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HIGH-RISK EMERGENCY MEDICINE

Challenging Cardiovascular Cases

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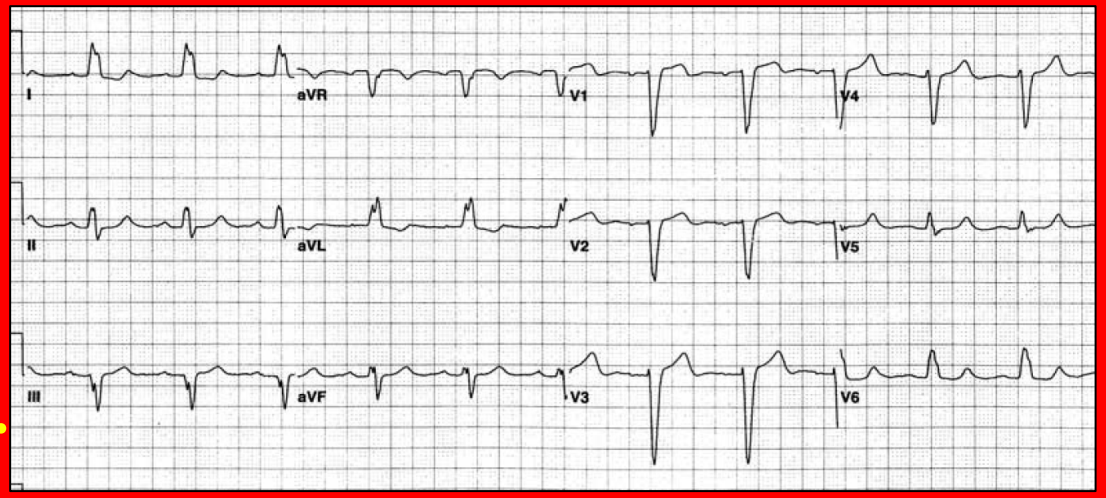
Case #1

59 Male with Chest Pain

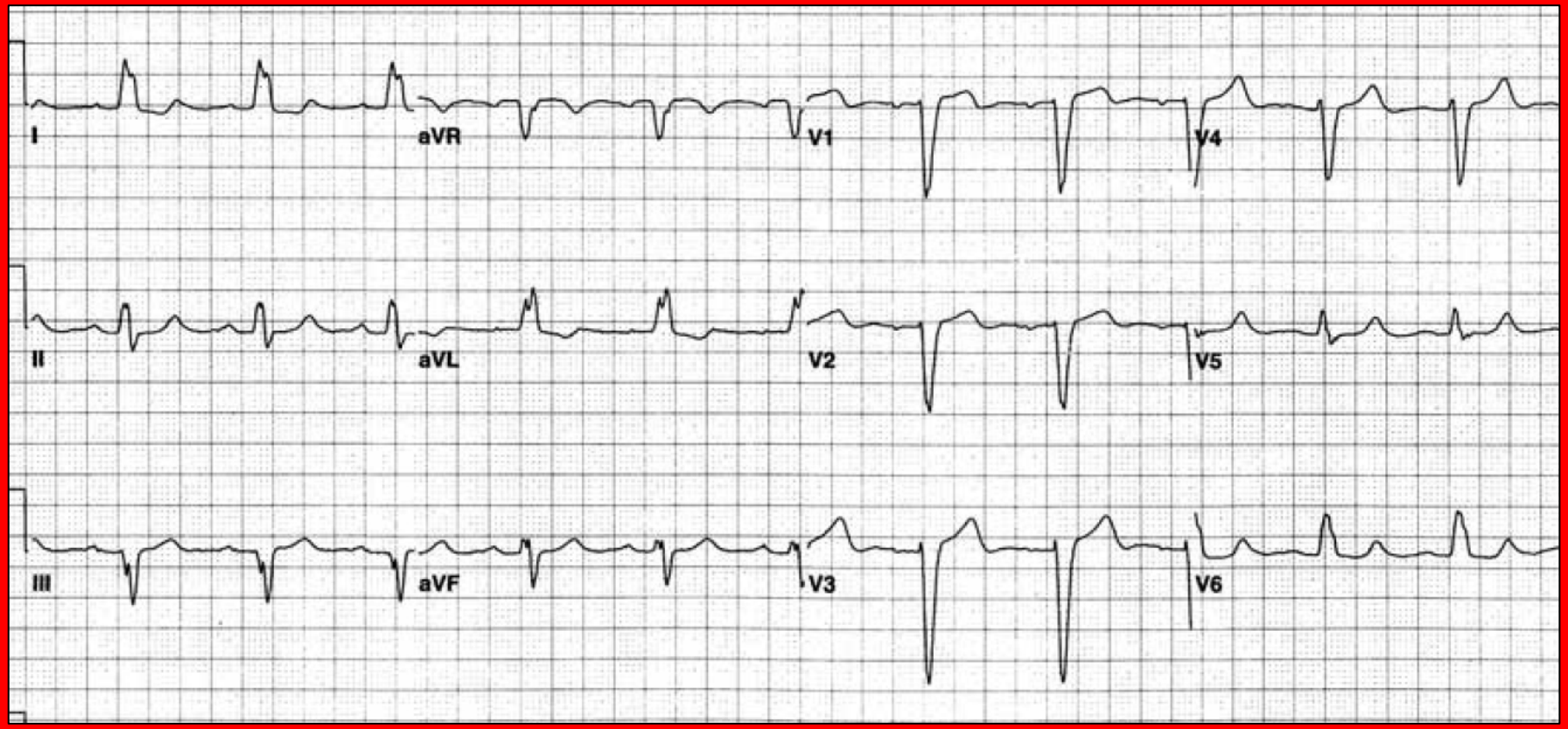
90/70, 75, 24, 37, 92% (4l O_2)

- EMS enroute with patient in VT …spontaneous conversion prior to arrival
- PMH: CAD, MI, DM
- Alert, pale, & diaphoretic pulmonary edema noted
- ECG……



Case #1

59 Male with Chest Pain & Recent NSVT



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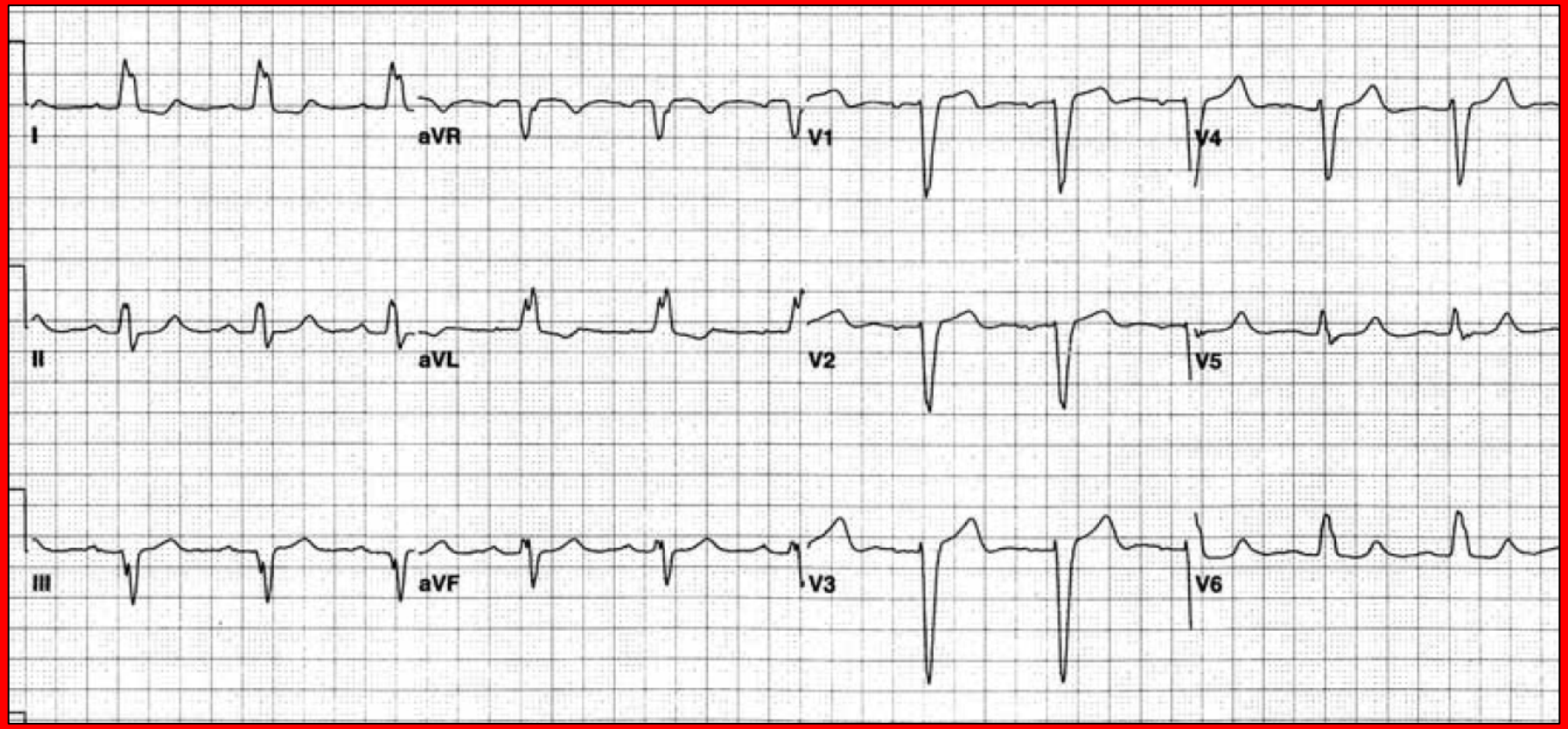
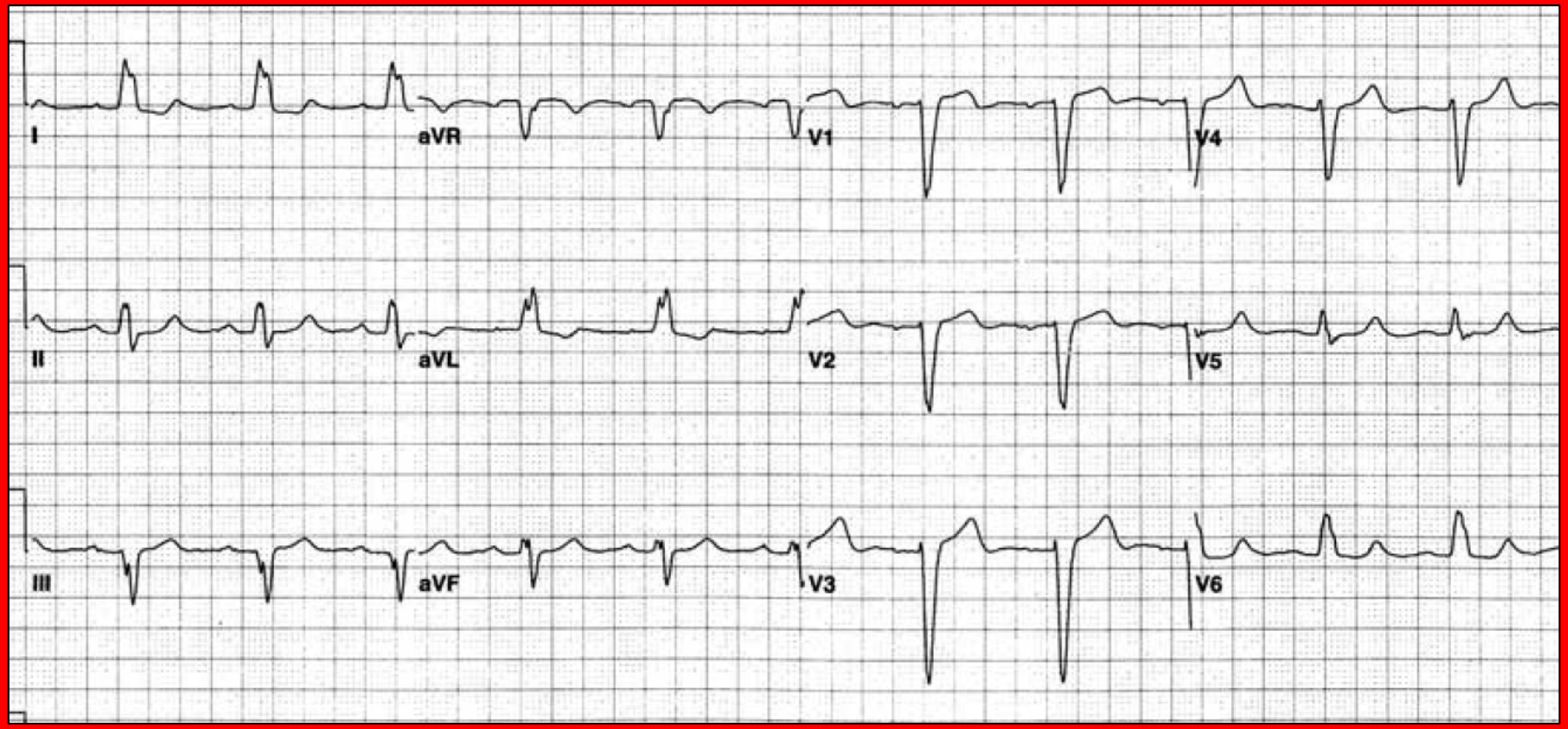


sinus rhythm with LBBB & anticipated ST/T configurations

Case #1

59 Male with Chest Pain & Recent NSVT



...so no ECG evidence of AMI

This guy is sick, right?

No Modified Sgarbossa criteria

Is the LBBB old or new? Does that matter?

What’s next?

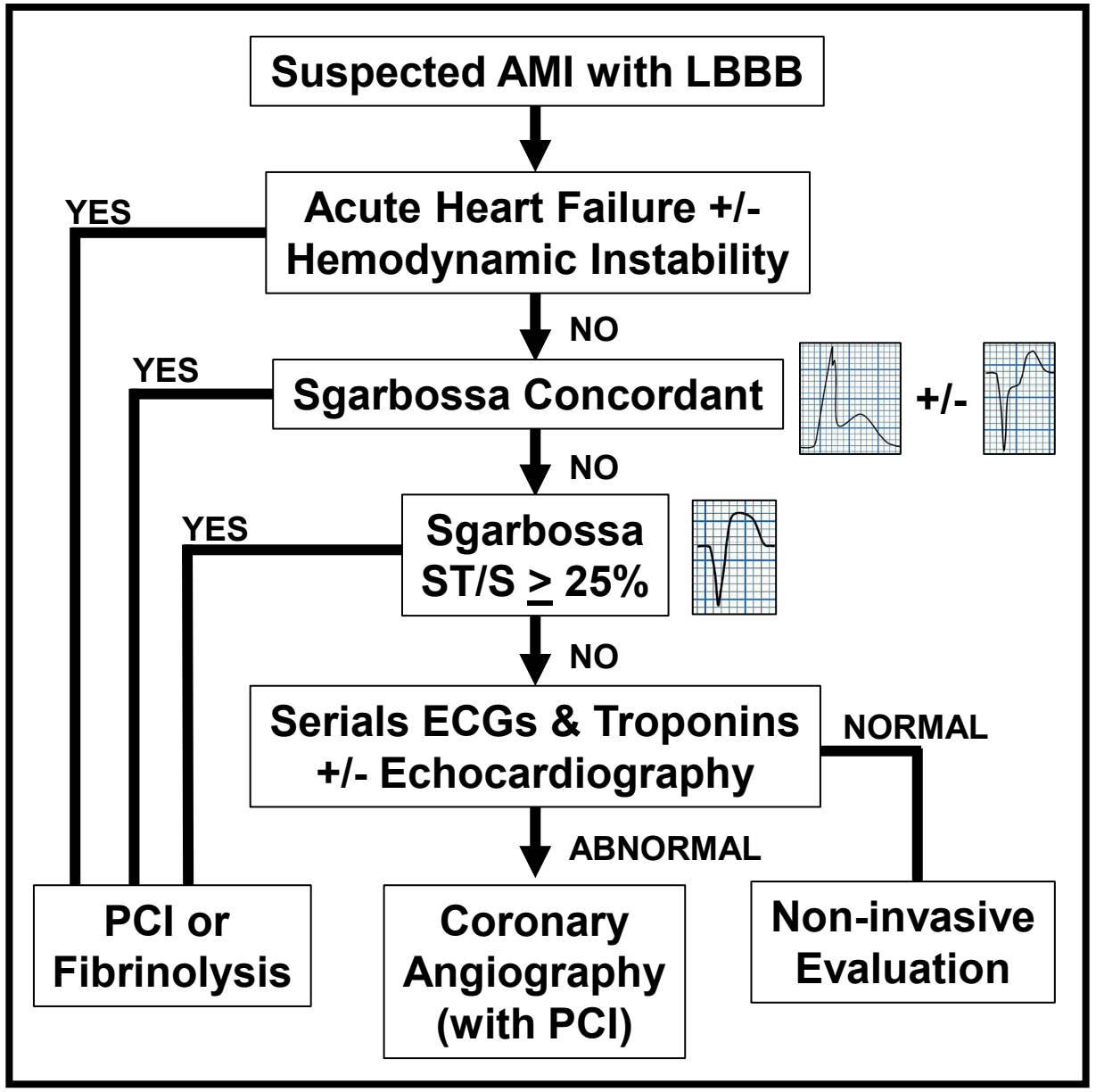
Challenge of AMI Diagnosis with LBBB

- **Confounds ECG diagnosis of AMI**
  - *Magnitude unknown*
  - *Large % LBBB AMI "not initially detectable" by ECG*
- **Mimics STEMI**
  - *Most common cause of ST elevation in ACS-suspected patients*
  - *Most frequent "pseudo-infarct" pattern*
- **Associated higher CV risk**
  - *Pre-existing or new LBBB*
  - *Larger AMI with lower EF*
  - *3 AVB, VT/VF, cardiogenic shock, & death more frequent*

Challenge of AMI Diagnosis with LBBB

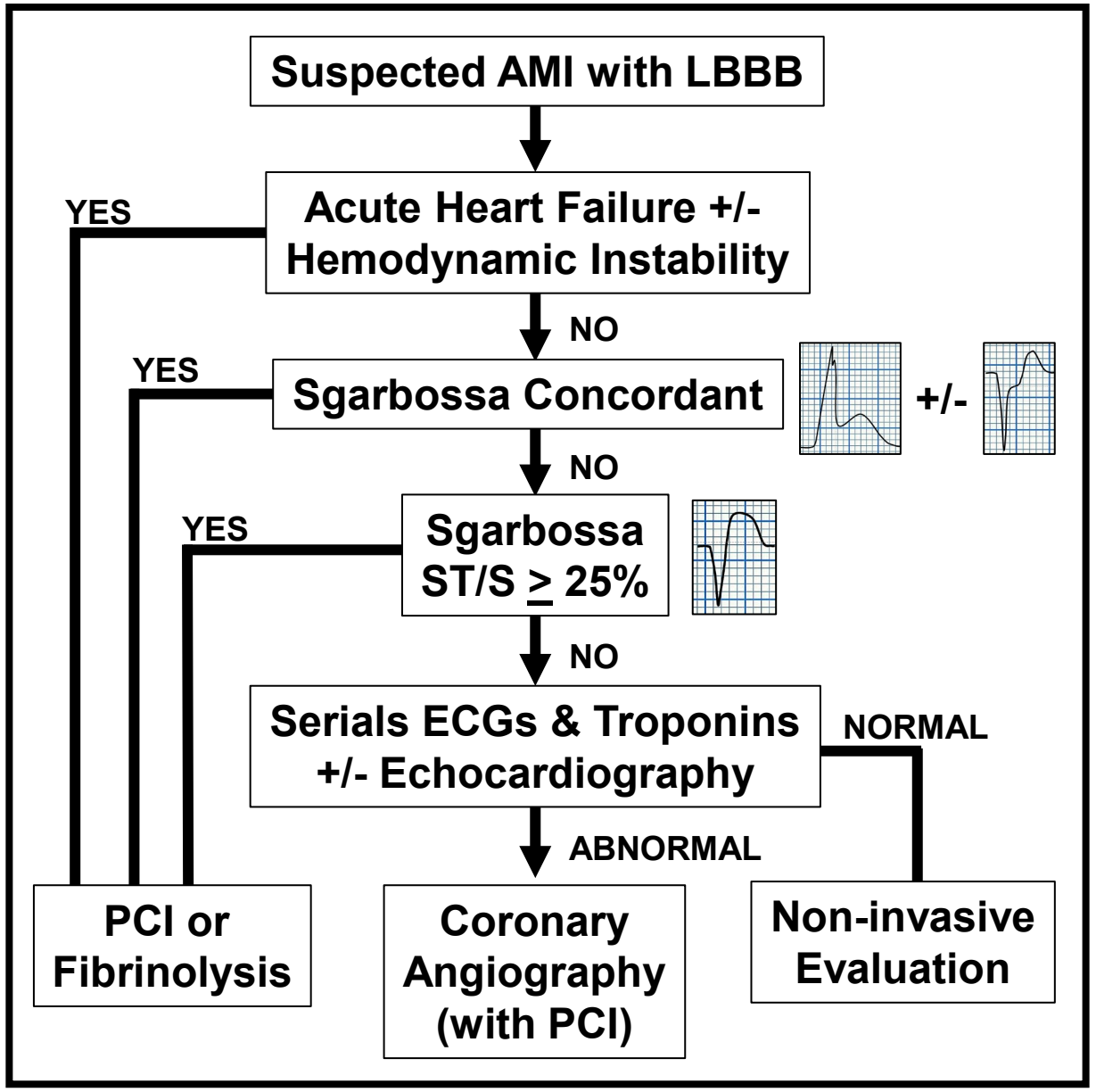
- **Extremely high-risk ACS presentation**
- **Patients benefit significantly from aggressive therapy**
- **Yet, diagnosis is frequently delayed & time-to-treatment commonly prolonged**
- **Much to gain but also much to lose**
- **EM determines early diagnostic & management approach**

How do we optimize early diagnosis & treatment?



