SVT: Diagnosis and Treatment

Gustavo X. Morales MD
Assistant Professor of Medicine
Cardiac Electrophysiology Service
<table>
<thead>
<tr>
<th>Medical-Content Category</th>
<th>Relative Percentage</th>
</tr>
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<tbody>
<tr>
<td>Cardiovascular Disease</td>
<td>14%</td>
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<tr>
<td>Gastroenterology</td>
<td>9%</td>
</tr>
<tr>
<td>Pulmonary Disease</td>
<td>10%</td>
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<tr>
<td>Infectious Disease</td>
<td>9%</td>
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<tr>
<td>Rheumatology/Orthopedics</td>
<td>8%</td>
</tr>
<tr>
<td>Endocrinology, Diabetes and Metabolism</td>
<td>8%</td>
</tr>
<tr>
<td>Medical Oncology</td>
<td>7%</td>
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<tr>
<td>Hematology</td>
<td>6%</td>
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<tr>
<td>Nephrology/Urology</td>
<td>6%</td>
</tr>
<tr>
<td>Allergy/Immunology</td>
<td>3%</td>
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<tr>
<td>Psychiatry</td>
<td>4%</td>
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<tr>
<td>Neurology</td>
<td>4%</td>
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<tr>
<td>Dermatology</td>
<td>4%</td>
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<tr>
<td>Obstetrics/Gynecology</td>
<td>3%</td>
</tr>
<tr>
<td>Ophthalmology</td>
<td>2%</td>
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<tr>
<td>Otorhinolaryngology</td>
<td>2%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>Cardiovascular Disease (14%)</td>
<td>30–32 as follows</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2–4</td>
</tr>
<tr>
<td>Pericardial disease</td>
<td>1–4</td>
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<tr>
<td>Ischemic heart disease</td>
<td>8–11</td>
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<tr>
<td>Arrhythmias</td>
<td>2–5</td>
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<tr>
<td>Congenital heart disease</td>
<td>0–1</td>
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<tr>
<td>Valvular heart disease</td>
<td>2–5</td>
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<tr>
<td>Myocardial disease</td>
<td>1–4</td>
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<tr>
<td>Cardiac tumors</td>
<td>0–1</td>
</tr>
<tr>
<td>Endocarditis and other cardiac vascular infections</td>
<td>0–1</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>0–2</td>
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<tr>
<td>Noncardiogenic syncope</td>
<td>0–1</td>
</tr>
<tr>
<td>Preoperative consultation</td>
<td>2–3</td>
</tr>
<tr>
<td>Miscellaneous cardiovascular disease</td>
<td>1–3</td>
</tr>
</tbody>
</table>
After completion of this presentation, the participant should be able to:

- Understand the mechanisms of SVT
- Diagnose SVT/Interpret the response to adenosine
- Understand various therapeutic options for SVT
Conduction System
Classification of Narrow QRS Complex Tachycardias by Structures Required for Initiation and Maintenance

Atrial tissue only

- Sinus tachycardia
- Inappropriate sinus tachycardia
- Sinus nodal reentrant tachycardia
- Atrial tachycardia
- Multifocal atrial tachycardia
- Atrial fibrillation
- Atrial flutter

AV junction

- AV nodal reentrant tachycardia
- Atrioventricular reentrant tachycardia
- Junctional tachycardia
- Junctional ectopic tachycardia in children
- Nonparoxysmal junctional tachycardia in adults
23 year-old female with sudden onset palpitations while watching TV?
ECG in SR

Panel B
Narrow QRS tachycardia (QRS duration less than 120 ms)

Regular tachycardia?

Yes

No

Visible P waves?

Yes

Atrial rate greater than ventricular rate?

