Stratification of Risk for Sudden Cardiac Death

Munther K. Homoud, M.D.

Tufts Medical Center

Boston, MA

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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

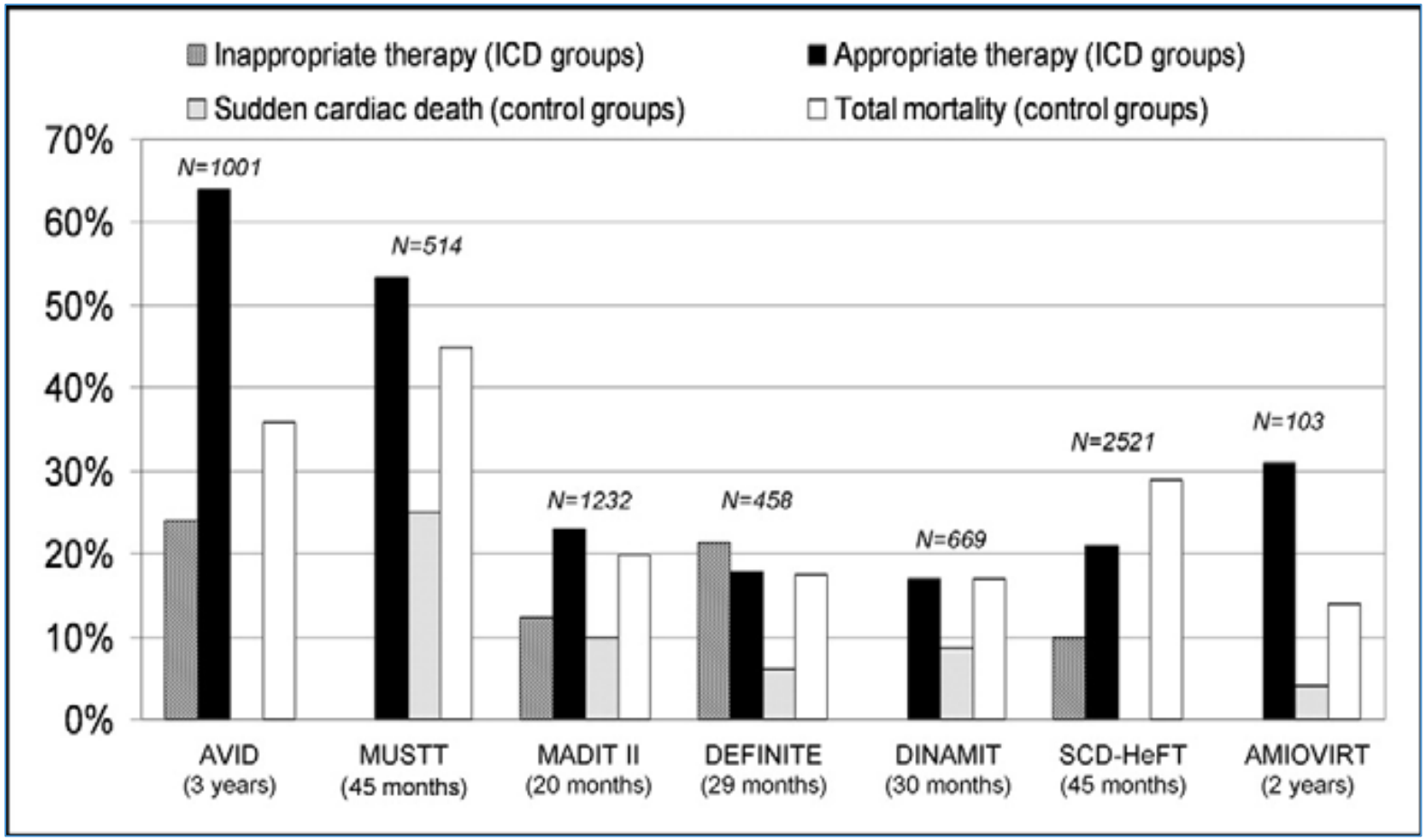
- 16 Million Americans have CAD
- 8 Million have had an MI
- Risk stratification is a continuum
- Most SCD occur in patients with no known risk factors or belong to the low risk group
- Goals of risk stratification
  - Identification of potential victims
  - Determine aggressiveness of therapy

Stratification of Risk for SCD

- The ideal risk stratifier should identify the largest number of patients who will suffer from SCD *(sensitivity)* and 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



Germano JJ et al. Frequency and Causes of Implantable Cardioverter-Defibrillator Therapies: Is Device Therapy Proarrhythmic? Am J Cardiol 2006;97:1255-1261