Cai Q et al: The left bundle-branch block puzzle in the 2013 ST-elevation myocardial infarction guideline: From falsely declaring emergency to denying reperfusion in a high-risk population. Are the Sgarbossa Criteria ready for prime time? Am Heart J 2013

A Rational Approach to Suspected AMI in LBBB Patient



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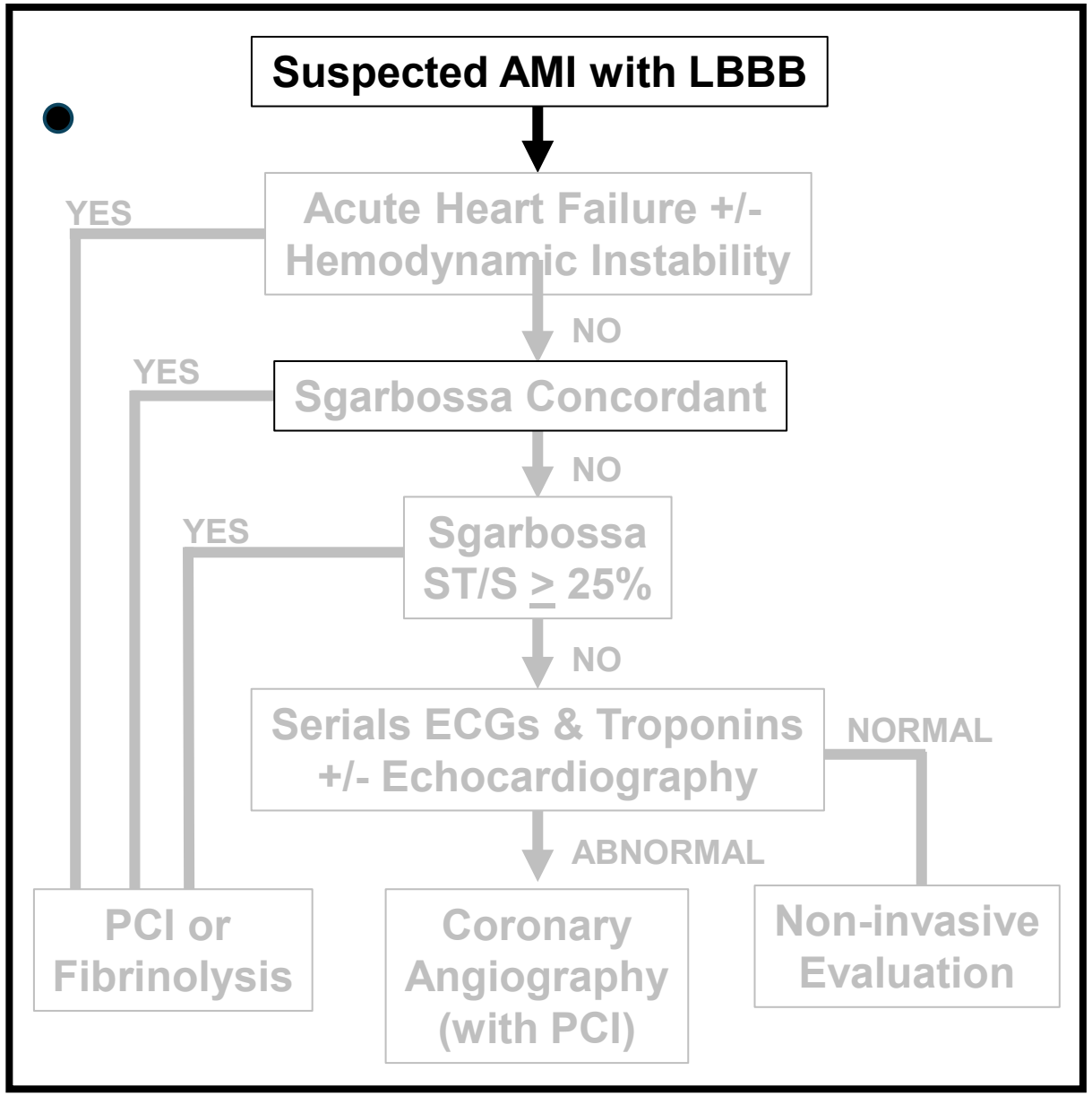
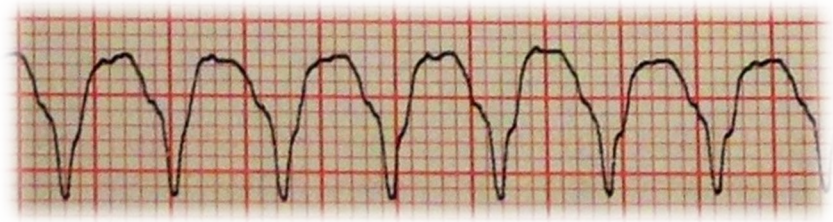
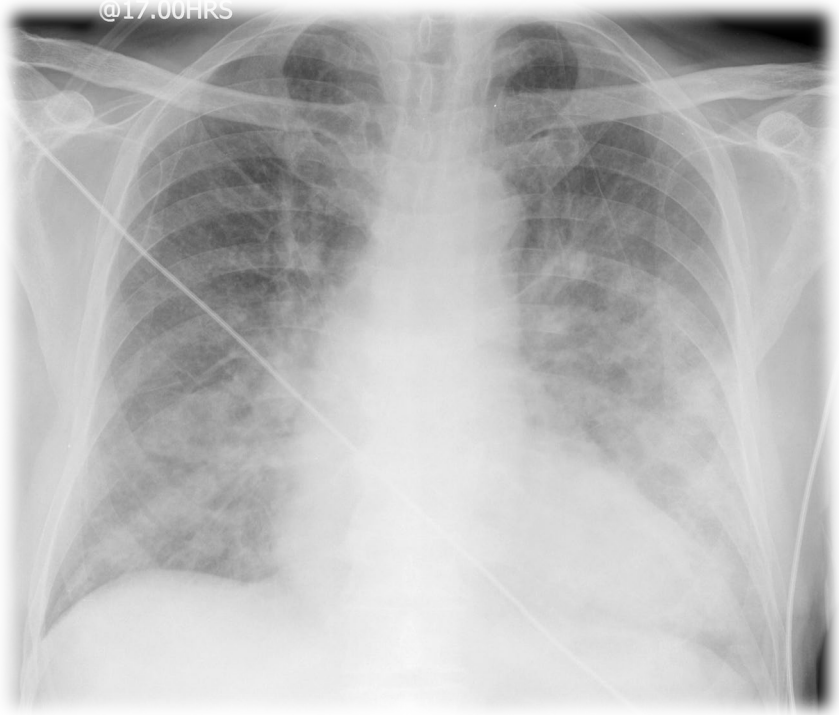
Clinical Presentation consistent with AMI

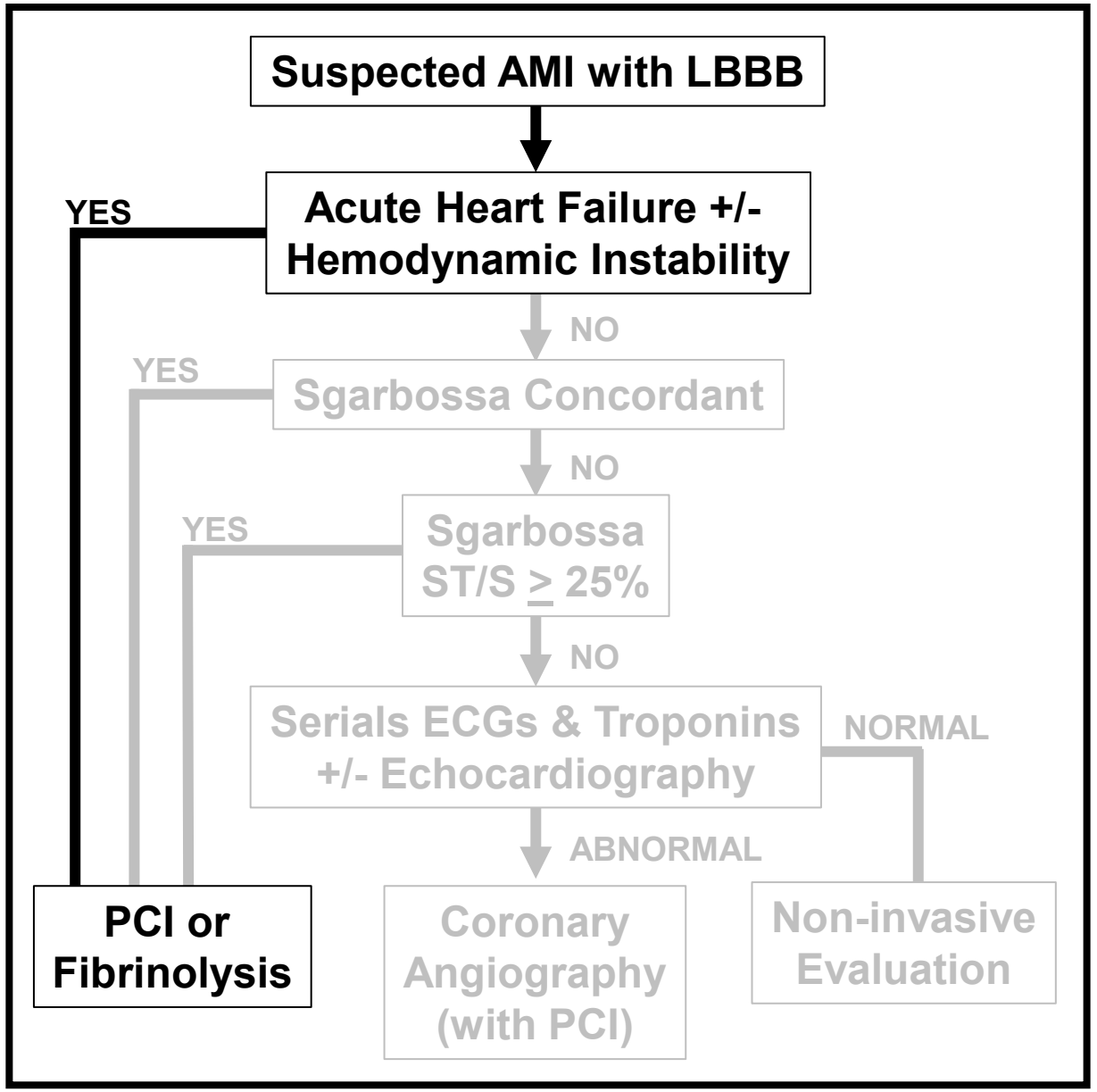


Cai Q et al, Am Heart J, 2013



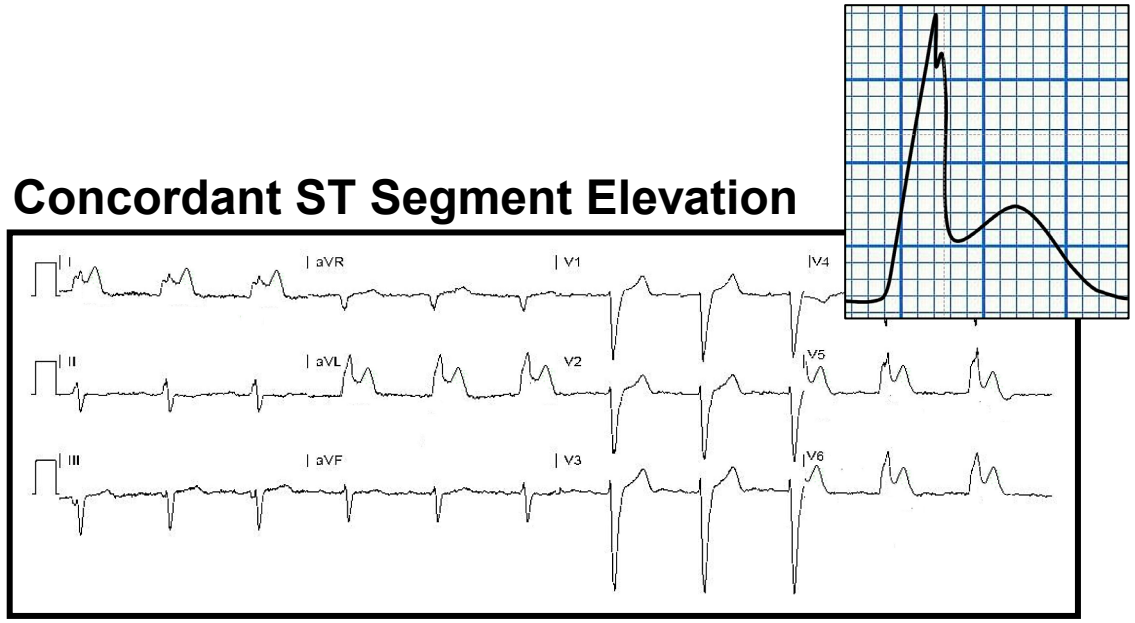
BP 70/40 mmHg



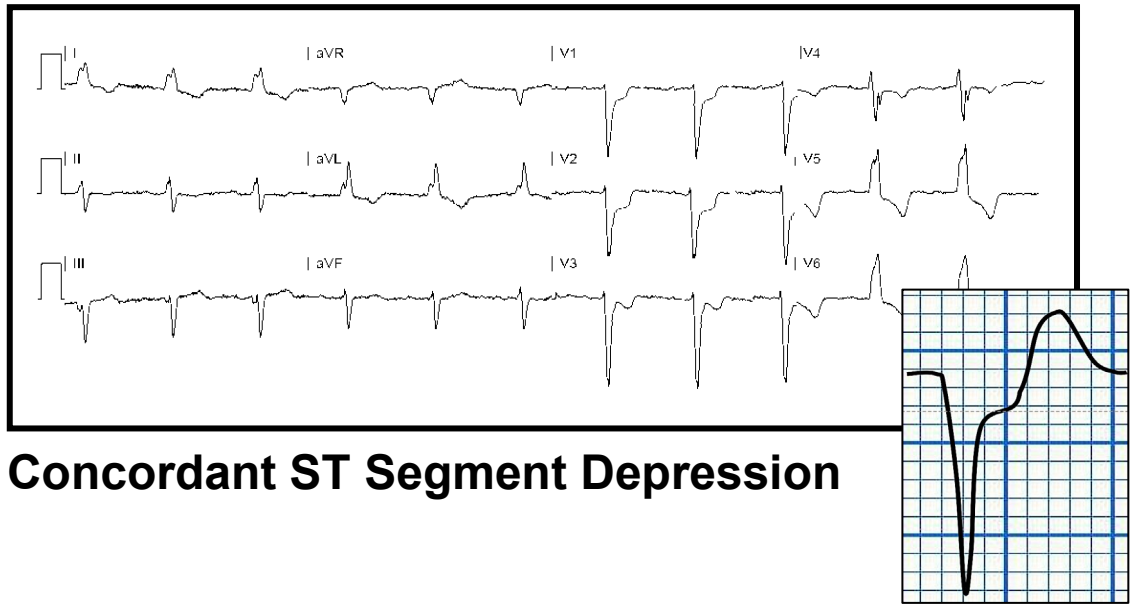


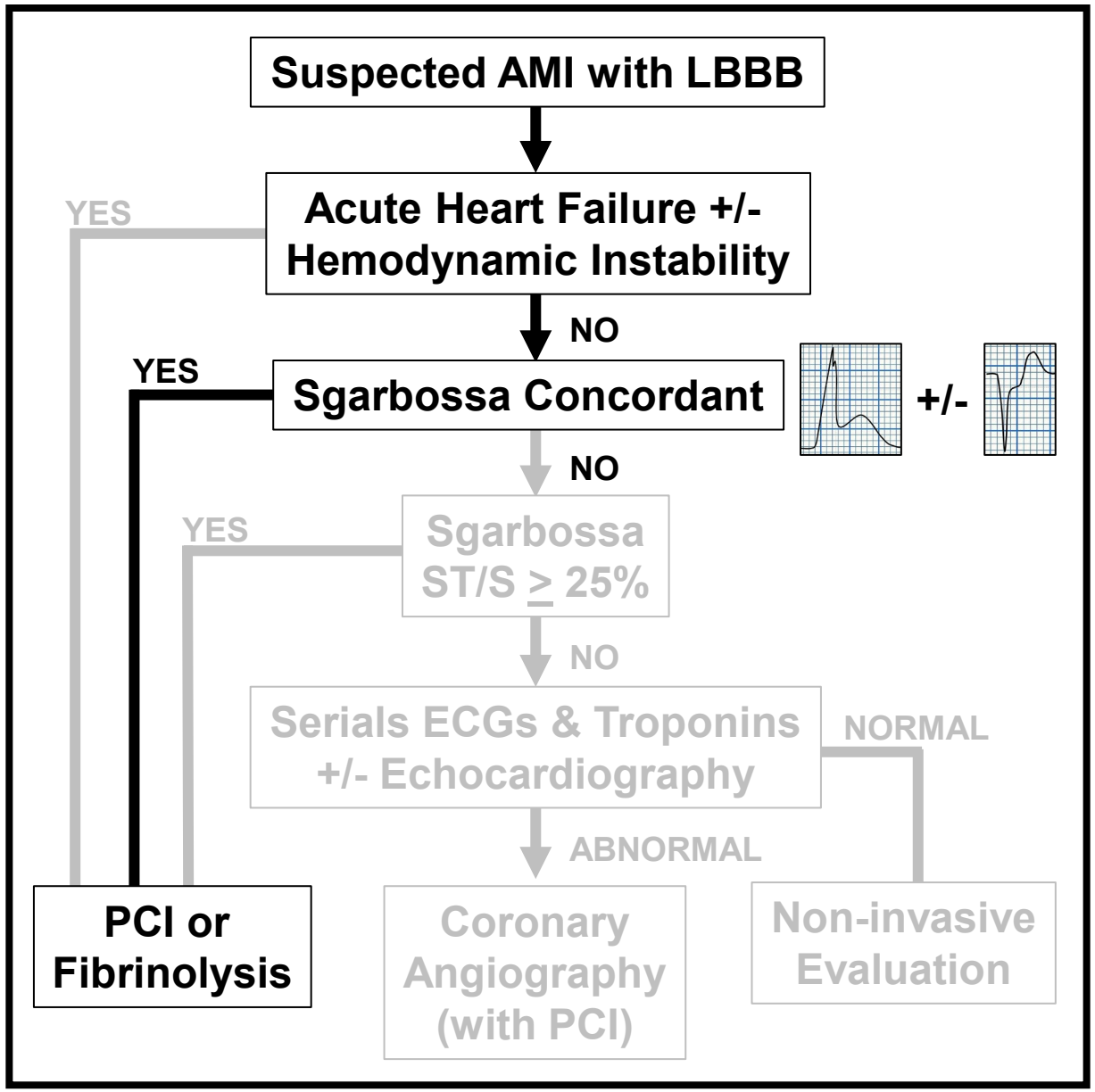
Cai Q et al, Am Heart J, 2013

Concordant ST Segment Elevation



Concordant ST Segment Depression





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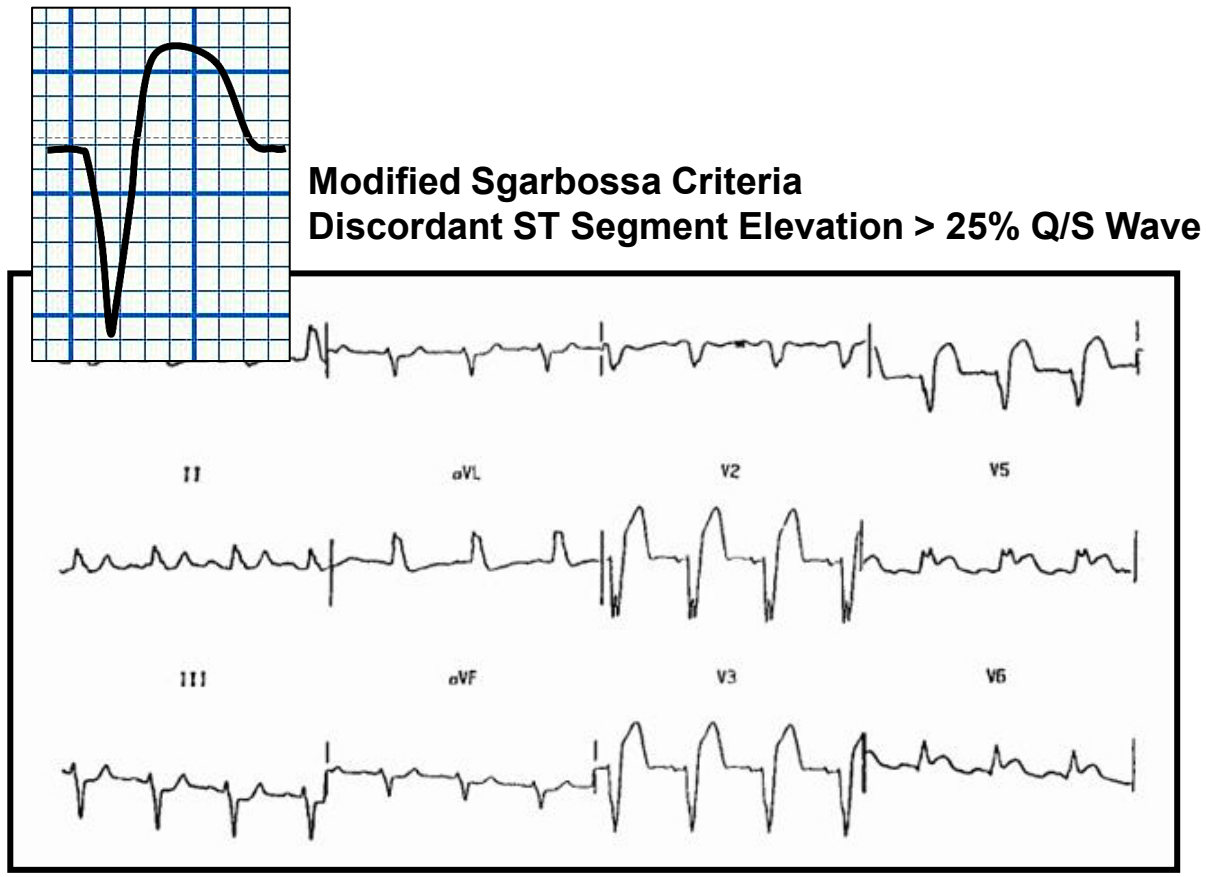

