CARDIAC CAUSES FOR STROKE

Dr. Aaron J. Feingold M.D.
Raritan Bay Cardiology Group
OVERVIEW

• The Connection between Stroke and Cardiac Causes
• Main Cardiac Causes: Embolic and Arrhythmic
• Clinical Effectiveness of Long-term Monitoring
• Working with your Cardiologist
2 CATEGORIES OF CARDIAC-RELATED STROKE

Embolic & Arrhythmic
EMBOLIC

- Embolic strokes are usually caused by an embolus (a blood clot or other moveable biological entity that forms elsewhere in the body and travels through the bloodstream to the brain). Embolic strokes often result from heart disease or heart surgery and occur rapidly and without any warning signs.
- 20% of Ischemic Strokes are cardio embolic
- Cardiac conditions that cause cerebral embolism are classified as major or minor depending on whether the causal link has or has not been fully established between cause and stroke.

<table>
<thead>
<tr>
<th>Cardio Embolic Stroke Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Myxoma</td>
</tr>
<tr>
<td>• Patent foramen ovale</td>
</tr>
<tr>
<td>• Left ventricle thrombus</td>
</tr>
<tr>
<td>• Atrial Septal Aneurysm</td>
</tr>
<tr>
<td>• Mitral valve prolapse</td>
</tr>
<tr>
<td>• Mitral annular calcification</td>
</tr>
<tr>
<td>• Calcific aortic stenosis</td>
</tr>
<tr>
<td>• Any congenital defect with a right to left shunt is a potential</td>
</tr>
<tr>
<td>• Infective endocarditis</td>
</tr>
<tr>
<td>• Prosthetic heart valves</td>
</tr>
</tbody>
</table>

MITRAL STENOSIS
LEFT VENTRICULAR THROMBOSIS
LEFT VENTRICULAR THROMBOSIS CONT.
ENDOCARDITIS
ENDOCARDITIS VEGETATION
MYXOMA
MYXOMA
PROSTHETIC HEART VALVES
PROSTHETIC HEART VALVE WITH THROMBUS
PATENT FORAMEN OVALE
ASCENDING AORTA ARTERIOSCLEROSIS
ARRHYTHMIC CAUSES OF STROKE

Atrial Fibrillation & Asystole
ATRIAL FIBRILLATION

- A Fib categorized as Embolic and Arrhythmic
- Most common cardiac cause of stroke, accounting for 45% of all cardioembolic ischemic strokes
  - Main pathogenesis of stroke in AF is a cerebral embolus originating from a left atrial thrombus
- The risk of patients with AF and prior stroke or transient ischemic attach is estimated to be 12% per year
- Patients with spontaneous by trans esophageal echo contrast or thrombus in the left atrium had a risk of recurrent stroke of 7.5%
ATRIAL FIBRILLATION

Normal ECG

Atrial Fibrillation
PARAXYSMAL ATRIAL FIBRILLATION
ECG Changes in stroke


Picture courtesy: [www.medscape.com](http://www.medscape.com)
CRYPTOGENIC STROKE

WHY AF MATTERS

• AF equals 5 fold increase for stroke risk¹
• Up to 90% of Paroxysmal Atrial Fibrillation (PAF) episodes may be asymptomatic.²
• Risk of stroke annually is equal for PAF and permanent AF ³
• Detection of AF in Cryptogenic Stroke Patients changes treatment
  ▪ Guidelines state change from antiplatelet to OAC⁴
  ▪ CHADS and CHADSvasc Score

2. Isreal et al, J AM Coll Cardiol. 2004;43:47-52;
IMPORTANCE OF AF AND STROKE

• 25-40% of Strokes are Cryptogenic

• AF is frequently paroxysmal and asymptomatic, making detection of AF difficult

• 25% of those with AF-associated stroke have no known prior history of AF

• Even in stroke patients with known PAF, 50-70% are in sinus rhythm at time of stroke

