Clinical Management & Prevention of SCD

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### Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden death</td>
<td>Non-traumatic, unexpected fatal event occurring within 1 hour of the onset of symptoms in an apparently healthy subject. If death is not witnessed, the definition applies when the victim was in good health 24 hours before the event.</td>
</tr>
<tr>
<td>SUDS and SUDI</td>
<td>Sudden death without an apparent cause and in which an autopsy has not been performed in an adult (SUDS) or in an infant &lt;1 year of age (SUDI).</td>
</tr>
<tr>
<td>SCD</td>
<td>The term is used when: • A congenital, or acquired, potentially fatal cardiac condition was known to be present during life; OR • Autopsy has identified a cardiac or vascular anomaly as the probable cause of the event; OR • No obvious extra-cardiac causes have been identified by post-mortem examination and therefore an arrhythmic event is a likely cause of death.</td>
</tr>
<tr>
<td>SADS and SIDS</td>
<td>Both autopsy and toxicology investigations are inconclusive, the heart is structurally normal at gross and histological examination and non-cardiac aetiologies are excluded in adults (SADS) and in infants (SIDS).</td>
</tr>
<tr>
<td>Aborted cardiac arrest</td>
<td>Unexpected circulatory arrest, occurring within 1 hour of onset of acute symptoms, which is reversed by successful resuscitation manoeuvres (e.g. defibrillation).</td>
</tr>
<tr>
<td>Idiopathic ventricular fibrillation</td>
<td>Clinical investigations are negative in a patient surviving an episode of ventricular fibrillation.</td>
</tr>
<tr>
<td>Primary prevention of SCD</td>
<td>Therapies to reduce the risk of SCD in individuals who are at risk of SCD but have not yet experienced an aborted cardiac arrest or life-threatening arrhythmias.</td>
</tr>
<tr>
<td>Secondary prevention of SCD</td>
<td>Therapies to reduce the risk of SCD in patients who have already experienced an aborted cardiac arrest or life-threatening arrhythmias.</td>
</tr>
</tbody>
</table>
Sudden Death from Cardiac Causes

Uncommon causes

<5%
Primary electrical and genetic ion-channel abnormalities, valvular or congenital heart disease, other causes

Cardiomyopathy

~10–15%
Hypertrophic cardiomyopathy

~80%
Dilated cardiomyopathy

Risk factors for coronary atherosclerosis:
older age, male sex, hyperlipidemia, smoking, hypertension, diabetes

Coronary atherosclerosis

Chronic myocardial scar caused by infarction

Acute plaque destabilization: rupture, fissure, hemorrhage, thrombosis

Triggers of cardiac arrest:
transient ischemia, hemodynamic fluctuations, neurocardiovascular influences, environmental factors

Sudden Death

Typical sequence of electrical events:

Sinus rhythm → Ventricular tachycardia → Ventricular fibrillation → Asystole

Adult Cardiac Arrest Algorithm - 2015 Update

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator

2. Rhythm shockable?
   Yes
   - VF/VT
   No
   - Asystole/PEA

3. Shock

4. CPR 2 min
   - IV/O access

5. Rhythm shockable?
   Yes
   - Shock
   No
   - CPR 2 min
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography

6. CPR 2 min
   - IV/O access

7. Rhythm shockable?
   Yes
   - Shock
   No
   - CPR 2 min
     - Amiodarone
     - Treat reversible causes

8. CPR 2 min
   - IV/O access

9. Rhythm shockable?
   Yes
   - CPR 2 min
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography
   No
   - CPR 2 min
     - IV/O access

10. CPR 2 min
    - IV/O access

11. CPR 2 min
    - Treat reversible causes

12. CPR 2 min
    - IV/O access

- If no signs of return of spontaneous circulation (ROSC), go to 10 or 11
- If ROSC, go to Post-Cardiac Arrest Care

