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Can Machine-learning Algorithms Predict Early Revision TKA in the Danish Knee Arthroplasty Registry?

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Background: TKA revision is a serious adverse event and as the demand for TKA rises, reducing the risk of revision TKA is increasingly important. Predictive tools based on machine-learning algorithms could reform clinical practice. Few attempts have been made to combine machine- learning algorithms with nationwide arthroplasty registries and, to the authors' knowledge, none have tried to predict early TKA revision.
Purpose / Aim of Study: Can we build a preoperative clinical tool capable of predicting early TKA revision?
Materials and Methods: From the Danish Knee Arthroplasty Registry (DKR), we retrieved all available preoperative variables of 25,104 TKAs conducted from 2012 to 2015 and 6,170 TKAs conducted in 2016. All TKAs were followed for 2 years with revision for any indication as outcome. The models were trained on data from 2012-2015 and temporal validated on data from 2016. We created four different predictive models; a logistic regression-based model (LASSO), two classification tree models (Random Forest and Gradient Boosting Model) and a supervised neural network. The models were compared with each other and with a non- informative model estimating no revisions for all observations. The models' performance was evaluated by calibration plot, accuracy, Brier's score, ROC-curve and area under the curve (AUC). The AUC depicts the models' discriminative capacity and, a priori, an AUC of 0.7 was chosen as threshold for a clinical meaningful model.
Findings / Results: The models' calibration plot, accuracy and Brier's score was not significantly better than the non-informative model and with AUCs ranging from 0.55-0.60, none of the models reached the predefined threshold for a successful model.
Conclusions: The inability to predict early TKA revision from pre-operative information in the DKR highlighted that (1) the rarity of revision makes it difficult to predict and (2) the preoperative variables collected in the DKR are not strongly associated with early revision. Future models might benefit from including other pre- and intraoperative information, while the arthroplasty registries might aid future models by providing an anonymous surgeon identification variable.