Importance of systematic right ventricular assessment in cardiac resynchronization therapy candidates: a machine-learning approach

Galli E.[1]; Le Rolle V.[1]; Smiseth OA.[2]; Duchenne J.[3]; Aalen JM.[2]; Larsen CK.[2]; Sade E.[4]; Hubert A.[1]; Anilkumar S.[5]; Penicka M.[6]; Linde C.[7]; Leclercq C.[1]; Hernandez A.[1]; Voigt J-U[3]; Donal E.[1]

[1]Univ Rennes, Inserm, LTSI - UMR 1099, F-35000 Rennes, France, RENNES, France
[2]University of Oslo, Oslo, Norway
[3]KU Leuven, Leuven, Belgium
[4]Baskent University, Ankara, Turkey
[5]Hamad Medical Corporation, Doha, Qatar
[6]Olv Hospital Aalst, Aalst, Belgium
[7]Karolinska Institute, Stockholm, Sweden

Funding Acknowledgements: Type of funding sources: None.

Background: Despite having all a systolic heart failure and broad QRS, patients proposed for cardiac resynchronization therapy (CRT) are highly heterogeneous and it remains extremely complicated to predict the impact of the device on left ventricular (LV) function and outcomes.

Objectives: We sought to evaluate the relative impact of clinical, electrocardiographic, and echocardiographic data on the left ventricular (LV) remodeling and prognosis of CRT-candidates by the application of machine learning (ML) approaches.

Methods: 193 patients with systolic heart failure undergoing CRT according to current recommendations were prospectively included in this multicentre study. We used a combination of the Boruta algorithm and random forest methods to identify features predicting both CRT volumetric response and prognosis (Figure 1). The model performance was tested by the area under the receiver operating curve (AUC). We also applied the K-medoid method to identify clusters of phenotypically-similar patients.

Results: From 28 clinical, electrocardiographic, and echocardiographic-derived variables, 16 features were predictive of CRT-response; 11 features were predictive of prognosis.

Among the predictors of CRT-response, 7 variables (44%) pertained to right ventricular (RV) size or function. Tricuspid annular plane systolic excursion was the main feature associated with prognosis. The selected features were associated with a very good prediction of both CRT response (AUC 0.81, 95% CI: 0.74-0.87) and outcomes (AUC 0.84, 95% CI: 0.75-0.93) (Figure 1, Supervised Machine Learning Panel). An unsupervised ML approach allowed the identifications of two phenogroups of patients who differed significantly in clinical and parameters, biventricular size and RV function. The two phenogroups had significant different prognosis (HR 4.70, 95% CI: 2.1-10.0, $p < 0.0001$; log – rank $p < 0.0001$; Figure 1, Unsupervised Machine Learning Panel).

Conclusions: Machine learning can reliably identify clinical and echocardiographic features associated with CRT-response and prognosis. The evaluation of both RV-size and function parameters has pivotal importance for the risk stratification of CRT-candidates and should be systematically assessed in patients undergoing CRT.

Abstract Figure 1