Care of the Complex Pilot

Arrhythmias

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Department of Cardiovascular Diseases
Mayo Medical Center, Rochester, MN, USA

Civil Aviation Medical Association
September 8, 2016
<table>
<thead>
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Learning Objectives

• Contemporary work-up & therapies for arrhythmias relevant to the FAA
  – Atrial Fibrillation (Meds and/or Ablation)
  – Ventricular Ectopy (Ablation and/or Meds: Non-structural heart disease)
  – SVT (Ablation and/or Meds)
  – Conduction Disease & Pacemakers

• Approach to the pilot with syncope
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<th>FAA Medical Certificate Class</th>
<th>Transport In-Command</th>
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<th>Private: Recreational, Student, Sport, Flight Instructor</th>
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<td>Any age Q 12 m</td>
<td>&lt; 40 yrs. Q 60 m &gt; 40 yrs. Q 24 m</td>
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<td>&lt; 40 yrs. Q 60 m &gt; 40 yrs. Q 24 m</td>
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<td>Any age Q 12 m</td>
<td>&lt; 40 yrs. Q 60 m &gt; 40 yrs. Q 24 m</td>
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Disqualifying Conditions Under 14 CFR Section 67:
Exceptions under Special Issuances by FAA (AASI)

- Angina
- Bipolar Disorder
- CV Valve Replacement
- CAD that has required Rx
- DM requiring insulin or OHA
- LOC without satisfactory explanation
- Epilepsy
- Heart replacement

- MI
- Permanent cardiac pacemaker
- Personality Disorder with Overt Acts
- Psychosis
- Substance abuse or dependence
- Transient loss of control over Nervous system function
Conditions Initially Disqualifying (All Classes) Must be Deferred to the AMCD or RFS (Not required if AASI is a Re-Cert)

- Psoriasis
- Asthma
- Atrial Fibrillation
- Bladder Cancer
- Breast Cancer
- Chronic Kidney Disease
- HTN
- Hypothyroidism
- Hyperthyroidism
- Lymphoma
- Melanoma
- Prostate Cancer
- Renal Carcinoma or Stones
- Migraines
- CLL
- COPD
- UC or Crohn’s or IBS
- Colon Cancer
- DVT, PE, Hypercoagulopathy
- DM Type II (not on Insulin)
- Glaucoma
- Hepatitis C
- MR/AR
- PAT
- OSA
- Testicular Cancer
- CLASS III
- PPM (NO ICD)
- Valve Replaced
- CAD
  - Angina
  - PCI
  - CABG
  - MI
  - Stents
Guidelines for AF Management

Multiple Devices Perform AECG for Detection of Arrhythmias
# Table of Contents of 2014 AF Guidelines

1. **Introduction**
2. **Clinical Characteristics and Evaluation of AF**
   - Classification, Mechanisms, Risk Factors, Initial Evaluation
3. **Thromboembolic Risk & Treatment**
   - Risk Stratification Schemes (CHADS\textsuperscript{2}, CHA2DS\textsuperscript{2}-VASc, & HAS-BLED)
   - Selection of Anticoagulants (VKA or NOACs & LAA surgical excision)
4. **Rate Control: Recommendations**
5. **Rhythm Control**
   - Thromboembolic Prevention, DC Cardioversion
   - Pharmacologic Acute Conversion & Long-term NSR Maintenance
   - Upstream Therapies
   - Catheter & Surgical Ablation
6. **Specific Patient Groups & AF**
   - HCM, ACS, Hyperthyroidism, Pulmonary Disease, WPW, CHF, POAF, Familial
7. **Evidence Gaps & Future Research Directions**

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AF Prevalence Increases with Age

AF risk doubles with each decade beyond age 50


Prevalence lower in Chinese & Japanese populations

Atrial Fibrillation: Associations

- **Cardiac**
  - Mitral Stenosis
  - Mitral Regurgitation
  - Mitral Valve Prolapse
  - Aortic Stenosis or Regurgitation
  - Myocardial Infarction
  - Hypertension
  - Supraventricular Tachycardia
  - Wolff-Parkinson-White Syndrome
  - Congenital Heart Disease
  - Hypertrophic Cardiomyopathy
  - Dilated Cardiomyopathy (CHF)
  - Peripartum
  - Amyloid Heart Disease
  - Sarcoidosis of the Heart
  - Myocarditis
  - Pericarditis (Viral, Post-Surgical)
  - Cardiac Neoplasms

- **Endocrine**
  - Thyrotoxicosis
  - Pheochromocytoma

- **Pulmonary**
  - COPD
  - Pulmonary Embolism
  - Obstructive Sleep Apnea
  - Obesity

- **Exogenous**
  - Alcohol
  - Caffeine
  - Illicit Drugs
  - Carbon Monoxide poisoning
  - Altitude
  - Hypothermia
  - Long-distance Athletics

- **Genetic**

- **Male Gender**

Treatment Strategies for AF

- Anticoagulation
- Rate control
- Antiarrhythmic drugs
- Cardioversion
- Ablation

First documented
- Silent
- Paroxysmal
- Persistent
- Long-standing persistent
- Permanent

‘Upstream’ therapy of concomitant conditions

Camm AJ et al: EHJ 31:2369, 2010
Demographic CVA Risk Factors in AF are Additive
Moving from CHADS₂ to CHA₂DS₂-VASc

**CHA₂DS₂-VASc Scoring**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Absent</th>
<th>Present</th>
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<tr>
<td>Prior CVA/TIA</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Recent CHF</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Age &gt;= 75 Years</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Diabetes</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Age 65-74 Years</td>
<td>0</td>
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<tr>
<td>CAD/PAD/Aortic</td>
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<td>1</td>
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<tr>
<td>Sex Female</td>
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Total CHA₂DS₂-VASc Score = 0-9

**CHA₂DS₂-VASc Score: Future Stroke Risk Stratification with AF**

<table>
<thead>
<tr>
<th>Score</th>
<th>Adjusted Stroke Rate/100 Pt-Yrs</th>
<th>CHADS₂</th>
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<tbody>
<tr>
<td>0</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1.3%</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2.2%</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3.2%</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4.0%</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>6.7%</td>
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<tr>
<td>6</td>
<td>9.8%</td>
<td>4</td>
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<td>7</td>
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<tr>
<td>8</td>
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<td>6</td>
</tr>
<tr>
<td>9</td>
<td>15.2%</td>
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**Shared Decision Making**

