Syncope:
What To Do When the Lights Go Out?

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Disclosure

I have no financial interests or relationships to disclose.

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Learning Objectives

Upon completion, the participant will be able to:

1. Conduct an appropriate diagnostic evaluation for the patient with syncope.
2. Recognize potentially life-threatening EKG's that are associated with syncope.
3. Describe patients with syncope that are "high risk" for subsequent fatal arrhythmia events.
4. Be familiar with the 2017 AHA/ACC guideline for syncope.

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Your Patient *"Passed Out"*... Your Differential Diagnosis Is:

CV causes

- **Autonomic**
  - Carotid sinus syncope
  - Cough
  - Defecation
  - Excessive vagal tone (athletes, adolescents)
  - Micturition
  - Postprandial
  - Sneeze
  - Swallow
  - Valsalva

Non-CV causes

- **Metabolic**
  - Alcoholism
  - Carbon monoxide
  - Drug-induced
  - Hyperventilation
  - Hypoglycemia
  - Hypothyroid
  - Hypoxia/asphyxiation
  - pheochromocytoma

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Your Patient *"Passed Out"*... Your Differential Diagnosis Is:

CV causes

- **Orthostatic hypotension**
  - Adrenal insufficiency
  - Autonomic insufficiency
    - CNS dz, alcoholism, DM
  - Dehydration
  - Drugs
    - Antihypertensives
    - Drugs of abuse
    - Vasodilators
    - CNS drugs
  - Hemorrhage
  - idiopathic

Non-CV causes

- **CNS**
  - Basilar artery migraine
  - Narcolepsy
  - Seizure
  - Subarachnoid hemorrhage
  - Subclavian steal
  - Vertebrobasilar insufficiency
  - Increased intracranial pressure

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Your Patient *"Passed Out"*... Your Differential Diagnosis Is:

CV causes

- **Obstructive lesions**
  - Aortic dissection
  - Aortic, mitral or pulmonary stenosis
  - Atrial myxoma
  - Cardiac tamponade
  - Congenital heart disease
  - Left ventricular dysfunction
  - Pulmonary embolism
  - Pulmonary hypertension

Non-CV causes

- **Psychiatric**
  - Anxiety disorder
  - Breath-holding spells
  - Conversion reaction
  - Drug-induced
    - Anticonvulsants
    - Antihistamines
    - Antiparkinson drugs
    - Cholinesterase inhibitors
    - TCA
  - Pseudoseizure

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Your Patient *"Passed Out"*... Your Differential Diagnosis Is:

CV causes

- **Dysrhythmias**
  - Bradyarrhythmia
    - Heart blocks, Sick sinus syndrome,
    - Meds: Beta and Ca-Channel blockers, digoxin, cholinesterase inhibitors
  - Tachyarrhythmias
    - Supraventricular and ventricular
  - Torsades de pointes
  - Drug induced
    - TCA, digoxin, antiarrhythmics
  - Prolonged Q-T syndrome
    - Congenital
    - Drug-induced
  - Myocardial infarction
  - Pacemaker failure, ICD malfunction

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What Do You Really Want to Know?

- Dangerous etiology vs. Benign etiology

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"Those Who Suffer from Frequent and Strong Faints Without Any Manifest Cause Die Suddenly"
Hippocrates (460 - 375 BC)

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What Do You Really Want to Know?

- Dangerous etiology vs. Benign etiology
- Medical-legal peril vs. None

Admit vs. discharge to home?

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What Do You Really Want to Know?

- Dangerous etiology vs. Benign etiology
- Medical-legal peril vs. None

Admit vs. discharge to home?

What work-up is needed?

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Syncope

- Definition - *very useful*
- Pathophysiology - *very useful*
- H & P elements - *that are useful*
- Tests/:
  Clinical Policies - *that might be useful*
- EKG's - *that are worrisome!*
- The outpatient evaluation

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Syncope - Definition

- "A brief loss of consciousness associated with an inability to maintain postural tone that spontaneously and completely resolves without medical intervention"

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Syncope - Definition

- "A **brief** loss of consciousness associated with an inability to maintain postural tone that spontaneously and completely resolves without medical intervention"

- **Brief:** not asleep/intoxicated, not post-ictal

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Syncope or Too Much to Drink (or Dead)?