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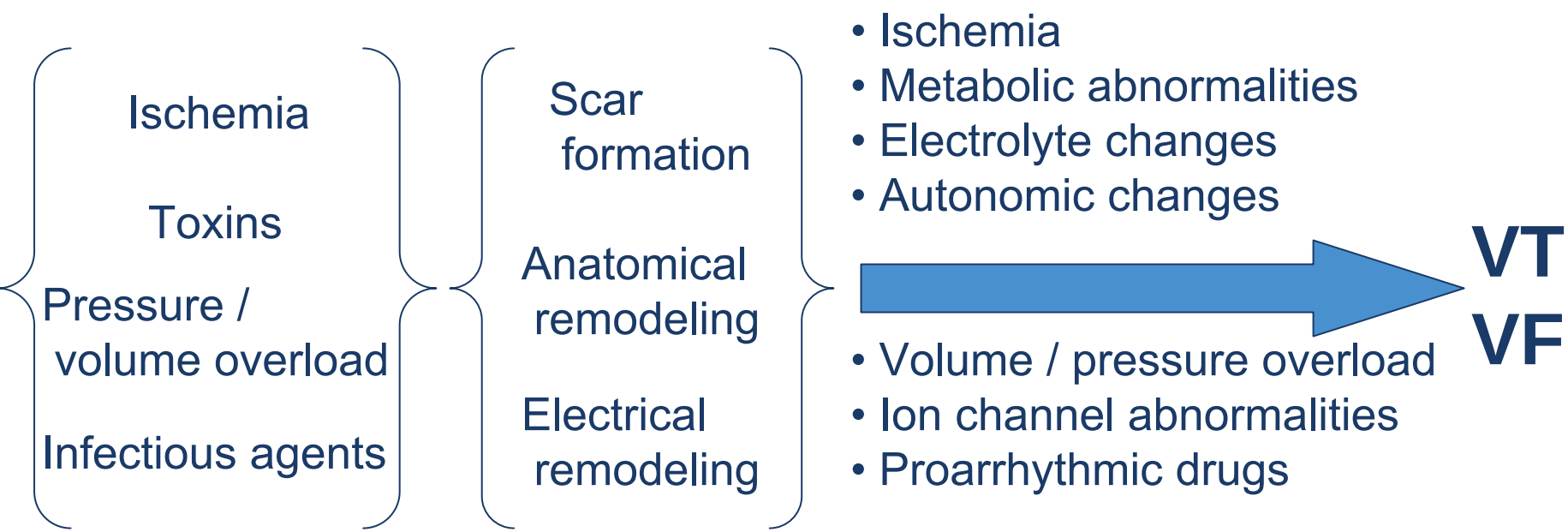
The Mechanism of SCD



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

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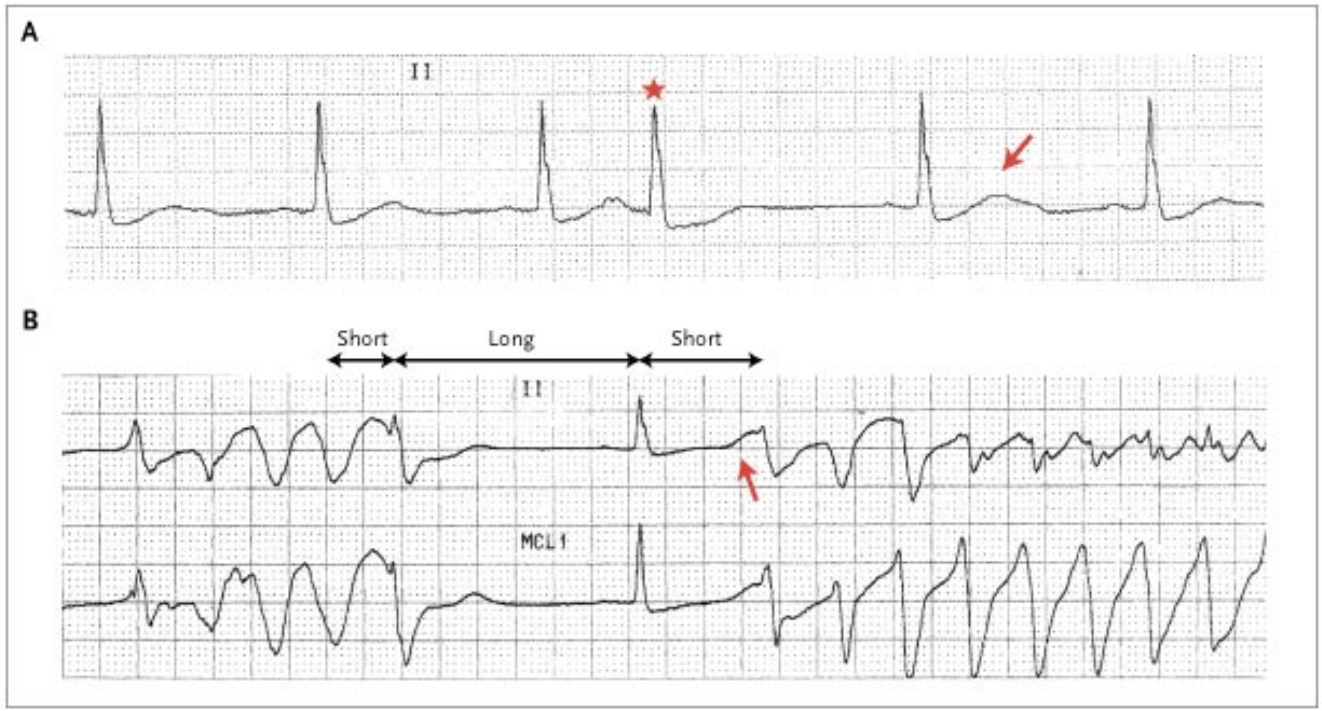
QRS Duration