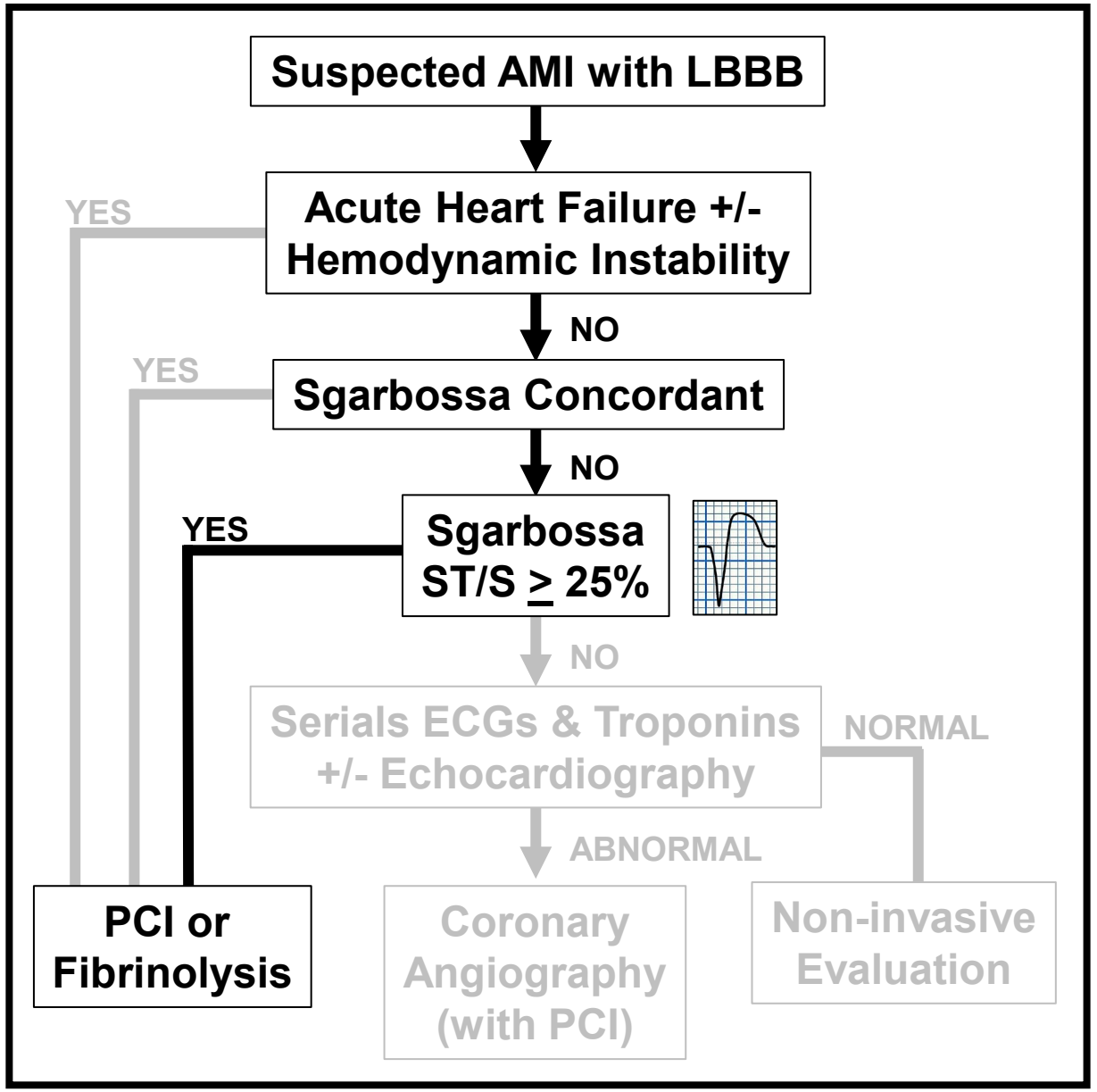

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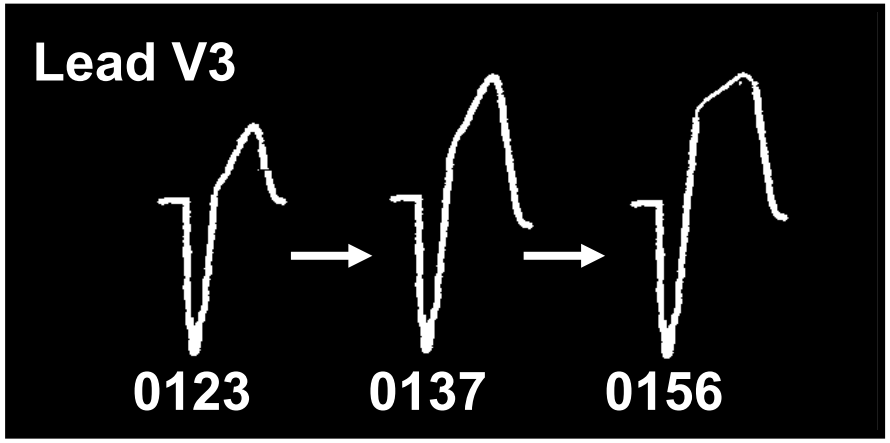
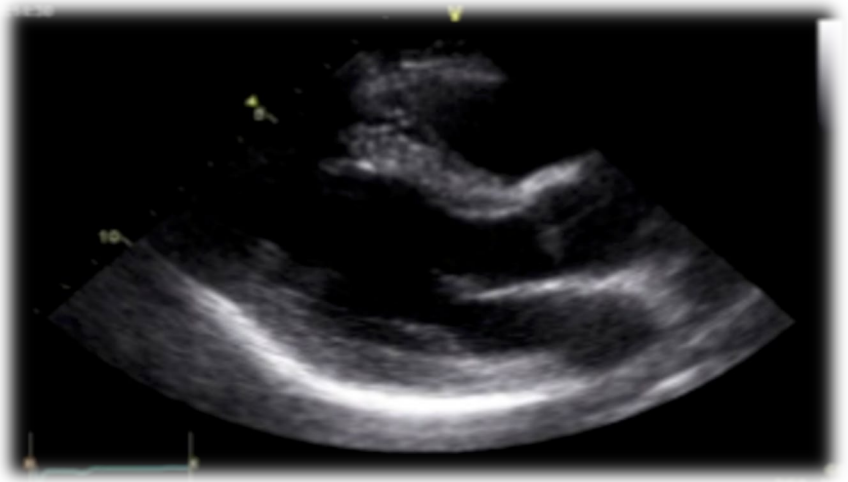
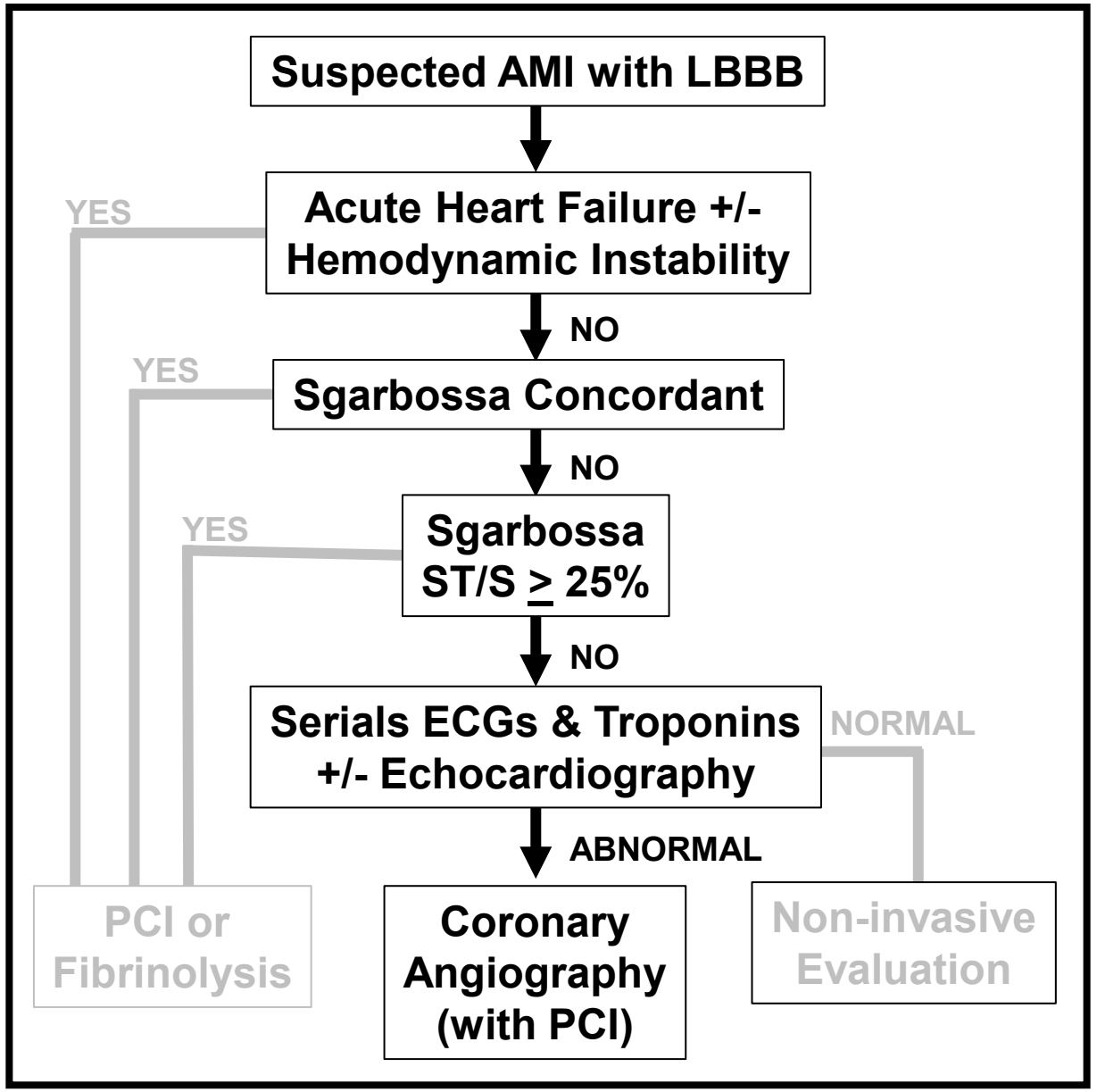


Troponin Trending

4.1 --- 15.6 --- 59.3…





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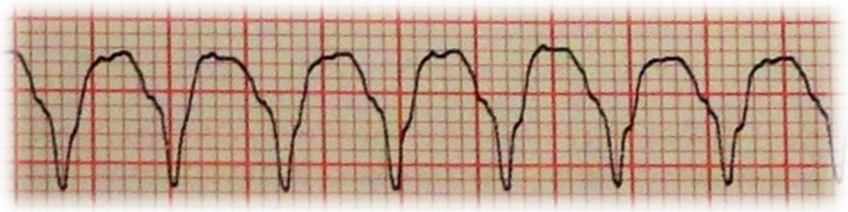

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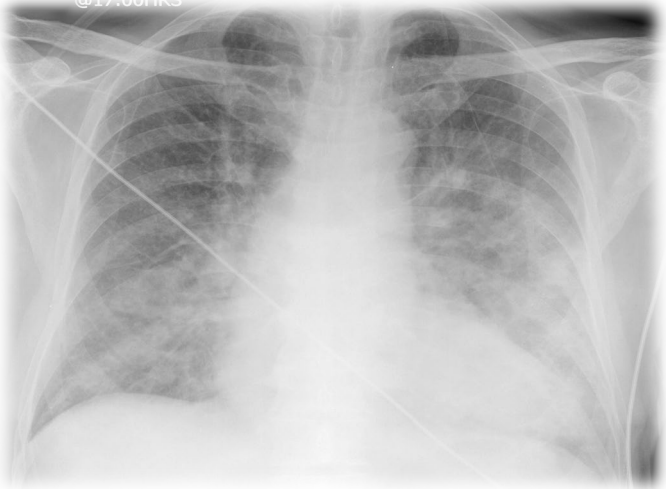
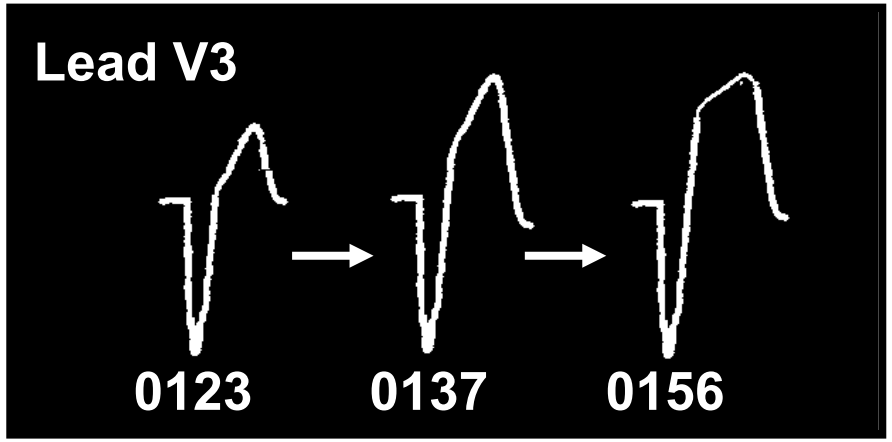
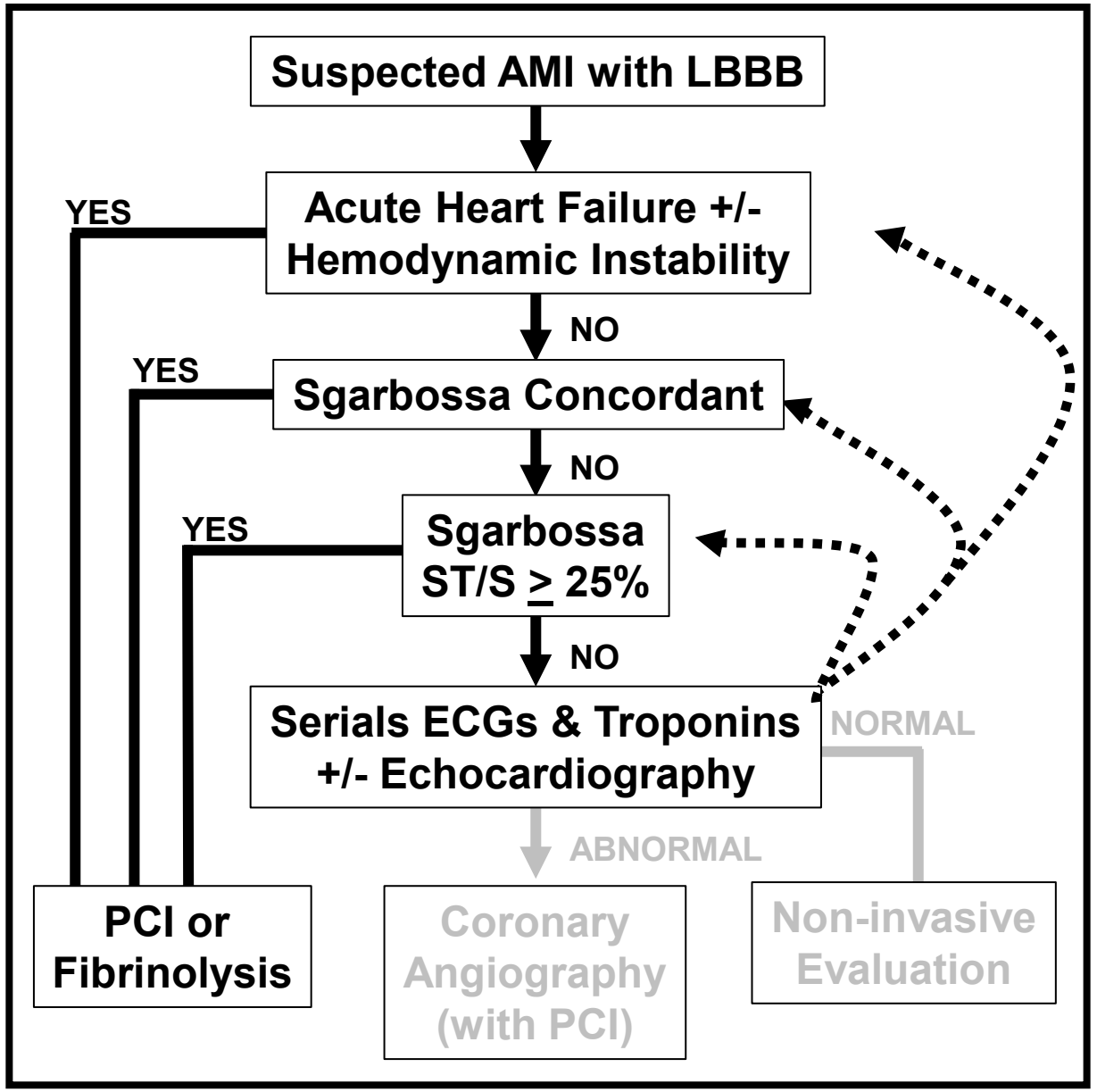
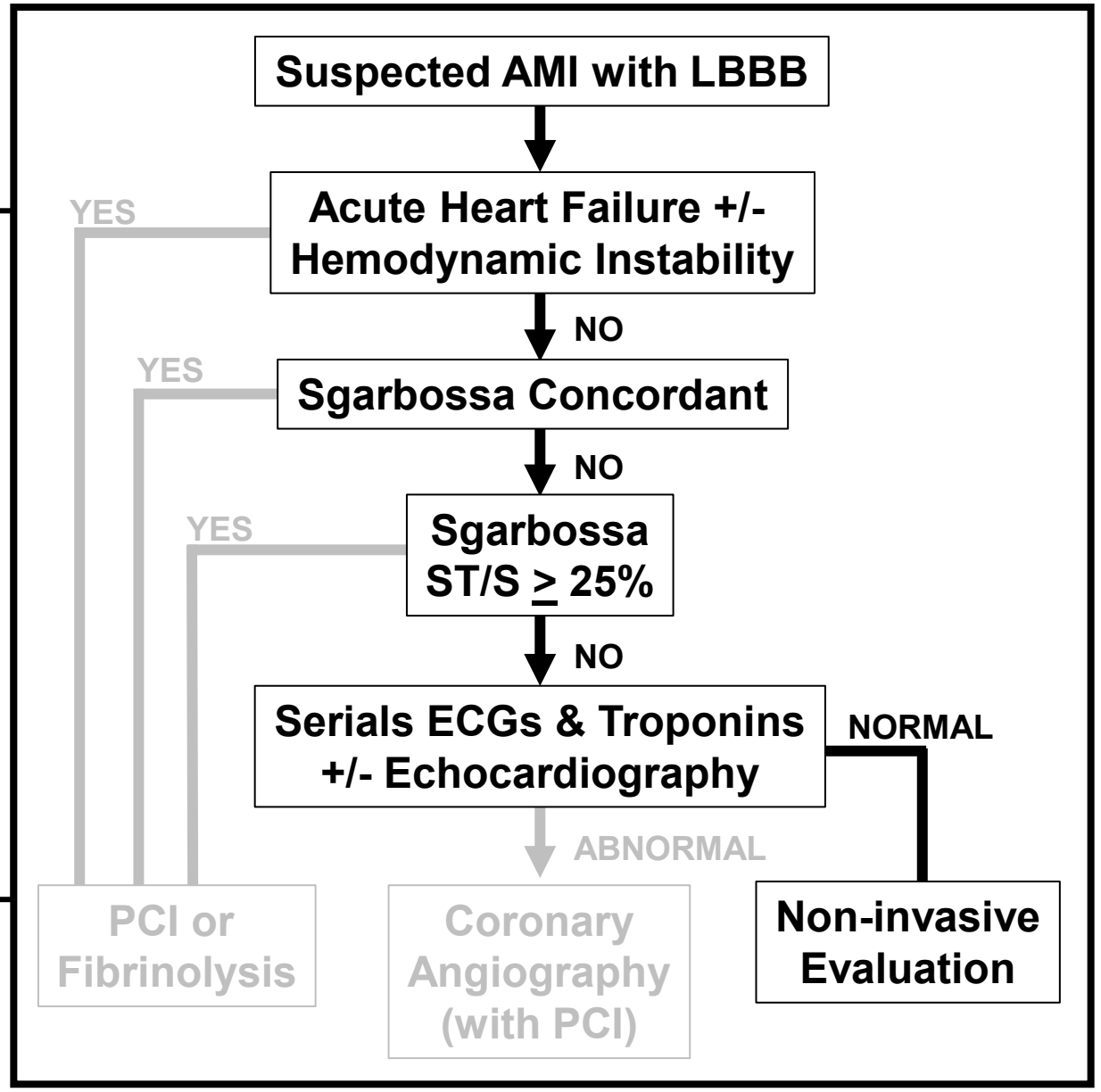






Cai Q et al, Am Heart J, 2013

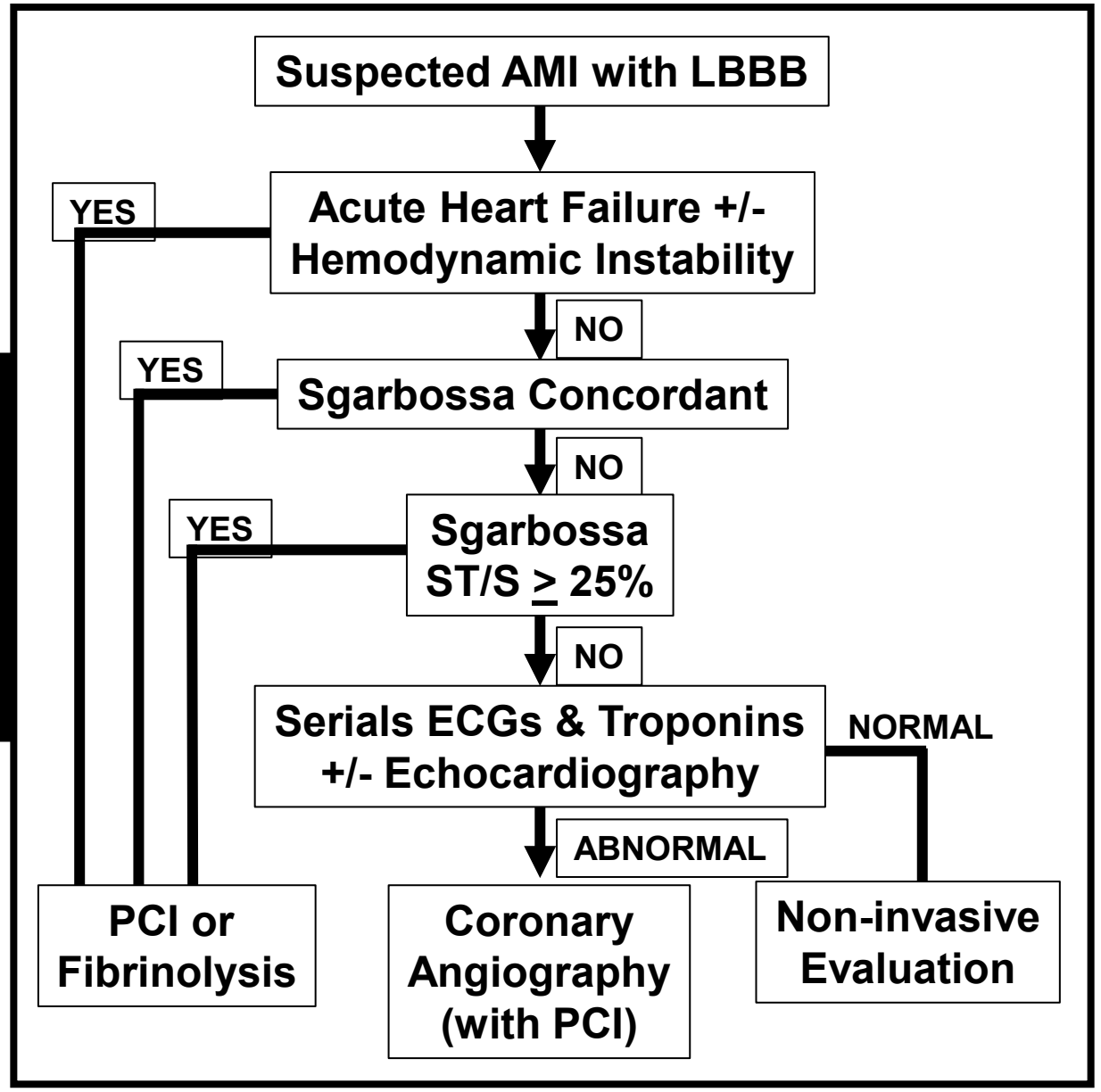
- **Further evaluation necessary?**
- **Non-invasive evaluation**
  - Stress nuclear
  - Echocardiography
  - Coronary CT angiography
- **Cardiac catheterization**
- **Consideration of alternative diagnoses**



Cai Q et al, Am Heart J, 2013

Additional considerations

- hsTrp testing
- Barcelona criteria
- Coronary CT angiography



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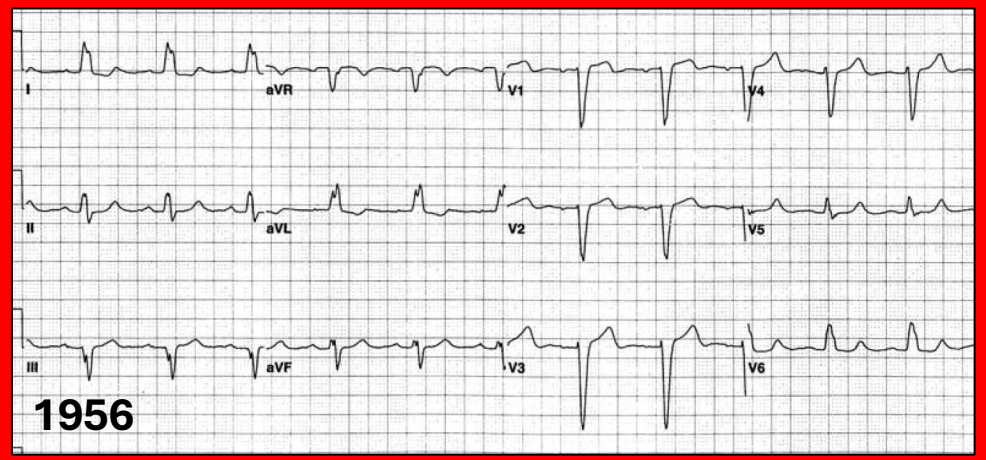
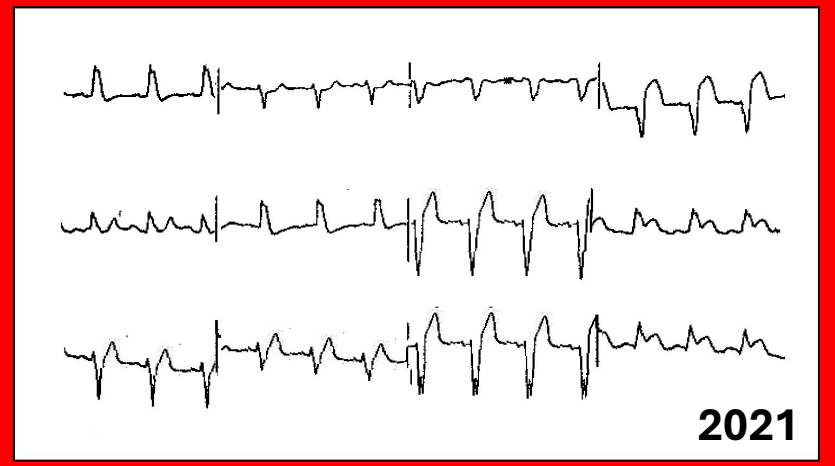
Case #1

