**PROBAST**

Study:

Device-measured physical activity data for classification of patients with ventricular arrhythmia events: A pilot investigation

Step 2: Type of prediction study

**Is the study a diagnostic or a prognostic study?**

Diagnostic

**Is the study a development only, development and validation or validation only study?**

Development only

**What is the model of interest?**

Random forest

**What is the outcome of interest?**

Step 3: Assess risk of bias

**Domain 1: Participants**

**Describe the sources of data and criteria for participant selection**

Physical activity data was available for 355 individuals with Boston Scientific cardiac implant-able electronic devices (CIEDs) followed through the Latitude remote monitoring system of the University of Colorado Hospital. The types of CIEDs from which data was collected include single-chamber and dual-chamber permanent pacemakers (PPM) and implantable cardioverter-defibrillators (ICDs), as well as biventricular pacers (also called cardiac resynchronization therapy (CRT) devices) with pacemaker only function (CRT-P) and defibrillator function (CRT-D) as well. For this analysis, we only analyzed data from 235 subjects in whom an entire year of activity data was available.

**1.1 Were appropriate data sources used, e.g. cohort, RCT or nested case-control study data?**

Y

**1.2 Were all inclusions and exclusions of participants appropriate?**

Y

**Risk of bias introduced by selection of participants:**

**Low**

**Rationale of bias rating**

No further eligibility criteria given

**Domain 2: Predictors**

**List and describe predictors included in the final model, e.g. definition and timing of assessment**

Activity was measured in minutes per day. For each subject, the mean, standard deviation, kurtosis, skew, minimum and maximum minutes of activity per day was calculated

**2.1 Were predictors defined and assessed in a similar way for all participants?**

Y

**2.2 Were predictor assessments made without knowledge of outcome data?**

Y

**2.3 Are all predictors available at the time the model intended to be used?**

Y

**Risk of bias introduced by predictors or their assessment**

Low

**Rationale of bias rating**

Activity data were collected the same way for every patient and independent of outcome.

**Domain 3: Outcome**

**Describe the outcome, how it was defined and determined, and the time interval between predictor assessment and outcome determination:**

We opted to examine the outcome of any ventricular tachycardia(VT) events identified by the device (both treated and monitored) as this was the most consistently available outcome unrelated to activity collected by CIEDs for clinical purposes. A subject is defined as having a VT episode if the ICD, which uses a built-in algorithm based on rate, morphology, onset, and atrial-ventricular relationship if an atrial lead is present (dual-chamber ICD), has identified an event as having occurred within the 6-month data collection period. These events can be divided into categories of VT or ventricular fibrillation (VF) by the device based primarily on the rate (VF is faster than VT), but for the purposes of this study, we have included both categories as VT. In general, ICDs do not specifically adjudicate a VT episode as monomorphic or polymorphic, and we were unable to make this determination from the data-base for this study. Subjects with PPMs implanted were assumed to not have any VT events during the period of study, but are included to improve power of this study based on the assumption that a clinical VT event in these subjects would prompt upgrade to an ICD from a PPM. Unlike ICDs, PPMs do not have built-in algorithms to discriminate VT from high ventricular rates as might be present with supraventricular tachycardia or atrial fibrillation with rapid ventricular rate, and for that reason were excluded. All VT events, including monomorphic and polymorphic that met criteria for VT were included. Nonsustained episodes of VT were excluded

**3.1 Was the outcome determined appropriately?**

Y

**3.2 Was a pre-specified or standard outcome definition used?**

Y

**3.3 Were predictors excluded from the outcome definition?**

Y

**3.4 Was the outcome defined and determined in a similar way for all participants?**

N

**3.5 Was the outcome determined without knowledge of predictor information?**

Y

**3.6 Was the time interval between predictor assessment and outcome determination appropriate?**

Y

**Risk of bias introduced by the outcome or its determination**

High

**Rationale of bias rating**

There is potential for bias due to assumptions made for PPM patients and the inability to distinguish VT types. Some precision is lost by merging VT and VF episodes, which could affect specificity in outcome reporting.

**Domain 4: Analysis**

**Describe number of participants, number of candidate predictors, outcome events and events per candidate predictor**

There were 49 (20.8%) subjects with at least one ventricular tachycardia (VT) episode during the year of data collection.

**Describe how the model was developed, predictor selection and risk group definition**

Multivariate logistic regression was performed with all features initially, followed by logistic regression withregularization using lasso, ridge, and elastic net regression. Decision tree analysis was performed using randomForest::randomForest, with boot-strap aggregation and random forest(sampled randomly by 6 features per tree).

**Describe whether and how the model was validated, either internally (cross validation, random split sample) or externally (e.g. temporal validation, geographical validation, different setting, different type of participants)**

To explicitly examine the predictive ability of models, including those above, to use physical activity data to predict VT episodes, we split the data into training (80%) and testing sets(20%).

**Describe the performance measures of the model, e.g. calibration, discrimination, classification, net benefit, and whether they were adjusted for optimism**

ACC, AUC, F1

**Describe any participants who were excluded from the analysis**

None

**Describe missing data on predictors and outcomes as well as methods used for missing data**

Not described

**4.1 Were there a reasonable number of participants with the outcome?**

N

**4.2 Were continuous and categorical predictors handled appropriately?**

Y

**4.3 Were all enrolled participants included in the analysis?**

Y

**4.4 Were participants with missing data handled appropriately?**

U

**4.5 Was selection of predictors based on univariable analysis avoided?**

Y

**4.6 Were complexities in the data (e.g. censoring, competing risks, sampling of controls)**

**accounted for appropriately?**

Y

**4.7 Were relevant model performance measures evaluated appropriately?**

Y

**4.8 Were model overfitting and optimism in model performance accounted for?**

N

**4.9 Do predictors and their assigned weights in the final model correspond to the results**

**from multivariable analysis?**

Y

**Risk of bias introduced by the analysis**

High

**Rationale of bias rating**

High

**Overall Risk of bias**

Small amount of outcomes, no proper crossvalidation