• AF is one of the only reasons to use anticoagulation for secondary stroke prevention
  • For almost all other reasons antiplatelet agents are used
  • Anticoagulants have significantly high risk associated with use.
<table>
<thead>
<tr>
<th>CHADS2 Risk</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Age &gt; 75</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1</td>
</tr>
<tr>
<td>Stroke or TIA</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHA2DS2-VASc Risk</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF or LVEF ≤ 40%</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Age ≥ 75</td>
<td>2</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1</td>
</tr>
<tr>
<td>Stroke/TIA/Thromboembolism</td>
<td>2</td>
</tr>
<tr>
<td>Vascular Disease</td>
<td>1</td>
</tr>
<tr>
<td>Age 65 - 74</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
</tr>
</tbody>
</table>

From ESC AF Guidelines
<table>
<thead>
<tr>
<th>CHADS2 criteria</th>
<th>Points</th>
<th>Stroke risk score</th>
<th>Recommended therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous stroke or TIA</td>
<td>2</td>
<td>High 2–6</td>
<td>Warfarin (INR 2–3)</td>
</tr>
<tr>
<td>Age ≥ 75 years</td>
<td>1</td>
<td>Moderate 1</td>
<td>Warfarin or aspirin</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
<td>Low 0</td>
<td>Aspirin 100–300 mg daily</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart failure</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## ANTICOAGULANTS

### New oral anticoagulants

<table>
<thead>
<tr>
<th>Dosing for AF</th>
<th>Monitoring</th>
<th>Special Considerations</th>
</tr>
</thead>
</table>
| **Dabigatran**                                    | - No specific monitoring for coagulation status  
- Renal function                                   | - Dose adjustment required for renal impairment  
- Major drug interactions with P-glycoprotein (PGP) inhibitors*  
- Dyspepsia                                         |
| **Rivaroxaban**                                   | - No specific monitoring for coagulation status  
- Renal function  
- Hepatic function                                  | - Dose adjustment required for renal impairment  
- Avoid in patients with hepatic dysfunction  
- Major drug interactions with combined PGP and strong CYP 3A4 inhibitors*  
- Studied in a higher-risk patient population (CHADS2 3.47) |
| **Apixaban**                                      | - No specific monitoring for coagulation status  
- Renal function                                    | - Dose adjusted in trials for two of three following factors:  
older than 80 years; serum creatinine (SCr) < or SCr > 1.5  
- 2.5 mg twice daily  
- Major drug interactions with combined PGP and strong CYP 3A4 inhibitors*  
- Less stroke, systemic embolism and bleeding with apixaban |

*Source: Lindsey J.

*Not TGA approved as of press date

*Examples include dronedarone, ketoconazole, amiodarone, verapamil, quinidine

*Examples include diltiazem, ritonavir
WATERSHED STROKES

• Watershed areas are at high risk of developing ischemia, or lack of blood flow, during extreme drops of blood pressure.

• Common triggers for watershed strokes include periods of extreme dehydration, arrhythmias, and sepsis.

• Cardiac arrhythmias cause hypo-perfusion and extreme drops in blood pressure; these include asystole, atrial fibrillation with slow ventricular response, non-profusing ventricular tachycardia, ventricular fibrillation, high-grade heart block, etc.
HIGH GRADE HEART BLOCK
ASYSTOLE
PAROXYSMAL ASYSTOLE
The Reveal XT Insertable Cardiac Monitor is an implantable patient-activated and automatically-activated monitoring system that records subcutaneous ECG and is indicated in the following cases:

1. Patients with clinical syndromes or situations at increased risk for cardiac arrhythmias

2. Patients who experience transient symptoms such as dizziness, palpitation, syncope and chest pain, that may suggest a cardiac arrhythmia

FDA 510(K) Cleared K082475, Nov. 7, 2008
REVEAL® XT ICM
PRODUCT OVERVIEW

- No wires or leads
- 3-year battery longevity
- Automatic ECG recording of arrhythmias (Atrial Fibrillation, asystole, bradycardia and Ventricular Tachycardia episodes)
- In-office or remote data transmissions via Medtronic CareLink® Network
- Only ICM approved for 1.5 and 3.0 T MRI scans
- Simple subcutaneous insertion
- Quick outpatient procedure

