Stratification of Risk for Sudden Cardiac Death

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Stratification of Risk for SCD

- 166,000 – 310,000 annually
- Overall 4.6% discharged alive
- 23% “shockable” rhythm (VT or VF)
- 8% of all cardiac arrest and 21% of VF arrest survived to hospital discharge
- 3% in Alabama, 16.3% in Seattle
- VF 23%, asystole 35%, PEA 32% (NRCPR 2006)
- Survival until discharge from in-hospital cardiac arrest varies between 15%-20%
Stratification of Risk for SCD

- 16 Million Americans have CAD
- 8 Million have had an MI
- Risk stratification is a continuum
- Most SCD occur in patients with no known risk factors or belong to the low risk group
- Goals of risk stratification
  - Identification of potential victims
  - Determine aggressiveness of therapy
Stratification of Risk for SCD

- The ideal risk stratifier should identify the largest number of patients who will suffer from SCD (sensitivity) and the smallest number who will not (specificity)

- **Identify the patient population at risk**
- **Understand the mechanism of SCD in that patient population**
- **Select the most appropriate test to identify the at-risk individuals**
- **Implement to most specific intervention to prevent SCD**
Appropriate and Inappropriate ICD Therapies


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The Mechanism of SCD

- Ischemia
- Metabolic abnormalities
- Electrolyte changes
- Autonomic changes
- Volume / pressure overload
- Ion channel abnormalities
- Proarrhythmic drugs

- Ischemia
- Toxins
- Pressure / volume overload
- Infectious agents

Scar formation
Anatomical remodeling
Electrical remodeling

VT
VF
Stratification of Risk for SCD

- **Slowed conduction**
  - QRS duration
  - signal-averaged electrocardiogram (SAECG)

- **Heterogeneities in ventricular repolarization**
  - QT interval
  - QT dispersion
  - T-wave alternans

- **Imbalance in autonomic tone**
  - heart rate variability (HRV)
  - heart rate turbulence
  - heart rate recovery after exercise
  - baroreceptor sensitivity

- **Extent of myocardial damage and scar formation**
  - left ventricular ejection fraction (LVEF)
  - 6-minute walk

- **Ventricular ectopy**
  - long term ambulatory monitoring
Left Ventricular Ejection Fraction (LVEF)

- Most consistently reported risk factor for SCD and HF mortality
- LVEF ≤ 30%-40% associated with 4.3 X RR of lethal arrhythmias
- MADIT I (LVEF ≤ 35%, NSVT, NYHA I-III) ↓ 46% mortality
- MADIT II (LVEF ≤ 30%) ↓ 31% mortality
- SCD-HeFT (LVEF ≤ 35%, NYHA II-III) ↓ 23% mortality
- In non-isch CMP LVEF ≤ 30% + NSVT ass. 8.2 X mortality
QRS Duration

[ECG waveform diagram]
QRS Duration

- Up to 2% of the population
- 20%-50% of the heart failure population
- In CASS; BBB associated with
  - More extensive CAD
  - Lower LVEF
  - Higher mortality
  - In LBBB; higher incidence of SCD
- In PainFREE RX II and MADIT II QRS width did not predict appropriate ICD discharges
- The association of IVCD/BBB and mortality in non ischemic CMP is more tenuous
Rhythm Recordings from a 76-Year-Old Woman with Renal Dysfunction Who Was Treated with Sotalol for Atrial Fibrillation

Electrocardiographic Patterns in the Three Common Forms of the Long-QT Syndrome
## Diagnosis of Long-QT

### Suggested Bazett-Corrected QTc Values for Diagnosing QT Prolongation

<table>
<thead>
<tr>
<th>Rating</th>
<th>1-15 yrs</th>
<th>Adult Male</th>
<th>Adult Female</th>
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<tbody>
<tr>
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<td>&lt; 440</td>
<td>&lt; 430</td>
<td>&lt; 450</td>
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<tr>
<td>Borderline</td>
<td>440-460</td>
<td>430-450</td>
<td>450-470</td>
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<tr>
<td>Prolonged</td>
<td>&gt; 460</td>
<td>&gt; 450</td>
<td>&gt; 470</td>
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</tbody>
</table>

The Short QT Syndrome

- Autosomal dominant
- QTc ≤ 340 msecs
- Increased risk of SCD due to VF
- AF often at a young age
- Short atrial and vent. refractory periods
Signal Averaged ECG (SAECG)

Vector magnitude signals for unfiltered (left) and high-pass filtered (right, 40 Hz) SAECG recorded in an MI patient

Signal Averaged ECG (SAECG)

- Abnormal in 25%-35% of post MI patients
- 3.3%-9% will suffer SCD within the next 3 years.
- Strong negative predictive power (95%)
Kaplan-Meier Analysis of the Probability of Death According to Study Group
Short Term Heart Rate Variability

