Sudden Cardiac Death (SCD): unexpected death due to cardiac causes that occurs in a short time period (generally within 1 hour of symptom onset) in a person with known or unknown cardiac disease.

Main causes of SCD are ventricular tachyarrhythmias: ventricular tachycardia (VT) and ventricular fibrillation (VF).

Main preventive treatments: antiarrhythmic drugs and implantable cardioverter defibrillator

325 000 SCD / year in the USA:
- 80% of high coronary-risk profile or post-infarction patients
- 30% of post-infarction patients with ejection fraction < 35% and congestive heart failure (recommended to implantation)
- 15% of patients with previous cardiac arrest or ventricular tachycardia (recommended to implantation)

Among patients implanted in primary prevention, only 2% to 5% per year suffer a ventricular arrhythmia resulting in SCD

In the USA, in primary prevention:

2011
- 130 000 ICD-implantations

2016
- 100 000 devices will be replaced without having delivery any therapy

Health issues due to the peri- and postoperative complications

Economic issue caused by unnecessary implantations

The selection of prophylactic ICD-implantation candidates must be improved

Purpose of this study

Design a neural network classifier, the inputs of which are the descriptors obtained from Holter recordings, to select patients who do not need implantation during the next 6 months with a NPV* > 90% and a PPV** > 20%

* negative predictive value (NPV) = true negatives / all negatives
** positive predictive value (PPV) = true positives / all positives

186 pre-implantation 30-min Holter recordings of patients equipped with an implantable cardioverter defibrillator (67±11 years of age, 163 males)

Positive group: 44 patients with treated arrhythmias
Negative group: 142 patients without treated arrhythmias

Feature grouping & Feature selection

There are always three main ingredients required for the production of a clinical arrhythmia, the arrhythmogenic substrate, the trigger factor and the modulation factors of which the most common is the autonomic nervous system. Dr. P. Cournel

The features are grouped according to the arrhythmogenic factor they describe.

In each of the 3 groups, the most relevant features for a classification between recordings that lead or not to treated event are selected thanks to the random probe method (Stoppiaga et al., "A random feature for variable and feature selection", Journal of Machine Learning Research 2003;3:1389-1414)

Conventional classifier

- Single hidden layer neural network

Ad hoc classifier

- Classifier capitalizing on the arrhythmogenic decomposition of the inputs

One subnetwork per hub of inputs
Complexity of each subnetwork determined by cross-validation
Each subnetwork outputs merged into a nonlinear output neuron

Estimate the probability for a patient to undergo ventricular arrhythmia

Performances of both designed classifiers estimated by a cross-test procedure

Performances

<table>
<thead>
<tr>
<th>Performances</th>
<th>Current position</th>
<th>Conventional classifier</th>
<th>Ad hoc classifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of the ICD-implantations</td>
<td>n.a.</td>
<td>52% ± 19%</td>
<td>59% ± 15%</td>
</tr>
<tr>
<td>Unnecessary implantations at 6 months</td>
<td>96% - 98%</td>
<td>75% ± 20%</td>
<td>69% ± 19%</td>
</tr>
<tr>
<td>Positive Predictive Value</td>
<td>2% - 5%</td>
<td>25% ± 20%</td>
<td>31% ± 19%</td>
</tr>
<tr>
<td>Missed implantations</td>
<td>n.a.</td>
<td>32% ± 13%</td>
<td>23% ± 19%</td>
</tr>
<tr>
<td>Negative Predictive Value</td>
<td>n.a.</td>
<td>68% ± 13%</td>
<td>77% ± 13%</td>
</tr>
</tbody>
</table>

Conclusions

Improving ICD-implantation candidates selection may be possible
But getting a more suitable and larger database is essential