CPR Quality
- Push hard (at least 2 inches [5 cm] and fast [100-120/min]) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If PtcCO2 <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If pressure below diastolic pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation
- Biphasic: Manufacturer recommendation (e.g., initial dose of 120-200 J); if unknown, use maximum available.
- Second and subsequent doses should be equivalent, and higher doses may be considered.
- Monophasic: 360 J

Drug Therapy
- Epinephrine IV/O dose: 1 mg every 3.5 minutes
- Amiodarone IV/O dose: First dose: 300 mg bolus. Second dose: 150 mg

Advanced Airway
- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ETT tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abnormal sustained increase in PtcCO2, typically ≥40 mm Hg
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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Link MS et al. Circulation. 2015;132:S444-64.
Sustained VAs and ACS

- Urgent angiogram and complete revascularization as appropriate
- Beta-blocker therapy (e.g. 5 mg metoprolol i.v.)
  - Recurrent VT/VF or frequent non-sustained VT
    - Cardioversion/defibrillation
      - Overdrive pacing
      - Amiodarone 300 mg i.v.
      - Lidocaine
    - Consider need for further revascularization
      - (check LV function, repeat angiogram)
      - Consider repletion of K⁺ and Mg²⁺
    - Consider catheter ablation and/or sedation and referral to specialist center
  - Patient Stable

ACS = acute coronary syndromes; i.v. = intravenous; K⁺ = potassium;
LV = left ventricular; Mg²⁺ = magnesium; VF = ventricular fibrillation;
VT = ventricular tachycardia.

General Evaluation of Patients with Documented or Suspected VA
Diagnostic Workup

Clinical History
- Angina pectoris or shortness of breath
- Family history of premature SCD (age <40 years) or early-onset heart disease
- ECG during tachycardia

Other transient cause e.g.
- Drugs
- Electrolytes
- Chest trauma

Acute ischemia
- (STEMI, NSTEMI)
- Urgent angiogram and revascularisation

Reverse transient cause

Evaluate for cardiovascular diseases
- ECG
- Echocardiogram / CMR
- History
- Other tests

Secondary prevention for SCD (ACEI, beta-blockers, statin, amiplatelets)

Re-evaluate LVEF 6-10 weeks after event

Evaluate for complete reversal of cause

ECG
- Echocardiogram
- History and Family history

Structural heart disease and congenital heart diseases suspected (e.g., Stable CAD, sarcoidosis, aortic valve disease, DCM)

Inherited arrhythmogenic disease or cardiomyopathy suspected

Sudden death victims
- Autopsy in collaboration with pathologists
- Obtain blood and tissue samples
- Molecular autopsy after autopsy
- Offer family counselling and support
- Refer family for cardiology / SCD workup

No detectable heart disease

Further patient assessment, e.g.
- Stress test, Holter 48 hours
- Consider coronary angiogram
- Refer patients to experienced centers for risk evaluation, catheter ablation, drugs and ICD
- Drug challenges, EPS
- CMR, CT, myocardial biopsy
- Signal averaged ECG, TOE based on suspected disease

Treatment of underlying heart disease (e.g., valve repair, medication)
- Assess risk for SCD