- 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

QT Interval



Rhythm Recordings from a 76-Year-Old Woman with Renal Dysfunction Who Was Treated with Sotalol for Atrial Fibrillation

Roden D. N Engl J Med 2004;350:1013-1022

The NEW ENGLAND JOURNAL of MEDICINE

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QT Interval

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

Roden D. N Engl J Med 2008;358:169-176

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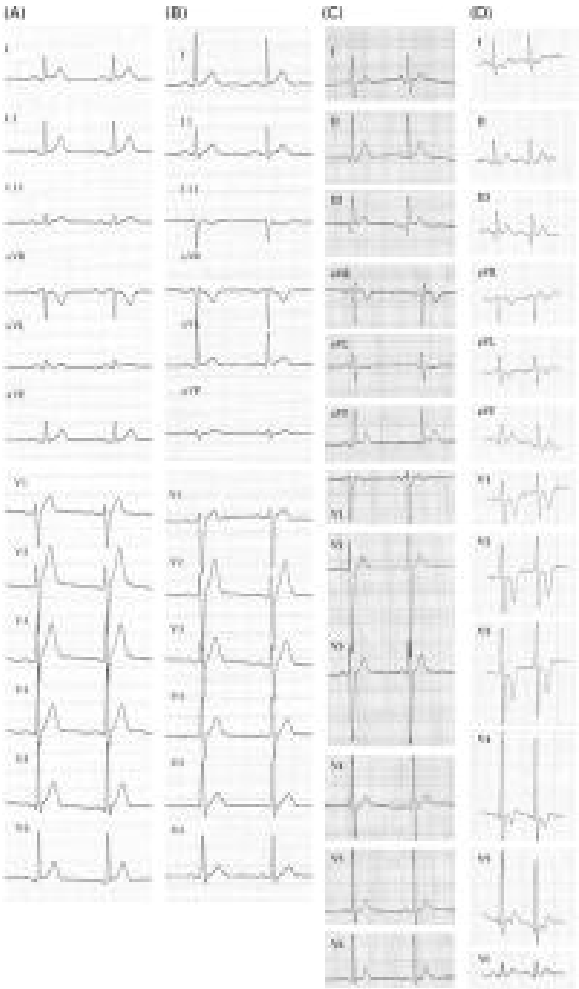
Diagnosis of Long-QT

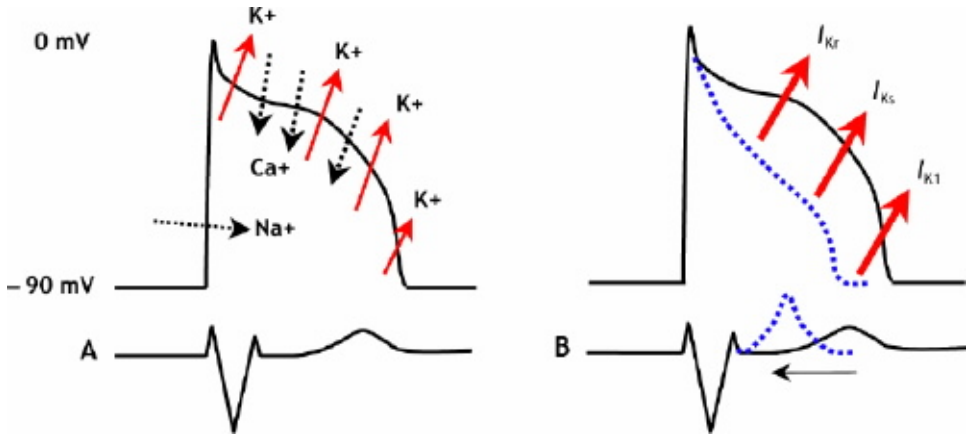
Suggested Bazett-Corrected QTc Values for Diagnosing QT Prolongation

Rating	1-15 yrs	Adult Male	Adult Female
Normal	< 440	< 430	< 450
Borderline	440-**460**	430-**450**	450-**470**
Prolonged	> 460	> 450	> 470