- Evaluates the modulation of the SN by the autonomic nervous system
- SN variability becomes a surrogate for the influence of the autonomic nervous system on the ventricle
- Parasympathetic tone increases high frequency oscillations in HRV while sympathetic affects low frequency oscillations
- Most cardiac arrests / ventricular arrhythmias occur during heightened sympathetic tone
- Limited clinical role in risk stratification
Ambulatory ECG (Holter Monitor)

- PVCs $\geq 10$ bph portend a high future risk of SCD

- In post MI pts. when coupled with an LVEF $\leq 40\%$ the mortality is 20\% (EMIAT)

- NSVT PPV 20\%-50\% in ischemic CMP and used for risk stratification

- In non-ischemic CMP
  - In DEFINITE LVEF $\leq 35\%$, NSVT or PVCs $\geq 10$ bph, ICD significantly reduced the incidence of arrhythmic mortality and a trend to reduce mortality
  - In SCD-HeFT; LVEF $\leq 35\%$, class II-III mortality reduction demonstrated without using VA as a risk stratifier

- Greatest value in post-MI patients with an LVEF 35\%-40\%
• A better predictor of total mortality than SCD

• ALIVE
  – 5-21 days post MI
  – LVEF 15%-35%
  – In the placebo arm of the study, patients with ↓ HRV had a 64% greater mortality than those with normal or high HRV

• DINAMIT
  – 674 patients, 6-40 days post MI, LVEF ≤ 35%
  – ↓ HRV or ↑ resting HR on Holter
  – No mortality difference between ICD and no-ICD arms
Functional Status

- A strong predictor of total mortality
- NYHA class II 5% total mortality / 85% SCD,
- NYHA class IV 21% total mortality / 33% SCD
- Marked inter personal variability (56%)
- TOVA; class III strongest predictor of ICD discharges
- SCD-HeFT; no primary prevention benefit for class III
- DEFINITE; greater benefit in class III
- MADIT II; no difference amongst classes
Exercise Stress Testing

- Heart Rate Recovery
  - Correlates with parasympathetic tone
  - ≤ 12 bpm decrease in HR in the first minute post ETT is associated with a 2 fold increase in all-cause mortality
  - Remains predictive even after adjusting for all other known adverse exercise related predictors.
  - Confounded by lack of standardization

- Post Recovery PVCs
Micro T Wave Alternans

Micro T Wave Alternans

- First observed in 1908 and significance realized in 1913!
- Rosenbaum established an association with ventricular tachyarrhythmias and SCD in 1994
- Similar / superior to many other risk factors for SCD
- Requires exercise to achieve a target heart rate
- Confounded by AF, frequent PVCs
Micro T Wave Alternans

Micro T Wave Alternans

• Chow T et al. (JACC 2006;47:1820)
  – 768 post MI patients, LVEF ≤ 35%
  – MTWA negative vs. non-negative
  – Non-negative associated with a > 2X increase in total or arrhythmic mortality.
  – No difference between positive and intermediate

• ALPHA study
  – Non ischemic CMP, LVEF ≤ 40%
  – NYHA class II/III
  – Patients with an abnormal MTWA had a 4X higher risk of cardiac mortality and life-threatening arrhythmias
Stratification of Risk for SCD

- The field of risk stratification requires substantial further development

Thank you
Bulleted text example

• Text goes here
  – Second level text
    • Third level text
      – Fourth level text
        » Fifth level text
Sample title slide

• Chart colors. Click on squares of color to add to your color list in Microsoft Excel, Microsoft graph chart and tables as well as adding to your fill palettes
Placing images example

- Recruiting highly motivated, talented new team members

John Schreiber, MD
Pediatrician-in-Chief

Kent Yucel, MD, FACR
Radiologist-in-Chief

Johanna Seddon, MD
Director,
Ophthalmic Epidemiology
and Genetics Service
• **55 New Medical Staff Appointments — Fiscal Year 07**

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Number</th>
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<tbody>
<tr>
<td>Anesthesia</td>
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<tr>
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<tr>
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<tr>
<td>Medicine – Geographic &amp; ID</td>
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<tr>
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<tr>
<td>Surgery/Vascular</td>
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</table>
Chart 1 example

Inpatient Patient Falls per 1000 Patient Days

October 11, 2009

Tufts Medical Center
• Increasing donations and building our donor base
  – Best fundraising year thus far in history of Medical Center, running $3.2 million ahead of FY06
Chart 3 example

- Attracting more patients: Increased ED Visits

![Bar chart showing ED visits](chart.png)

- FY 2004 Actual: 30,589
- FY 2005 Actual: 31,544
- FY 2006 Actual: 31,091
- FY 2007 Projected: 31,844

Legend:
- Adult
- Pedi