HAS-BLED Scoring System for Bleeding Assessment on OAC (Warfarin)

<table>
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<tr>
<th>Risk Factor (Each = 1 point)</th>
<th>Points</th>
<th>Annual Bleed Rate</th>
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<tbody>
<tr>
<td>Hypertension</td>
<td>0</td>
<td>0.9 %</td>
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<tr>
<td>Renal Dysfunction</td>
<td>1</td>
<td>3.4 %</td>
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<tr>
<td>Liver Disease</td>
<td>2</td>
<td>4.1 %</td>
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<tr>
<td>Stroke</td>
<td>3</td>
<td>5.8 %</td>
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<tr>
<td>Bleeding Hx or Predisposition</td>
<td>4</td>
<td>8.9 %</td>
</tr>
<tr>
<td>Labile INR</td>
<td>5</td>
<td>9.1 %</td>
</tr>
<tr>
<td>Elderly</td>
<td></td>
<td></td>
</tr>
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<td>Medications</td>
<td></td>
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<tr>
<td>ETOH</td>
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Lip, et al, J ACC 2011; 57:173
ACC/AHA/HRS 2014 Guidelines
Section 3: Thromboembolic Risk and Treatment

- **Class I**

  1. Antithrombotic therapy (OAC) should be individualized based on shared decision making after discussion of the absolute & RRs of stroke and bleeding, & the patient’s values and preferences. (C)
  2. Selection of antithrombotic Rx should be based on the risk of thromboembolism, irrespective of AF pattern (B).
  3. In non-valvular AF, the CHA$_2$DS$_2$-VASc score is recommended to assess stroke risk (B).
  4. With mechanical valves, warfarin target 2-3 or 2.5-3.5 is based on type/location of valve prosthesis (B).
  5. In non-valvular AF with CHA$_2$DS$_2$-VASc score 2 or greater, OAC recommended: warfarin (2-3) (A), dabigatran (B), rivaroxaban (B), apixaban (B).
  6. While on warfarin, monitor INR weekly initially, and then monthly when on chronic stable therapy (A).
  7. If in nonvalvular AF, unable to to maintain stable INR with warfarin, then change to NOAC (C).
  8. Re-evaluate the need & choice of OAC therapy at periodic intervals: review thrombotic & bleeding risks (C).
  9. Bridging Rx with UFH or LMWH is recommended for pts. With AF and mechanical valves for procedures that require interruption of warfarin. Balance the risk of stroke vs. bleeding. (C).
  10. For patients in #9, the decision should take into consideration the time the patient will not be anticoagulated (C).
  11. Renal function should be evaluated prior to initiation of NOACs and should be re-evaluated at least yearly (C).
  12. Treat atrial flutter the same as atrial fibrillation in regards to the use of antithrombotic therapy. (C).

FAA requires Pilots at INR 2-3 > 80% of time

*January, et al., Circulation, 2014*
ACC/AHA/HRS 2014 Guidelines
Section 3: Thromboembolic Risk and Treatment

• **Class IIa**
  1. For patients with nonvalvular AF & CHA₂DS₂-VASc of 0, reasonable to omit antithrombotic therapy. (B)
  2. For patients with nonvalvular AF & CHA₂DS₂-VASc of 2 or greater and who have end-stage CKD (Creatinine Clearance < 15 mL/min) or who are on hemodialysis, prescribe warfarin (INR 2-3). (B)

• **Class IIb**
  1. For patients with nonvalvular AF & CHA₂DS₂-VASc of 1, no antithrombotic therapy or treatment with an OAC or aspirin may be considered. (C)
  2. For patients with nonvalvular AF & moderate-severe CKD with CHA₂DS₂-VASc of 2 or greater, treatment with reduced doses of NOAC may be considered (dabigatran, rivaroxaban, or apixaban), but safety and efficacy have not been established (C).
  3. In patients with AF undergoing PCI, BMS may be considered to minimize the duration of dual anti-platelet therapy. OAC can stop at time of procedure to reduce vascular bleeding (C).
  4. Following PCI or CABG in AF patients and a CHA₂DS₂-VASc of 2 or greater, it may be reasonable to use clopidogrel (75 mg QD) concurrently with OACs but without aspirin (B).

• **Class III**
  1. Dabigatran (direct thrombin inhibitor) and rivaroxaban (factor Xa inhibitor) are NOT recommended in patients with AF and end-stage CKD or on hemodialysis (C).
  2. Dabigatran should not be used in AF patients and a mechanical heart valve (B).

*January, et al., Circulation, 2014*
# Novel Oral Anticoagulants
## Randomized Trials vs. Warfarin

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<th>Drug</th>
<th>Dabigatran</th>
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<td>ROCKET-AF Ref. 109</td>
<td>ARISTOTLE Ref. 110</td>
<td>ENGAGE-AF Ref. 111</td>
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<td>DRUG Mechanism</td>
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<td>Direct Factor Xa Inhibitor</td>
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<tr>
<td>Patient Number</td>
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<td>18,201</td>
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<td>Warfarin Ischemic Stroke/Year %</td>
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<td>1.42</td>
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<td>Study Drug Ischemic Stroke/Year %</td>
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<td>Warfarin Major Bleeding/Year %</td>
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Atrial Fibrillation & Embolic Stroke Prevention in the 21\textsuperscript{st} Century

**Anti Platelet Medications**
- ASA; Clopidogrel, Dipyridamole, Ticagrelor, Prasugrel, Cilostazol

**OAC (VKA: Warfarin)**
- Warfarin; Dabigatran, Rivaroxaban, Apixaban, Edoxaban

**LAA Exclusion: Open surgical resection or suture/staple closure**
- LAA Exclusion: Open surgical resection or suture/staple closure; Open: TigerPaw\textsuperscript{®}, Open or VATS robotic: AtriClip\textsuperscript{®}, Percutaneous endocardial plugs: Watchman\textsuperscript{®}, PLAATO\textsuperscript{®}, Amplatz\textsuperscript{®}; Percutaneous Epicardial: Lariat\textsuperscript{®}, Aegis\textsuperscript{®}

**Class IIb:** LAA Surgical Excision may be considered in patients Undergoing Cardiac Surgery
The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has completed its review of your premarket approval application (PMA) for the WATCHMAN LAA Closure Technology. This device is indicated to reduce the risk of thromboembolism from the left atrial appendage (LAA) in patients with non-valvular atrial fibrillation who:

- Are at increased risk for stroke and systemic embolism based on CHADS\textsubscript{2} or CHA\textsubscript{2}DS\textsubscript{2}-VASc scores and are recommended for anticoagulation therapy;
- Are deemed by their physicians to be suitable for warfarin; and
- Have an appropriate rationale to seek a non-pharmacologic alternative to warfarin, taking into account the safety and effectiveness of the device compared to warfarin.