Goldenberg I et al. J Cardiovasc Electrophysiol, 2006 (17) 333-336

QT Interval



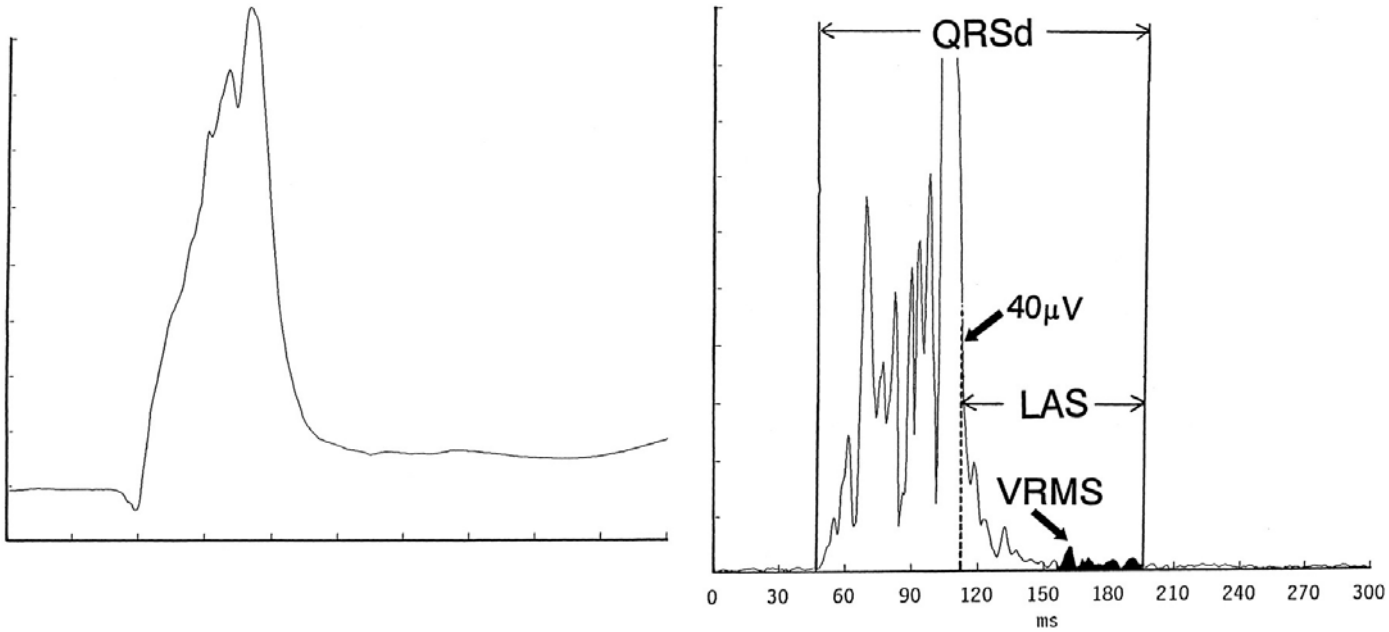


The Short QT Syndrome

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

Brugada R et al. Canadian Medical J 2005 73(11); 1349-1354

Signal Averaged ECG (SAECG)



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

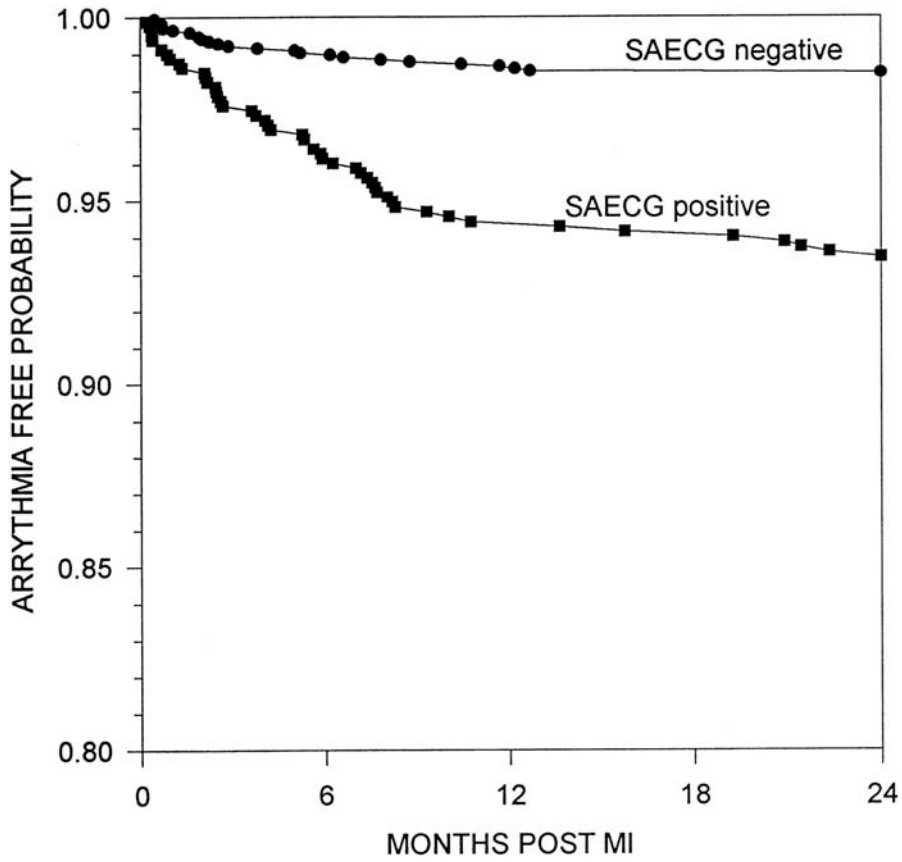
Circulation

Savard, P. et al. Circulation 1997;96:202-213

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%)