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Syncope - Definition

- "A **brief** loss of consciousness associated with an inability to maintain postural tone that **spontaneously** and completely resolves without medical intervention"

- **Brief**: not asleep/intoxicated, not post-ictal
- **Spontaneous:** no intervention needed.... so rarely=> "hypoglycemia"

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Syncope - Definition

- "A **brief** loss of consciousness associated with an inability to maintain postural tone that **spontaneously** and **completely** resolves without medical intervention"

- Brief: not asleep/intoxicated, not post-ictal
- Spontaneous: no intervention needed.... so rarely=> "hypoglycemia"
- **Completely:** no neurologic deficit, return to baseline

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Syncope- Pathophysiology

- Global cerebral hypoperfusion

Forget the "TIA" diagnosis/eval

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Syncope

- Definition *- very useful*
- Pathophysiology *- very useful*
- H & P elements *- that are useful*
- Tests/:
  Clinical Policies *- that might be useful*
- EKG's *- that are worrisome!*
- The outpatient evaluation

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Syncope - History

High - risk	**Lower - risk**
Older age	younger age
(+) CV diagnosis	(-) CV diagnosis
(+) CHF	(-) CHF
(+) Family Hx	(-) Family Hx
No prodrome	(+) prodrome
Supine position	
Assoc. with exertion	(-) exertion

(think structural outflow obstruction)

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Syncope - History
Age Does Matter!!!

- Methods: prospective study, ED pts (+) syncope
- Results: 477 patients, 97% f/u @14 days
  - 80 (18%) patients with "serious event"

AGE	# (%) serious outcome	Odds Ratio
< 40	4/141 (3%)	1.0
40-59	15/112 (13%)	2.7
60- 79	30/115 (26%)	3.8
80+	31/109 (28%)	3.9

Note: 63/80 events were noted in ED

Sun, BC, et al. J Am Ger Soc, 2007

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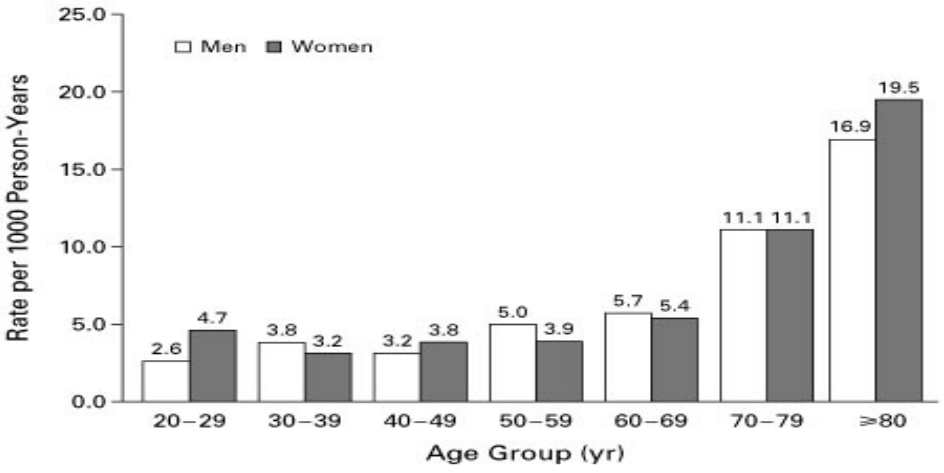
Incidence Rates of Syncope According to Age and Sex



Soteriades, E. et al. N Engl J Med 2002;347:878-885

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Syncope - History

High - risk	Lower - risk
• Older age ✓	younger age
• (+) CV diagnosis	(-) CV diagnosis
• **(+) CHF**	(-) CHF
• (+) Family Hx	(-) Family Hx
• No prodrome	(+) prodrome
• Supine position	
• Assoc. with exertion	(-) exertion

(think structural outflow obstruction)

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Data to Support Risk Factors