Specific treatment
- Genetic testing
- Family screening
- Assess risk for SCD

Consider to obtain second opinion on cause of VT/VF

## History and Physical Examination

### Table 6: Important Considerations in the Evaluation of Patients With Known or Suspected VA

<table>
<thead>
<tr>
<th>Component</th>
<th>Assessment and Findings Relevant for VA and/or SCD Risk</th>
</tr>
</thead>
</table>
| **History** | 1. Symptoms/events related to arrhythmia: Palpitations, lightheadedness, syncope, dyspnea, chest pain, cardiac arrest  
  2. Symptoms related to underlying heart disease: Dyspnea at rest or on exertion, orthopnea, paroxysmal nocturnal dyspnea, chest pain, edema  
  3. Precipitating factors: Exercise, emotional stress  
  4. Known heart disease: Coronary, valvular (e.g., mitral valve prolapse), congenital heart disease, other  
  5. Risk factors for heart disease: Hypertension, diabetes mellitus, hyperlipidemia, and smoking  
  6. Medications:  
    - Antiarrhythmic medications  
    - Other medications with potential for QT prolongation and torsades de pointes  
    - Medications with potential to provoke or aggravate VA  
      > Stimulants including cocaine and amphetamines  
      > Supplements including anabolic steroids  
    - Medication-medicine interaction that could cause QT prolongation and torsades de pointes  
  7. Past medical history:  
    - Thyroid disease  
    - Acute kidney injury, chronic kidney disease, or electrolyte abnormalities  
    - Stroke or embolic events  
    - Lung disease  
    - Epilepsy (arrhythmic syncope can be misdiagnosed as epilepsy)  
    - Alcohol or illicit drug use  
    - Use of over-the-counter medications that could cause QT prolongation and torsades de pointes  
    - Unexplained motor vehicle crashes |
| **Family History** | 1. SCD, SCA, or unexplained drowning in a first-degree relative  
  2. SIDS or repetitive spontaneous pregnancy losses given their potential association with cardiac channelopathies  
  3. Heart disease  
    - IHD  
    - Cardiomyopathy: Hypertrophic, dilated, ARVC  
    - Congenital heart disease  
    - Cardiac channelopathies: Long QT, Brugada, Short QT, CPVT  
    - Arrhythmias  
    - Conduction disorders, pacemakers/ICDs  
  4. Neuromuscular disease associated with cardiomyopathies  
    - Muscular dystrophy  
  5. Epilepsy |
| **Examination** | 1. Heart rate and regularity, blood pressure  
  2. Jugular venous pressure  
  3. Murmurs  
  4. Pulses and bruits  
  5. Edema  
  6. Sternotomy scars |

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ARVC = arrhythmogenic right ventricular cardiomyopathy; CPVT = catecholaminergic polymorphic ventricular tachycardia; IHD = ischemic heart disease; SCA = sudden cardiac arrest; SCD = sudden cardiac death; SIDS = sudden infant death syndrome; VA = ventricular arrhythmia.
# 12-lead ECCG and Exercise Testing

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th><strong>Recommendations for 12-lead ECG and Exercise Testing</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. In patients with sustained, hemodynamically stable, wide complex tachycardia, a 12-lead ECG during tachycardia should be obtained.</td>
</tr>
<tr>
<td>I</td>
<td>B-NR</td>
<td>2. In patients with VA symptoms associated with exertion, suspected ischemic heart disease, or catecholaminergic polymorphic ventricular tachycardia, exercise treadmill testing is useful to assess for exercise-induced VA.</td>
</tr>
<tr>
<td>I</td>
<td>B-NR</td>
<td>3. In patients with suspected or documented VA, a 12-lead ECG should be obtained in sinus rhythm to look for evidence of heart disease.</td>
</tr>
</tbody>
</table>
# Recommendation for Ambulatory Electrocardiography

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation for Ambulatory Electrocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. Ambulatory ECG monitoring is useful to evaluate whether symptoms, including palpitations, presyncope, or syncope, are caused by VA.</td>
</tr>
</tbody>
</table>

# Recommendation for Implanted Cardiac Monitors

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation for Implanted Cardiac Monitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIA</td>
<td>B-NR</td>
<td>1. In patients with sporadic symptoms (including syncope) suspected to be related to VA implanted cardiac monitors can be useful.</td>
</tr>
</tbody>
</table>
Noninvasive Cardiac Imaging

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations for Noninvasive Cardiac Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. In patients with known or suspected VA that may be associated with underlying structural heart disease or a risk of SCA, echocardiography is recommended for evaluation of cardiac structure and function.</td>
</tr>
<tr>
<td>IIa</td>
<td>C-EO</td>
<td>2. In patients presenting with VA who are suspected of having structural heart disease, cardiac MRI or CT can be useful to detect and characterize underlying structural heart disease.</td>
</tr>
<tr>
<td>COR</td>
<td>LOE</td>
<td>Recommendation for Biomarkers</td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>IIa</td>
<td>B-R</td>
<td>1. In patients with structural heart disease, measurement of natriuretic peptides (BNP or N-terminal pro-BNP) can be useful by adding prognostic information to standard risk factors for predicting SCD or SCA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation for Genetic Counselling</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C-EO</td>
<td>1. In patients and family members in whom genetic testing for risk stratification for SCA/SCD is recommended, genetic counseling is beneficial.</td>
</tr>
</tbody>
</table>
Invasive Cardiac Imaging