Signal Averaged ECG (SAECG)



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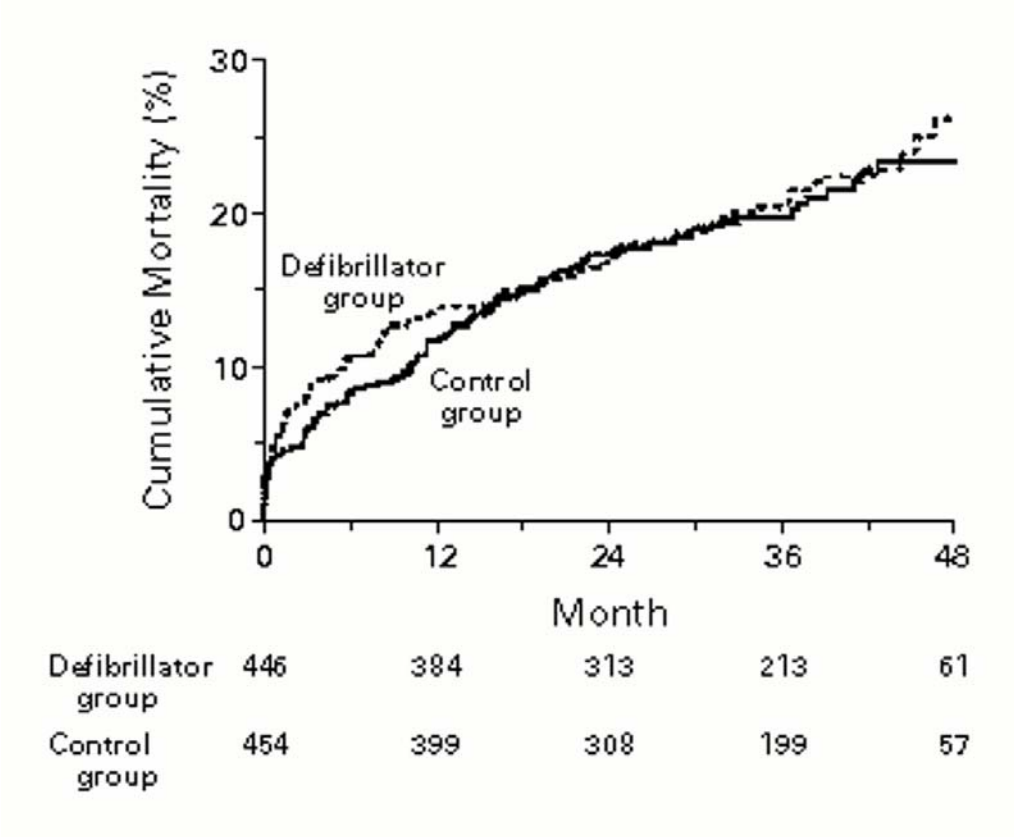
Signal Averaged ECG (SAECG)



Kaplan-Meier Analysis of the Probability of Death According to Study Group

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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 ≥ 10 bph portend a high future risk of SCD
- In post MI pts. when coupled with an LVEF ≤ 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 ≤ 35%, NSVT or PVCs . 10 bph, ICD significantly reduced the incidence of arrhythmic mortality and a trend to reduce mortality
  - In SCD-HeFT; LVEF ≤ 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%

Ambulatory ECG (Long-Term HRV)