No

Atrial fibrillation
Atrial tachycardia/flutter with variable AV conduction
MAT

Atrial flutter or
Atrial tachycardia

Analyze RP interval

Long
(RP longer than PR)

Atrial tachycardia
PJRT
Atypical AVNRT

Short
(RP shorter than PR)

RP shorter than 70 ms

AVNRT

RP longer than 70 ms

AVRT
AVNRT
Atrial tachycardia
23 year-old female with sudden onset palpitations while watching TV?
ECG in SR

Panel B

I, aVR, V1, V4
II, aVL, V2, V5
III, aVF, V3, V6
AV Nodal Reentry

- Common form of recurrent, paroxysmal SVT
- 60-65% of PSVTs
- ECG – Discrete P waves not visible
  – A&V depolarize simultaneously
- Symptoms – Palpitations
  – Lightheadedness
  – Chest discomfort
  – Anxiety

Mechanism
AVNRT
AVNRT
Response to Adenosine

Regular narrow QRS-complex tachycardia

IV adenosine

- No change in rate
  - Inadequate dose/delivery
  - Consider VT (fascicular or high septal origin)

- Gradual slowing then reacceleration of rate
  - Sinus tachycardia
  - Focal AT
  - Nonparoxysmal junctional tachycardia

- Sudden termination
  - AVNRT
  - AVRT
  - Sinus node re-entry
  - Focal AT

- Persisting atrial tachycardia with transient high-grade AV block
  - Atrial flutter
  - AT
ACC/AHA Guidelines for long term treatment of AVNRT

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Recommendation</th>
<th>Class</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorly tolerated AVNRT with hemodynamic intolerance</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Verapamil, diltiazem, beta blockers, sotalol,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>amiodarone</td>
<td>Ia</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Flecainide,* propafenone*</td>
<td>Ia</td>
<td>C</td>
</tr>
<tr>
<td>Recurrent symptomatic AVNRT</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Verapamil</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Diltiazem, beta blockers</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Digoxin†</td>
<td>Ib</td>
<td>C</td>
</tr>
<tr>
<td>Recurrent AVNRT unresponsive to beta blockade or calcium-channel blocker and patient not desiring RF ablation</td>
<td>Flecainide,* propafenone,* sotalol</td>
<td>Ia</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Amiodarone</td>
<td>Ib</td>
<td>C</td>
</tr>
<tr>
<td>AVNRT with infrequent or single episode in patients who desire complete control of arrhythmia</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Documented PSVT with only dual AV-nodal pathways or single echo beats demonstrated during electrophysiological study and no other identified cause of arrhythmia</td>
<td>Verapamil, diltiazem, beta blockers, flecainide,* propafenone*</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Catheter ablation;‡</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>No therapy</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Infrequent, well-tolerated AVNRT</td>
<td>Vagal maneuvers</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Pill-in-the-pocket</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Verapamil, diltiazem, beta blockers</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
</table>
**AV Nodal Reentry: Ablation**

- **Ablation**: Slow pathway - antegrade AV nodal
- **Site**: Inferior to CS ostium
- **Efficacy**: 99%
- **Complications**: AV block <1.0%, Recurrence 5%

Site of Slow Pathway Ablation

AVNRT Ablation
Accessory Pathways
Accessory AV Pathways

- Asymptomatic to sudden cardiac death
- Conduction: Antegrade and/or retrograde
- SVT may be frequent or recurrent

Wolff-Parkinson-White Syndrome

- Delta wave

- Accessory pathway without delta wave

- If accessory pathway capable of rapid antegrade conduction
  - VF from rapid conduction of AF
Pre-excitation

Preexcitation
Delta wave
Delta wave

[Diagram of the heart with labeled nodes and pathways]
Tachycardia with Accessory pathways

A
Sinus rhythm

B
Antidromic tachycardia

C
Orthodromic tachycardia

D
Atrial fibrillation
Orthodromic Reciprocating Tachycardia

Response to Adenosine

Regular narrow QRS-complex tachycardia

IV adenosine

- No change in rate
  - Inadequate dose/delivery
  - Consider VT (fascicular or high septal origin)