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation for Invasive Imaging: Cardiac Catheterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C-EO</td>
<td>1. In patients who have recovered from unexplained SCA, CT or invasive coronary angiography is useful to confirm the presence or absence of ischemic heart disease and guide decisions for myocardial revascularization.</td>
</tr>
</tbody>
</table>

Al-Khatib SM et al. Heart Rhythm 2017
## Diagnostic Approach for Family Members

### Table 4  Diagnostic approach for family members of sudden unexplained death syndrome or sudden arrhythmic death syndrome victims

<table>
<thead>
<tr>
<th>Approach</th>
<th>Action*</th>
</tr>
</thead>
</table>
| History taking and physical examination | • Personal clinical history  
   • Family history focused on cardiac diseases or sudden deaths |
| ECG                             | • Baseline 12-lead ECG with standard and high precordial leads  
   • 24-hour ambulatory ECG  
   • Exercise stress test  
   • Signal-averaged ECG  
   • Provocative test with ajmaline/flecainide (when Brugada syndrome is suspected) |
| Cardiac imaging                 | • Two-dimensional echocardiography and/or CMR (with or without contrast) |
| Genetic testing                 | • Targeted molecular testing and genetic counselling if there is the clinical suspicion of a specific disease  
   • Referral to a tertiary centre specialized in evaluation of the genetics of arrhythmias |

CMR = cardiac magnetic resonance; ECG = electrocardiogram.

*The recommendations in this table are based on the consensus of this panel of experts and not on evidence-based data.
Secondary Prevention of SCD in IHD

Secondary prevention in pts with IHD

SCA survivor* or sustained spontaneous monomorphic VT*

Ischemia warranting revascularization

Yes

Revascularize & reassess SCD risk (Class I)

No

ICD candidate†

Yes

ICD (Class I)

No

GDMT (Class I)

ICD (Class I)

Extended monitoring

Cardiac syncope†

LVEF≤35%

Yes

ICD (Class I)

EP study (Class IIa)

No

Inducible VA

Yes

Extended monitoring

No

Al-Khatib SM et al. Heart Rhythm 2017
## Recommendations for Patients With Coronary Artery Spasm

References that support the recommendations are summarized in Online Data Supplement 20.

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. In patients with VA due to coronary artery spasm, treatment with maximally tolerated doses of a calcium channel blocker and smoking cessation are indicated to reduce recurrent ischemia and VA (1, 2).</td>
</tr>
<tr>
<td>IIA</td>
<td>B-NR</td>
<td>2. In patients resuscitated from SCA due to coronary artery spasm in whom medical therapy is ineffective or not tolerated, an ICD is reasonable if meaningful survival of greater than 1 year is expected (3-6).</td>
</tr>
<tr>
<td>IIB</td>
<td>B-NR</td>
<td>3. In patients resuscitated from SCA due to coronary artery spasm, an ICD in addition to medical therapy may be reasonable if meaningful survival of greater than 1 year is expected (3-6).</td>
</tr>
</tbody>
</table>
Preventing SCD with HF Medications

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation for Pharmacological Prevention of SCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>A</td>
<td>1. In patients with HFrEF (LVEF ≤40%), treatment with a beta blocker, a mineralocorticoid receptor antagonist and either an angiotensin-converting enzyme inhibitor, an angiotensin-receptor blocker, or an angiotensin receptor-neprilysin inhibitor is recommended to reduce SCD and all-cause mortality.</td>
</tr>
</tbody>
</table>
Effects of Sacubitril/Valsartan in HFrEF