- **Methods:** Retrospective study, Kaiser data, 02-06
  - 22,189 patients with 23,951 syncope episodes
  - 307 deaths in 30 days
- **Results:**

	Hazard Ratio
-CHF: (age 18-59)	**14.3**
(age 60-79)	3.1
(age 80+)	2.3
-Diabetes	1.5
-Seizure	1.6
-Dementia	1.4

30-day Death rate:
0.2% < 60yrs without CHF, 2.5% all ages with CHF

Derose SF, et al. Acad Emerg Med 2012

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Syncope - History

High - risk	Lower - risk
• Older age	younger age
• (+) CV diagnosis	(-) CV diagnosis
• **(+) CHF**	(-) CHF
• (+) Family Hx	(-) Family Hx
• No prodrome	(+) prodrome
• Supine position	
• Assoc. with exertion	(-) exertion

(think structural outflow obstruction)

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Syncope - Step 2 in History
The Episode....

Syncope vs. Seizure

- Ask observers
  - Duration
  - Interventions required
  - Seizure activity, tongue biting, incontinence

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Syncope vs. Seizure

Don't confuse with *"convulsive syncope"*

- 0.03% of all blood donors
- 12% of all syncope
- Men> women
- Individual variable response to global cerebral hypoperfusion

Lin JT, et al. Ann Neurol 1982 11(5): 525-8.

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Syncope vs. Seizure

Suggests seizure	Suggests syncope
• Tongue biting	• Presyncopal/prodrome
• Head turning/posturing	• Warmth before spell
• No memory of LOC	• Remembered LOC
• LOC assoc. with stress	• Prolonged sitting or standing
• Cyanosis observed	• Any chest pain
• Limb jerking observed	• Palpitations
• Postictal confusion	• Dyspnea
• Postictal headache	

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Syncope History-
Step 1: Risk Factors
Step 2: The Episode

Step 3: What Are the Meds?

- Syncope Clinic, Duke Univ
  - 70 pts - 13% of syncope due to meds

Hanlon, JT, et al. Arch Intern Med, 1990

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Syncope History-

Step 3: What Are the Meds?

- Drugs that cause hypotension
  - Alpha blockers, diuretics
- Drugs that cause bradyarrhythmias
  - B-blockers, Ca+ channel blockers,
  - ***Alzheimer meds?***
- Drugs that cause prolonged QT

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Cholinesterase Inhibitors Do Increase Risk of Syncope!!!

- **Methods:** population-based cohort study,
  - Location: Ontario, Canada; 2002-2004
  - Patients with dx: dementia
- **Results:**

	Controls n=61,499	(+) cholinesterase n= 19,803
Hospital visits for syncope	1.76x (1.57-1.98)	
Bradycardia		1.69x (1.32-2.15)
Pacer insertion		1.49x (1.12-2.00)
Hip fracture		1.18x (1.04-1.34)

Gill, SS, et al. Arch Intern Med, May 11, 2009

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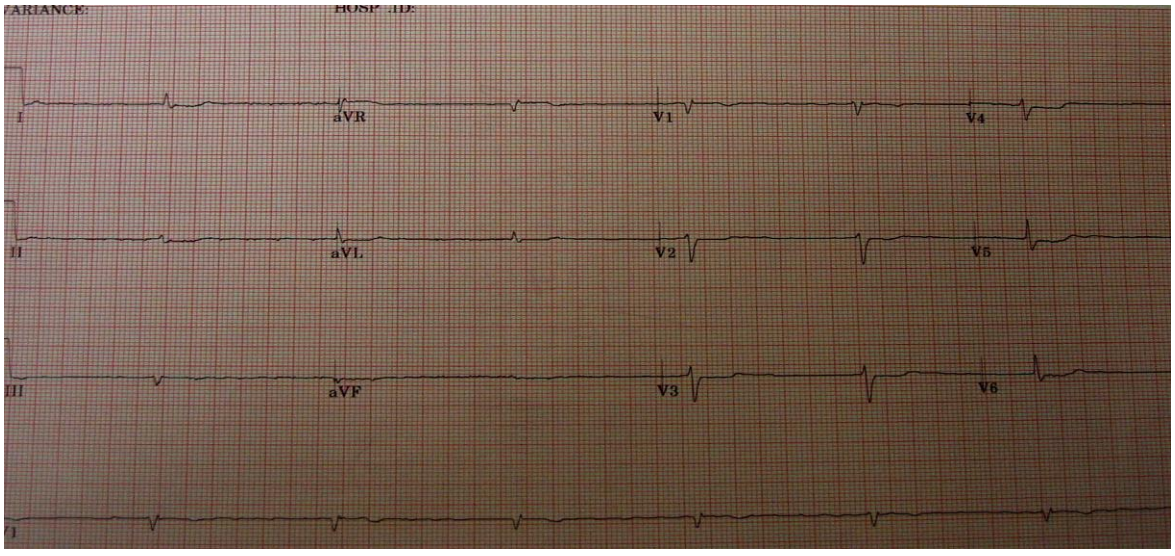
Oct 11, 2009 - 85 y/o Near Syncope
Meds: Verapamil, Digoxin, Aricept, Exelon Patch