- 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

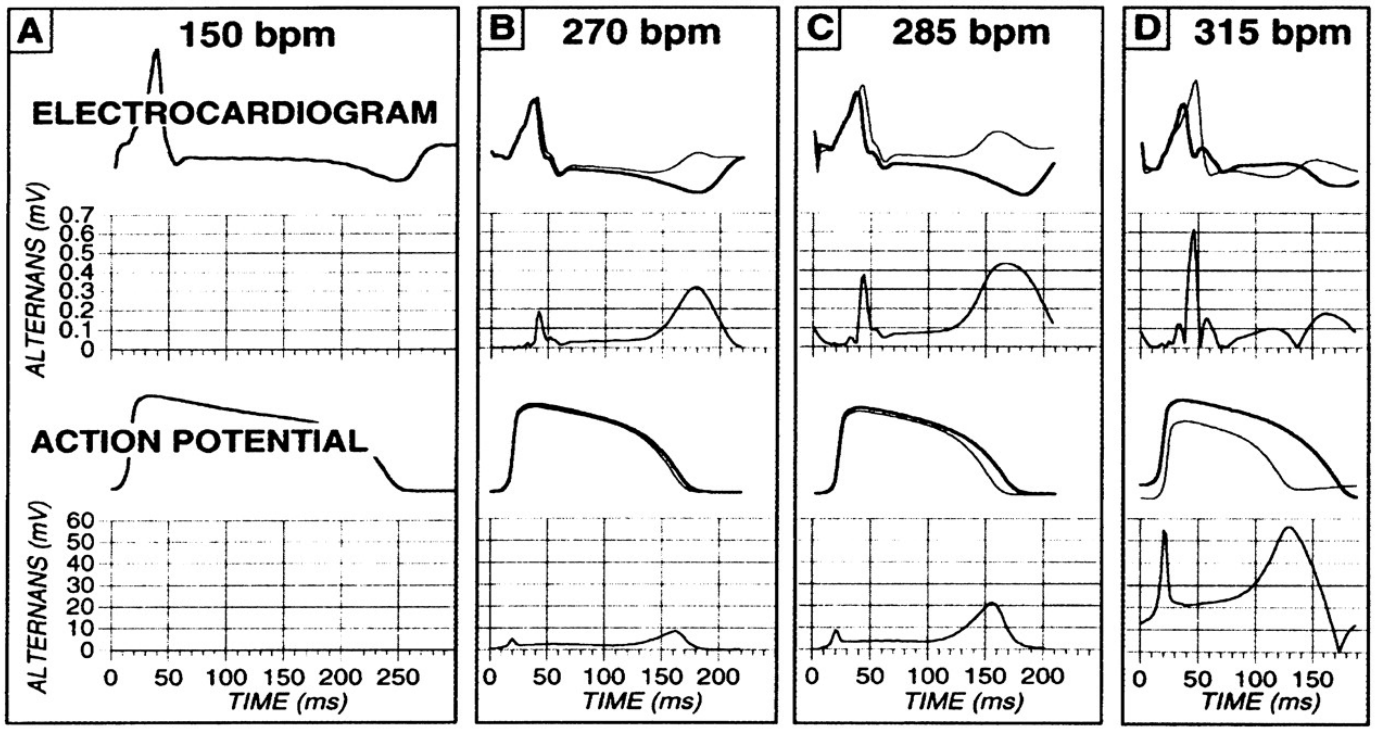
Functional Status

- 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



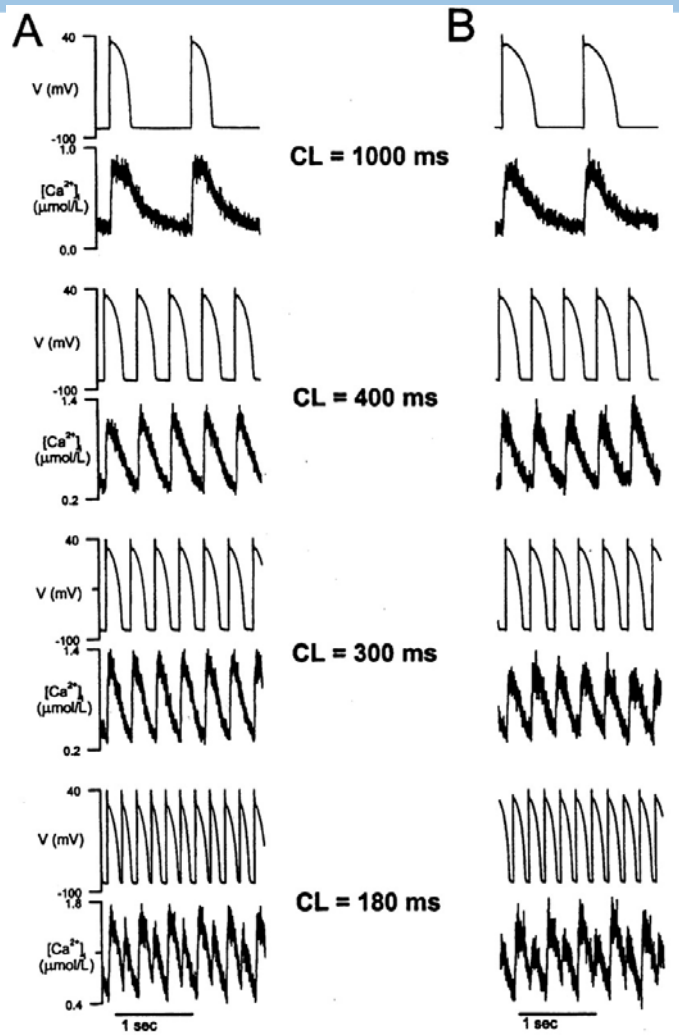
Walker, M. L et al. Cardiovasc Res 2003 57:599-614;
doi:10.1016/S0008-6363(02)00737-X

Cardiovascular Research

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



Walker, M. L et al. Cardiovasc Res 2003 57:599-614; doi:10.1016/S0008-6363(02)00737-X

Cardiovascular Research

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 you 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