- Gradual slowing then reacceleration of rate
  - Sinus tachycardia
  - Focal AT
  - Nonparoxysmal junctional tachycardia

- Sudden termination
  - AVNRT
  - AVRT
  - Sinus node re-entry
  - Focal AT

- Persisting atrial tachycardia with transient high-grade AV block
  - Atrial flutter
  - AT
Anatomic Locations

Accessory Pathways
WPW: Case Study

- 18 year old male basketball player
- Presented to ER with:
  - Multiple episodes of near-syncope
- Adenosine 12 mg accelerated the heart rate
- Emergency cardioversion performed
AF with Multiple Accessory Pathways
AF → VF

Courtesy of Dr. Brian Olshansky.
What happens in A Fib?

lead I

lead II

lead III

Atrial fibrillation
Management

- **Acute:** Maneuvers
  - AV blockers
  - Cardioversion

- **Chronic:** Predictors of high vs low risk
  - Special groups
  - Antiarrhythmics: Class Ic

# Acute Management of SVT

## TABLE 1. Recommendations for Acute Management of Hemodynamically Stable and Regular Tachycardia

<table>
<thead>
<tr>
<th>ECG</th>
<th>Recommendation*</th>
<th>Classification</th>
<th>Level of Evidence</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow QRS-complex tachycardia (SVT)</td>
<td>Vagal maneuvers</td>
<td>I</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adenosine</td>
<td>I</td>
<td>A</td>
<td>15,17,18</td>
</tr>
<tr>
<td></td>
<td>Verapamil, diltiazem</td>
<td>I</td>
<td>A</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Beta blockers</td>
<td>IIb</td>
<td>C</td>
<td>20,21</td>
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<tr>
<td></td>
<td>Amiodarone</td>
<td>IIb</td>
<td>C</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Digoxin</td>
<td>IIb</td>
<td>C</td>
<td></td>
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</table>
### ACC/AHA Recommendation with AP mediated arrhythmias

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Recommendation</th>
<th>Classification</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPW syndrome (pre-excitation and symptomatic arrhythmias), well tolerated</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Flecaïnide, propafenone</td>
<td>Ila</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Sotalol, amiodarone, beta blockers</td>
<td>Ila</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Verapamil, diltiazem, digoxin</td>
<td>III</td>
<td>C</td>
</tr>
<tr>
<td>WPW syndrome (with AF and rapid-conduction or poorly tolerated AVRT)</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVRT, poorly tolerated (no pre-excitation)</td>
<td>Catheter ablation</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Flecaïnide, propafenone</td>
<td>Ila</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Sotalol, amiodarone</td>
<td>Ila</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Beta blockers</td>
<td>IIb</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Verapamil, diltiazem, digoxin</td>
<td>III</td>
<td>C</td>
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<tr>
<td>Single or Infrequent AVRT episode(s) (no pre-excitation)</td>
<td>None</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Vagal maneuvers</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Fill-in-the-pocket— verapamil, diltiazem, beta blockers</td>
<td>I</td>
<td>B</td>
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</tbody>
</table>
Catheter Ablation of WPW

Transeptal

Retrograde
Role of ablation

- Efficacy: 89-99%
  - Highest left-sided pathways
  - Lower septal and right-sided

- Recurrence: 3-9%
30 y/o male with palpitations
30 y/o male with palpitations
Ablation
23 y/o female with palpitations
Cryoablation
Post Ablation ECG
Atrial Tachycardia
Atrial Tachycardia

- 5-15% of all SVT’s
  - Higher in pediatric population
  - Normal hearts
  - S/P surgery for congenital lesions

- Paroxysmal or persistent
  - Persistent atrial tachycardia can cause tachycardia induced cardiomyopathy
Location of Atrial Tachycardias
Atrial Tachycardia

Baseline ECG
Atrial Tachycardia

Transient AV Block After 12 mg IV Adenosine
Response to Adenosine

Regular narrow QRS-complex tachycardia

IV adenosine

- No change in rate
  - Inadequate dose/delivery
  - Consider VT (fascicular or high septal origin)