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Syncope History

Step 3: What Are the Meds?

- Drugs that cause hypotension
  - Alpha blockers, diuretics
- Drugs that cause bradyarrhythmias
  - B-blockers, Ca+ channel blockers,
  - ***Alzheimer meds?***
- Drugs that cause prolonged QT

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Drugs That Can Cause Prolong QTc/Torsades

Antiarrhythmics
- Amiodarone
- Disopyramide
- Sotalol
- Flecainide
- Ibutilide
- Procainamide
- Propafenone
- Quinidine

Anti-anginal
- Ranolazine

Macrolides
- Erythromycin
- Clarithromycin
- **Azithromycin**

Quinolones
- Ciprofloxacin
- Gatifloxacin
- **Levofloxacin**
- Moxifloxacin

Antifungal
- **Fluconazole**
- Itraconazole

TCA's/SSRI's
- Amitriptyline
- Desipramine
- Doxepin
- Fluoxetine
- Imipramine
- Paroxetine
- Sertraline
- Trazodone
- Venlafaxine

Anti-emetic
- **ondansetron**
- **droperidol**

Antipsychotic
- Droperidol
- Haloperidol
- Pimozide
- **Quetiapine**
- Risperidone
- Paliperidone
- Thioridazine
- Chlorpromazine
- **Citalopram**

www.crediblemeds.org

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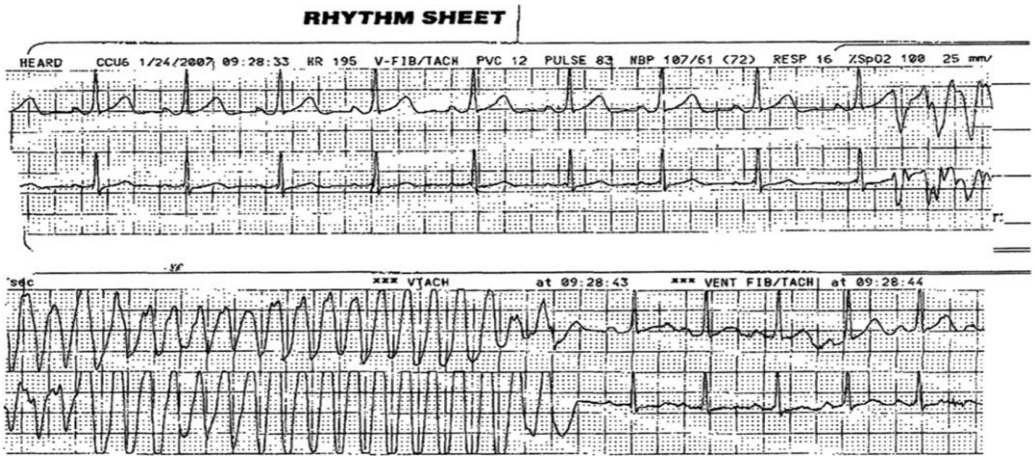
Azithromycin-induced Polymorphic Ventricular Tachycardia (VT) in a 24-year-old Woman with No Structural Heart Disease and a Normal ECG. The Arrhythmias Resolved with Stopping the Drug.