---

1. Reveal XT has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use. Please see Reveal XT clinician manual for more details.
Minimally invasive outpatient procedure with local anesthetic and no leads or fluoroscopy
CARDIAC COMPASS® REPORT
TREND DIAGNOSTICS

- Daily AF Burden
- Ventricular Rate During AF
- Day/Night HR
- Patient Activity
- Heart Rate Variability
SURPRISE STUDY
UPDATED RESULTS

Methods:
- 85 patients with cryptogenic stroke/TIA and no AF on 24-hour telemetry were implanted with Reveal XT
- All patients had a minimum of 6 months of monitoring

Results
14 of 85 (16.5%) of patients diagnosed with AF
- Median time from stroke onset to first recorded event - 98 days
- Average AF burden was 2 hours per day monitored
- CHADS$_2$Vasc in AF group was 4.14 vs. 3.24 in no AF (p=0.03)

Christensen LM. et al. Paroxystic Atrial Fibrillation (PAF) in Patients with minor ischemic stroke or transient ischemic attack. 2013 EuroStroke
STROKE ETIOLOGIES

THE CHALLENGE OF CRYPTOGENIC STROKE

Types of Ischemic Stroke

- Atherothrombotic (25-30%)
  
  *Stenotic artery feeding area of infarction*

- Cardioembolic (20%)
  
  *A thrombus or other material dislodges from the heart or aortic arch*

- Other/Uncommon (5-10%)

- Cryptogenic (25-40%)
  
  *Unknown cause*

SYMPTOMS AND INTERMITTENT MONITORING
THE TIP OF THE AF ICEBERG

Symptoms / Intermittent monitoring
Continuous monitoring
OCCULT ATRIAL FIBRILLATION IN CRYPTOGENIC STROKE
DETECTION BY 7-DAY ECG VS. ICM, RITTER ET AL.

Methods:
60 patients with cryptogenic stroke implanted

Compared ICM to 7-day Holter monitor
• Patient workup included Cerebral imagining, ECG,
  72 hour telemetry, 24-hour Holter, TEE

Results:
AF detected in 10 pts (17%)
Average time to detection
  64 days post-stroke

Yield of ICM (17%) vs. 7-day ECG
(1.7%) significantly higher p=0.0077

Data from 574 AT500 IPG patients were analyzed retrospectively over 1 year, with intermittent monitoring simulated by analyzing data from randomly selected days.

“Intermittent and symptom-based monitoring is highly inaccurate for identifying patients with any or long-duration AT/AF and for assessing AT/AF burden.”

**Example:** Quarterly Holter recording detects AF in 54% of the patients with AF, and is correct 29% of the time in ruling out AF in patients.

---

PATIENT PATHWAY FOR ACUTE STROKE

Standard stroke workup

- MRA or CTA of intracranial
- TEE

Symptomatic carotid stenosis greater than 50%

CEA or stent

Intracranial stenosis

Positive TEE

Anticoagulation

Positive TEE

All testing negative?

- Implant Reveal XT IRL

Monofocal

- Medical management
- Antiplatelet agents

Multifocal

- Angiogram
- Lumbar puncture
- Vasculitis workup

Standard Stroke Workup:

- Carotid dopplers
- Telemetry bed
- Fasting lipid panel
- Glucose control
- Blood pressure management
- Hypercoagulation labs if age < 50
FORGING THE FRIENDSHIP

Cardiologists often are consulted on stroke patients due to a history of cardiac disease

- Use this as an opportunity to ask if this stroke could be embolic, and if you can assist with further cardiac investigation for an embolic source
- Be available to perform TEEs, even though it is low yield, and sometimes inconvenient

- Cardiologists are not able to identify cryptogenic stroke patients on their own.
CONCLUSION

Embolic strokes have a specific appearance on a diagnostic MRI.

With no known hx of AF, the workup is usually negative, leaving us with a diagnosis of cryptogenic stroke.

The yield of diagnosing AF in these patients can be quite high if proper protocol is followed.

An enthusiastic and cooperative partnership between a neurologist and cardiologist is imperative.