**Endogenous Compensatory Peptides**
- NPR-A, NPR-B, B2, calcitonin receptor-like receptor
- NPs, Bradykinin, ADM
- Vasodilation
- Blood pressure
- Sympathetic tone
- Natriuresis/diuresis
- Vasopressin
- Aldosterone
- Fibrosis
- Hypertrophy

**SNS**
- α₁, β₁, β₂ receptors
- Vasoconstriction
- RAAS activity
- Heart rate
- Contractility

**HF SYMPTOMS & PROGRESSION**

**RAAS**
- Ang II
- AT1R
- Vasoconstriction
- Blood pressure
- Sympathetic tone
- Vasopressin
- Aldosterone
- Hypertrophy
- Fibrosis

**Sacubitril/valsartan**
- ARB
- Enhance the beneficial effects of endogenous compensatory peptides
- Suppress deleterious effects of RAAS

ADM, adrenomedullin; Ang II, angiotensin II; ARB, angiotensin II receptor blocker; AT1R, angiotensin II type 1 receptor; ECPs, endogenous compensatory peptides; HFrEF, heart failure with reduced ejection fraction; NEP, nepriyisin; NPs, natriuretic peptides; SNS, sympathetic nervous system; RAAS, renin-angiotensin-aldosterone system.

Sacubitril/Valsartan: PARADIGM-HF Study

**PARADIGM-HF: Reduction of CV Death or First HF Hospitalization**

- **Sudden Cardiac Death**
  - **Enalapril (n=4,212)**
  - **Entresto (n=4,187)**
  - **20% ↓**
  - HR 0.80, 95% CI (0.73, 0.87), P=0.000004

- **ED Visit for HF**
  - **30% ↓**
  - HR 0.70, 95% CI (0.52-0.94), P=0.017

- **Stays in Intensive Care**
  - **18% ↓**
  - HR 0.82, 95% CI (0.72-0.94), P=0.005

**PARADIGM-HF study design**: A multinational, randomized, double-blind, active-controlled, 2-arm, event-driven trial. 8,442 patients with class II, III, or IV heart failure and an ejection fraction of 40% or less were randomly assigned to receive either LCZ696 (at a dose of 200 mg twice daily) or enalapril (at a dose of 10 mg twice daily), in addition to recommended therapy.

Post-hoc Analysis of PARADIGM-HF

Rate of Sudden Death

Paradigm-HF study design: A multinational, randomized, double-blind, active-controlled, 2-arm, event-driven trial. 8,442 patients with class II, III, or IV heart failure and an ejection fraction of 40% or less were randomly assigned to receive either LCZ696 (at a dose of 200 mg twice daily) or enalapril (at a dose of 10 mg twice daily), in addition to recommended therapy.

ARNI decreased VAs and appropriate ICD shocks

Kaplan-Meier curve of ventricular arrhythmias

Survival free from NSVT and VT

VT
- Number at risk (VT)
  - Entresto: 120, 120, 120, 120, 119, 119
  - ACEi/ARB: 120, 119, 119, 115, 113, 113

NSVT
- Number at risk (NSVT)
  - Entresto: 120, 111, 103, 95, 86, 82
  - ACEi/ARB: 120, 104, 90, 77, 67, 59

Time (Months)

Study design: This study prospectively included 120 HFrEF patients with ICD or ICD-CRT. Patients were observed for 9 months under angiotensin inhibition alone. Then, ACEi or ARB was stopped and Entresto was initiated and patients were observed for a further 9 months under angiotensin-neprilysin inhibition. Primary outcome was to establish appropriate ICD shocks under ARNI as compared to angiotensin inhibition.
Treatment of HFrEF Stage C and D

Step 1: Establish Dx of HFrEF; assess volume; initiate GDMT

- HFrEF NYHA class I–IV (Stage C)
- ACEI or ARB AND GDMT beta blocker; diuretics as needed (COR I)