Zhenjiang Yang et al. Circ Arrhythm Electrophysiol. 2017;10:e003560

American Heart Association.

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Is Azithromycin Associated with Arrhythmia and Death?

Yes

- ***Ray WA, et al. NEJM 2012***

Tennessee Medicaid cohort
CV death HR 2.49 (1.38-4.5)
compared to amoxicillin

- ***Rao GA, et al. Ann Fam Med 2014***

VA data base
All death HR 1.62 (1.15-2.3)
compared to amoxicillin

No

- ***Svanstrom, et al. NEJM 2013***

Danish database
No difference vs. PCN

- ***Trifiro G, et al. CMAJ 2017***

European database
No difference vs. Amoxicillin

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Syncope History-
Step 1: Risk Factors
Step 2: The Episode

Step 3: What Are the Meds?

Next--- The Physical Exam
But, what is useful?

- Vitals Signs
- Cardiac Exam
- Abdominal Exam
- Neuro Exam

?????????

- *Orthostatics?*
- *Carotid sinus massage?*

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Orthostatic Hypotension

- Defined: 20mmHg drop in BPsys **standing**
- May indicate:
  - volume depletion
  - Cardiac pump failure
  - Medications
  - Autonomic insufficiency

However, it is present in asymptomatic pts
40% in age >70
23% in age <60

Atkins, D, et al. Am J Med, 1991

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Orthostatic Hypotension

- Defined: 20mmHg drop in BPsys **standing**

Not to be confused with….

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Orthostatic Hypotension

- Defined: 20mmHg drop in BPsys **standing**

Not to be confused with….

Postural (orthostatic) tachycardia syndrome (POTS)

- Defined: Increase HR ≥ 30 bpm
  - No orthostatic hypotension
  - Frequent symptoms upon standing *(lightheaded, palpitations, tremulousness, blurred vision, weakness)*
  - **Will feel pre-syncope, but do not pass out**

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Postural (Orthostatic) Tachycardia Syndrome (POTS)

- Pathophysiology: dysautonomia, ?autoimmune?
- Common: 1-3 million Americans
  - 5-10x more common than orthostatic hypotension
  - Women:Men: 5:1

POTS incidence rises significantly post-COVID-19

(Pixabay)

The incidence rate of postural orthostatic tachycardia syndrome has risen significantly since the COVID-19 pandemic, according to a study in the European Heart Journal -- Quality of Care and Clinical Outcomes. Researchers using TriNetX data found that post-pandemic, the incidence rate increased from 1.42 to 20.3 per 1 million person-years. They emphasized the need to screen for the condition in post-COVID patients. **Full Story:** Healio

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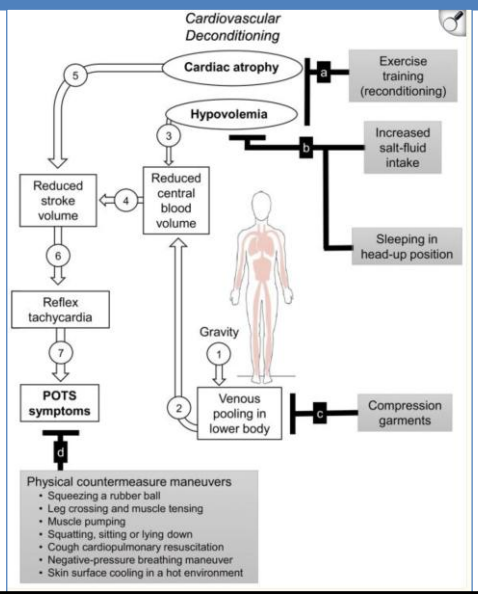
Postural (Orthostatic) Tachycardia Syndrome (POTS)