We are pleased to inform you that the PMA is approved. You may begin commercial distribution of the device in accordance with the conditions of approval described below.
WATCHMAN® Endocardial Plug 9 months Human
ACC/AHA/HRS 2014 Guidelines
Section 4: Rate Control Recommendations

• **Class I**
  1. Beta blockers (BB) or nondihydropyridine calcium channel blockers (CCB) is recommended for AF pts. (B)
  2. IV BB or CCB is recommended to slow HR in the acute setting without WPW. DCCV if unstable (B).
  3. In patients who have AF-related symptoms with activity, HR control should be assessed during exertion, adjusting meds to maintain HR in physiologic range (C).

• **Class IIa**
  1. HR control (resting HR < 80 bpm) strategy is reasonable for symptomatic AF patients. (B)
  2. IV amiodarone can be useful for rate control in critically ill patients without WPW. (C)
  3. AV Nodal ablation with permanent ventricular pacing is reasonable to control HR when pharmacologic therapy is inadequate and rhythm control is not achievable. (B)

• **Class IIb**
  1. A lenient rate-control strategy (resting HR < 110 bpm) may be reasonable if patients remain asymptomatic and LV systolic function is preserved. (B)
  2. Oral amiodarone may be useful for ventricular rate control when other measures are unsuccessful or contraindicated. (C)

**FAA DQ:**
Pauses > 3 seconds during day
Resting HR>100 or > 120 minimal exercise

January, et al., Circulation, 2014
Drug Therapy
Ventricular Rate Control

AFib

- No other CV disease
  - β-blocker: Diltiazem Verapamil

- HTN or HFpEF
  - β-blocker: Diltiazem Verapamil

- LV dysfunction or HF
  - β-blocker: Digoxin

- COPD
  - β-blocker: Diltiazem Verapamil

Amiodarone

Guidelines 2014, Circulation

Courtesy: Dr. WK Shen
ACC/AHA/HRS 2014 Guidelines
Section 4: Rate Control Recommendations

- **Class III**

1. AV Nodal ablation with permanent ventricular pacing should not be performed to improve rate control without prior attempts to achieve rate control with medications. (C)

2. Nondihydropyridine calcium channel antagonists should not be used in patients with decompensated heart failure as these may lead to further hemodynamic compromise. (C)

3. In patients with WPW and AF, digoxin, CCB, or IV amiodarone should not be administered as they may increase the ventricular response and may result in VF. (B)

4. Dronedarone should not be used to control the ventricular rate in patients with permanent AF as it increases the risk of the combined endpoint of stroke, MI, systemic embolism, or cardiovascular death. (B)

*January, et al., Circulation, 2014*
AVNA in AF with PPM Meta-Analysis

Procedural Death 0.27 %
Left-sided Ablation 6.9 %
Redo Ablation 2.9 %
Lead Failure 0.23 %
Stroke 0.19 %
SCD at 30 m. f/u 2.1 %

Complications:

“Dependency” DQ’s for Class I/II and possibly III

Chatterjee, et al, Circ Arrhythm Electrophysiol 5:2012, 68-76
ACC/AHA/HRS 2014 Guidelines
Section 5.1: Rhythm Control: Thromboembolic Prevention Recommendations

• **Class I**

  1. For AF (or AFl) patients of 48 hours or longer, or if unknown, OAC with warfarin (INR 2-3) is recommended for at least 3 weeks prior to and 4 weeks after cardioversion, regardless of CHA$_2$DS$_2$-VASc score and the method (DCCV or pharmacologic) used to restore NSR. (B)

  2. For AF/AFl patients > 48 hours duration, or unknown that requires immediate DCCV for hemodynamic instability, anticoagulation should be initiated as soon as possible and continued for at least 4 weeks after cardioversion unless contraindicated. (C)

  3. For AF/AFl patients < 48 hours and with high risk of stroke, IV heparin or LMWH, or administration of NOAC is recommended as soon as possible before or immediately after cardioversion, followed by long-term OAC. (C)

  4. Following AF cardioversion of ANY duration, the decision regarding long-term OAC therapy should be based on the thromboembolic risk profile. (C)

• **Class IIa**

  1. For AF/AFl patients of 48 hour duration or longer, or of unknown duration who have not been anticoagulated for the preceding 3 weeks, it is reasonable to perform TEE prior to cardioversion & proceed with cardioversion if no LA thrombus is identified, including the LAA, provided that OAC is achieved before TEE and maintained after conversion for at least 4 weeks. (B)

  2. For AF/AFl patients of 48 hours duration or longer, or of unknown duration, OAC with dabigatran, rivaroxaban, or apixaban (NOACs) is reasonable for at least 3 weeks prior and 4 weeks after cardioversion. (C)

• **Class IIb**

  1. For AF/AFl patients of less than 48 hours, who are at low thromboembolic risk, anticoagulation (IV heparin, LMWH, or a NOAC) **OR** no antithrombotic therapy may be considered for cardioversion, without the need for post-cardioversion oral anticoagulation. (C)

  *January, et al., Circulation, 2014*
ACC/AHA/HRS 2014 Guidelines
Section 5.3: Rhythm Control: Pharmacologic Cardioversion Recommendations

• **Class I**
  1. Flecainide, dofetilide, propafenone, and IV ibutilide are useful for pharmacological cardioversion of AF/AFl provided contraindications to the selected drug are absent. (A)