- Gradual slowing then reacceleration of rate
  - Sinus tachycardia
  - Focal AT
  - Nonparoxysmal junctional tachycardia

- Sudden termination
  - AVNRT
  - AVRT
  - Sinus node re-entry
  - Focal AT

- Persisting atrial tachycardia with transient high-grade AV block
  - Atrial flutter
  - AT
60 y/o female with palpitations
Adenosine 6 mg IV
50 y/o male post CABG
Atrial Flutter
65 y/o male with palpitations
Common Atrial Flutter

- ECG: “Sawtooth” pattern in leads II, III, aVF
- Counterclockwise macro-reentry in RA
- Ablate an “isthmus” between TV and IVC
- Efficacy >90%
- Recurrence <10%
- Complications rare
Reentry Circuit
Oblique View of Right Atrium

- Superior Vena Cava
- Fossa Ovalis
- Eustachian Ridge
- Inferior Vena Cava
- Crista Terminalis
- Pectinate Muscle
- Orifice of Coronary Sinus

Counterclockwise Atrial Flutter

Courtesy of Dr. Brian Olshansky.
Typical Atrial Flutter
Clockwise Atrial Flutter
Adenosine and Atrial Flutter
ACC/AHA Guidelines

Atrial flutter

Unstable
- CHF, shock, acute MI
  - DC cardioversion

Stable
- Rate control: AV-nodal blockers
  - Conversion
    - DC cardioversion
    - Atrial pacing
    - Pharmacological conversion

If therapy for prevention of recurrences warranted
- Antiarrhythmic drugs
- Catheter ablation
Therapeutic options

- Rate control: AV blocking agents
- Anticoagulation
- Rhythm control: Class Ia
  - Class Ic
  - Class III
RF Ablation Atrial Flutter

Optimal Candidates

- Patient preference as primary therapy
- Drug refractory or significant side-effects
- Symptomatic patients
- Chronic and sustained
- Hybrid therapy for AF

Ablation of Atrial Flutter

Symptom Improvement

Asymptomatic

%

Overall Group A Group B

Pre Ablation Post Ablation

Group A - flutter alone
Group B - flutter and fib

Catheters in Flutter Ablation
AF after atrial Flutter Ablation

- 25% experience AF after atrial flutter ablation
- Easier to manage AF
- Flutter initiates AF in some patients
Radiofrequency (RF) Ablation

- EPS + RFA has replaced drug therapy for many arrhythmias
- Safe and effective
- Percutaneous catheters via veins
- Pacing, and recording in the heart
- Discrete RF lesions eliminates critical part of circuits of SVT
Clinical Indications for Ablation

- Paroxysmal supraventricular tachycardia (SVT)
  - AV nodal reentry
  - Accessory AV pathway
  - Atrial flutter
- Focal atrial tachycardia
- Drug refractory arrhythmias
  - AF (ventricular rate control)
  - Monomorphic VT in structural heart disease
  - Bundle branch reentry
  - Idiopathic (RVOT and apical-septal LV VT)

RF Ablation Lesion

<table>
<thead>
<tr>
<th>Type of Arrhythmia</th>
<th>Success Rate (%)</th>
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<tbody>
<tr>
<td>WPW or SVT (concealed bypass tract)</td>
<td>85-95</td>
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<tr>
<td>AV Node Reentry</td>
<td>95+</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>60-80</td>
</tr>
<tr>
<td>Typical Atrial Flutter</td>
<td>90</td>
</tr>
<tr>
<td>Atrial Tachycardia</td>
<td>70-80</td>
</tr>
<tr>
<td>Ventricular Tachycardia (Normal Heart)</td>
<td>90</td>
</tr>
<tr>
<td>Ventricular Tachycardia (Structural Heart Disease)</td>
<td>60</td>
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</table>