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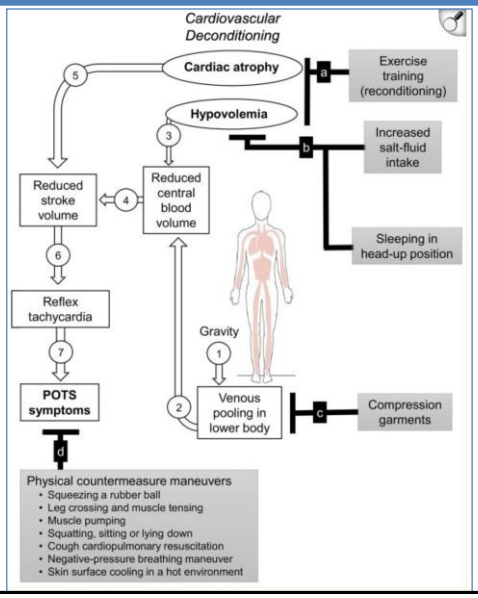
Postural (Orthostatic) Tachycardia Syndrome (POTS)



Drug therapy

- ✓ midodrine,
- ✓ ivabradine,
- ✓ bisoprolol,
- ✓ fludrocortisone,
- ✓ droxidopa,
- ✓ desmopressin,
- ✓ propranolol,
- ✓ modafinil,
- ✓ methylphenidate,
- ✓ melatonin

All sample sizes 10-50 subjects.

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Carotid sinus hypersensitivity

- First described by Ibn Sina (Avicenna) 980-1037
- Asystole > 3 sec after 5-10 sec of carotid message ***OR*** ***drop of 50mm Hg BPsys***
- Suggested as common cause of syncope and falls in the elderly
- Pacing is effective for bradyarrhythmia
  Pacing ***not*** effective for vasodepressive

- ***How common is it?***
- ***Is it the cause of the syncopal episode?***

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Carotid Sinus Hypersensitivity

- Methods: 272 pts., age >65, single practice in GB
- Results: (+) CSH in 107 (37%)
  - Pts with (+) hx of syncope, falls, dizziness (n= 192) **41%**
  - Pts with no hx of syncope no falls, dizziness (n=80) **35%**

Kerr, SRJ, et al. Arch Intern Med, 2006

- ***How common is it?*** ***Very common, in elderly***
- ***Is it the cause of the syncopal episode?*** ***???***

The presence of CSH (and orthostatics) does not preclude looking for other causes

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Syncope History-
Step 1: Risk Factors
Step 2: The Episode

Step 3: What Are the Meds?

Step 4--- The Physical Exam But, What's Useful?

- Vitals Signs
- Cardiac Exam
- Abdominal Exam
- Neuro Exam

- Orthostatics
- Carotid sinus massage?

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Syncope History-
Step 1: Risk Factors
Step 2: The Episode

Step 3: What Are the Meds?

Step 4--- The Physical Exam

Step 5 – the tests….
But which ones?

Ask the question: "How are you feeling?"

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Syncope: The Dangerous Causes

- ACS
- Aortic dissection
- PE
- AAA
- Ectopic pregnancy
- GI bleed
- SAH

➢Routine troponin[1],
➢R/O MI protocols[2],
➢Head CT[3]
have low/no yield!

[1]Hing, R, et al, 2005
[2]Link, MS, et al, 2001
[3]Giglio P, et al, 2005

"Be a sniper, don't use a shotgun!!"
A. Mattu

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Syncope: What Diagnostic Studies Are Needed (to Risk Stratify)? ACEP 2007

- Answer: **EKG only**
  - Note: the yield is < 5%
  - But it is low-cost, non-invasive
  - And can potentially identify life-threatening conditions
- ACC/AHA agree (2006, 2017)
  - ***"Routine and comprehensive testing is not useful" (Class III recommendation)***
- ***All other studies are guided by H & P***

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ARS Question 1: ACEP (2007) and AHA/ACC (2017) Policies States Which of the Following Tests Should Be Performed **in All Patients with Syncope?**

- A. EKG
- B. EKG + CBC
- C. EKG + CBC + troponin
- D. EKG + CBC + troponin + head CT
- E. Head CT

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Same Holds True for Elderly!!