• **Class IIa**
  1. Administration of oral amiodarone is a reasonable option for pharmacological cardioversion of AF. (A)
  2. Propafenone or flecainide (“Pill-in-the-Pocket”) in addition to a BB or CCB is reasonable to terminated AF outside the hospital once the treatment has been observed to be safe in a monitored setting for selected patients. (B)

• **Class IIb**
  1. None

• **Class III**
  1. Dofetilide therapy should not be initiated out of hospital owing to the risk of excessive QT prolongation that can cause torsades de pointes. (B)

January, et al., Circulation, 2014
ACC/AHA/HRS 2014 Guidelines
Section 5.4: Antiarrhythmic Drugs to Maintain Sinus Rhythm: Recommendations

- **Class I**
  1. Before initiating antiarrhythmic drug (AAD) therapy, treatment of precipitating or reversible causes of AF is recommended. (C)
  2. The following antiarrhythmic drugs are recommended in AF patients to maintain sinus rhythm, depending on underlying heart disease and comorbidities: amiodarone, dofetilide, dronedarone, flecainide, propafenone, sotalol. (A)
  3. The risks of the AAD, including proarrhythmia, should be considered before initiating therapy. (C)
  4. Owing to potential toxicity, amiodarone should only be used after consideration of risks and when other agents have failed or are contraindicated. (C)

- **Class IIa**
  1. A rhythm-control strategy with AAD can be useful in patients with AF for the Rx of tachycardia-induced cardiomyopathy (TICM). (C)

- **Class IIb**
  1. It may be reasonable to continue current AAD therapy in the setting of infrequent, well tolerated AF recurrences when the drug has reduced the frequency or symptoms of AF. (C)

- **Class III**
  1. AAD should not be continued when AF becomes permanent, including dronedarone. (B)
  2. Dronedarone should not be used or AF Rx in NYHA III or IV HF patients (last 4 weeks). (B)

January, et al., Circulation, 2014
# Oral Antiarrhythmic Drugs for AF

| Vaughn Williams Class | Drug Name     | Release Year | 
|-----------------------|---------------|
| I-A                   | Quinidine     | 1918         |
| I-A                   | Disopyramide  | 1962         |
| I-C                   | Flecainide    | 1975         |
| I-C                   | Propafenone   | 1976         |
| III                   | Sotalol       | 1992         |
| III                   | Dofetilide    | 2000         |
| III                   | Amiodarone    | 1967         |
| III                   | Dronedarone   | 2009         |

<table>
<thead>
<tr>
<th>Ion Channels Blocked</th>
<th>Excretion Renal/ Hepatic</th>
<th>Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{Na} )</td>
<td>( I_{Kr} )</td>
<td>( I_{Ach} ) ( \alpha ) ( +/- ) Thrombocytopenia, Cinchonism, Pruritis, Nausea, Diarrhea</td>
</tr>
<tr>
<td>( I_{Na} )</td>
<td>( I_{kr} ) Ach</td>
<td>++/+ Blurred vision, urinary retention, dry mouth, CHF</td>
</tr>
<tr>
<td>( I_{Na} )</td>
<td>( I_{Na} ) ( \beta )</td>
<td>0/+++ Blurred vision, headache, CHF</td>
</tr>
<tr>
<td>( I_{Kr} )</td>
<td>( I_{Kr} ) ( \beta )</td>
<td>+++/0 Dysgeusia with metallic taste, bronchospasm</td>
</tr>
<tr>
<td>( I_{Kr} )</td>
<td>( I_{Kr} ) ( \beta )</td>
<td>+++/+ Minimal</td>
</tr>
<tr>
<td>( I_{Kr} )</td>
<td>( I_{Kr} ) ( \beta )</td>
<td>0/++ Pulmonary alveolitis, hepatitis, ataxia, hyper/hypothyroidism, skin discoloration, neuropathy, optic neuritis, anorexia</td>
</tr>
<tr>
<td>( I_{Kr} )</td>
<td>( I_{Kr} ) ( \beta )</td>
<td>+/- Anorexia, hepatitis, headache, alopecia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NSR Long-Term</th>
<th>Pro-arrhythmia</th>
<th>Negative Inotropic</th>
<th>Negative Chronotropic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
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<td>5</td>
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<tr>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Rhythm Control
Choices of Antiarrhythmic Drugs

- **No or minimal structural heart disease**
  - Dofetilide
  - Dronedarone
  - Flecainide
  - Propafenone
  - Sotalol

- **MI/ischemia**
  - Dofetilide
  - Dronedarone
  - Sotalol

- **Significant LVH**
  - Amiodarone
  - Dronedarone*
  - Sotalol*
  - Dofetilide*

- **HF**
  - Dofetilide

---

AF Guidelines 2014

Courtesy: Dr. WK Shen
ACC/AHA/HRS 2014 Guidelines
Section 5.5: Upstream Therapy: Recommendations

- **Class I**
  1. None.

- **Class IIa**
  1. An ACE inhibitor or angiotensin-receptor blocker (ARB) is reasonable for primary prevention of new-onset AF in patients with heart failure with reduced LVEF. (B)

- **Class IIb**
  1. Therapy with an ACE inhibitor or ARB may be considered for primary prevention of new-onset AF in the setting of hypertension. (B)
  2. Statin therapy may be reasonable for primary prevention of new onset AF after coronary artery surgery (POAF). (A)

- **Class III**
  1. Therapy with an ACE inhibitor, ARB, or statin is not beneficial for primary prevention of AF in patients without cardiovascular disease. (B)

*January, et al., Circulation, 2014*
ACC/AHA/HRS 2014 Guidelines-SYMPPTOMATIC Patients
Section 5.6: AF Catheter Ablation to Maintain Sinus Rhythm: Recommendations

• I-A: ABL for PAF Patients who are refractory or intolerant to at least one CLASS I or III AAD [MEDS]
• I-C: Prior to ablation, assessment of the procedural risks and outcomes relevant to the individual patient is recommended

• IIa: ABL for Persistent after MEDS (A) or for PAF before MEDS (B)
• IIa-C: SURG for Concomitant Surgery for other indications: Pre/post MEDS, all patterns except Longstanding IIb-C(Pre MEDS)
• IIb-B: ABL for Persistent prior to MEDS
• IIb-C: ABL for Longstanding persistent (> 12 months) after MEDS
• IIb-B Stand-alone SURG: all patterns of AF Post MEDS who prefer surgery to ABL
• IIb-B: Stand-alone SURG: all patterns of AF Post MEDS who have failed ABL

• III-C: ABL should not be performed in patients who cannot be treated with anticoagulant therapy during & following the procedure.
• III-C: ABL to restore NSR should not be performed with the sole intent of obviating the need for anticoagulation.

