MEDICAL SCHOOL
UNIVERSITY OF MICHIGAN

Capstone for Impact Submission | GY2019

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

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Branch: Procedure Based Care

Path of Excellence: N/A

Handover/Transition:
If this project can be continued by another UMMS student, you may contact them at the following email address/phone number (N/A if project cannot be handed over): **N/A**

Summary:

Ureteral stent placement during ureteroscopic lithotripsy may be a source of anxiety for patients because of the morbidity associated with stents such as pain, hematuria, urinary urgency, and urinary frequency. Ureteral stents can be useful in preventing ureteral obstruction secondary to edema following ureteroscopic lithotripsy. In response to feedback from a patient advocate from the Michigan Urological Surgery Improvement Collaborative, I decided to try to improve our ability to counsel patients about their likelihood of receiving a ureteral stent following kidney stone surgery.

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. It is important to note that this tool was designed not to determine who should receive a ureteral stent but rather to reflect practice patterns and evaluate a patient's likelihood of receiving a stent.

The pieces of patient information that are inputs for our model, also known as predictors, were narrowed to those deemed to be clinically relevant and important to the model. The predictors ultimately used 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. Surgeon preference for stent placement was identified as a major predictor, as placement rates varied from 40-100% between surgeons. However, this was not incorporated into the model out of a desire to avoid its use as a tool for "doctor shopping".

The model was found to be generally well-calibrated, i.e. patients estimated to have a high likelihood of stent placement did indeed have a high rate of stent placement, and patients estimated to have a low likelihood of

stent placement had a low stent placement rate. Accordingly, this model may be suitable for use in improving patients' informed consent prior to kidney stone surgery.

Methodology:

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/Conclusion:

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, 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.

Reflection/Lessons Learned:

The process of informed consent is challenging and imperfect. It is not always possible to bridge the large knowledge gap between patient and provider in a short clinic visit. Machine learning is a powerful technique capable of harnessing large amounts of data to generate tools to help patients understand the ramifications of the procedures they will undergo, thus helping to improve informed consent.