# RF Ablation Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Prevalence (%)</th>
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<tbody>
<tr>
<td>Death</td>
<td>0.1</td>
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<tr>
<td><strong>Non-fatal complications:</strong></td>
<td></td>
</tr>
<tr>
<td>Tamponade</td>
<td>0.5</td>
</tr>
<tr>
<td>AV block</td>
<td>0.5</td>
</tr>
<tr>
<td>Pericarditis</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Femoral artery complications:</strong></td>
<td></td>
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<tr>
<td>Thrombolic occlusion</td>
<td>0.2</td>
</tr>
<tr>
<td>Hematoma</td>
<td>0.2</td>
</tr>
<tr>
<td>AV fistula</td>
<td>0.1</td>
</tr>
</tbody>
</table>

RF Ablation Utilization (US)

Number of Procedures

120,000
80,000
40,000
0

1993 1997

Conclusion

- AVNRT is the most common SVT
- The ECG is crucial to make a presumptive diagnosis
- Response to adenosine is helpful in treatment and diagnosis of SVT
- Catheter ablation is an attractive option for patients with symptomatic SVT
Question 1

Which one is the most common form of narrow complex, regular tachycardia?

a) Atrial tachycardia
b) Accessory pathway mediated tachycardia
c) AV node reentrant tachycardia
d) Atrial fibrillation
Which one is the most common form of narrow complex, regular tachycardia?

a) Atrial tachycardia
b)Accessory pathway mediated tachycardia
c) AV node reentrant tachycardia
d) Atrial fibrillation
Question 2

What effect adenosine has in patients with atrial flutter with rapid ventricular response?

a) No effect on ventricular rate
b) Transient AV block allowing us to see flutter waves
c) Termination of atrial flutter
d) All of the above
Question 2

What effect adenosine has in patients with atrial flutter with rapid ventricular response?

a) No effect on ventricular rate
b) **Transient AV block allowing us to see flutter waves**
c) Termination of atrial flutter
d) All of the above
Question 3

A 26 year-old male admitted in the hospital for appendicitis, develops palpitations in the floor, the ecg is show. Patient vitals is stable, he just feels anxious.
Question 3

Which is the acute best treatment for his condition?

a) Electrical cardioversion
b) Verapamil 5 mg IV
c) Procainamide 1 gram IV
d) Amiodarone 150 mg IV
e) Adenosine 6 to 12 mg IV
Which is the acute best treatment for his condition?

a) Electrical cardioversion
b) Verapamil 5 mg IV
c) Procainamide 1 gram IV
d) Amiodarone 150 mg IV
e) Adenosine 6 to 12 mg IV
A 45 y/o female has been in the ER 3 times with palpitations, despite been on beta blockers. His ECG in your office is shown.
Question 4

Which is the best next step in his management?

a) Stop beta blocker, start flecainide 100 mg TID
b) Add digoxin 0.125 mg PO daily
c) Refer for EPS/Ablation
d) Reassure patient that he will not die with this condition
Which is the best next step in his management?

a) Stop beta blocker, start flecainide 100 mg TID
b) Add digoxin 0.125 mg PO daily
c) Refer for EPS/Ablation
d) Reassure patient that he will not die with this condition
You administer adenosine to the following arrhythmia and immediately terminates converting to sinus rhythm.
Question 5

Which of the following statements about this rhythm is correct?

a) This rhythm cannot be atrial tachycardia
b) If the baseline ECG in sinus rhythm has a delta wave, I should not have given adenosine as he could go into VF

c) The rhythm is atrial flutter

d) The AV node is most likely part of the arrhythmia circuit
Question 5

Which of the following statements about this rhythm is correct?

a) This rhythm cannot be atrial tachycardia
b) If the baseline ECG in sinus rhythm has a delta wave, I should not have given adenosine as he could go into VF
c) The rhythm is atrial flutter
d) The AV node is most likely part of the arrhythmia circuit
THANKS