AF Ablation Techniques & Endpoints for PVI, Linear, & CFAE lesions sets
35 Years of Cardiac Surgery
20 Years of Catheter Ablation
Recurrences of AF in Patients Undergoing AF Ablation are Mostly due to PV Recurrent Conduction (Double Lasso Technique)

100 patients:
88 PAF
12 Persistent

29% recurrence at mean of 8 months

80% of the patients studied had recurrent PV conduction and PV tachycardias

Efficacy of RFA in Patients with AF
A Meta-Analysis

Ablation Success
How, and Can We Get There?

Paroxysmal
Persist/chronic

PV isolation
Non-PV foci
Linear abl
Redo

50 60 75 90

0 10 20 30 40 50 60 70 80 90 100

% "Courtesy: Dr. DL Packer"
AF Catheter Ablation Complications

- Stroke + TIA, Silent Microemboli (0-7 %, 7-38 %)
- Air Embolism (< 1 %)
- Pulmonary Vein Stenosis (0-38 %; 5 % → 1 % → 0.3 %)
- Pericardial Tamponade (0.2-6.0 %)
- Vascular Bleeding (0-13 %)
- AV Fistula (0.4-1.0 %)
- Femoral Pseudoaneurysm (0.5 %)
- Eso-LA Fistula (0.10-0.25 %)
- Peri-esophageal vagal nerve injury (< 1 %)
- Acute Coronary Occlusion (Esp. CX; ~ 0.2%)
- Radiation Burns (< 0.2 %; Excess Fatal CA: 0.1%)
- Pericarditis (20-30%): higher AF recurrence early
- Dressler’s (prolonged pain, fluid retention): < 0.5 %
- Phrenic Nerve Injury (Esp. RSPV: 0.5% RF; 7-10% Cryo)
- Mitral Valve Trauma from Circular Catheters (< 0.3 %)
- Mortality Risk: 0.1 %
- ERAF (~40%); LA Flutter Pro-Arrhythmias (1–50 %); 7-10 %

Surgical Ablation of AF
12 Year Follow-up of MAZE III: Single Center Experience: Mayo Clinic

Freedom from AF

<table>
<thead>
<tr>
<th>Type</th>
<th>5 y</th>
<th>10 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paroxysmal</td>
<td>90 %</td>
<td>64 %</td>
</tr>
<tr>
<td>Persistent</td>
<td>80 %</td>
<td>62 %</td>
</tr>
</tbody>
</table>

Fig 3. Freedom from atrial fibrillation (AF). Kaplan-Meier curve demonstrating freedom from AF in patients who have undergone a Cox-maze procedure separated according to lone preoperative paroxysmal AF (■), lone preoperative chronic AF (♦), and combine maze-mitral valve surgery (●).

AF is a Chronic Disease

Fibrosis
(Galectin-3)
Inflammation

HFpEF

AF

CVA

Sinus Node Dysfunction

Aging & Promoters

Cognitive Decline

Jalife, Current Opinion CV 2013: 29(1)
Ho, et al, Am Heart J 2014: 0:1-6.e1
FAA Certification for AF

• Applicant must apply for the AASI with deferral and documentation to the AMCD or RFS for first time certification. Testing required:
  • Maximal Bruce TMET
  • 2-D Echocardiogram
  • 24-Hour Holter Monitor pre/post treatment
  • TFTs
  • If Class I/II class, exercise radionuclide stress test

• Examiners may re-issue a certificate if:
  • FAA has granted authorization;
  • Summary of the applicant’s medical condition since last FAA medical exam is available, including a statement regarding any further episodes of AF;
  • The name and dosage of medications used for treatment is available with comments regarding side effects if any;
  • Current 24-hour Holter Monitor report is performed in last 90 days;
  • A minimum monthly INR is available for last 6 months for those on warfarin

• MUST defer to AMCD or RFS if
  • Holter shows HR > 120 or Pauses > 3 seconds;
  • > 20% of the INR values are < 2.0 or > 3.0.
  • Applicant has had emboli, thrombosis, bleeding that required intervention
FAA Certification for AF

• **Radiofrequency Ablation**
  • 90 days of stabilized recovery
  • After recovery following testing:
    • 24-Hour Holter Monitor pre/post treatment
    • Resting ECG and tracings
    • Medical records and detailed status report from EP MD
    • If first time, exercise testing also needed

• **Cardioversion** *(Spontaneous, Chemical, or DC)*
  • 30 days of observation and recovery
  • After recovery following testing:
    • 24-Hour Holter Monitor pre/post treatment
    • Resting ECG and tracings
    • Medical records and detailed status report from Cardiology or EP MD
    • If first time, exercise testing also needed
Mechanisms for Ventricular Tachycardia

- CAD: 95%
- ARVC
- DCM: 95%
- Others: 5%

More than 1 PVC or pairs/triplets on ECG will trigger further work-up
Idiopathic Ventricular Tachycardia
Clinical Features

- Causes <5% of clinical VT cases
- Structurally normal heart
- Ages 20-50 years, but also pediatric/geriatric presentations
- Overwhelming excellent prognosis; SCD rare
- Presenting symptoms: Palpitations 80%, dizziness 50%, syncope 10%
- Occasional presentation with TICM
Ablation of PVCs/VT \textsubscript{ns} Can Restore LVEF

\textbf{CONTROLS}

\begin{itemize}
  \item Baseline: 28\pm13\%
  \item Follow-up: 29\pm13\%
\end{itemize}

\textbf{ABLAITION}

\begin{itemize}
  \item Pre Ablation: 34.5\pm13\%
  \item Post Ablation: 59\pm7\%
\end{itemize}

