PREDICTORS OF SUDDEN CARDIAC DEATH IN ISCHAEMIC & DILATED CARDIOMYOPATHY.

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Leading Causes of Death in the US

- Septicemia
- Nephritis
- Alzheimer’s Disease
- Influenza/Pneumonia
- Diabetes
- Accidents/Injuries
- Chronic Lower Respiratory Diseases
- Cerebrovascular Disease
- Other Cardiac Causes
- Sudden Cardiac Arrest
- All Cancers

SCD is responsible for **two thirds** of all deaths related to heart disease

*National Vital Statistics Report vol 49, 2001*
Definition of SCD

- Death due to any cardiac disease that occurs out of hospital, in an emergency department, or in an individual reported dead on arrival at a hospital within 1 hour after the onset of symptoms.

- It may be due to VT, VF, Asystole or non arrhythmic causes.
SCD epidemiology

- CAD accounts for at least 80% of SCD
- SCD occurs as a first clinical event of CAD in approximately 30% of cases

* ion-channel abnormalities, valvular or congenital heart disease, other causes

AHA. Heart Disease and Stroke Statistics–2003 Update
Triggers or Modulators

- changes in ANS activity
- metabolic disturbances
- myocardial ischemia
- electrolyte abnormalities
- acute volume and/or pressure overload
- ion channel abnormalities
- proarrhythmic actions of cardiac and noncardiac drugs

The electrophysiological alterations induced by all these conditions initiate and maintain VT/VF
Despite all the advances in the early access to medical care, early cardiopulmonary resuscitation, early defibrillation & early advanced care, the overall mortality from a cardiac arrest remains high.
This underscores the need for risk stratification techniques to identify patients at high risk for these events and effective interventions that can prevent or abort these events.
Risk stratification tools

- Extent of myocardial damage and scar formation
  LVEF, NYHA
- Slowed conduction
  QRS duration, SAECG
- Heterogeneities in ventricular repolarisation
  QT interval, QT dispersion, T-wave alternans
- Imbalance in autonomic tone
  HRV, heart rate turbulence, baroreceptor sensitivity
- Ventricular ectopy
  long-term ambulatory monitoring
1-myocardial damage & scar formation

A- LV EF

B- 6 MINUTE WALK TEST
Reduced LV EF is the most consistently reported risk factor for overall mortality & SCD in the heart failure population.

Majority of studies concluded that EF ≤ 30-40% is the threshold for identifying high risk individuals.

Studies showed that majority of SCD occur in patients with more preserved EF which shows the limited sensitivity of this test.
“the single most important risk factor for overall mortality and sudden cardiac death”
6 minute walk test/NYHA class

- They are predictors of syndrome of CHF which may predispose to ventricular arrhythmias & SCD in patients with systolic dysfunction.
- Their role as risk stratification tool is untested.
2-Detection of slow conduction

A- QRS duration.

B- SAECG.
QRS DURATION

- Simple measure of ventricular activation measured on 12 lead ECG.
- Manifestation of intra-ventricular or inter-ventricular conduction delay or block.
- Observational studies suggest that QRS prolongation is a significant marker for poor outcome in patients with depressed EF especially due to CAD.
- **MADIT-II** concluded that QRS duration >120msec is an important indicator of which patients were likely to benefit from ICD.

- **MUSTT** concluded that patients with QRS >120msec or LBBB had 50% increase risk of SCD independent of EF.

- **DEFINITE** did not show a relationship between QRS duration and all cause mortality.
Signal averaged ECG

- Abnormal SAECG may identify patients with prior MI at risk for SCD.

- It has a high negative value, useful for identification of patients at low risk.

- Routine use of SAECG to identify patients at high risk of SCD is not adequately supported at this time.
3-Heterogeneity in ventricular repolarization

A- QT interval.
B- QT dispersion
C- T-wave alternans.
QT interval

- Reflection of the summed ventricular action potential durations.

- It shortens with increasing heart rate and is corrected by Bazett's formula (\(\frac{QT}{\sqrt{RR}}\)).

- QT prolongation has been associated with mortality in patients with depressed EF.

- Studies evaluating the QT prolongation for prediction of SCD in patients who do not have long QT syndrome have demonstrated mixed results.
QT dispersion

- Maximal difference between QT intervals in the surface ECG.

- Reflect dispersion of myocardial recovery associated with arrhythmia risk.

- Several recent studies have found no relation between QT dispersion & outcome.
T-wave alternans

- Reflection of repolarization alternans at the level of single cell.

- Arises when heart rate exceeds the capacity of cardiac cells to cycle intracellular calcium.

- Rate dependent phenomenon

- Occurs at relatively lower heart rates in patients susceptible to life threatening ventricular arrhythmias.
- It requires graded exercise to elevate heart rate

- Exercise induced T-wave alternans is a better predictor than pacing induced.

