# Multidimensional Vectorcardiography. Is More Better?

*Alfonso Aranda[1,2], Pietro Bonizzi[1], Joël Karel[1], Ralf Peeters[1]*

*1. Department of Data Science and Knowledge Engineering, Maastricht University (The Netherlands)*

*2. Medtronic Bakken Research Center (Maastricht, The Netherlands)*

**Aims**: Vectorcardiography (VCG) is generated by projecting signals from several leads onto three main orthogonal axes. There is evidence that by doing this projection, some relevant diagnostic information may be lost. We investigated a new way to reduce this information loss. We generated a 12-dimensional VCG ($VCG_{12D}$) from the standard 12-lead ECG system and compared its performance in diagnosing myocardial infarction (MI) with standard Frank VCG ($VCG_{Frank}$) and with a three-dimensional projection of the 12-lead ECG obtained with principal component analysis ($VCG_{PCA}$).

**Methods:** All 148 MI patients and 52 healthy controls from the PTB Diagnostic ECG Database were selected. Standard 12-lead ECG and $VCG_{Frank}$ were available for all subjects. We generated $VCG_{12D}$ using all the leads of the standard 12-lead ECG and associating them with coordinates in a 12-dimensional space. A set of standard parameters in the VCG literature (loop-area, loop-perimeter, etc.) were computed for $VCG_{12D}$, $VCG_{Frank}$, and $VCG_{PCA}$. Then, single feature logistic regression was used to assess performance of each individual parameter in diagnosing MI, for $VCG_{12D}$, $VCG_{PCA}$ and $VCG_{Frank}$, respectively. Additionally, a multivariate lasso regression model was generated for $VCG_{12D}$, $VCG_{PCA}$ and $VCG_{Frank}$, respectively, by using all parameters as initial input.

**Results**: When diagnosing the MI condition with single feature logistic regression, the best single feature performances for $VCG_{Frank}$ and $VCG_{12D}$ were comparable, having AUC of 0.94 and 0.95 respectively. Performance for $VCG_{PCA}$ was poorer, with AUC of 0.81 for its best feature. When using lasso, AUC was 0.93 for $VCG_{Frank}$, 0.97 for $VCG_{12D}$ and 0.90 for $VCG_{PCA}$.

**Conclusion:** $VCG_{12D}$ performs better than $VCG_{PCA}$ and not significantly better than $VCG_{Frank}$. This partially confirms that projecting information into 3D may cause a loss of diagnostically relevant information. Nonetheless, differences between $VCG_{12D}$ and $VCG_{Frank}$ are not significant and more research is needed to investigate potential benefits of a multidimensional VCG.