Continued Chest Pain …Serial ECGs





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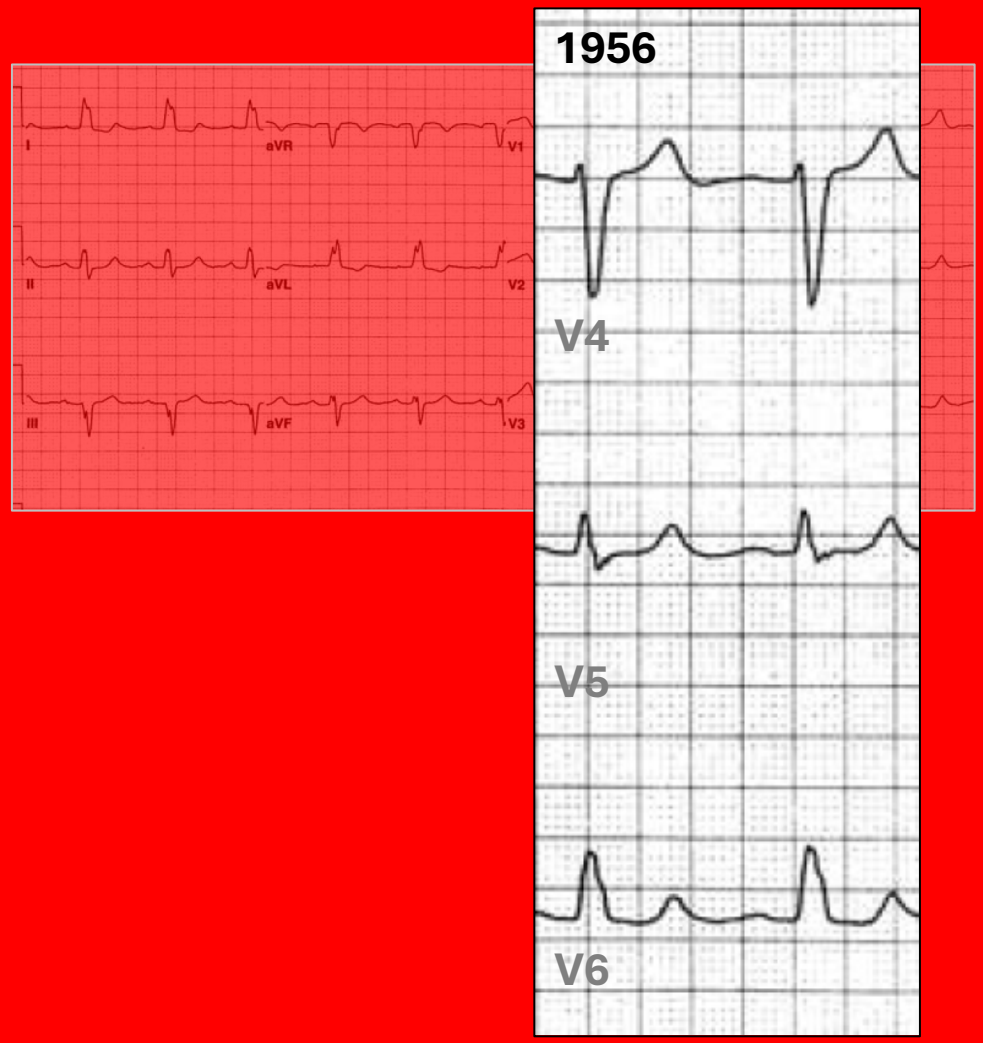
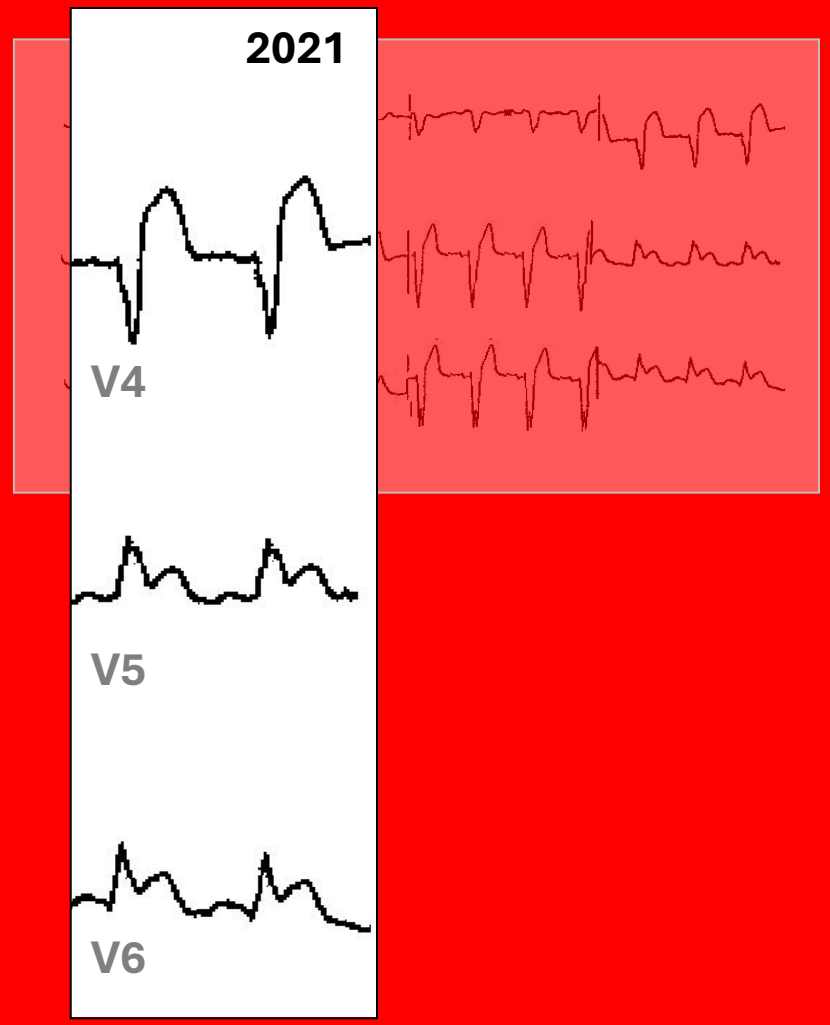
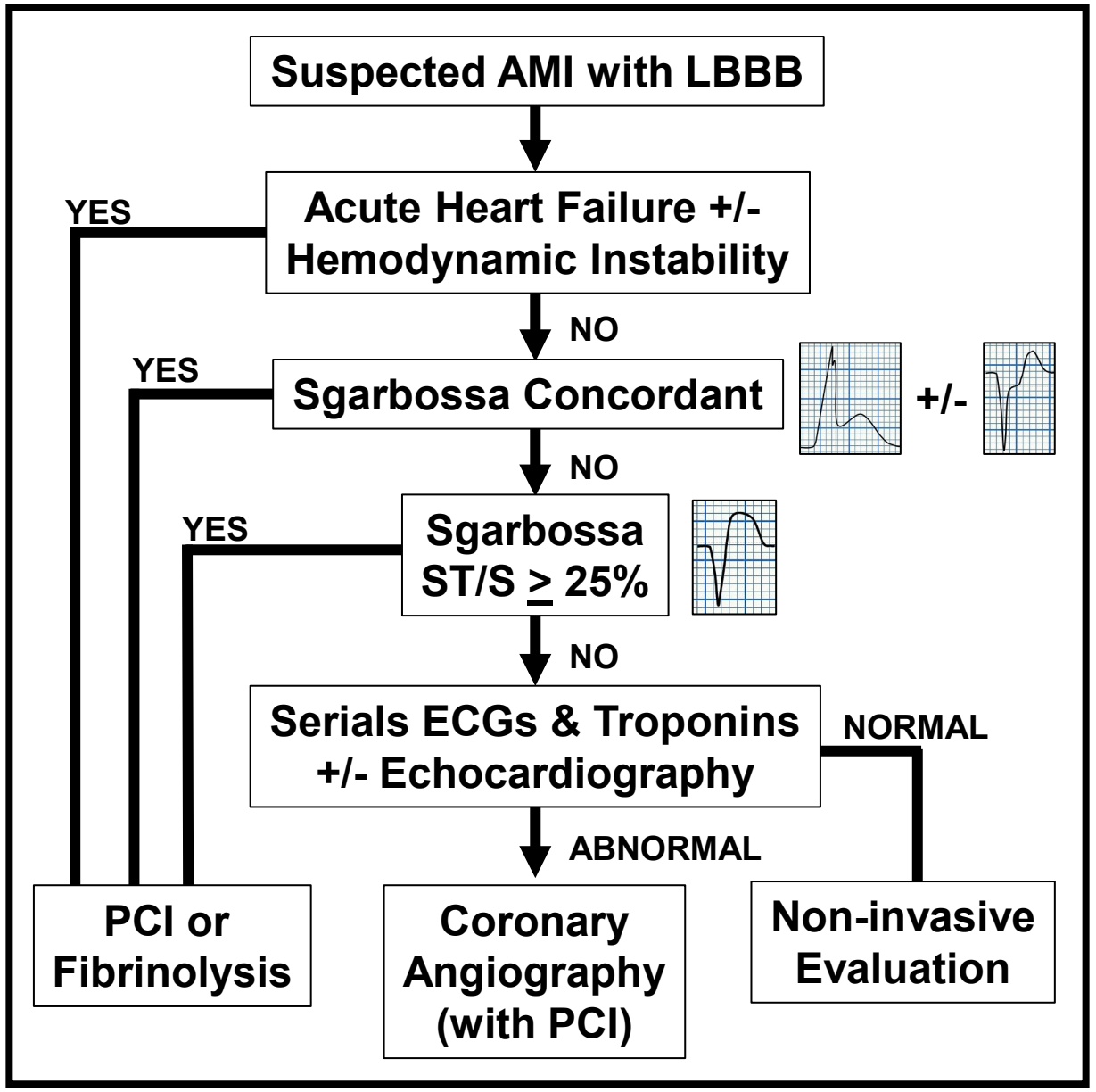




A Rational Approach to Suspected AMI in LBBB Patient



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What should you do with the patient <u>strongly suspected of AMI</u> with LBBB that is…

…Sgarbossa-positive? **Treat for AMI, whether new or pre-existing LBBB**

…Sgarbossa-negative? **Pursue AMI DX via other means, whether new or pre-existing LBBB**

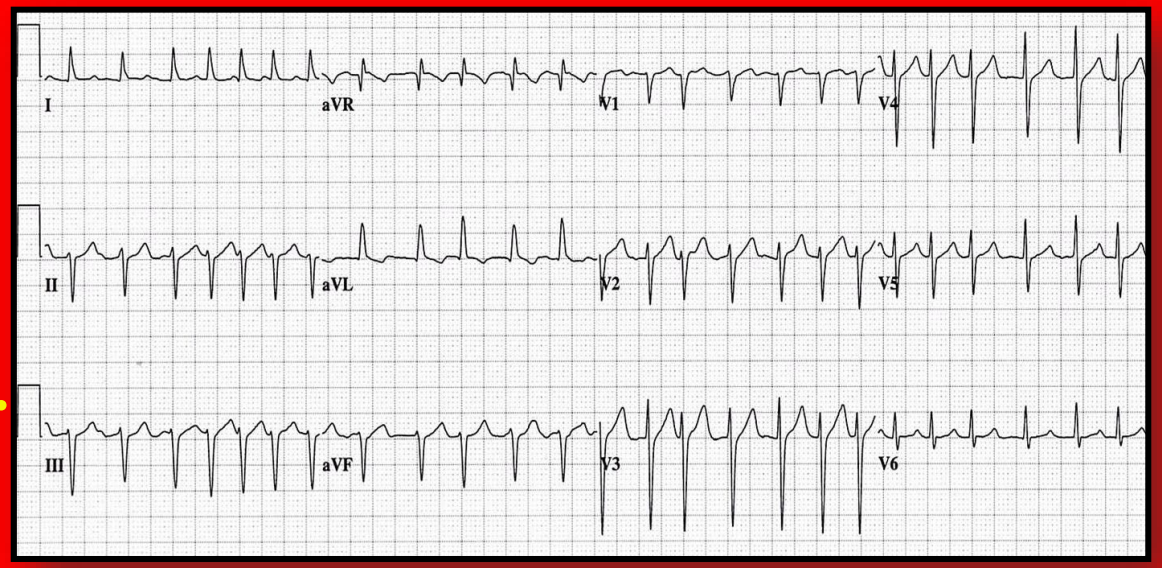
…new onset? **If Sgarbossa negative, pursue AMI DX via other means**

…pre-existing? **If Sgarbossa negative, pursue AMI DX via other means**

Case #2

68 Female with Fever & Tachycardia

- Right flank pain with N/V, fever, & dysuria for 3 days
- PMH: HTN, Paroxysmal Afib, DM
- Alert & ill-appearing -- 125/74, 163, 20, 39.1, 97% RA
- Right CVAT
- UA UTI
- ECG.....



- WBC 19
- Lactate 5.1

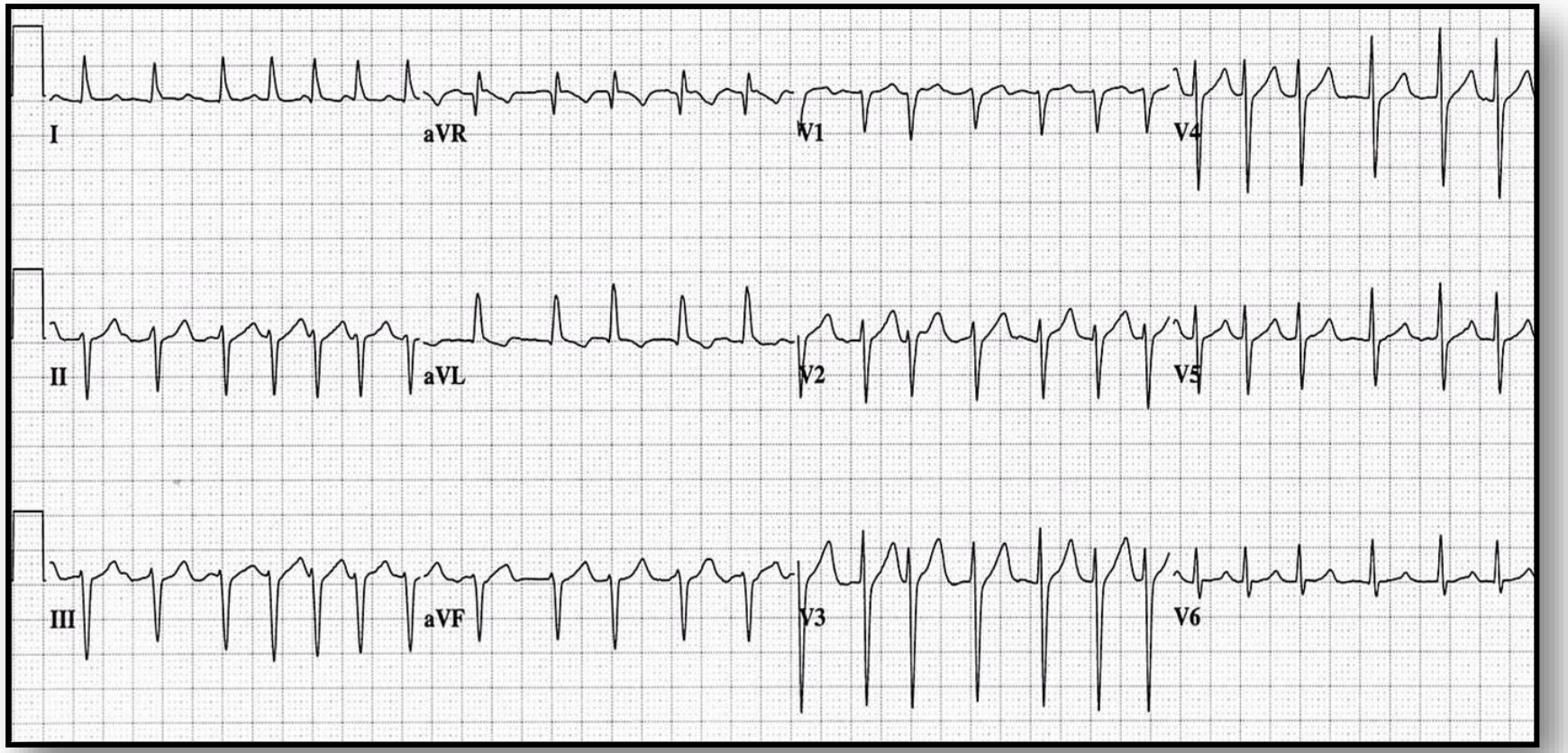
She’s sort of sick …but it’s just Afib with RVR, right?

Diltiazem or metoprolol IV …which one Doctor?

Atrial Fibrillation

- **2nd most common NCT seen in ED & ICUs**
- **Variable heart history**
  - Young adult with “holiday heart” – not common
  - Middle-aged adult – “lone” afib, increasingly common
  - Older adult with heart disease – most common
- **Pathophysiologic issues**
  - Rapid ventricular response
  - Loss of atrial “kick” -- contribution to cardiac output
  - Thromboembolism – stroke, ischemic limb / viscera

Atrial Fibrillation



Rapid.....Irregularly Irregular.....No P Waves.....Narrow QRS Complex

Atrial Fibrillation

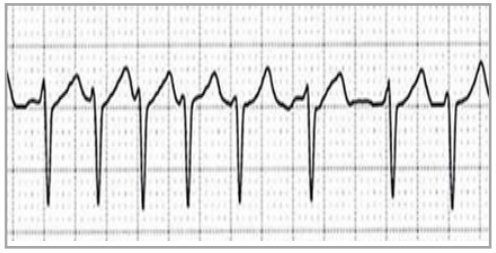
- **Diagnosis & treatment usually straightforward**
  - If tachycardic & unstable, synchronized cardioversion with sedation
  - If tachycardic & stable, rate control

- **What happens if another medical issue is simultaneously occurring …*& the situation is complex*?**

Complex Atrial Fibrillation

Atrial Fibrillation with RVR + **Other Pathologic Physiologic Stressor** = **Complex Atrial Fibrillation**

Example



+ **Urosepsis with Septic Shock** = **Atrial Fibrillation in Complex Clinical Scenario**

ED Course

- Urosepsis - IV fluids & antibiotics
- Heart rate declines to ~130
- Hospitalist asks you to order IV diltiazem …you politely disagree …admitted to hospitalist service
- BP gradually declines …88/62 & patient is lethargic
- Somebody says “We need to shock her!”

Now, she’s really pretty sick, right?

Diltiazem or metoprolol IV?

Or let’s just shock her now, right?

Complex Atrial Fibrillation

- **Recognize critical illness with complex needs**
  - The rhythm

    and
  - Physiologically stressful medical event

- **Focus on resuscitation with <u>different</u> <u>short-term</u> goals**
  - Treat underlying issue(s)
  - Hold on cardioversion & rate control, at least for now

Complex Atrial Fibrillation

CARDIOLOGY/ORIGINAL RESEARCH

Emergency Department Patients With Atrial Fibrillation or Flutter and an Acute Underlying Medical Illness May Not Benefit From Attempts to Control Rate or Rhythm

- **416 patients with AF -- rate vs rhythm control & adverse event**

- **Adverse effect: 55/135 (41%) in rate/rhythm Rx vs 20/281 (7%) in non-rate/non-rhythm Rx**

Scheuermeyer FX et al, Ann EM 2015;65:511

Complex Atrial Fibrillation

CARDIOLOGY/ORIGINAL RESEARCH

Emergency Department Patients With Atrial Fibrillation or Flutter and an Acute Underlying Medical Illness May Not Benefit From Attempts to Control Rate or Rhythm

Strategy	Adverse Event Rate	Success
Rate / Rhythm Control (#135)	**41%**	**18%** **19% rate** **13% rhythm**
Supportive Therapy (#281)	**7%**	**NA**

Scheuermeyer FX et al, Ann EM 2015;65:511

Complex Atrial Fibrillation

CARDIOLOGY/ORIGINAL RESEARCH

Emergency Department Patients With Atrial Fibrillation or Flutter and an Acute Underlying Medical Illness May Not Benefit From Attempts to Control Rate or Rhythm

"In ED patients with complex atrial fibrillation…

…attempts at rate & rhythm control are associated with a nearly 6-fold higher adverse event rate than that for patients who are not managed with rate or rhythm control

…success rates of rate or rhythm control attempts appear low."

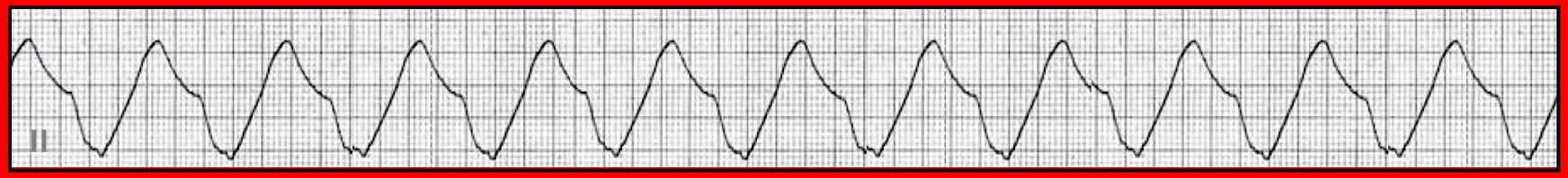
Scheuermeyer FX et al, Ann EM 2015;65:511