Step 2: Consider the following patient scenarios

- NYHA class II–IV, provided est. C:Cl >30 mL/min & K+ <5.0 mEq/L
  - Aldosterone antagonist (COR I)
- NYHA class II–III HF
  - Adequate BP on ACEI or ARB; No C/I to ARB or sacubitril
  - Discontinue ACEI or ARB; initiate ARNI* (COR I)
- NYHA class III–IV, in black patients
  - Hydral-Nitrites†† (COR I)
- NYHA class II–III, LVEF ≤35%; (caveat: >1 y survival; >40 d post MI)
  - ICD‡ (COR I)
- NYHA class II–IV, LVEF ≤35%, NSR & QRS ≥150 ms with LBBB pattern
  - CRT or CRT-D‡ (COR I)
- NYHA class II–III, NSR, heart rate ≥70 bpm on maximally tolerated dose beta blocker
  - Ivabradine (COR IIa)

Step 3: Implement indicated GDMT. Choices are not mutually exclusive, and no order is inferred

- Refractory NYHA class III–IV (Stage D)
  - Symptoms improved
  - Palliative care‡ (COR I)
  - Transplant‡ (COR I)
  - LVAD‡ (COR IIa)

Step 4: Reassess symptoms

- Symptoms improved

Step 5: Consider additional therapy

- Investigational studies§

Continue GDMT with serial reassessment & optimized dosing/adherence

Recommendations for ARNI and Ivabradine

- In patients with chronic symptomatic HFrEF NYHA class II or III who tolerate an ACE inhibitor or ARB, replacement by an ARNI is recommended to further reduce morbidity and mortality (Class I, Level of Evidence: B-R).

- Ivabradine can be beneficial to reduce HF hospitalization for patients with symptomatic (NYHA class II-III) stable chronic HFrEF (LVEF ≤35%) who are receiving GDEM, including a beta blocker at maximum tolerated dose, and who are in sinus rhythm with a heart rate of 70 bpm or greater at rest (Class IIa, Level of Evidence: B-R).
ICD Trials for Primary Prevention of SCD

Table 1. Major implantable cardioverter-defibrillator trials for primary prevention of sudden cardiac death

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>No. of patients</th>
<th>Endpoint</th>
<th>Hazard ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MADIT I [2]</td>
<td>Post MI&lt;br&gt;NSVT&lt;br&gt;LVEF ≤ 35%&lt;br&gt;Inducible VT on EP study</td>
<td>196</td>
<td>Death from any cause</td>
<td>0.46</td>
<td>0.009</td>
</tr>
<tr>
<td>MUSTT [3]</td>
<td>Post MI&lt;br&gt;LVEF ≤ 40%&lt;br&gt;NSVT&lt;br&gt;Inducible VT on EP study</td>
<td>707</td>
<td>Cardiac arrest or death from arrhythmia</td>
<td>0.24</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>MADIT II [4]</td>
<td>Post MI&lt;br&gt;LVEF ≤ 30%</td>
<td>1232</td>
<td>Death from any cause</td>
<td>0.69</td>
<td>0.016</td>
</tr>
<tr>
<td>SCD-HeFT [5]</td>
<td>Prior MI or NICM&lt;br&gt;LVEF ≤ 35%&lt;br&gt;NYHA class II/III</td>
<td>2521</td>
<td>Death from any cause</td>
<td>0.77</td>
<td>0.007</td>
</tr>
<tr>
<td>CABG-patch [6]</td>
<td>CABG&lt;br&gt;LVEF &lt; 36%&lt;br&gt;Positive SAECG</td>
<td>900</td>
<td>Death from any cause</td>
<td>1.07</td>
<td>0.64</td>
</tr>
<tr>
<td>DINAMIT [7]</td>
<td>Recent MI (within 6-40 d)&lt;br&gt;LVEF ≤ 35%&lt;br&gt;Impaired cardiac autonomic function</td>
<td>674</td>
<td>Death from any cause</td>
<td>1.08</td>
<td>0.66</td>
</tr>
<tr>
<td>DEFINITE [11]</td>
<td>NICM&lt;br&gt;LVEF &lt; 36%&lt;br&gt;PVCs, or NSVT</td>
<td>458</td>
<td>Death from any cause</td>
<td>0.65</td>
<td>0.08</td>
</tr>
</tbody>
</table>

