dataset. Results: A total of 9805 UTI patients over 65 years had their urine sample submitted for AST at least once over the four years. E.coli, Klebsiella, Proteus species were the most commonly identified pathogens among the UTI patients without catheter whereas Sertia, Staphylococcus aureus; Enterobacter was common with the catheter. The validated CART model shows slight differences in the sensitivity, specificity, PPV and NPV in between the models with and without the causative organisms. The sensitivity, specificity, PPV and NPV for the model with non-clinical predictors was between 74% and 88% depending on the antimicrobial. Conclusion: The CART models developed using non-clinical predictors have good performance when predicting antimicrobial resistance. These models predict which antimicrobial may be the most appropriate based on non-clinical factors. Other CART models, prospective data collection and validation and an increasing number of non-clinical factors will improve model performance. The presented model provides an alternative approach to decision making on antimicrobial prescribing for UTIs in older patients.

Keywords : antimicrobial resistance, urinary tract infection, prediction, decision tree
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