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Making a list example

- 55 New Medical Staff Appointments — Fiscal Year 07

Anesthesia	3	Pediatrics/Critical Care	2
Dentistry	1	Pediatrics/General Peds	4
Dermatology	1	Pediatrics/Infectious Disease	1
Obstetrics/Gynecology	1	Pediatrics/Nephrology	1
Medicine – NECQA	5	Pediatrics/Newborn Medicine	2
Medicine – GI	1	Pediatrics/Pulmonary	1
Medicine – Geographic & ID	1	Pediatrics/CCSN	1
Medicine – General Internal	3	Psychiatry	1
Medicine –		Radiology	2
Medicine – Family Practice	2	Radiology/Interventional	3
Hematology/Oncology	1	Radiology/Neuroradiology	2
Neurology	1	Radiology/Pediatric	5
Ophthalmology	5	Rehabilitation Medicine	1
Orthopaedics - Hand	1	Surgery/General	1
Pediatrics/Cardiology	1	Surgery/Vascular	1

Chart 1 example

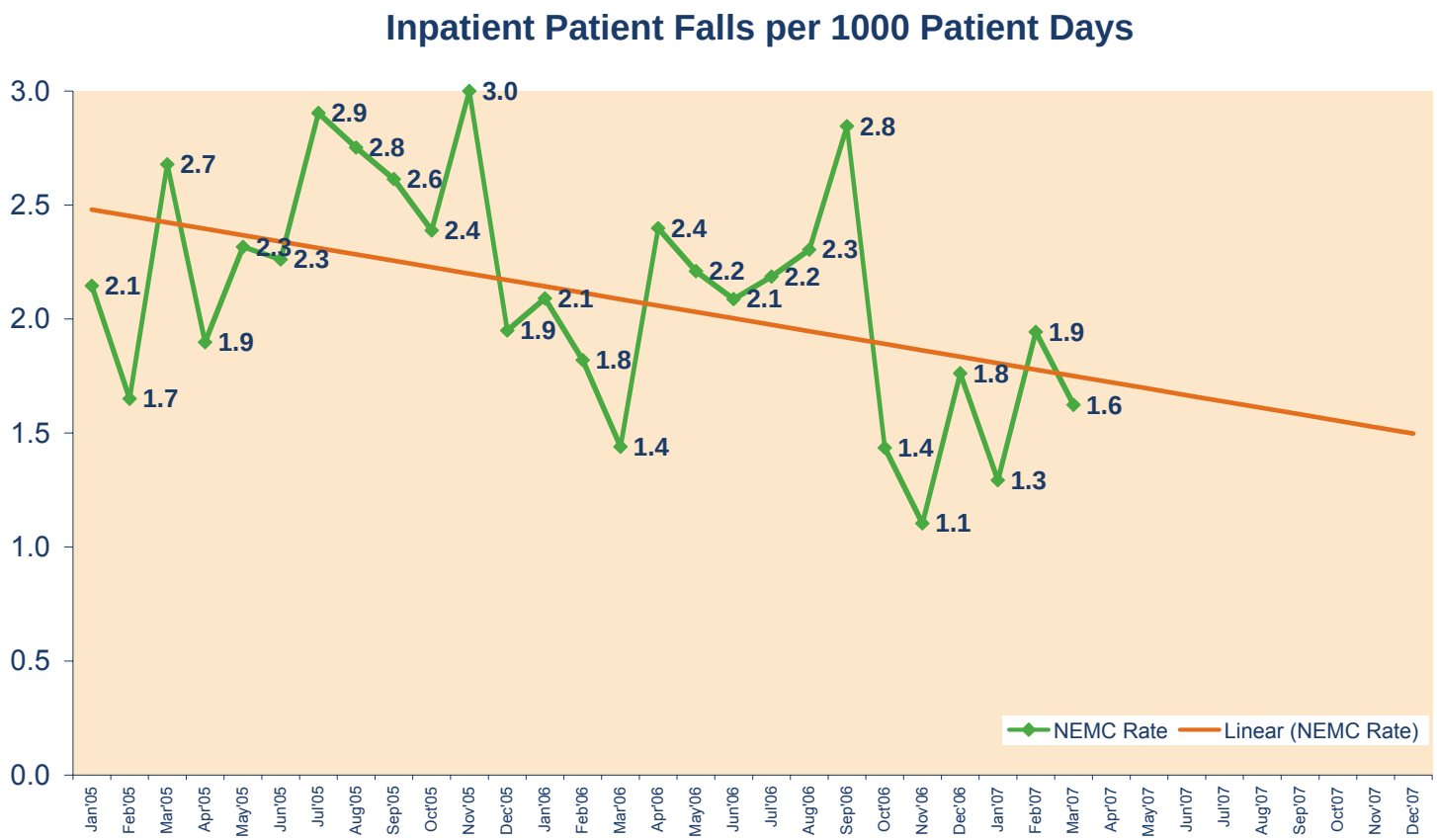

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Chart 2 example

- Increasing donations and building our donor base
  - Best fundraising year thus far in history of Medical Center, running $3.2 million ahead of FY06

