Machine learning in heart failure – diagnosis and treatment

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Using Machine Learning to Create a Self-Driving Echocardiographic Laboratory

N = 14,035


D’hooge J & Fraser AG, Circ. 2018; 138: 1636-8
Heart failure should be diagnosed by stress testing

Heart failure should be diagnosed objectively
Metabolic pathways to diastolic heart failure

Quantitative stress echocardiography for LV longitudinal function, N = 156

- 392 patients
- 415 proteomic biomarkers
- 2 clusters
- 17 independent biomarkers
- 1.9 × excess risk of death or hospitalisation

Velocity, strain, strain rate in all 18 LV segments
Imputation & alignment
Principal component analysis
K nearest neighbour

Velocity in 2 basal LV segments
Time alignment
Multiple kernel learning
Hierarchical clustering

Interpretation, visualisation of learned patterns

Sanchez-Martinez S et al, Med Image Anal. 2017; 35: 70-82
Sanchez-Martinez S et al, Circ Cardiovasc Imaging. 2018; 11: e007138
Tabassian M et al, J Am Soc Echocardiogr. 2018; 31: 1272-84
Concatenated traces of segmental myocardial function – Normal subject vs. Patient with heart failure with normal EF

**Strain rate**  \( 189 \pm 30 \) Hz

5,958 data points per subject
Accuracy of PCA modeling and KNN classifier: which test is best?

- Healthy
- Hypertensive
- Breathless
- HFPEF

Tabassian M et al, J Am Soc Echocardiogr. 2018; 31: 1272-84
Machine learning identifies breathless subjects

Machine learning identifies poor 6 minute-walk distance

Tabassian M et al, JASE 2018; 31: 1272-84
Figure 3: Variability of learned characteristics of the clusters

Cluster 1 ≈ healthy

Cluster 2 ≈ HFPEF
Machine learning to identify phenotypes of heart failure & response to treatment
1106 patients (LVEF ≤ 30%, QRS ≥ 130 ms, NYHA class ≤II) in MADIT-CRT

**My clinical perspective on machine learning ..**

- Alternative to expert acquisition and interpretation
- An extension of analytical methods to cope with big data
- Dependent on quality of data and validity of training set
- Machine learning will not always be correct
- Outputs should be reproducible and interpretable
- Outputs should be clinically relevant / translatable
- Clinicians need to understand / collaborate / direct ..