EMS 11
FIRE RESCUE
ALBEMARLE COUNTY

Case #3

33 Male with N/V & Lethargy

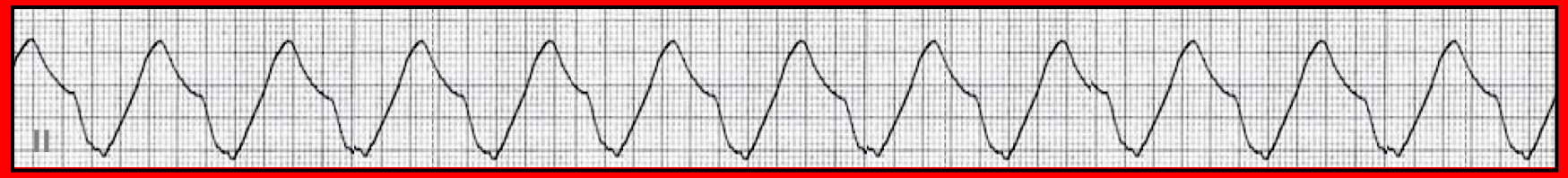
unknown medical history

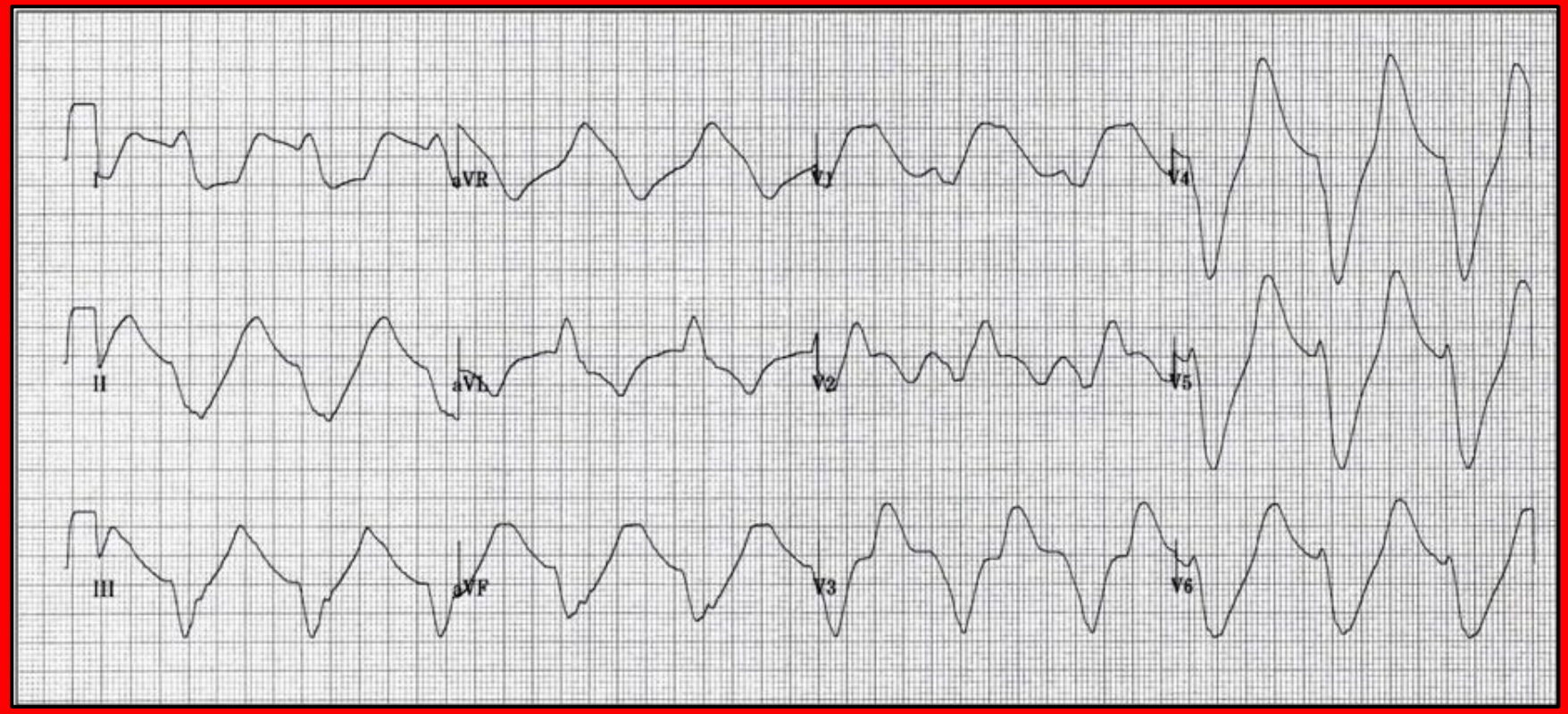


Case #3

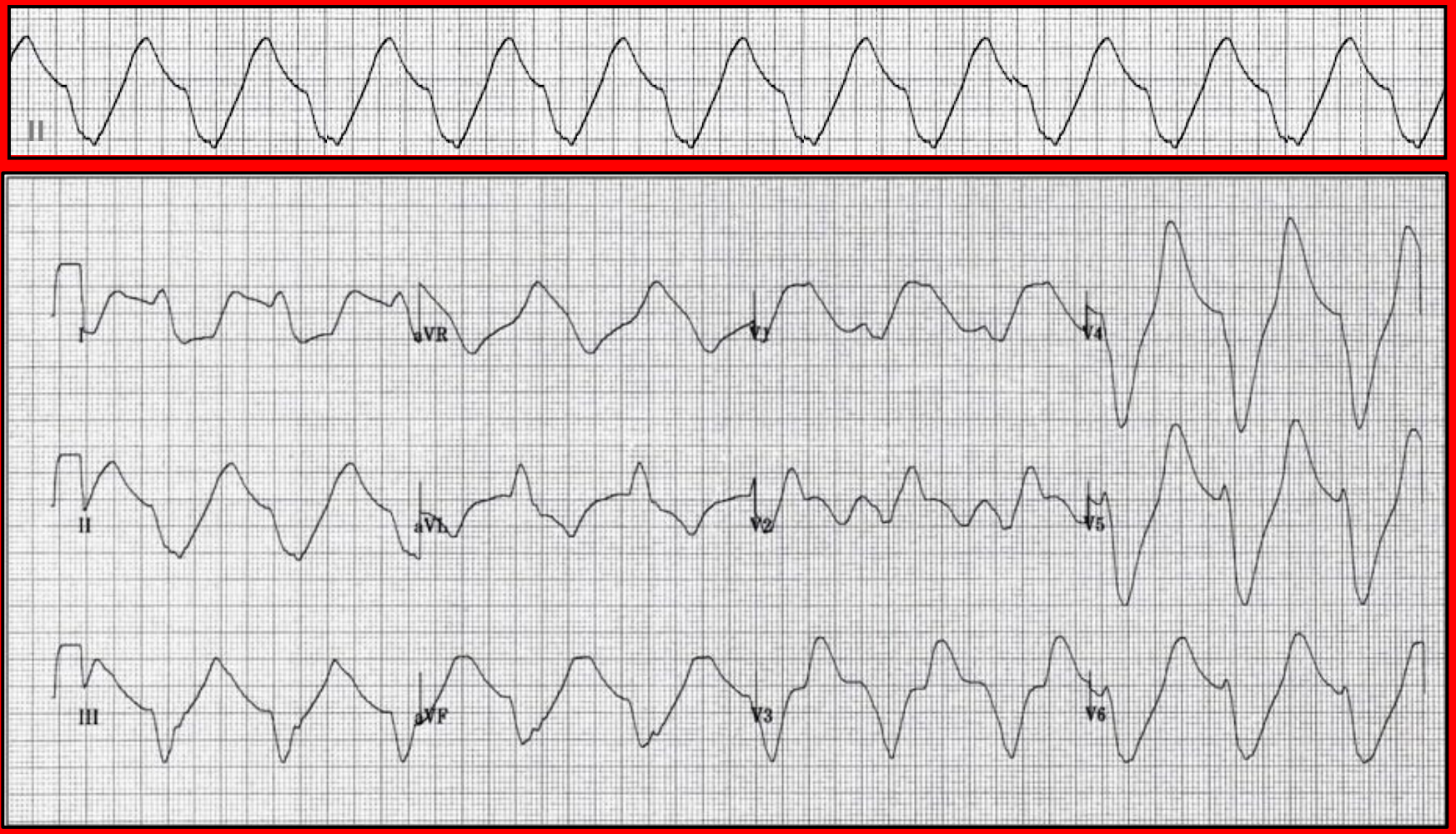
33 Male with N/V & Lethargy

unknown medical history

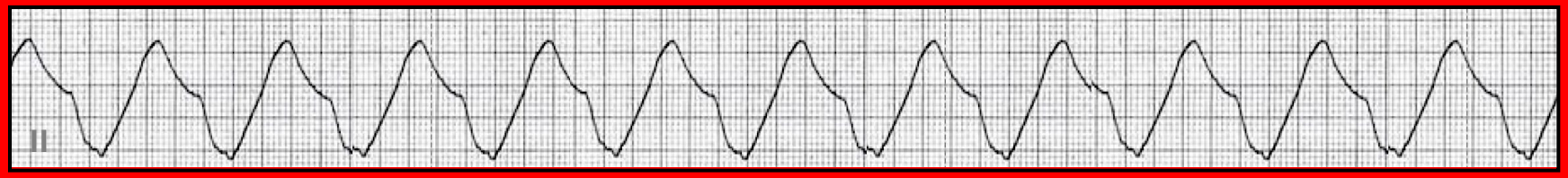




OK, really, really wide but not fast



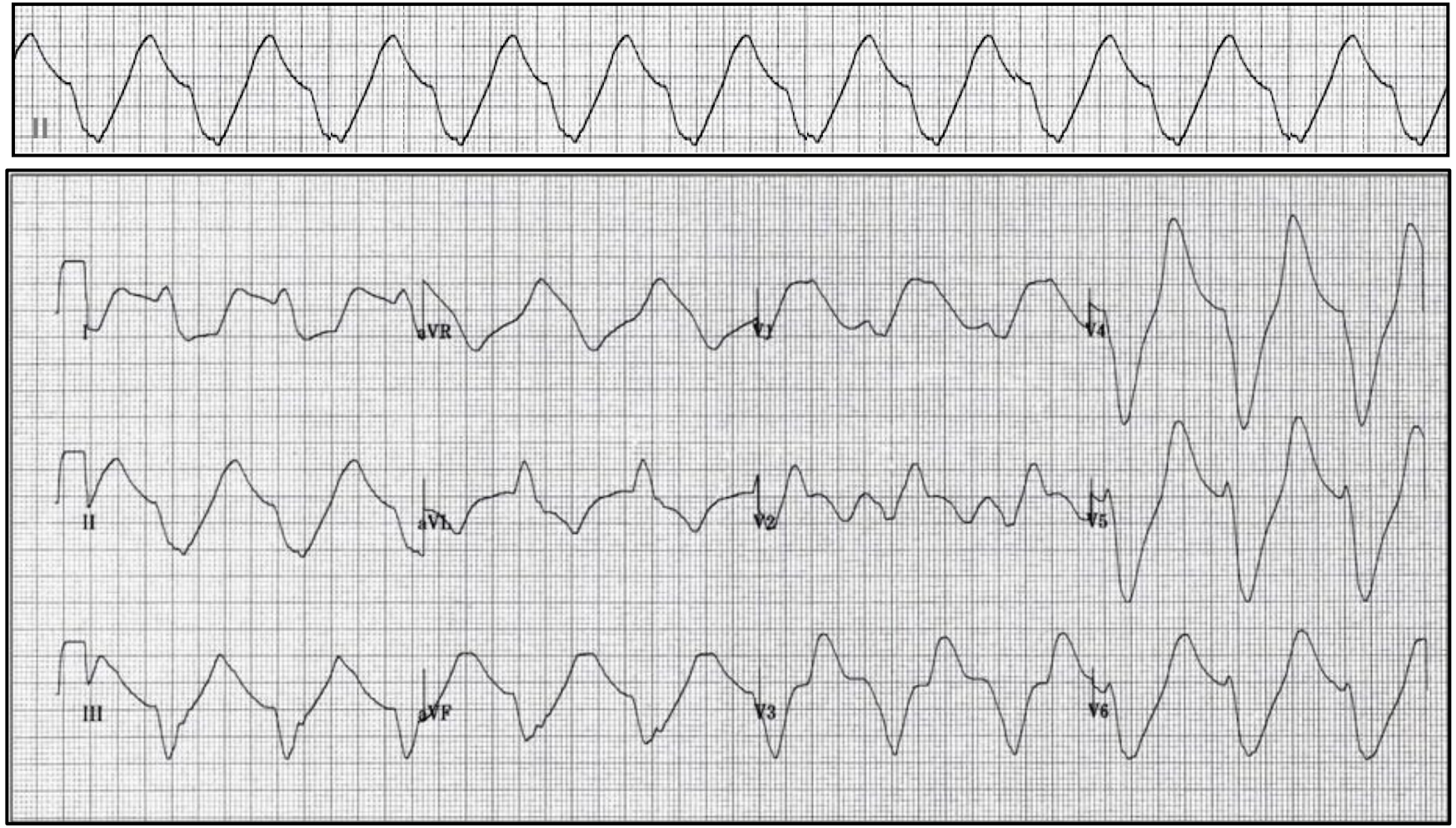
Hint...



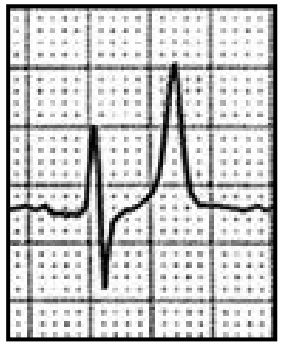
K = 8.3 mEq/L

Sinoventricular Rhythm due to Hyperkalemia

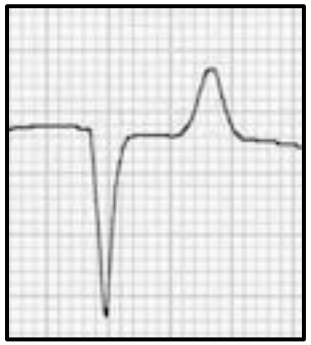
treatment aimed at lowering the K!



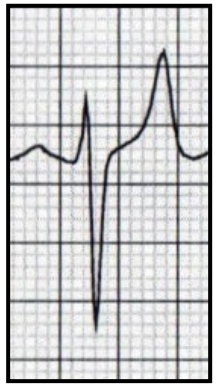
ECG Findings of Hyperkalemia



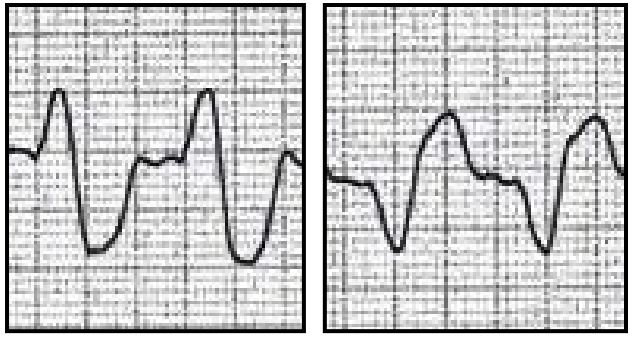
Prominent T wave



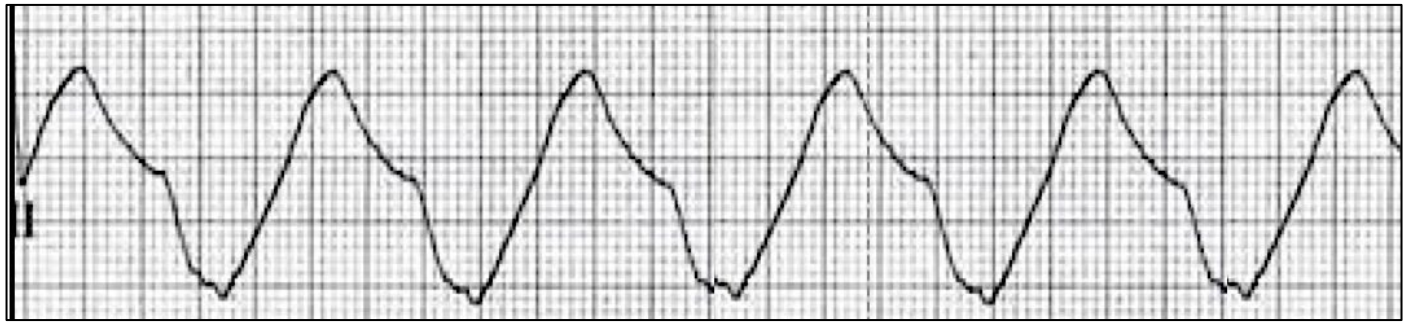
More pronounced QRS complex widening



Prominent T wave & minimal QRS complex widening

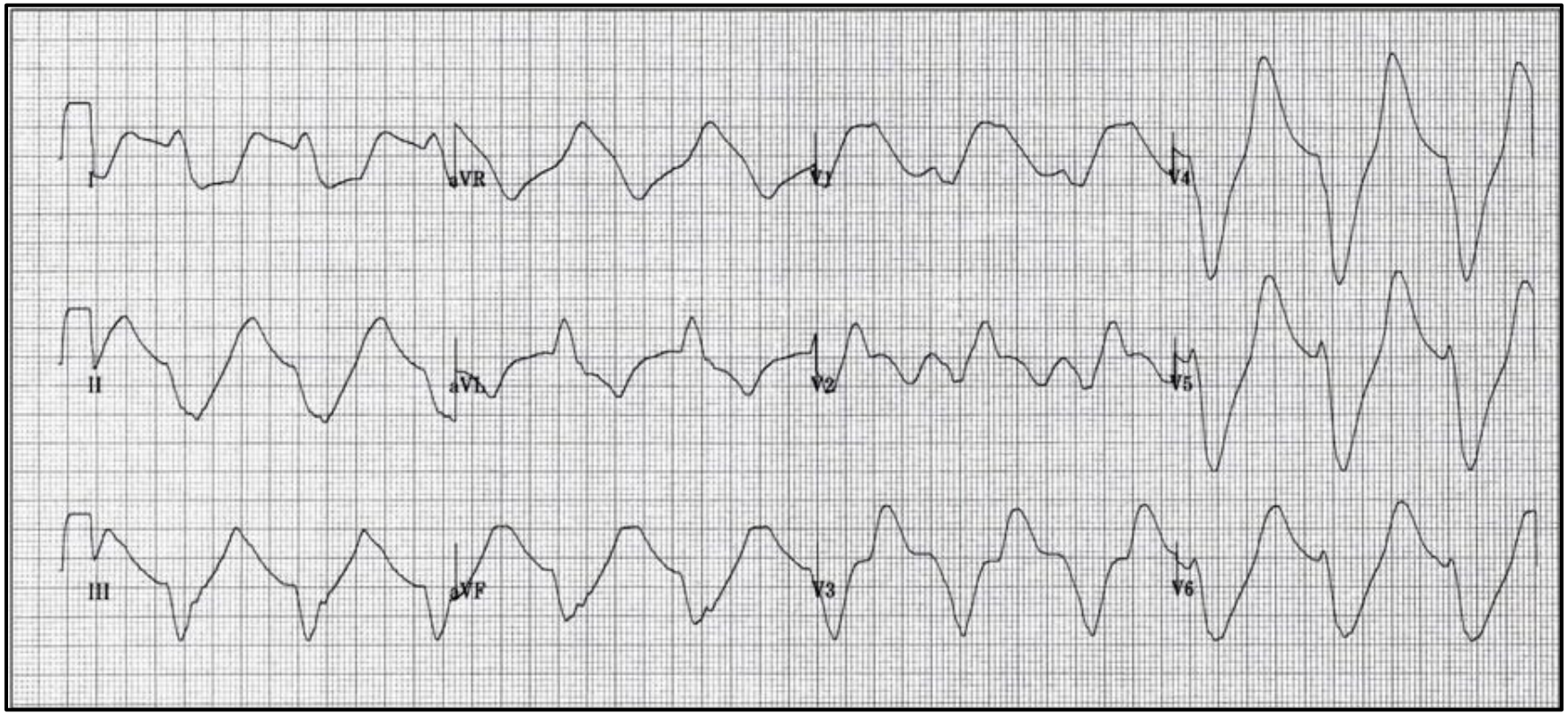


Pronounced QRS complex widening



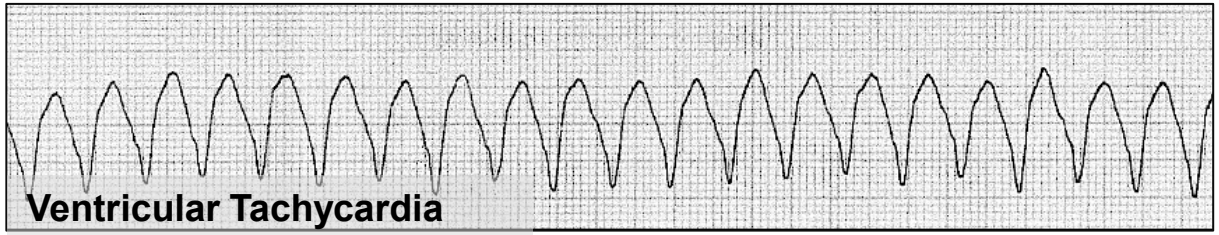
Sinoventricular rhythm… slow, regular, & very wide QRS complex

Sinoventricular Rhythm
Severe Hyperkalemia



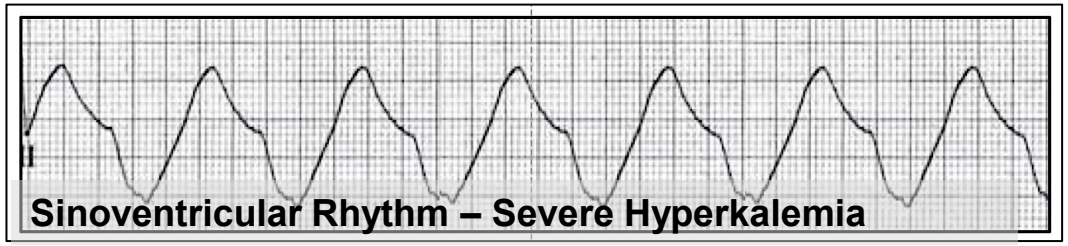
Regular, Slow to Slow-normal Rate with <u>Extremely</u>
Widened QRS Complex…& no P Waves

Comparison of Rhythms

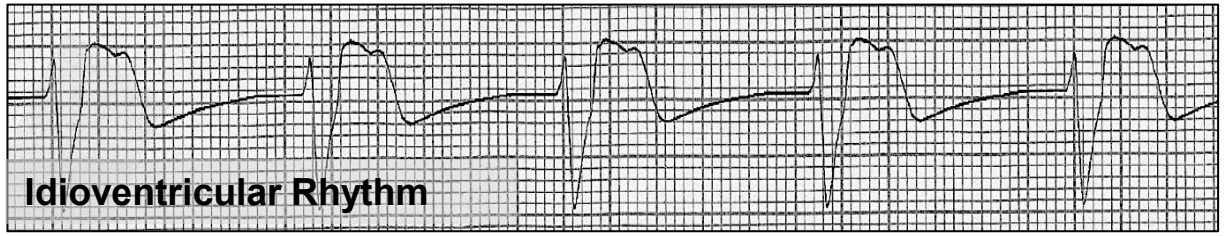


- Tachycardia ~ 170 - 190 bpm
- QRS width ~ 0.12 – 0.16 sec

- Normal rare ~ 100 bpm
- QRS very width ~ 20 sec

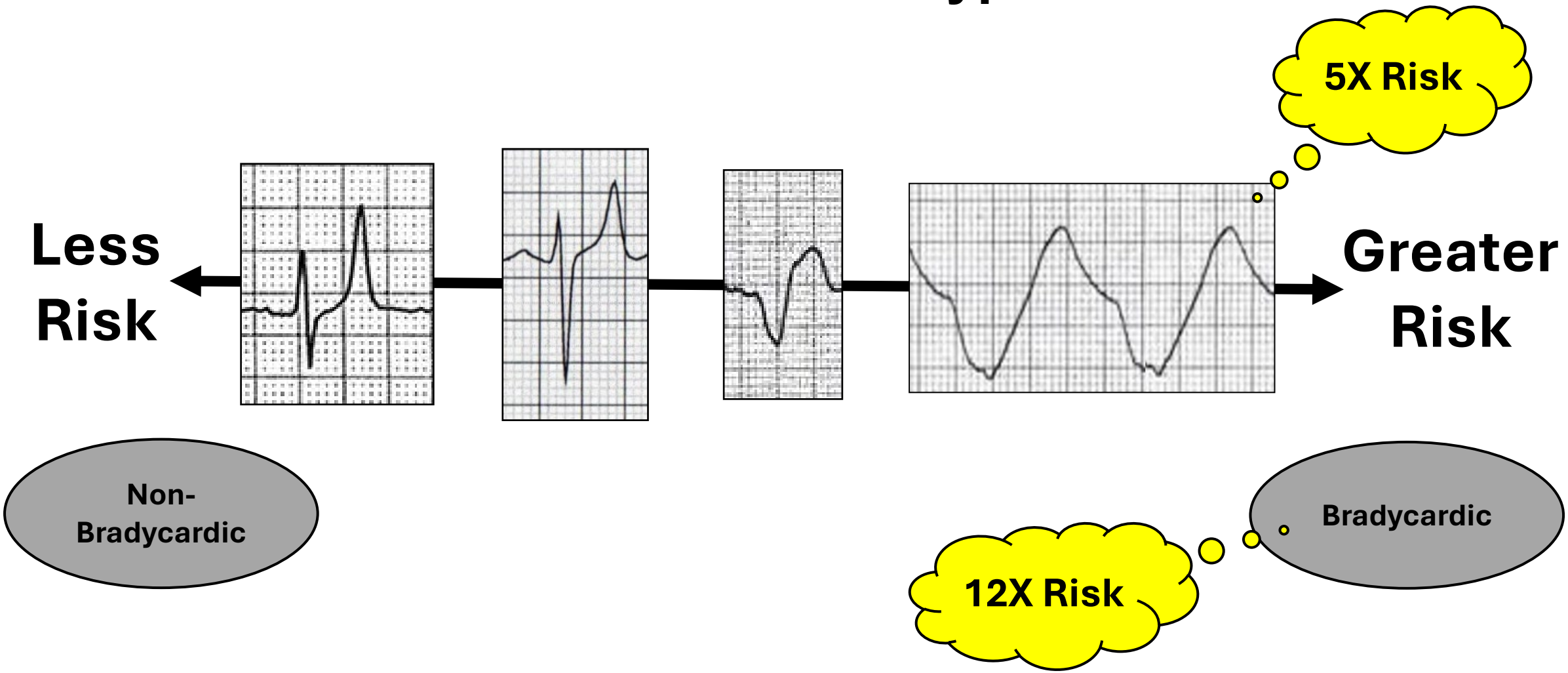


- Slow to slow-normal rate
- QRS extremely wide ~ 0.20 – 0.40 sec



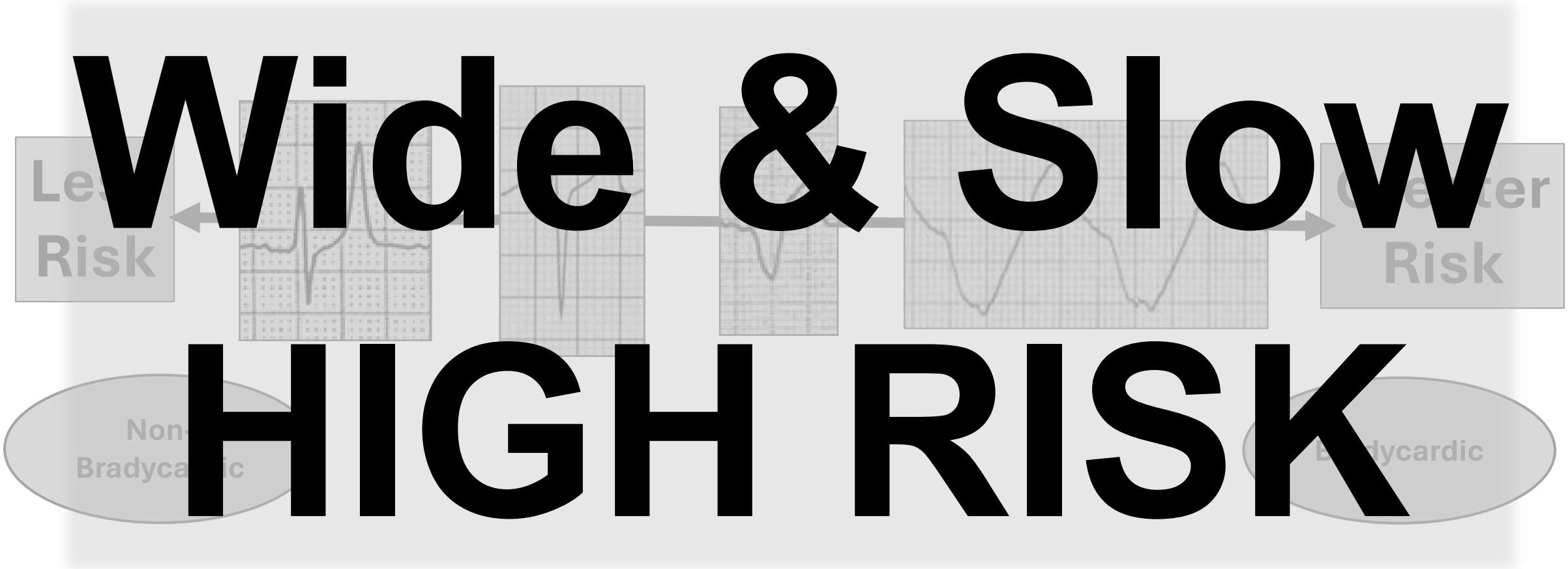
- Bradycardia ~ 30 – 45 bpm
- QRS width ~ 0.12 – 0.16 sec

ECG Prediction of Short-term Adverse Outcome with Hyperkalemia



Durfey et al, West J Emerg Med 2017

ECG Prediction of Short-term Adverse Outcome with Hyperkalemia



Yet another sick one!

