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Using a clinical registry and machine learning to predict ureteral stent placement following ureteroscopy

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INTRODUCTION AND OBJECTIVES: Ureteral stent placement during ureteroscopy (URS) may be a source of anxiety for patients because of the morbidity associated with stents. Using machine learning to harness high-quality clinical registry data, we sought to develop and validate a prediction model aimed at improving shared decision-making by informing patients of their personalized likelihood of stent placement.

METHODS: We used the Michigan Urological Surgery Improvement Collaborative Reducing Operative Complications from Kidney Stones (MUSIC ROCKS) registry. This all-payer registry captures detailed clinical and operative data for patients undergoing ambulatory stone surgery in the state of Michigan. To understand predictors for stent placement, we identified all patients who underwent URS between June 2016 and April 2018. The data were divided randomly into a training set and a test set using 2:1 sampling stratified by practice. Using the training set, we developed a random forest model to predict stent placement. Predictors were selected based on importance within the model and clinical relevance. We applied the model to the test set and measured the area under the receiver operating characteristic curve (AUC) to assess validity.

RESULTS: We identified 4,386 patients who underwent URS of whom 3,224 received a stent. Predictors used within the model were: use of laser lithotripsy, size of largest stone, prior stent placement, age, body mass index, procedure acuity, stone location, and history of prior kidney stone surgery. The model achieved an AUC of 0.70 on the test set. Slight improvement was seen with exclusion of 447 patients from practices that placed a stent in >90% of cases, with AUC increasing to 0.72. The model was generally well-calibrated (Figure), with a scaled Brier score of 0.15.

CONCLUSIONS: A model predicting ureteral stent placement following URS can inform patient decision-making using a set of eight predictors. Surgeon preference plays a sizable role in influencing the likelihood of ureteral stent placement. Our model was generally well-calibrated and thus suitable for informing patients.

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Figure. Calibration plot for stent placement prediction model. Dotted line denotes equality between predicted and observed probabilities.