Monomorphic VT in structurally normal heart

VT morphology

LBBB pattern, inferior axis

S wave in L1, R-wave transition in V1 or V2

RBBB, left axis

RBBB, right axis

S wave in V5 or V6 absent

S wave in V5 or V6 present

Posterior fascicle exit

Anterior fascicle exit

Infravalvular LVOT VT

Infra- and supravalvular LVOT VT

RVOT VT

None of the above morphology, sensitive to β-blocker

Idiopathic propranolol-sensitive (automatic) monomorphic VT (IPVT)

Typical RVOT VT

RVOT VT: Adenosine-Sensitive Ventricular Tachycardia

- Accounts for over 80% of all VT in normal hearts
- RVOT origin with 2 subtypes
  - Subtype 1: Repetitive monomorphomic VT (RMVT)
  - Subtype 2: Paroxysmal exercise-induced sustained VT
- Spontaneous remissions in 5-20% cases
- Morphology: LBBB/RAD or normal axis
Lead II

Adenosine 1.5 mg

Do NOT Confuse RVOT VT with VT Associated with ARVD/C
Arrhythmogenic RV Cardiomyopathy

Muthappins, Calkins Prog CV Dis, 2008
RVOT vs. ARVC VT ECG

![ECG Image]

Table 1  Electrocardiographic ARVD/C risk score

<table>
<thead>
<tr>
<th>ECG characteristic</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior T-wave inversions ($V_1$-$V_3$) in sinus rhythm</td>
<td>3</td>
</tr>
<tr>
<td>VT/PVC</td>
<td></td>
</tr>
<tr>
<td>Lead I QRS duration $\geq$ 120 ms</td>
<td>2</td>
</tr>
<tr>
<td>QRS notching (multiple leads)</td>
<td>2</td>
</tr>
<tr>
<td>$V_5$ transition or later</td>
<td>1</td>
</tr>
<tr>
<td>Maximum total</td>
<td>8</td>
</tr>
</tbody>
</table>

Hoffmayer, et al, HRJ, 2013, 10:477
ARVC ECG (Late Epsilon)
Monomorphic VT in structurally normal heart

VT morphology

LBBB pattern, inferior axis
- S wave in L1, R-wave transition in V1 or V2
  - S wave in V5 or V6 absent
    - RVOT VT
  - S wave in V5 or V6 present
    - Supravalvular LVOT VT
    - Infravalvular LVOT VT

RBBB, left axis
- Posterior fascicle exit
  - ILVT

RBBB, right axis
- Anterior fascicle exit

None of the above morphology, sensitive to β-blocker

Idiopathic propranolol-sensitive (automatic) monomorphic VT (IPVT)

43 Year old Man with Palpitations and Near-Syncope
Vector of Lead V1 can localize the PVC/VT focus

Sleeve Anatomy Relevant for VT Aortic and Pulmonary Cusp Ablation

Table 1: Anatomic locations of myocardial extensions noted in the great arteries and the semilunar valves

<table>
<thead>
<tr>
<th>Location</th>
<th>No. (%) of hearts</th>
<th>Mean ± SD extension (mm)</th>
<th>Upper range of extension (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension into aorta (n=603)</td>
<td>342 (57)</td>
<td>2.8 ± 1.2</td>
<td>8</td>
</tr>
<tr>
<td>Extension above any cusp#</td>
<td>332 (55)</td>
<td>1.5 ± 0.5</td>
<td>2</td>
</tr>
<tr>
<td>Above right coronary cusp</td>
<td>145 (24)</td>
<td>1.3 ± 0.5</td>
<td>2</td>
</tr>
<tr>
<td>Above non-coronary cusp</td>
<td>4 (1)</td>
<td>2.2 ± 1.1</td>
<td>8</td>
</tr>
<tr>
<td>Intercuspal extension#</td>
<td>13 (2.2%)</td>
<td>3.0 ± 1.2</td>
<td>4</td>
</tr>
<tr>
<td>Aortic valvar extension (N=603)</td>
<td>12 (2.0%)</td>
<td>3.2 ± 1.1</td>
<td>5</td>
</tr>
<tr>
<td>Right coronary cusp</td>
<td>5 (0.8%)</td>
<td>2.3 ± 0.5</td>
<td>3</td>
</tr>
<tr>
<td>Left coronary cusp</td>
<td>4 (0.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-coronary cusp</td>
<td>106 (17%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension into PA (N=602)</td>
<td>446 (74)</td>
<td>4.0 ± 2.5</td>
<td>19</td>
</tr>
<tr>
<td>Extension above any cusp#</td>
<td>340 (56)</td>
<td>3.6 ± 2.1</td>
<td>16</td>
</tr>
<tr>
<td>Above right pulmonary cusp</td>
<td>268 (45)</td>
<td>3.7 ± 2.2</td>
<td>13</td>
</tr>
<tr>
<td>Above left pulmonary cusp</td>
<td>313 (52)</td>
<td>3.4 ± 1.8</td>
<td>12</td>
</tr>
<tr>
<td>Above anterior pulmonary cusp</td>
<td>360 (60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercuspal extension#</td>
<td>10 (1.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary valvar extension (N=602)</td>
<td>0 (0%)</td>
<td>3.0 ± 1.2</td>
<td>5</td>
</tr>
<tr>
<td>Right pulmonary cusp</td>
<td>5 (0.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left pulmonary cusp</td>
<td>8 (1.3%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gami, Noheria, Lachman, Edwards, Friedman, Talreja, Hammill, Munger, Packer, Asirvatham: JCEP, 2011; 30, 5-15
Monomorphic VT in structurally normal heart

VT morphology

LBBB pattern, inferior axis
S wave in L1, R-wave transition in V1 or V2

S wave in V5 or V6 absent
RVOT VT

S wave in V5 or V6 present
Supravalvular LVOT VT
Infravalvular LVOT VT

RBBB, left axis
Posterior fascicle exit
ILVT

RBBB, right axis
Anterior fascicle exit

None of the above morphology, sensitive to β-blocker

Idiopathic propranolol-sensitive (automatic) monomorphic VT (IPVT)

IL LV VT Originating in LPHF
Idiopathic LV VT (Fascicular)
(Verapamil-Sensitive VT)