Hyperkalemia with a wide & slow rhythm

Highest risk for decompensation

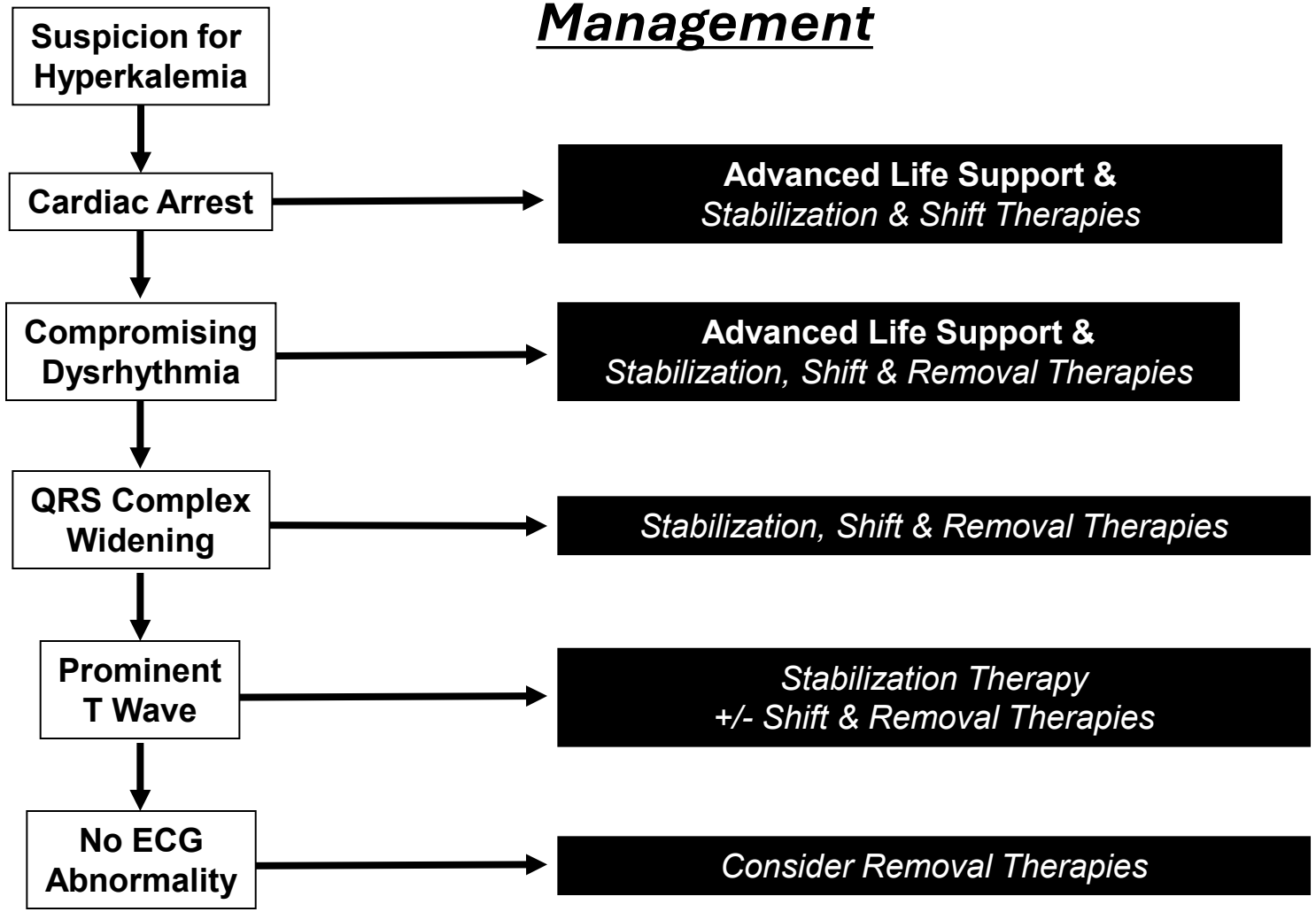
So what do we do?

Hyperkalemia Treatment

Goals of Therapy

1. **Membrane Stabilization**
   - Calcium
2. **Intracellular Potassium Shift**
   - Bicarbonate
   - Glucose / insulin
   - Adrenergic agonists
3. **Permanent Potassium Removal**
   - GI binding resin
   - Loop diuretics / IVF
   - Hemodialysis

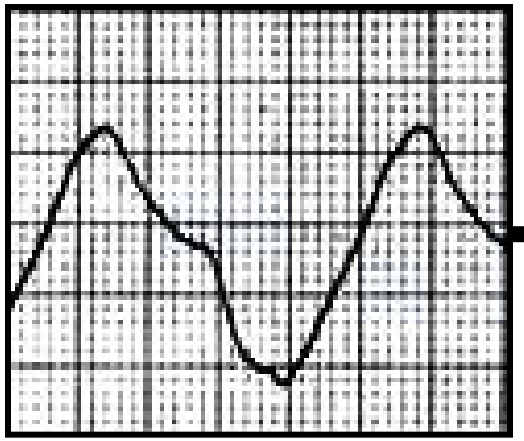
ECG-Guided Management



ECG Response to Therapy

…over 15 minutes with therapy, normalization of ECG

0918



Sinoventricular Rhythm

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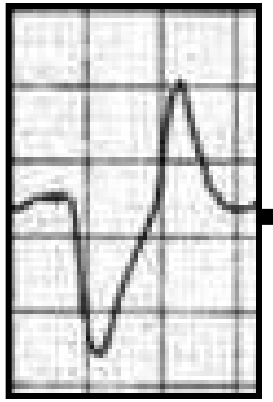
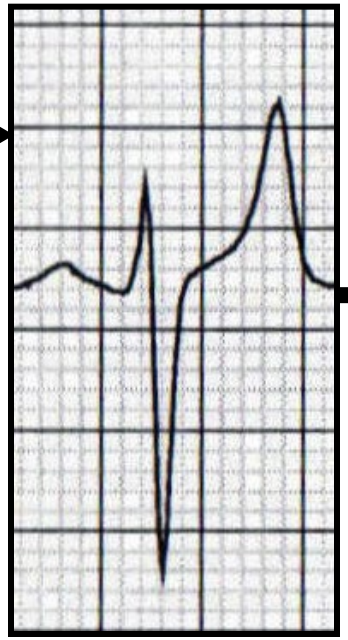


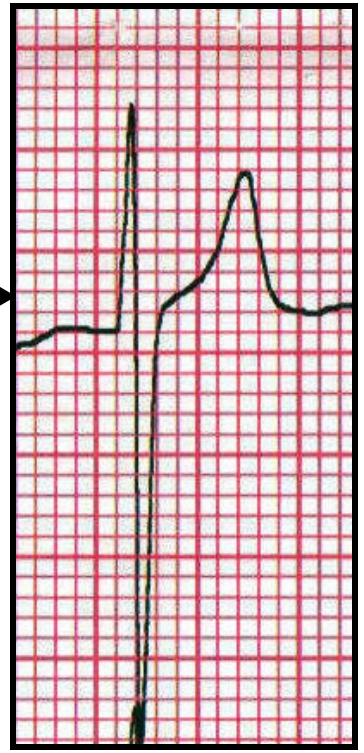
Widened QRS Complex

0928



Prominent T Wave with Minimal QRS Complex Widening

0933



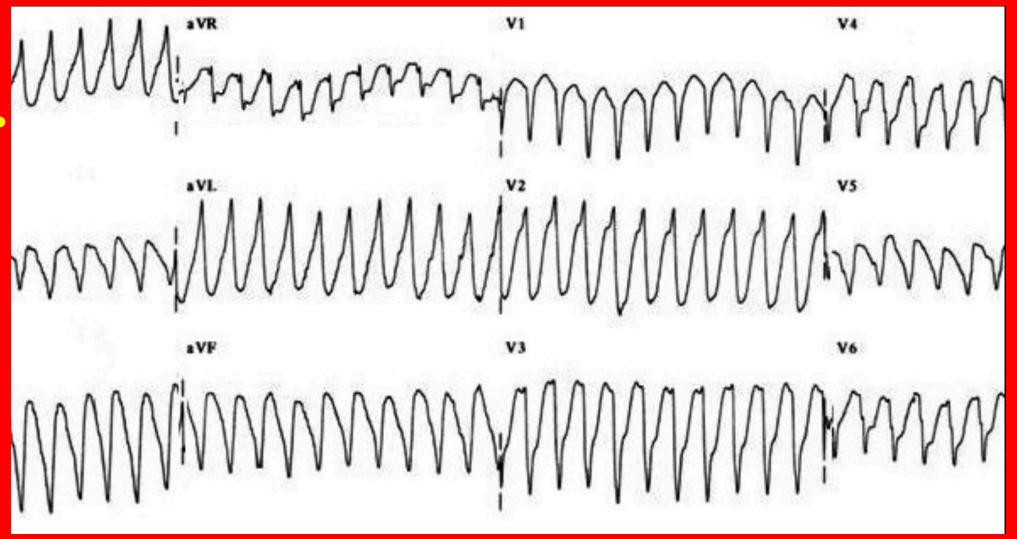
Normalization


GUARD
02

Case #4

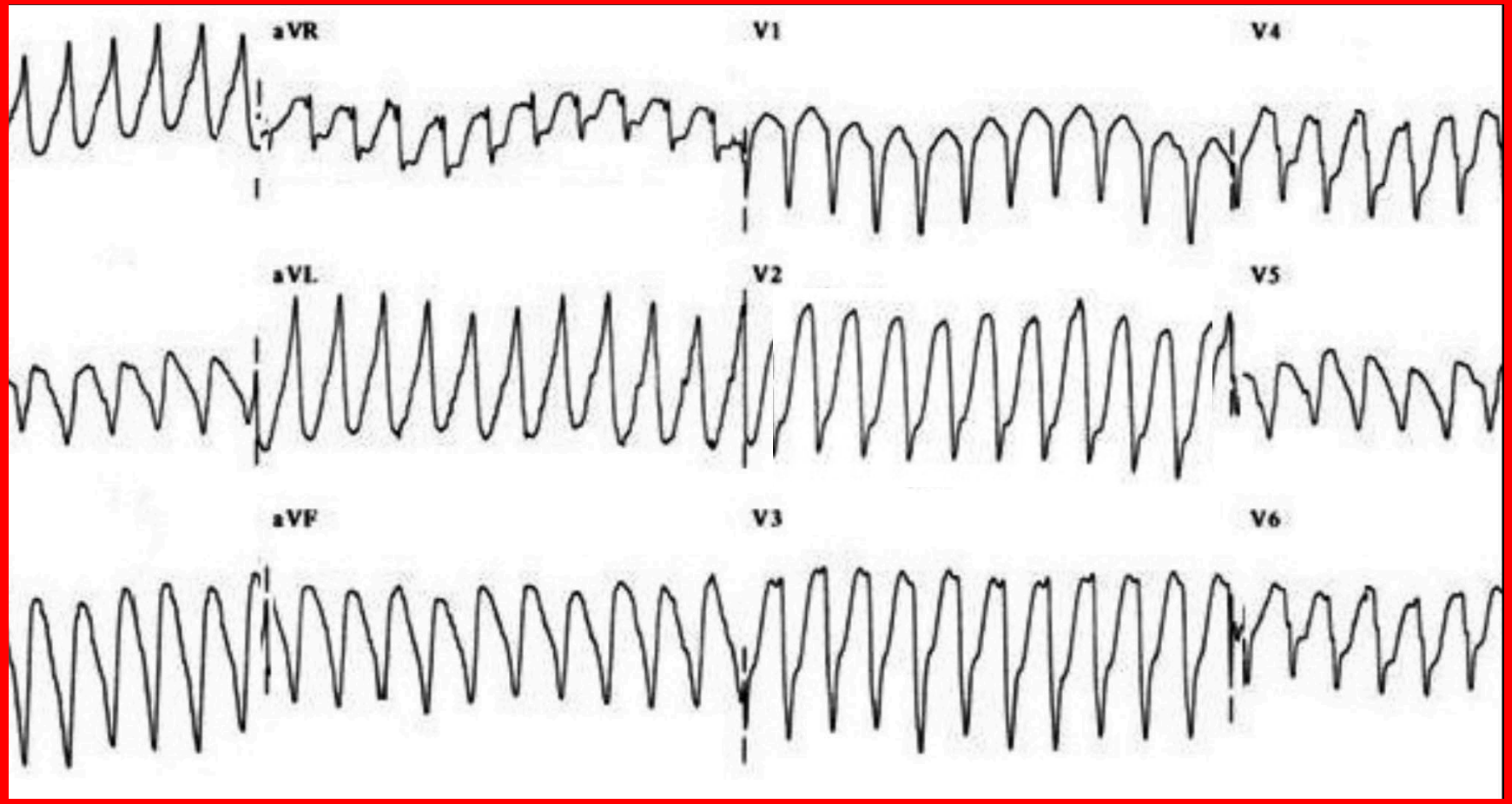
58 Male with Weakness & Palpitations

- Sudden onset of palpitations with progressive weakness
- PMH: MI, CAD with stenting, CHF
- Alert & oriented -- 115/59, 170, 20, 37, 95% RA
- ECG.....



Case #4

58 Male with Weakness & Palpitations



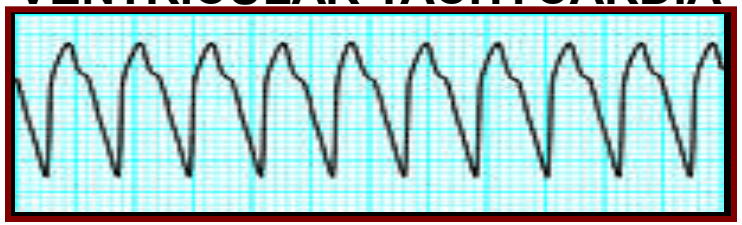
Another sick one!

Wide complex tachycardia …but what's the actual rhythm diagnosis?

We need to know the rhythm DX before we treat him, right?

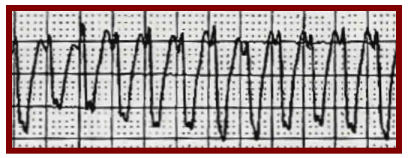
Wide Complex Tachycardia

VENTRICULAR TACHYCARDIA

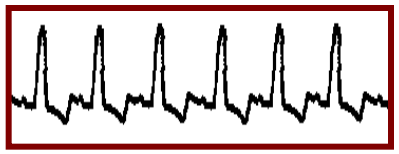


ABERRANT SVT

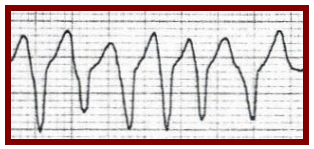
AVNRT w/ BBB



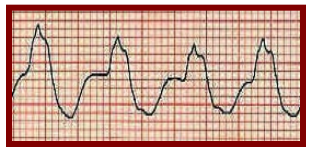
ST w/ BBB



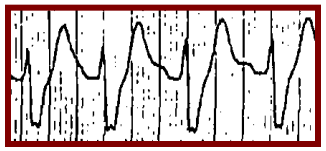
WPW AFIB



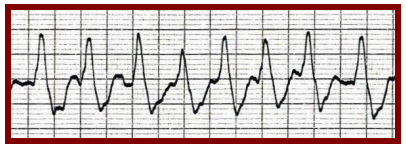
METABOLIC



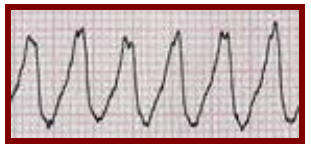
TOXIC



AFIB w/ BBB



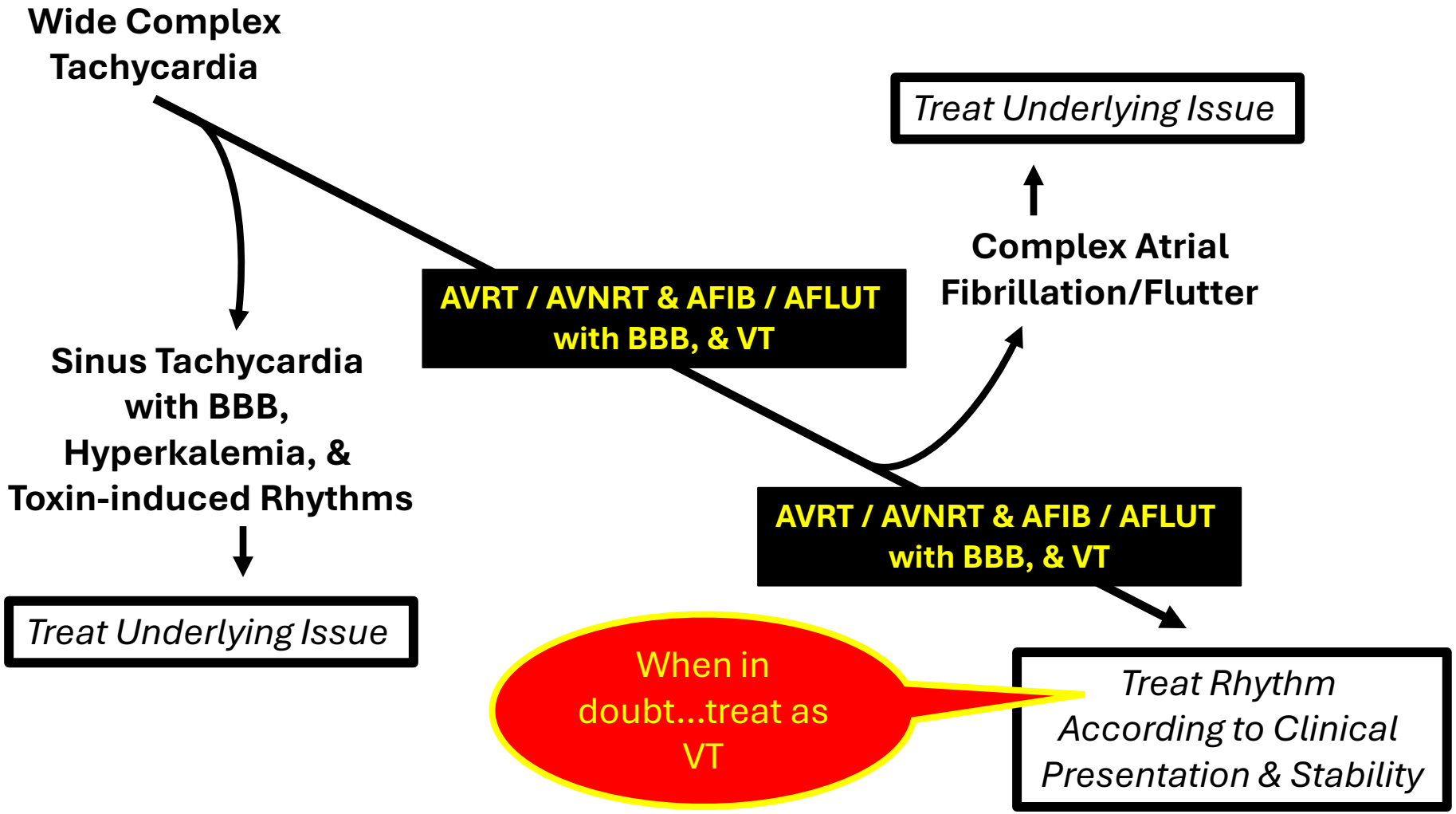
WPW AVRT



Wide Complex Tachycardia

- Challenging presentation …with a broad rhythm differential diagnosis
- Yes …we stress about this presentation
- But common sense + rational management = correct approach
- When in doubt, assume VT…but you must first exclude certain other rhythm presentations

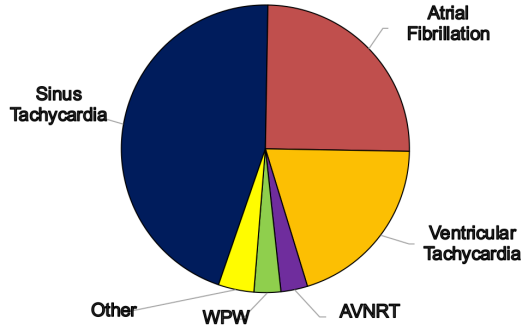
Management
Wide Complex Tachycardia

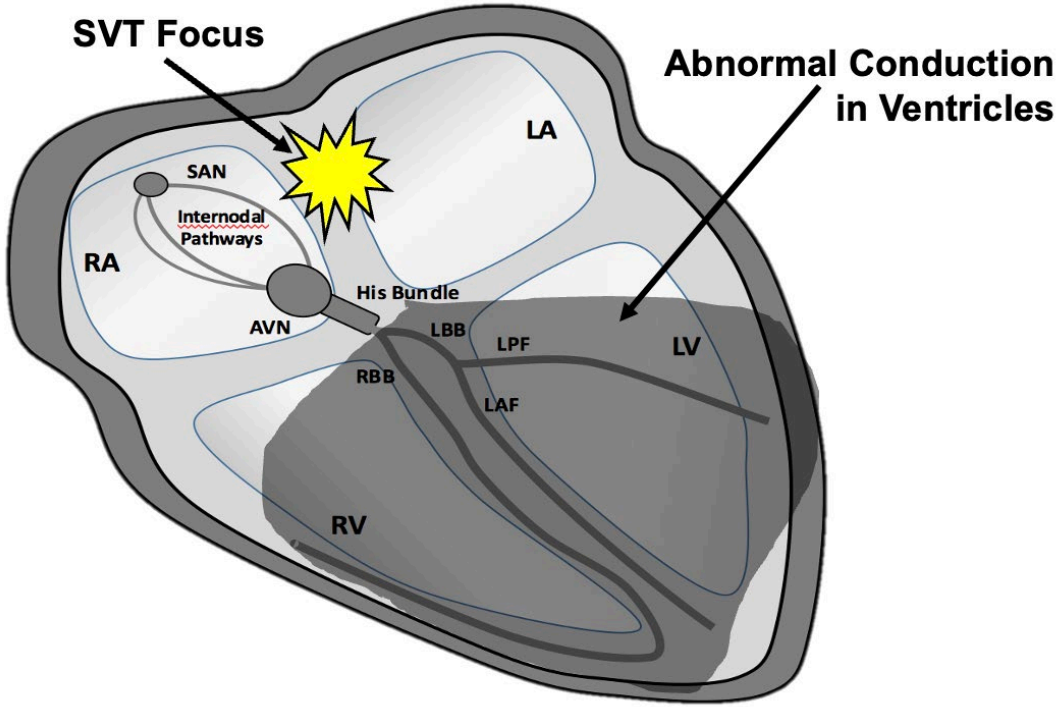


Supraventricular Tachycardia with Aberrant Conduction

ECG Differential Diagnosis

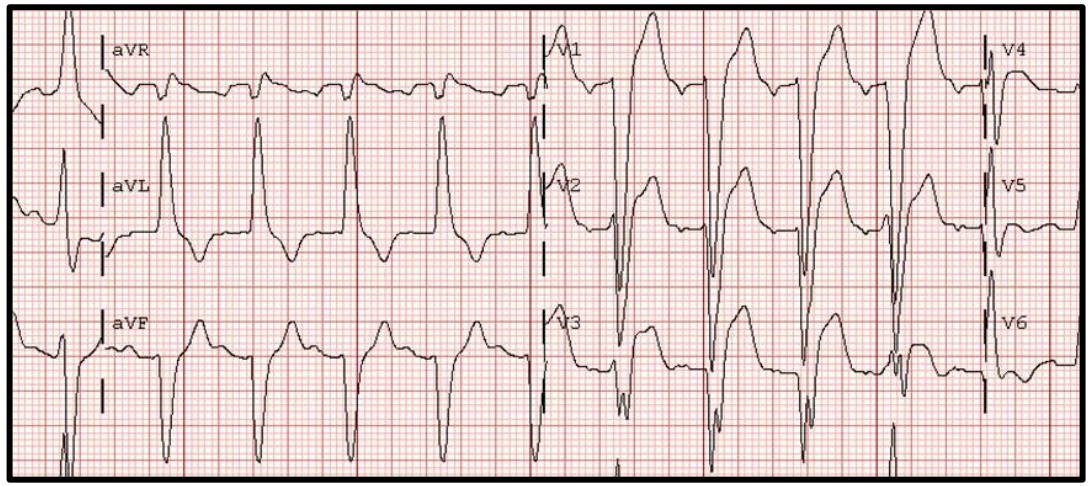
- Sinus tachycardia with BBB & toxic/metabolic
- Atrial fibrillation/flutter with BBB
- AVNRT with BBB
- WPW-related atrial fibrillation
- WPW-related antidromic AVRT
- Artifact-related “apparent” WCT
- Others…



