

Machine Learning Classification on Blood Pressure Variability: from SPRINT Trial to Community eHealth Program in Hong Kong

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Introduction. Hypertension has long been considered a modifiable major risk factor of cardiovascular diseases. However, visit-to-visit blood pressure variability (BPV) has recently been gaining attention and studies have suggested that it is independent of blood pressure (BP) and associated with cardiovascular risks. However, many aspects of BPV such as measurement frequency and interaction with drugs remain unclear. In this work, we would begin by presenting our post hoc analysis on BPV based on SPRINT trial. This is followed by a discussion on a community-based BP-monitoring programme, named eHealth, as a way forward to our SPRINT study.

Methods. The SPRINT trial is a well-characterized randomized control trial which investigated the benefit of intensive hypertensive treatment (targeted at a systolic BP of less than 120 mmHg) on patients with increased cardiovascular risk when compared with standard treatment (less than 140 mmHg). Our post hoc analysis included subjects without primary events during the first 18 months after randomization. BP measurements during the first 18 months were used to ascertain a subject's BPV. Visit-to-visit BPV is defined by the mean absolute deviation of difference between trend line fitted using linear regression and monthly BP measurements. The k-means algorithm, a machine learning method for clustering, was applied to assign subjects to low, medium and high BPV subgroups. Kaplan-Meier curves were plotted and differences were compared via log-ranked test. Cox proportional-hazards models were fitted for each BPV group with adjustments of covariates. Standard treatment group was used as the referent and hazard ratios (HR) with 95% confidence intervals (CI) were reported. The eHealth programme is an initiative aimed at providing continuous healthcare services to Hong Kong senior citizens. The participants' BP were measured two to three times per week. Yearly surveys were conducted which captures the subjects' demographics and health statuses. Self-reported one-year hospitalization history was used as the study end-point. BPV were derived by using each subject's BP records within the one-year period. Stepwise multivariate logistic regression was used to investigate the adjusted association of BPV group with risk of hospitalization, which were presented in odds ratio (OR) with a 95% CI.

Results. A total of 7,863 subjects were included for SPRINT with an average (standard deviation, SD) of 7.9 (0.3) BP readings per person. By applying the k-means algorithm, 46.6%, 40.5%, and 12.9% subjects were stratified as low, medium and high BPV group respectively (Figure 1). Only low BPV subjects had a significantly reduced risk of primary outcome from undertaking intensive treatment (HR of low BPV subjects, 0.59; 95% CI, 0.40-0.89). In contrast, high BPV subjects were found to have a significantly increased risk of serious adverse events (SAE) from undertaking intensive treatment (HR of high BPV subjects, 1.24; 95% CI, 1.02-1.51). For eHealth, a total of 2,039 subjects were included with an average (SD) of 109 (59.5) BP readings per person. 44.1%, 42.9%, and 13.0% subjects belonged to low, medium and high BPV group respectively (Figure 1). In multivariate analysis, subjects belonged medium and high BPV groups were at increased risk of hospitalization (OR, 1.40; 95% CI, 1.11-1.77 and OR, 1.72; 95% CI, 1.25-2.36, respectively).

Conclusion. In our analysis of SPRINT, as the effect of intensive treatment was found to be significantly more protective than that of standard treatment only for low BPV subjects and intensive treatment only for high BPV subjects resulted in increased risk of SAE, it is suggested that intensive hypertensive treatment should only be applied to low BPV subjects but not high BPV subjects. Despite the drastically different BP measurement frequency and follow-up duration in eHealth, similar clustering results were found. Given a community setting, BPV was also found to be significantly associated with prospective hospitalization.