- Morphology: RBBB/LAD; originates in the LV
- 80% of patients are men or boys
- Similar age and symptoms to RVOT VT
- ECG of VT: Short RS (<60-80 ms), and QRSD <140 ms
- At EPS, originates in the LPHF region
- Inducible with atrial burst pacing
- Purkinje fiber potentials that precede earliest ventricular activations with short retrograde VH intervals
- Mechanism: Microreentry as entrainment
387 Patients with LV idiopathic VT

- Aortic Root
- Aorto-Mitral Continuity
- Epicardial
- Mitral Valve Annulus
- Fascicular
- Papillary Muscles
FAA Certification for VT

- Ablation or medical Rx (BB or CCB) remain options for patients with VTns & no evidence of structural heart disease
- Continued ongoing status reports
- Caveats for testing after ablation/meds akin to AF recommendations.
- Consult with consulting cardiologist or electrophysiologist

FAA Certification
Conduction Disease

- RBBB under 30 no evaluation
- RBBB over 30: Baseline CV examination—if negative, no deferral—can use TMET.
- LBBB: more likely related to structural disease: Baseline CV examination including Nuclear stress testing.

FAA Certification Class III: PPMs

- **ICDs are disqualification**
- **2-month recovery period after the PPI to allow recovery & stabilization.** Pilot can submit the following:
  1. Copies of hospital/medical records pertaining to the PPM indication, make of generator and leads, model & serial #, admission/discharge summaries, operative report, and all ECG tracings
  2. PPM evaluation of function to include description and documentation of underlying rate and rhythm (with PPM turned off/down), current settings, surveillance record, and exclusion of myopotential inhibition or PPM-syndrome, Power pack data (BOL and ERI/EOL)
  3. Readable samples of all surveillance records over last 6 months (free and magnet)
  4. Assessment from MD regarding general physical and cardiac exam and current meds
  5. Report of current FBG and lipid panel
  6. Current Holter Monitor with 24 consecutive hours including representative tracings
  7. Current TTE
  8. Current TMET
  9. Records release

Mailings to Medical Appeals Section, AAM-313, AMCD, FAA
PO Box 26080 Oklahoma City, OK 73125-9914
Causes of LOC or Syncope

CP = Cardiopulmonary
CVA = Stroke or TIA

- **Unknown**
- Orthostatic
- Bradycardias (Includes CSH)
- VT/VF
- SVT
- Seizures
- Meds/Other
- Intoxication
- Endocrine
- Factitious
- Bleeding
- Narcolepsy
- Psychiatric
- Sleep deprived

Neurocardiogenic Syncope
(Includes VDS, Micturation/Cough-induced)

Munger, TM
Cardiac Structural and/or Arrhythmic Causes of Syncope

Ventricular Tachycardia
- WPW; 1:1 AT
- In elderly: AVNRT

Ventricular Fibrillation/SCD
- (Myopathic, Anatomic, or Channelopathy)

SVT
- HCM, CAD, AS, AAD: AFl/AF

Bradycardias
- (CSH, Complete AV Block, Lower Grade AV Blocks, Sick Sinus Syndrome)

Cardiopulmonary
- Pulmonary Embolism
- Dissection/Marfan's
- Cerebral Aneurysm
- Cerebral Embolism
- Asthma
- HCM
- Congenital
- PPH
- AS, MVP
- Tumors

Munger, TM
Syncope events/visits per 1000 patient-years

**General population**
18.1 – 39.7

**General practice**
9.3

**ED**
0.7

Syncope per 100,000/yr
1,810-3,970

930

70

Eur Heart J 2009 30:2631-2671; doi:10.1093/eurheartj/ehp298
For ages 15-30,
Estimated Incidence of syncope = 0.2-0.3% per year
= 200-300 cases per 100,000 population per year
Syncope Among USAF Military Trainees

34,791 trainees
112 Cases of syncope or pre-syncope
Incidence 19.6 per 1,000 patient-years
Neuro-cardiogenic more than half
Four patients with lacerations/suture
2 patients with CV disease:
  CAD (1), LQTS (1)
Annual Rates (Per 100,000): 1998-2012
Overall Syncope Rates (153,172 Cases)

For ages 18-30, Reported Incidence of syncope = 700-4000 cases per 100,000 population per year

MSMR (Medial Surveillance Monthly Report), November, 2013 (Volume 20)
When is Syncope Worrisome

History

Cardiac syncope

- Presence of severe structural heart disease
- During exertion, or supine
- Preceded by palpitations or accompanied by chest pain
- Family history of sudden death (LQTS, Brugada, SQTS, J-Wave Syndrome, HCM, ARVD, LVNC)

Courtesy: WK Shen, MD
Epidemiology of SCD in the Young

Maron BJ, *NEJM* 2003, 1064-1075
### Exertional Syncope & Sudden Death

#### Risk Stratification and the HISTORY

<table>
<thead>
<tr>
<th>Feature</th>
<th>NCS or Non-arrhythmia</th>
<th>Arrhythmia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prodrome</td>
<td>Light-headed, warmth, nausea</td>
<td>None or brief light-headedness</td>
</tr>
<tr>
<td>Number of episodes</td>
<td>Multiple</td>
<td>Few or one</td>
</tr>
<tr>
<td>Situational Factors</td>
<td>Fear, fright, upright posture, post-exercise</td>
<td>Exertional or supine</td>
</tr>
<tr>
<td>Post-syncope Symptoms</td>
<td>Fatigue</td>
<td>None</td>
</tr>
<tr>
<td>Injury</td>
<td>Unusual</td>
<td>Common</td>
</tr>
<tr>
<td>Underlying Heart Disease</td>
<td>Unusual</td>
<td>Common</td>
</tr>
<tr>
<td>Family History</td>
<td>Unusual</td>
<td>Possible</td>
</tr>
</tbody>
</table>

**Link:** MS, Estes MNA, *Prog CV Dese* 2008, 44-57
European Survey of Diagnostic Testing in Syncope Patients

Figure 1 Utilization of different diagnostic examinations for the assessment of patients with syncope.