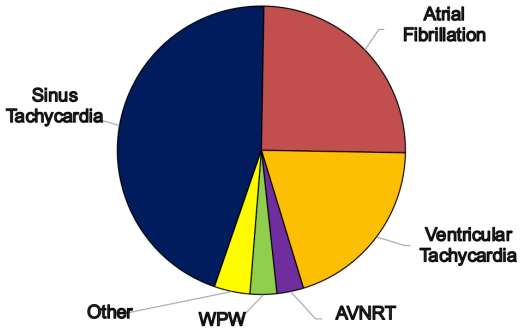


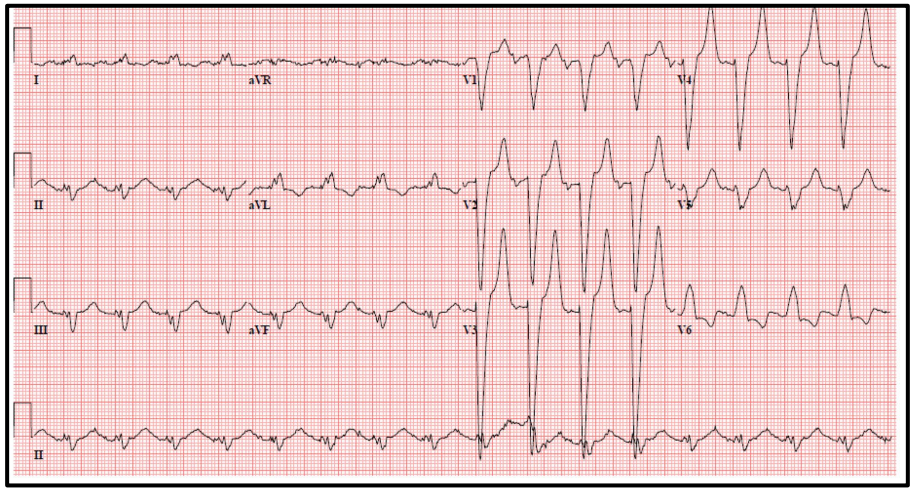
Supraventricular Tachycardia with Aberrant Conduction

Sinus Tachycardia with Aberrant Conduction

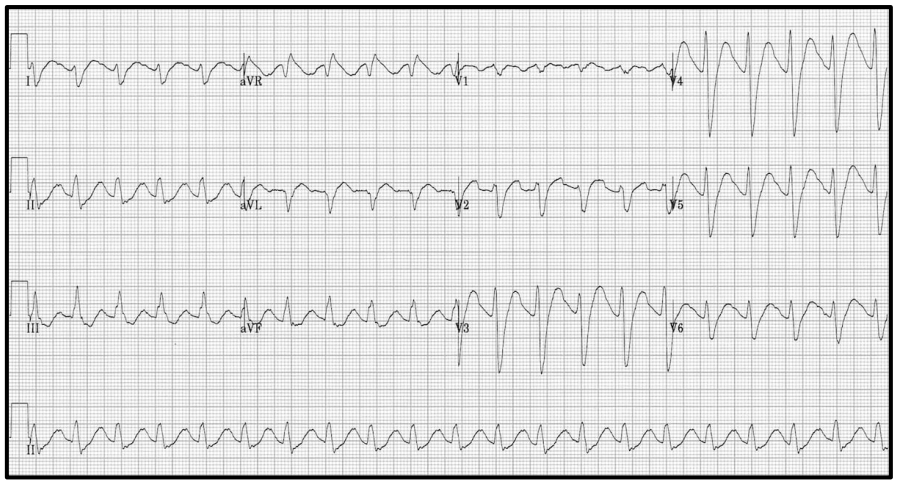


Sinus Tachycardia with Bundle Branch Block



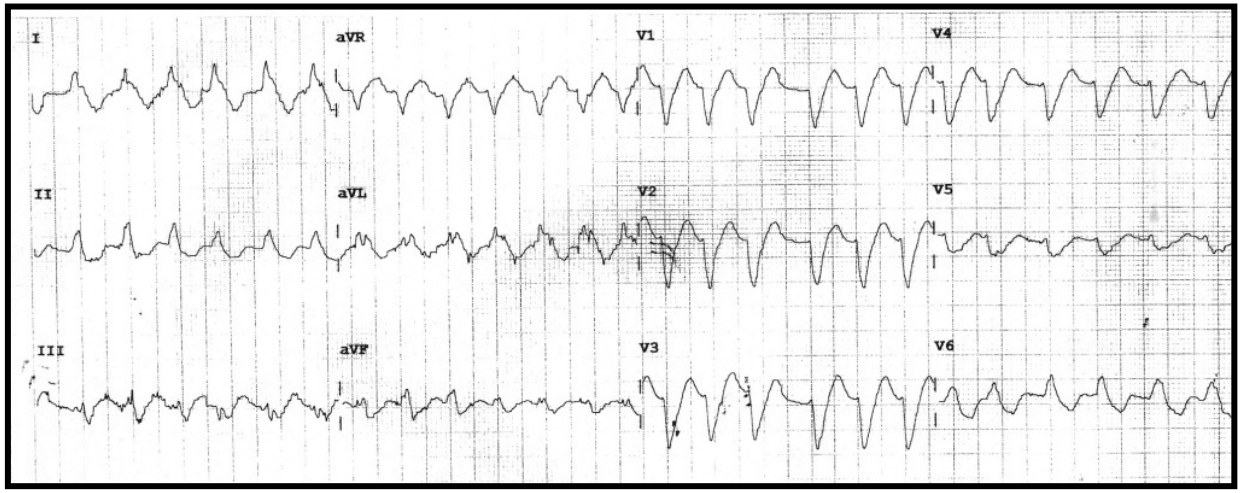


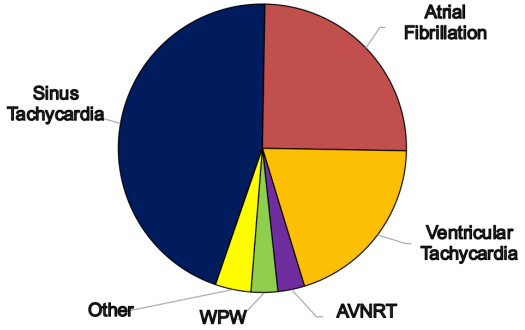
Sinus Tachycardia with Hyperkalemia



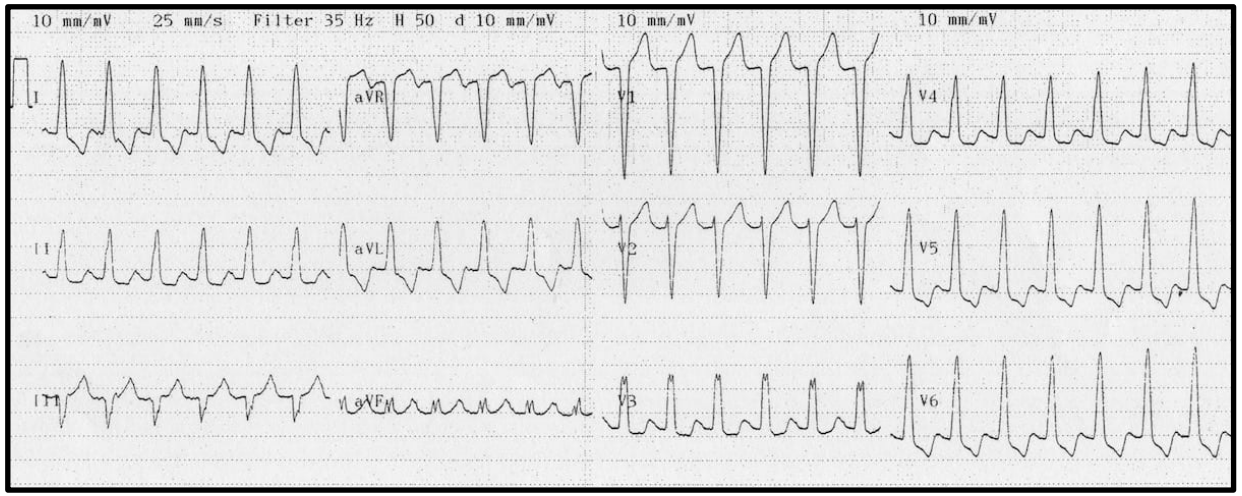
Sinus Tachycardia with Sodium Channel Blockade

Supraventricular Tachycardia with Aberrant Conduction





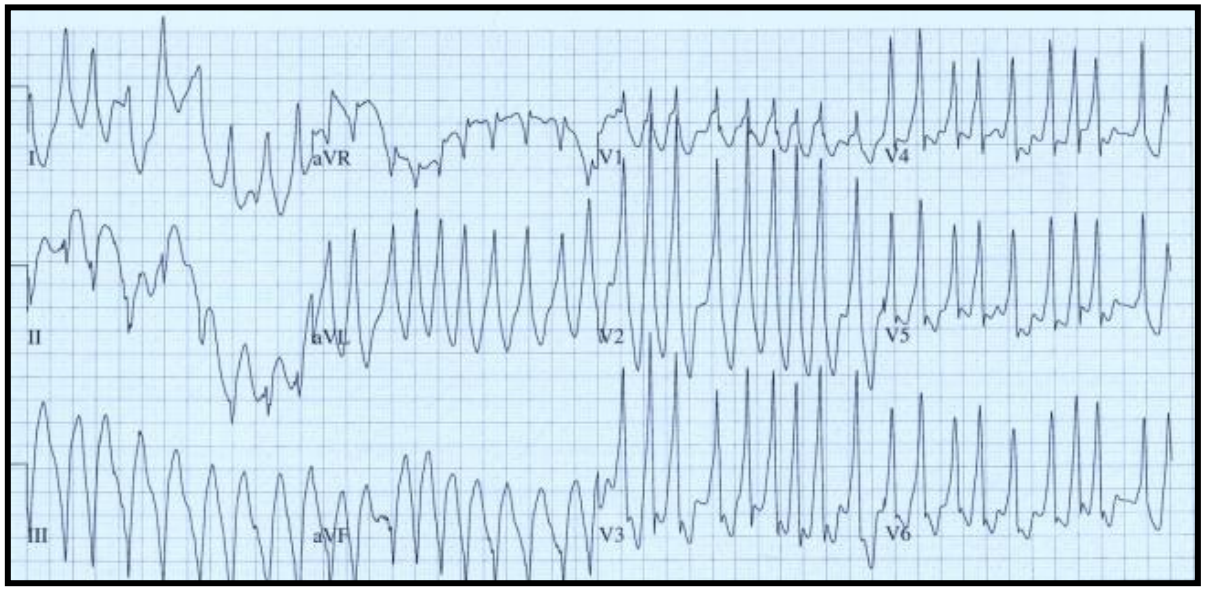
Atrial Fibrillation with RVR & Bundle Branch block



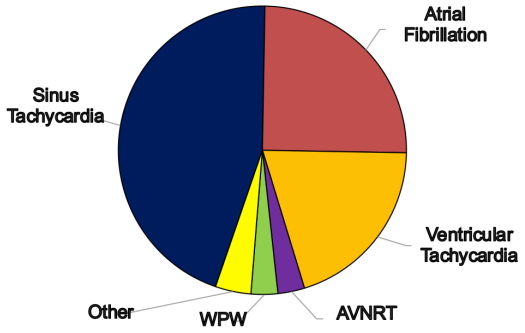
AVNRT with Bundle Branch Block

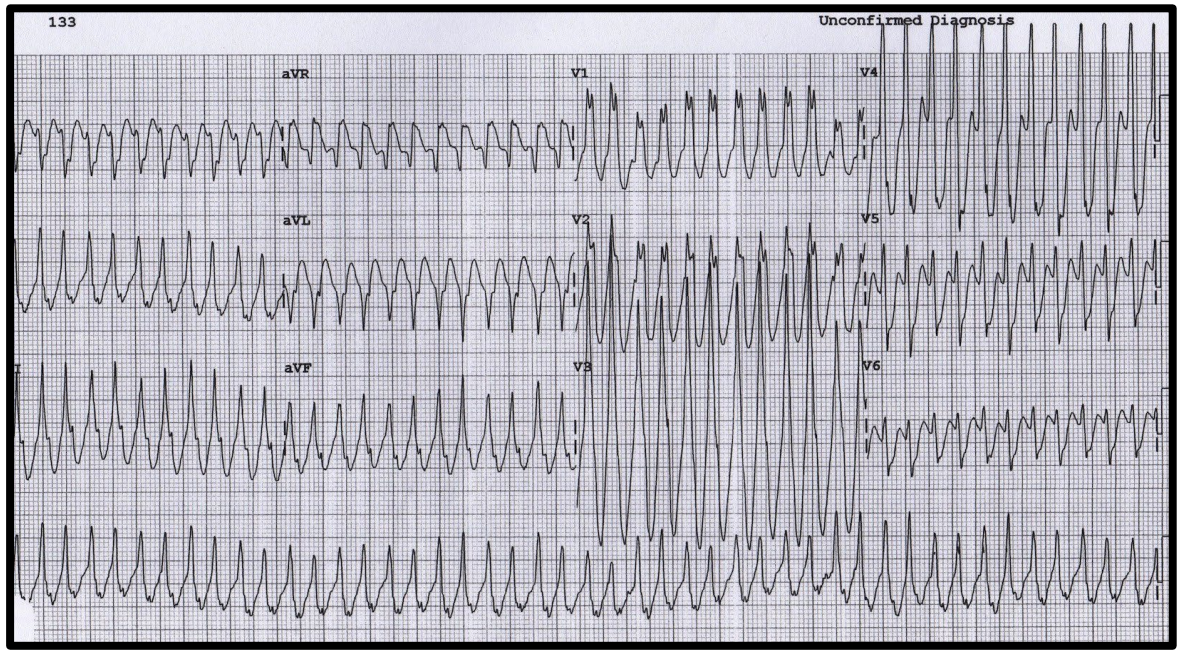
Supraventricular Tachycardia with Aberrant Conduction

WPW-related Wide Complex Tachycardias



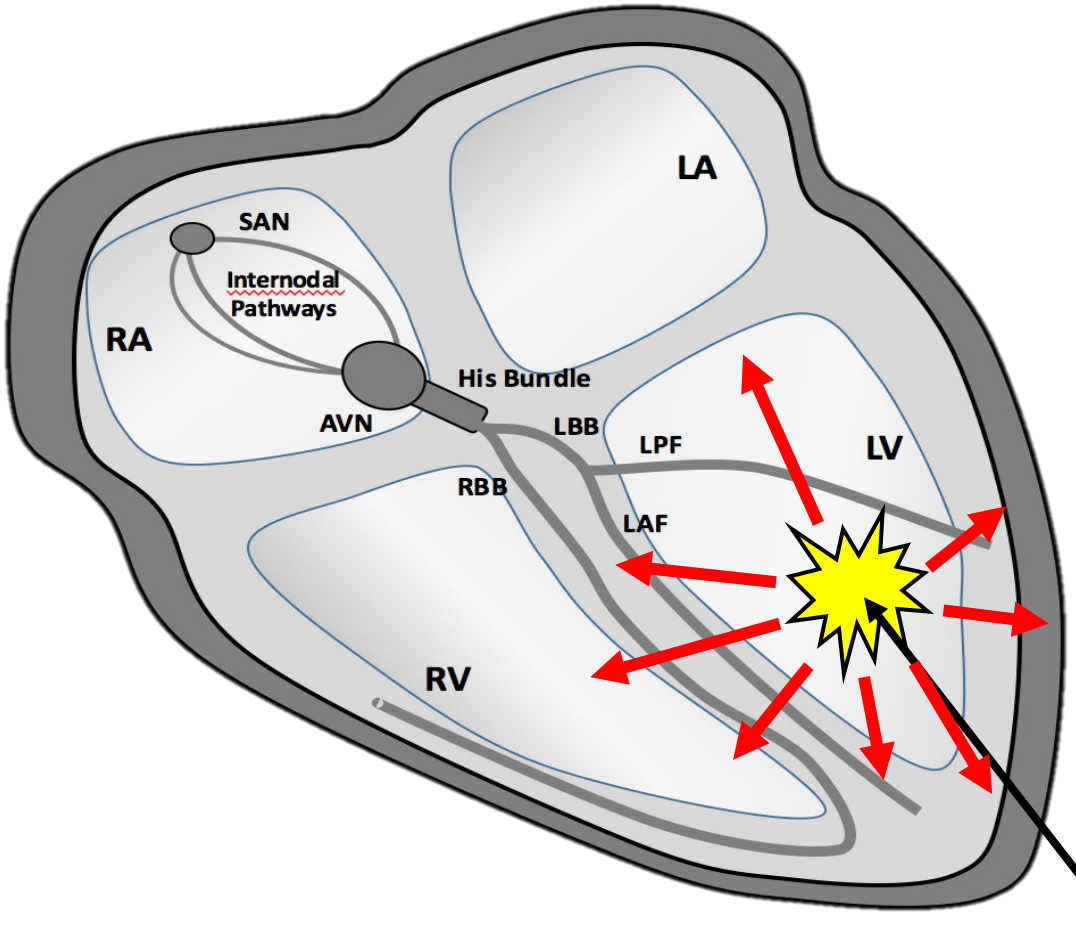
WPW-related Atrial Fibrillation

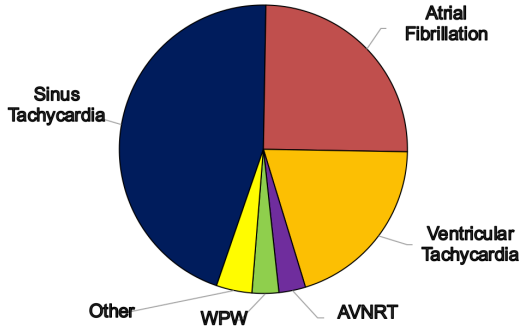


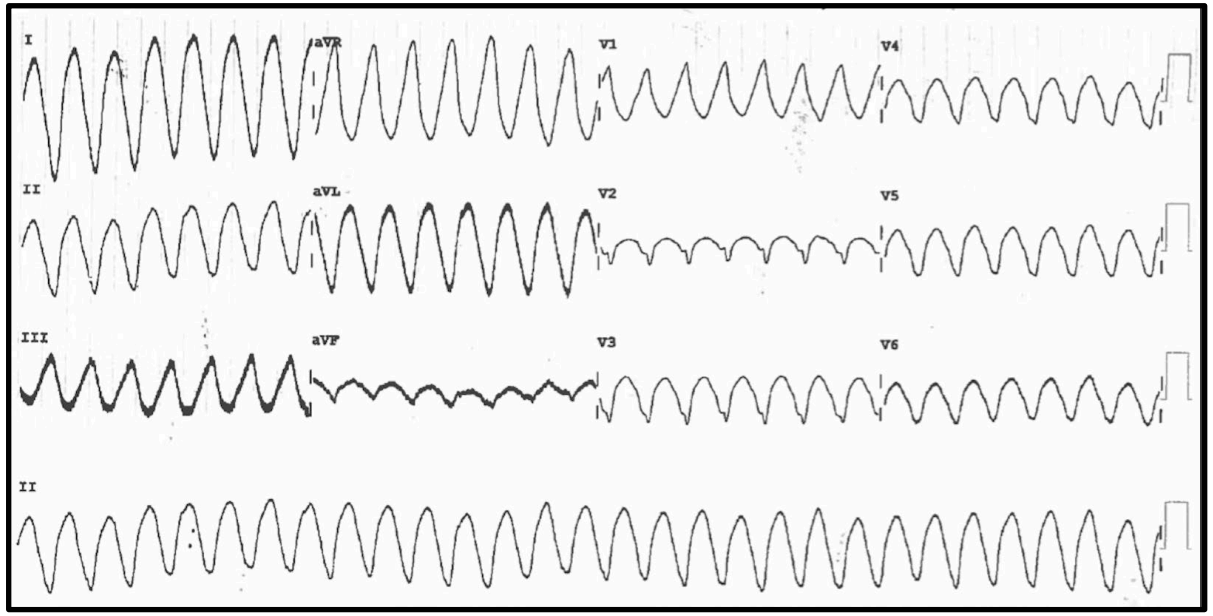


Antidromic AVRT

Ventricular Tachycardia







Clinical Presentation

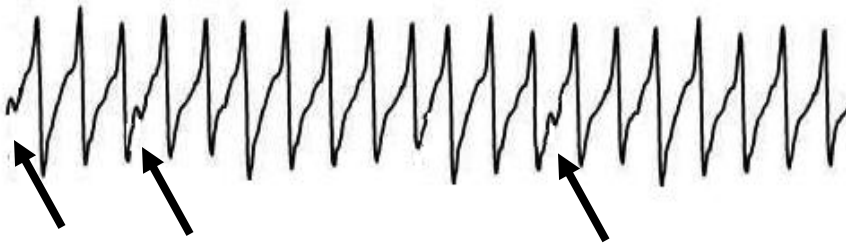
- **Age**
  - Increasing age -- increasing incidence of VT
  - Age > 50…favors VT
  - Age < 50…favors SVT

- **PMH**
  - Congenital Heart Disease with surgery…favors SVT
  - CAD / MI / CHF…favors VT

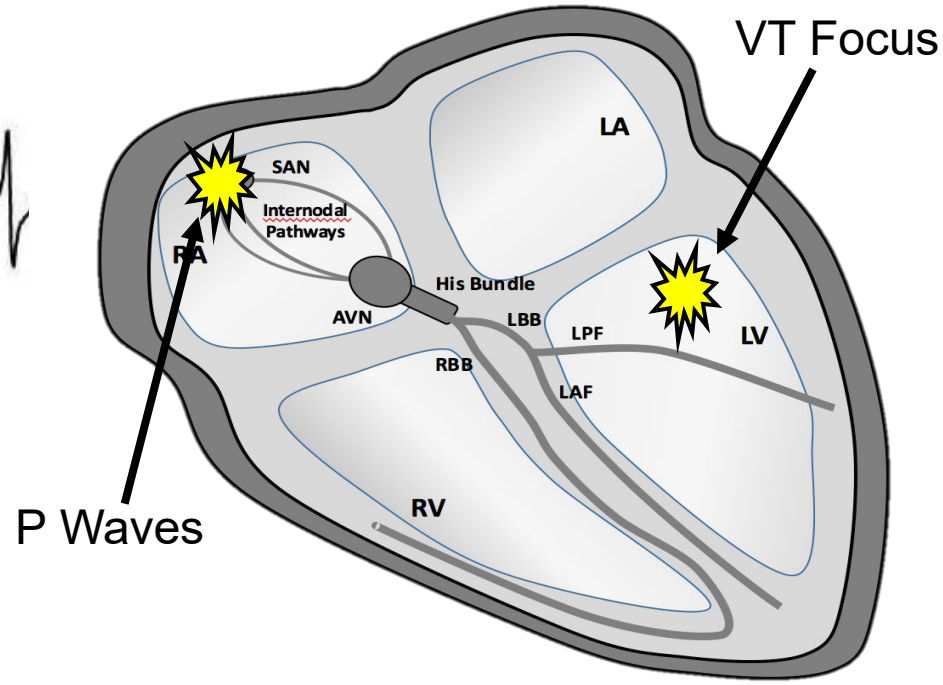
- **Symptoms & signs – not helpful**

AV Dissociation

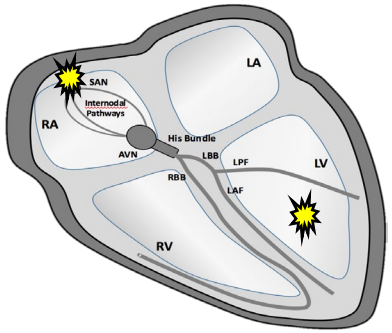
- **Ventricular focus produces WCT**
- **Continued SAN activity…atrial depolarization…P waves**