MADIT, Multicenter Automatic Defibrillator Trial; MI, myocardial infarction; NSVT, nonsustained ventricular tachycardia; LVEF, left ventricular ejection fraction; VT, ventricular tachycardia; EP, electrophysiology study; MUSTT, Multicenter Unsustained Tachycardia Trial; SCD-HeFT, Sudden Cardiac Death in Heart Failure Trial; NICM, nonischemic cardiomyopathy; NYHA, New York Heart Association; CABG, coronary artery bypass graft surgery; SAECG, signal-averaged electrocardiogram; DINAMIT, Defibrillator IN Acute Myocardial Infarction Trial; DEFINITE, The Defibrillators in Nonischemic Cardiomyopathy Treatment Evaluation; PVCs, premature ventricular complexes.
Primary Prevention of SCD in IHD

Primary prevention in pts with IHD, LVEF ≤40%

MI <40 d and/or revascularization <90 d

Yes* → EP study (especially in the presence of NSVT)

Inducible sustained VT → Yes → ICD (Class I)

No → GDMT (Class I)

WCD (Class IIb)

Reassess LVEF >40 d after MI and/or >90 d after revascularization

NYHA class I
LVEF ≤30%

Yes → ICD (Class I)*

NYHA class II or III
LVEF ≤35%

LVEF ≤40%, NSVT, inducible sustained VT on EP study

Yes → ICD (Class I)

No → GDMT

NYHA class IV candidate for advanced HF therapy†

Yes → ICD should not be implanted (Class III: No Benefit)

No → ICD (Class IIa)
Prevention of SCD in Patients with NICM

Patients with NICM

SCA survivor/sustained VT (spontaneous/inducible)

Yes

No

ICD candidate*

ICD (Class I)

Amiodarone (Class IIb)

Symptoms concerning for VA

No

Yes

Arrhythmogenic syncope suspected

ICD candidate*

ICD (Class Ila)

EP Study (Class IIa)

Class II-III HF and LVEF ≤35%

No

Yes

NICM due to LMNA mutation and 2° risk factors

ICD candidate*

Yes

No

ICD (Class Ila)

WCD (Class IIb)

If LVEF ≤35% and Class II-III HF

Reassess LVEF ≥3mo

If positive
# Subcutaneous ICD

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations for Subcutaneous Implantable Cardioverter-Defibrillator</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. In patients who meet criteria for an ICD who have inadequate vascular access or are at high risk for infection, and in whom pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated, a subcutaneous implantable cardioverter-defibrillator is recommended.</td>
</tr>
<tr>
<td>IIa</td>
<td>B-NR</td>
<td>2. In patients who meet indication for an ICD, implantation of a subcutaneous implantable cardioverter-defibrillator is reasonable if pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated.</td>
</tr>
<tr>
<td>III: Harm</td>
<td>B-NR</td>
<td>3. In patients with an indication for bradycardia pacing or CRT, or for whom antitachycardia pacing for VT termination is required, a subcutaneous implantable cardioverter-defibrillator should not be implanted.</td>
</tr>
</tbody>
</table>
Summary

- The majority of such sudden deaths are caused by acute ventricular tachyarrhythmias, often triggered by acute coronary events.
- For patients with HF and depressed LV function, appropriate medical therapy is important to reduce SCD.
- ICDs are an effective treatment strategy for patients with aborted sudden cardiac death (SCD) and ventricular tachyarrhythmias.
- Several randomized clinical trials have demonstrated the efficacy of ICDs in the primary prevention of SCD.
- ICD implantation is recommended as a standard of care by the guidelines in patients who have ischemic or nonischemic cardiomyopathy and a low left ventricular ejection fraction.
Thanks for your attention !!