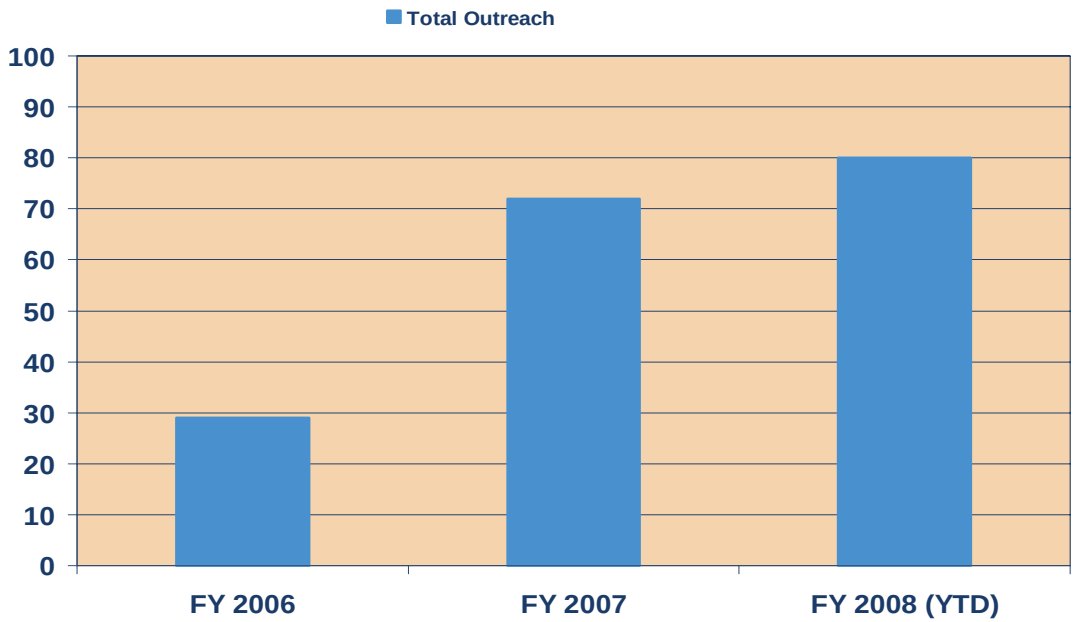

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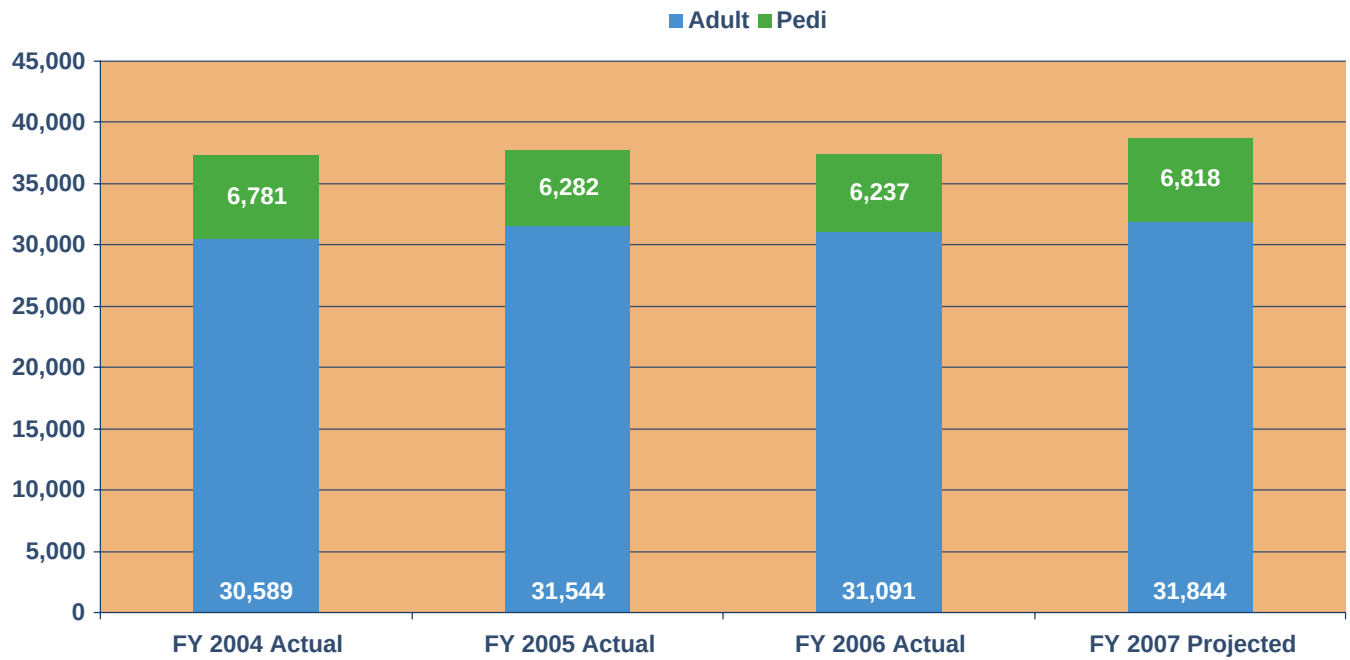
Chart 3 example

- Attracting more patients: Increased ED Visits



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