- **Less common**
- **Strongly favors VT**

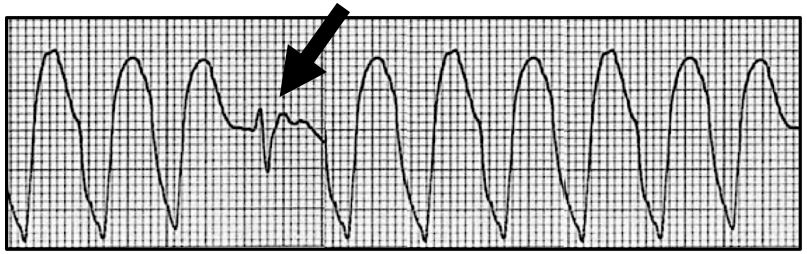


Fusion & Capture Beats

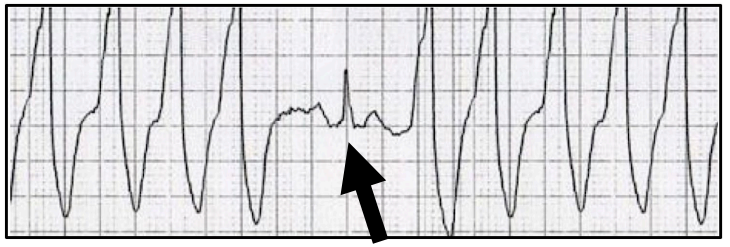


- **SAN-initiated impulse causes depolarization of ventricle**
  - Partial – fusion beat
  - Complete – capture beat

- **Fusion beat**
  - Fusion of SV & V impulses
  - Intermediate width QRS



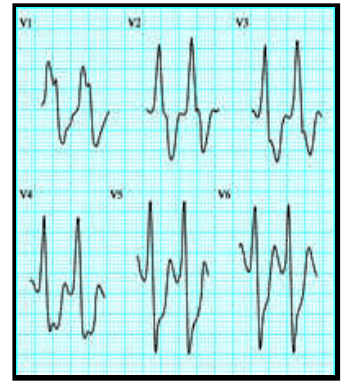
- **Capture beat**
  - Supraventricular impulse activates ventricles
  - Results in narrow QRS



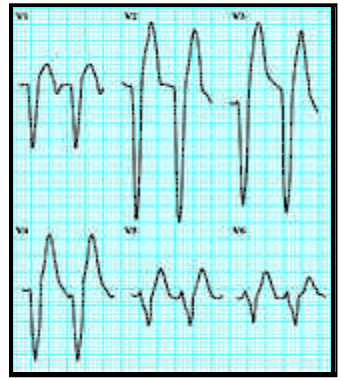
- **Strongly favors VT**

QRS Complex

- **Precordial concordance**
  - All complexes with same polarity (V1 - V6)
    - Positive
    - Negative



Positive Concordance



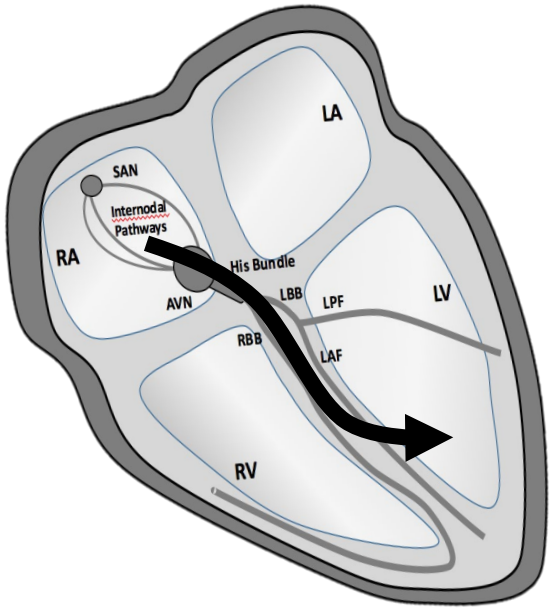
Negative Concordance

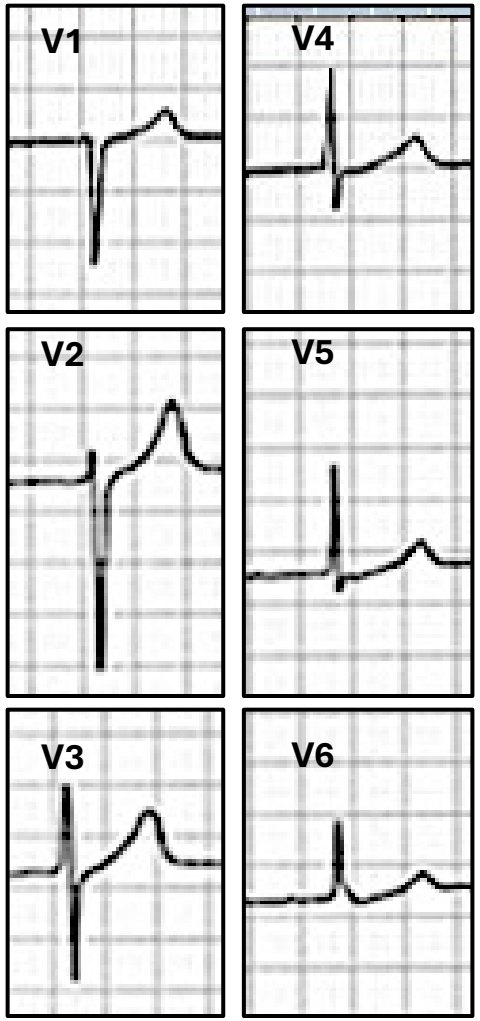
- **Strongly favors VT**
  - Positive “frequently VT”
  - Negative “always VT”

QRS COMPLEX

So why is this important?

- **If supraventricular source…**
  - Negative QRS in V1
  - Transition of “-” to “+” from V1 to V6
  - Positive QRS in V6



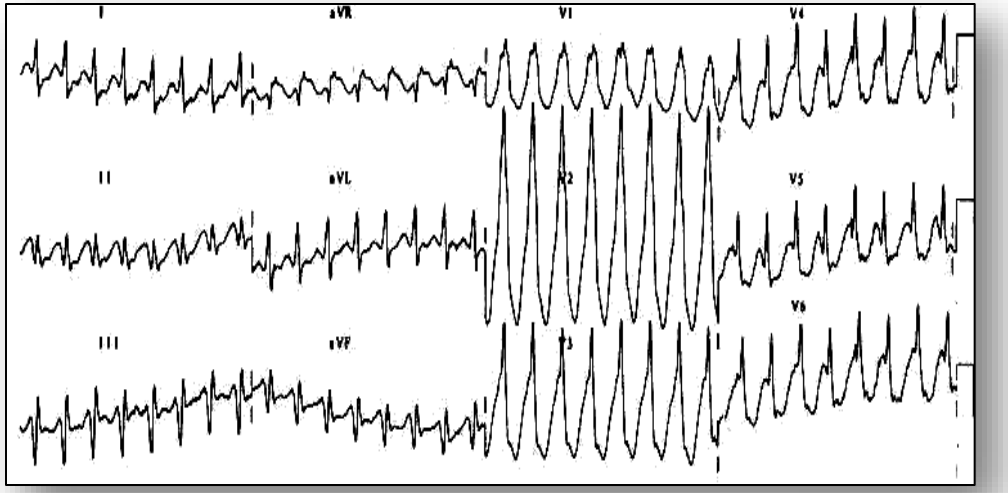


Normal R Wave Progression (V1-V6)

negative to positive

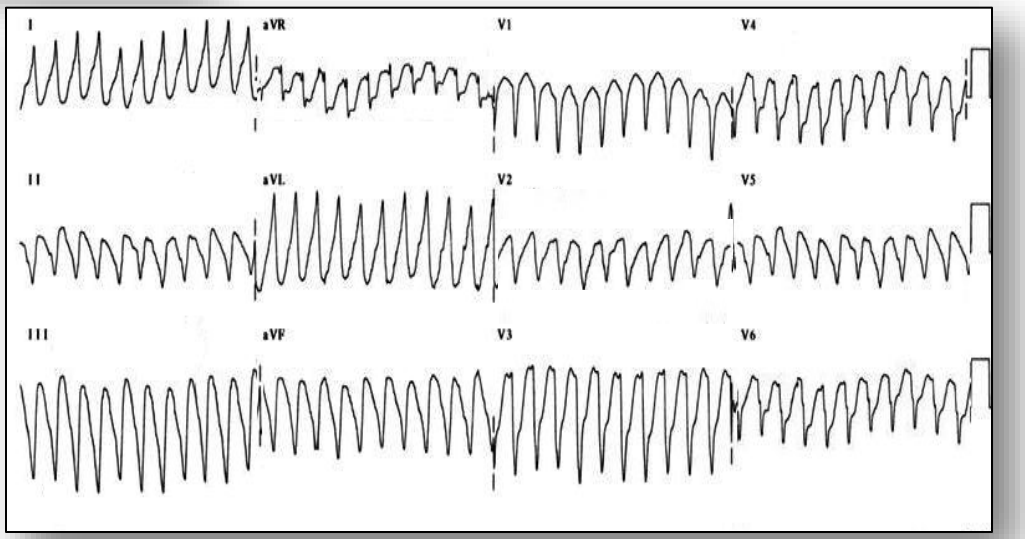
Concordance - Positive & Negative

Strongly Favors VT

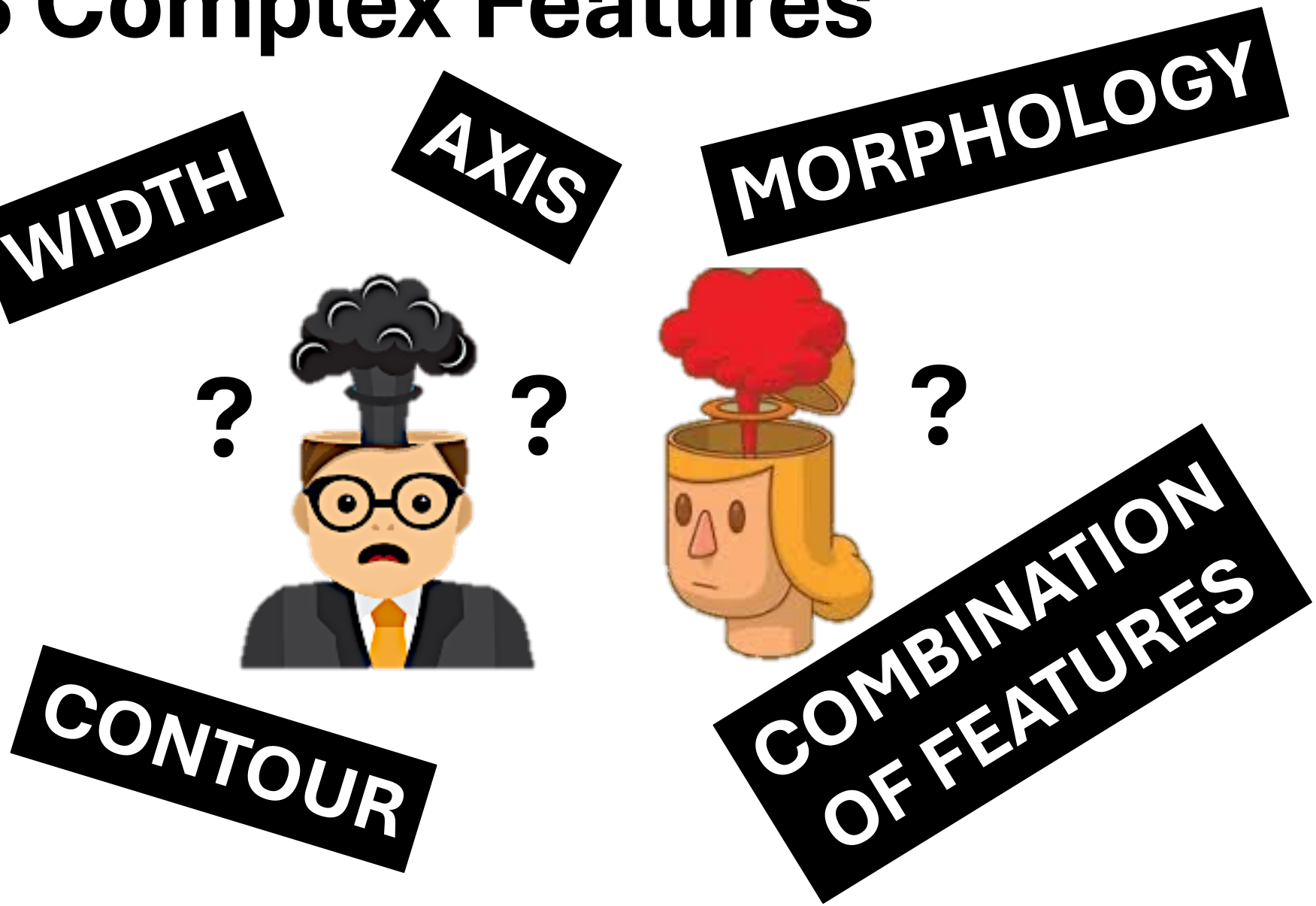


Positive Concordance

Negative Concordance



QRS Complex Features



Diagnostic Algorithms

- **Wellens' Criteria** (1978)
  - AV dissociation & various QRS features
  - Cumbersome & limited non-cardiologist application
- **Kindwall** (1988)
  - Similar findings, limited to leads V1 & V6
- **Brugada Algorithm** (1991)
  - Low accuracy & inter-rater reliability
  - Default DX = SVT with aberrant conduction
- **Vereckei** (2007 & 2008) – 4-step & aVR-only algorithms
  - More accurate / yet still unable to discriminate reliably
- **Becker & Crijns** (2011) -- 3 criteria required:
  - VT diagnosed via any algorithm
  - Presence of AV dissociation
  - History of MI, cardiomyopathy, CHD or cardiac surgery
- **Comparison study of 5 algorithms** (2012)
  - Older = newer versions RE diagnostic accuracy
  - All limited by few/no patients with anti-arrhythmic Rx, pre-existing BBB, or known SVT

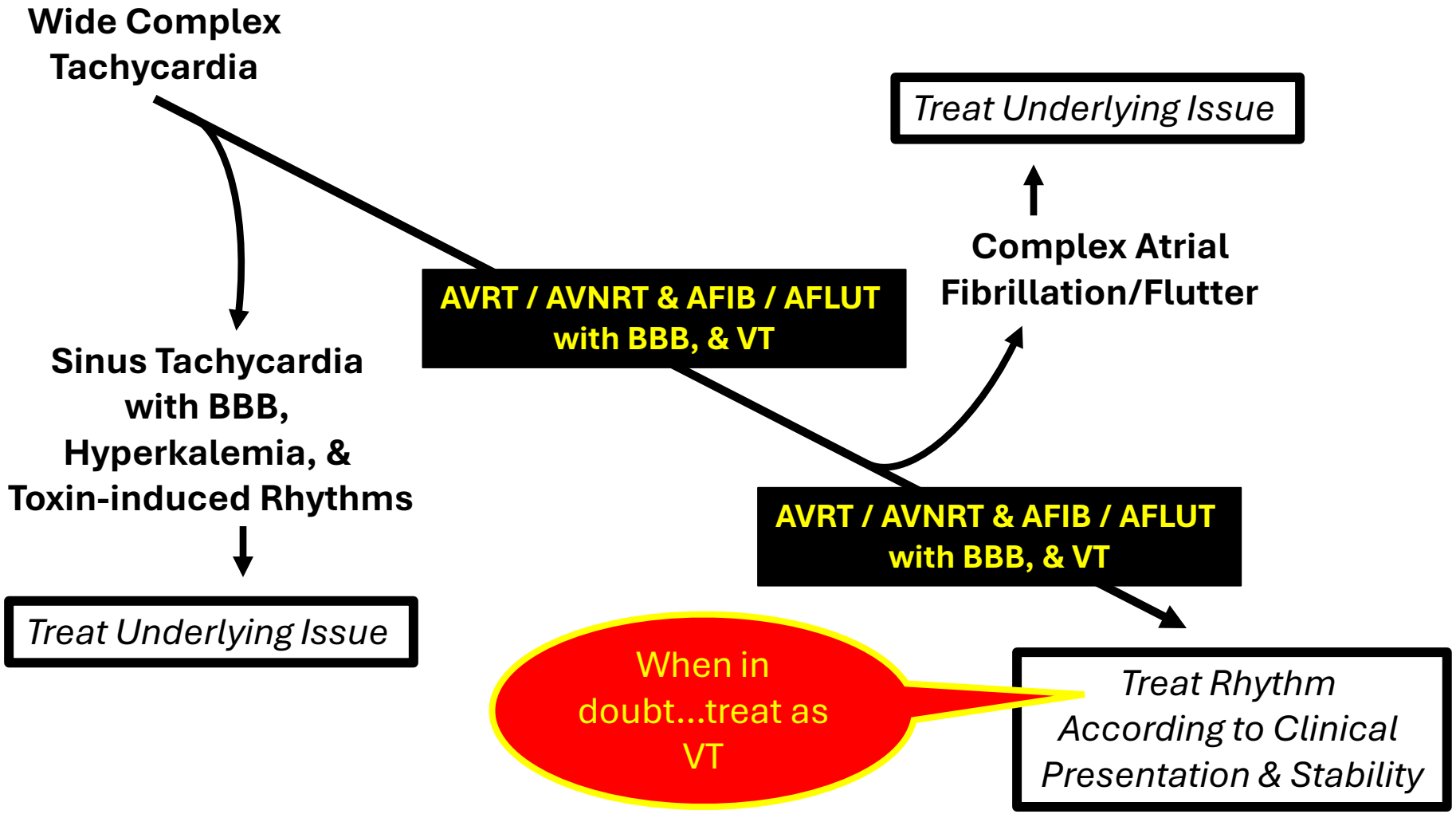
- **Few SVT with aberrancy…mostly VT**
- **Caution with default DX -- SVT with aberrancy**
- **Bottom line – all limited in diagnostic accuracy**

So, once again, what's the rhythm diagnosis?

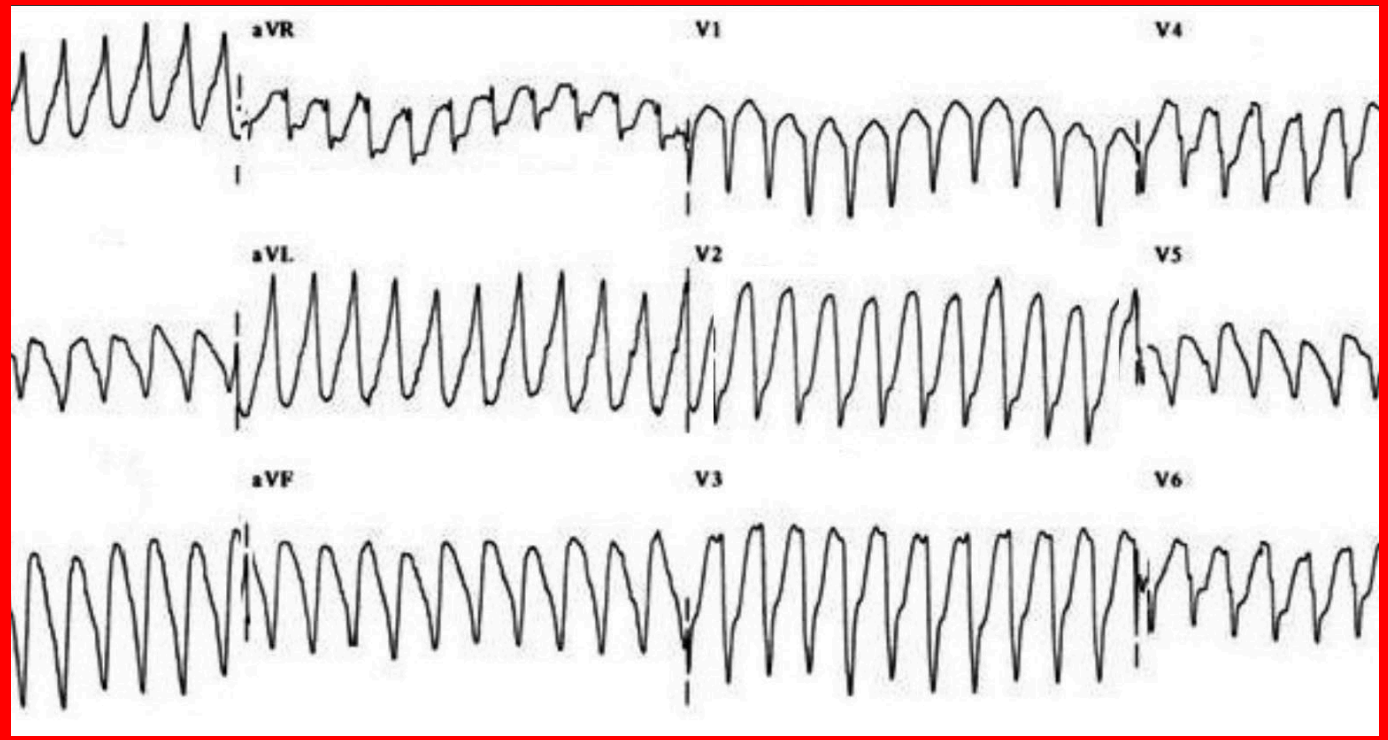
We said that we can't treat until we know, right?

WRONG!

Management
Wide Complex Tachycardia



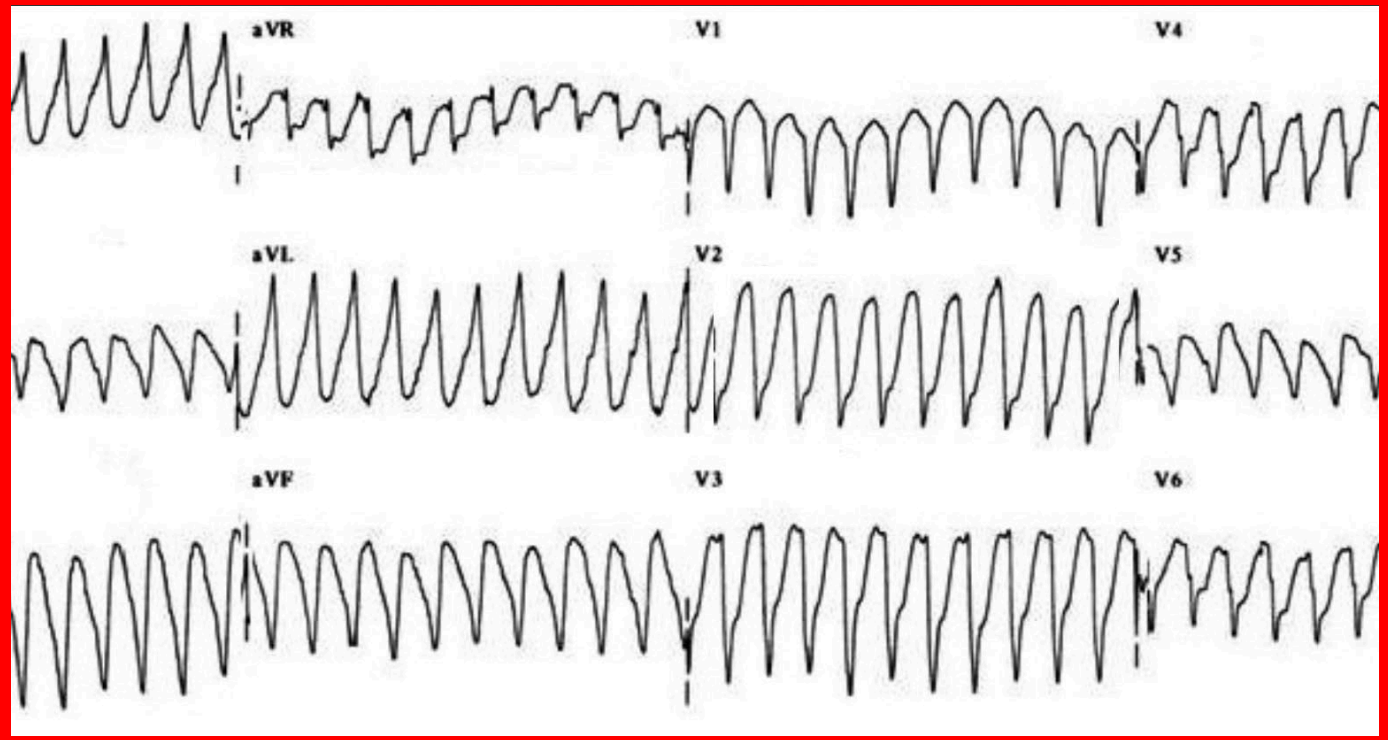
Case #4



Ventricular Tachycardia

- **Clinical**
  - Age > 50 years
  - MI / CAD / CHF history
- **ECG**
  - Rapid, regular, wide
  - AV dissociation
  - Precordial negative concordance

Case #4



Amiodarone bolus with infusion

BP declined with lethargy

Synchronized cardioversion

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