**PROBAST**

Study:

Automated recognition of hypertension through overnight continuous HRV monitoring

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?**

SVM

**What is the outcome of interest?**

Detection of hypertension

Step 3: Assess risk of bias

**Domain 1: Participants**

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

To validate the usefulness of our waist belt monitoring system, we collected ECG data from 28 hypertensive patients (ages ranging from 52 to 71 years, 10 female, 18 male) and 24 non-hypertensive controls.

**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**

**Domain 2: Predictors**

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

We developed a wearable heart rate monitoring system based on a waist belt, as seen in Fig. 1. The belt is comprised of three kinds of sensors: three dry electrodes, a 3-axis accelerometer and two pressure sensors with different sensitivities. Across our participants, we collected heart rate data for 7–9 h.

**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**

Predictors can be easily applied and are independent.

**Domain 3: Outcome**

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

Distinguish between hypertensive vs non-hypertensive patients

**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?**

Y

**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**

Low

**Rationale of bias rating**

Outcome is based on medical diagnosis before study.

**Domain 4: Analysis**

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

After removing these individuals, the patient population consisted of people ranging from 52 to 71 years, 9 female, 15 male. None of the control subjects were excluded. 48 patients.

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

We use two linear classifiers to recognize hypertensive and non-hypertensive subjects: L1-regularized logistic regression and linear support vector machine (SVM).

From the entire feature set (20 features) including time-domain, frequency-domain, and entropy features, We selected a subset in order to reduce the risk of over-fitting, and used a linear SVM weight for feature ranking for the reason that SVM yielded the most rapid convergence to the best performance on the given dataset. We used information gain as a feature selection metric and 7 top ranked features were selected

**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)**

For each dataset, a leave-one-subject-out cross validation procedure is conducted.

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

We use three evaluation metrics: Sensitivity (also known as recall), specificity, and accuracy

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

An author of this study who is a medical expert manually inspected the collected dataset to identify anomalous data (i.e., excessive motion noise, very short sleep times), and excluded those participants from the study. A total of 4 participants (1 female, and 3 male) were excluded from among the hypertensive patients. When we collected the data from them, all of them said they didn’t sleep very well during the night, and the female patient have worn the waist-belt for 2 h, and then gave up. Moreover, two of the patients have some other diseases, and their data could be influenced by complex reasons.

**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?**

Y

**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**

Small amount of patients in the dataset.

**Overall Risk of bias**

High