Dagres N, et al, Europace 2013, 1812-1815
Syncope While Driving
Clinical Characteristics, Causes, and Prognosis

Actuarial recurrence of syncope

<table>
<thead>
<tr>
<th>Time</th>
<th>Driving</th>
<th>Non-Driving</th>
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</thead>
<tbody>
<tr>
<td>6 months</td>
<td>12.0 %</td>
<td>12.0 %</td>
</tr>
<tr>
<td>1 year</td>
<td>14.1 %</td>
<td>17.0 %</td>
</tr>
<tr>
<td>8 years</td>
<td>25.1 %</td>
<td>28.9 %</td>
</tr>
</tbody>
</table>

No. at risk

<table>
<thead>
<tr>
<th>Time, y</th>
<th>Nondriving</th>
<th>Driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3,496</td>
<td>381</td>
</tr>
<tr>
<td>1</td>
<td>2,046</td>
<td>250</td>
</tr>
<tr>
<td>2</td>
<td>1,698</td>
<td>207</td>
</tr>
<tr>
<td>3</td>
<td>1,396</td>
<td>180</td>
</tr>
<tr>
<td>4</td>
<td>1,193</td>
<td>158</td>
</tr>
<tr>
<td>5</td>
<td>1,005</td>
<td>129</td>
</tr>
<tr>
<td>6</td>
<td>710</td>
<td>86</td>
</tr>
<tr>
<td>7</td>
<td>295</td>
<td>39</td>
</tr>
<tr>
<td>8</td>
<td>135</td>
<td>14</td>
</tr>
</tbody>
</table>

P = 0.21

Federal Government Recommendations
NHTSA (National Highway Traffic Safety Administration)—US Dept. of Transportation

• ACS: Restrict if symptoms at rest or at wheel
  Resume 1 week after PCI, 4 weeks after CAGB, 1-4 wks after successful cardiologist directed medical therapy

• AF or Flutter with RVR or bradycardia
  Resume after medical or device control

• PSVT including WPW
  No restriction if asymptomatic. Resume after 6 months of AAD therapy or ablation, or in case of RFA, sooner if no delta wave present, or negative f/u EPS

• VT
  No restriction if non-sustained & asymptomatic. Symptomatic VT and VF arrest: resume driving after 3 months with AAD (with or without ICD), if guided by EP testing. May resume 6 months if no symptoms, or on just AAD or with ICD alone. If VT sustained, asymptomatic patients treated the same. On long-distance travel, have companion & do not use cruise control.

• AV Block
  4 weeks after medication withdrawal & ECG documentation; 1 wk. after PPM

• SSS
  No restriction if asymptomatic. Otherwise as per PPM for AV Block patient

• CHF
  Do not drive if Class IV. Reassess Q 6-24 months

• HCM or Valve Disease
  Restrict if symptoms until treated

### ESC 2009 Recommendations Concerning Driving & Syncope

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Group 1 (private drivers)</th>
<th>Group 2 (professional drivers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac arrhythmias</td>
<td>After successful treatment is established</td>
<td>After successful treatment is established</td>
</tr>
<tr>
<td>Cardiac arrhythmia, medical treatment</td>
<td>After 1 week</td>
<td>After appropriate function is established</td>
</tr>
<tr>
<td>Pacemaker implant</td>
<td>After successful treatment is established</td>
<td>After long-term success is confirmed</td>
</tr>
<tr>
<td>Successful catheter ablation</td>
<td>In general low risk, restriction according current recommendations</td>
<td>Permanent restriction</td>
</tr>
<tr>
<td>ICD implant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflex syncope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single/mild</td>
<td>No restrictions</td>
<td>No restriction unless it occurred during high risk activity*</td>
</tr>
<tr>
<td>Recurrent and severe*</td>
<td>After symptoms are controlled</td>
<td>Permanent restriction unless effective treatment has been established</td>
</tr>
<tr>
<td>Unexplained syncope</td>
<td>No restrictions unless absence of prodrome, occurrence during driving, or presence of severe structural heart disease</td>
<td>After diagnosis and appropriate therapy is established</td>
</tr>
</tbody>
</table>

*Neurally mediated syncope is defined as severe if it is very frequent, or occurring during the prosecution of a “high risk” activity, or recurrent or unpredictable in “high-risk” patients.*

*Eur Heart J 2009, 30:2631-2671*
The Special Case of the Neurocardiogenic Syncope
Beyond Driving: The Workplace

Occupations of Some of TMM’s Syncope Patients over Last 30 yrs.

- Security Guard
- Police Officer
- Steel Worker
- Meat Cutter
- Farmer
- Miner
- LA Fire Department
- US Army Special Forces
- X-Country Munitions Driver
- Window Washer for Chicago Sear’s Tower
- Vascular Surgeon
- Interventional Cardiologist
### Annual Fatality Rates of Drivers and Work-Related Occupations over last 30 years

#### Annual Driving Fatalities/100,000

<table>
<thead>
<tr>
<th>Rank</th>
<th>Rate</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.8</td>
<td>16 Year old Men</td>
</tr>
<tr>
<td>2</td>
<td>44.7</td>
<td>21 Year old Men</td>
</tr>
<tr>
<td>3</td>
<td>22.7</td>
<td>18 Year old Women</td>
</tr>
<tr>
<td>4</td>
<td>18.1</td>
<td>≥ 85 Year old Women</td>
</tr>
<tr>
<td>5</td>
<td>45.0</td>
<td>≥ 85 Year old Men</td>
</tr>
<tr>
<td>6</td>
<td>25.0</td>
<td>55 Yr old VF Survivor w/ ICD @ 1 Year</td>
</tr>
<tr>
<td>7</td>
<td>427.0</td>
<td>(Prior to 2001)</td>
</tr>
</tbody>
</table>

#### Annual Occupational Fatalities/100,000

<table>
<thead>
<tr>
<th>Industry</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishers</td>
<td>103.6</td>
</tr>
<tr>
<td>Loggers</td>
<td>93.2</td>
</tr>
<tr>
<td>Pilots</td>
<td>80.4</td>
</tr>
<tr>
<td>Farmers &amp; Ranchers</td>
<td>39.5</td>
</tr>
<tr>
<td>Transportation</td>
<td>17.9</td>
</tr>
<tr>
<td>Construction &amp; Extraction</td>
<td>13.1</td>
</tr>
<tr>
<td>Professional</td>
<td>00.9</td>
</tr>
<tr>
<td>Administration &amp; Office Work</td>
<td>00.4</td>
</tr>
</tbody>
</table>

*HHS, CDC, 2007*
Questions & Answers