- Abnormal T-wave alternans is defined by the occurrence of >1.9µV of alternans starting at a heart rate <110 beats/min.

- Many cohort studies showed that T-wave alternans predicted risk in patients with CAD and in patients with DCM.
ABCD trial found that positive T-wave alternans test was as predictive of arrhythmic events as a positive EPS.

SCD-HeFT found no significant difference in arrhythmic events between those who had a positive versus a negative T-wave alternans test.
4-Imbalance in autonomic tone

A- Short term Heart rate variability.
B- Heart rate turbulence
C- Heart rate recovery after exercise
D- Baroreceptor sensitivity.
Short term Heart rate variability

- Mean of assessing autonomic nervous system modulation of SN.
- It is less reproducibly in patients with CHF than in normal persons.
- It correlates mainly with parasympathetic activity.
- Data showed conflicting results, so its use for risk stratification for SCD is not recommended.
Heart rate Turbulence

- Describes the short term fluctuation in sinus cycle length that follows a VPC.
- Measures vagal responsiveness.
- Requires the response to a number of premature beats (15-20) to be averaged.
- Higher slope indicates more parasympathetic responsiveness & correlate with improved prognosis.
Although some studies suggest it has significant predictive value after MI, further studies are needed to establish its clinical utility as a risk stratification tool.
Heart rate recovery after exercise

- Immediately after graded exercise HR normally falls in a biphasic manner, with initial rapid decline (first 30 sec to 1 min recovery).

- This was attenuated in patients with heart failure because of impaired parasympathetic tone & predict increased risk of death.

- 1 minute HR recovery ≤ 12 beats /min was associated with a markedly increased risk of all death.
Other data recommend $\leq 22$ beats /min at 2 minutes recovery as cutoff value.

Ventricular ectopy at recovery also reflect parasympathetic activity.

Occurrence of frequent or severe ventricular ectopy during the first 5 min of recovery has been linked to risk of death in patients with ICM & DCM.
Their value as risk stratification tools for SCD is still untested.
Baroreceptor sensitivity

- Refers to adaptation of cardiac periods (R-R intervals) to changes in blood pressure.

- Most applicable method to evaluate BRS is phenylephrine injection which causes reflex parasympathetic enhancement.

- Reduced BRS is linked with increased risk for serious ventricular arrhythmias.

- Normally injection of 25-100μg of phenylephrine causes increase in SBP >20 mmhg and RR prolongation >10msec for each 1 mmhg increase in BP.
Studies showed that BRS < 3msec /mmhg carried significant risk of cardiac mortality.
5-ventricular ectopy

- Long term ambulatory holter monitoring.

Patients with non ischaemic cardiomyopathy are at increased risk of SCD and frequently have high grade ventricular ectopy & NSVT.

The relationship between arrhythmia on holter monitoring & cardiac arrest is much less clear in patients with non-ischaemic than ischaemic cardiomyopathy.
It is recommended in patients with LVEF between 35-40% post MI with NSVT on holter monitoring are at high risk of SCD & should receive ICD therapy

Use of holter monitoring to detect ventricular ectopy or NSVT to risk stratify patients with DCM for SCD is still unclear.
CONCLUSIONS
<table>
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<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>NSVT</strong></td>
<td>predictive accuracy as a single variable has not been tested in randomized trials</td>
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<tr>
<td><strong>QRS duration</strong></td>
<td>prognostic power not tested in prospective trials</td>
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<tr>
<td><strong>QT dispersion</strong></td>
<td>methodological problems in measurement</td>
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<td><strong>SAECG:</strong></td>
<td>low positive predictive accuracy</td>
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<tr>
<td><strong>HRV, BRS, HR turbulence</strong></td>
<td>predictive power not tested in randomized trials</td>
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<td><strong>NYHA class</strong></td>
<td>more predictive of risk for progressive pump failure</td>
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<tr>
<td><strong>Microvolt T wave (repolarization) alternans</strong></td>
<td>high negative predictive accuracy (97%) - meta-analysis 2608 pts predicts difference in total mortality, but not in arrhythmic death (MASTER)</td>
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At present

EXPERT CONSENSUS DOCUMENT

American Heart Association/American College of Cardiology Foundation/Heart Rhythm Society Scientific Statement on Noninvasive Risk Stratification Techniques for Identifying Patients at Risk for Sudden Cardiac Death

* A Scientific Statement From the American Heart Association Council on Clinical Cardiology Committee on Electrocardiography and Arrhythmias and Council on Epidemiology and Prevention

- ... no marker has the power to predict patients at high risk in daily care
- ...the search continues for the perfect combination of tests
- ...currently, the primary technique to determine who is at risk of SCD is the LVEF
Thank you