- Methods: 2106 admits for syncope, age > 65
  - Yale Med Center, 7/1/02 - 12/31/06, retrospective

Test	#(%)	Helped determine etiology
EKG	2081 (99%)	72 (3%)
Telemetry	2001 (95%)	95 (5%)
Cardiac enzymes	1991 (95%)	9 (0.5%)
Head CT	1327 (63%)	7 (0.5%)
Echo	821 (39%)	13 (2%)
Carotid U/S, EEG		<1%

Estimated costs nationally =$6 billion/year

Mendu ML, et al, Arch Intern Med, July 27, 2009

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Syncope

- Definition ***- very useful***
- Pathophysiology ***- very useful***
- H & P elements ***- that are useful***
- Tests/:
  Clinical Policies ***- that might be useful***

- EKG's ***- that are worrisome!***
- The outpatient evaluation

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Syncope and EKG Findings

- **Bradycardias, conduction abnormalities (blocks)**
- Atrial and ventricular tachycardias
- Wolff-Parkinson-White (WPW)
- Prolonged QTc/Long QT syndrome
- Brugada Syndrome
- Hypertrophic Cardiomyopathy
- Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

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Syncope and EKG findings

1st degree A-V Block, Mobitz 1, Mobitz 2 and 3rd degree A-V block*

* Admit/Cardiology

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Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias,** conduction abnormalities (blocks)
  - LBBB:
  - RBBB:
  - Bifascicular blocks
  - Trifascicular blocks

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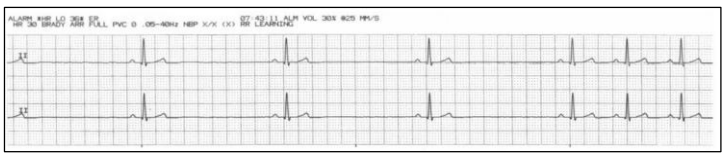
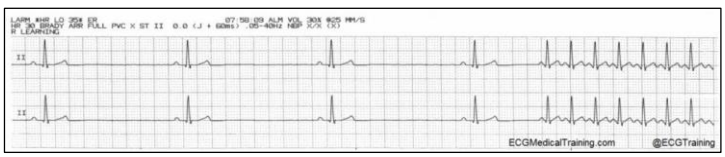
Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias,** conduction abnormalities (blocks)
  - **Sinus node dysfunction ("sick sinus syndrome")*** *(includes tachycardia-bradycardia syndrome)**
  - LBBB
  - RBBB



  - Bifascicular block
  - Trifascicular block



* Admit/Cardiology

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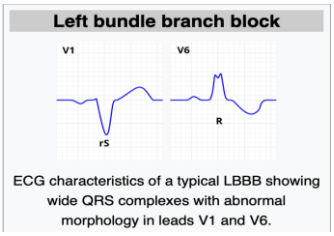
Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome")
    (includes tachycardia-bradycardia syndrome)
  - **LBBB: no issue** *(except if new + CP = AMI)**
  - **RBBB:**
  - **Bifascicular blocks**
  - **Trifascicular blocks**



ECG characteristics of a typical LBBB showing wide QRS complexes with abnormal morphology in leads V1 and V6.

* Admit/Cardiology

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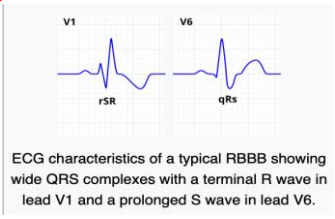
Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome")
    (includes tachycardia-bradycardia syndrome)
  - **LBBB: no issue** *(except if new + CP = AMI)**
  - **RBBB: no issue** *(except if ST elev V1,2 = Brugada)**
  - **Bifascicular blocks**
  - **Trifascicular blocks**



ECG characteristics of a typical RBBB showing wide QRS complexes with a terminal R wave in lead V1 and a prolonged S wave in lead V6.

* Admit/Cardiology

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Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome") *(includes tachycardia-bradycardia syndrome)*
  - **LBBB: no issue** *(except if new + CP = AMI)**
  - **RBBB: no issue** *(except if ST elev V1 = Brugada)**
  - ***OR***
  - **Bifascicular blocks = RBBB** + L ant. fascicular block*
  - **Trifascicular blocks**

* Admit/Cardiology

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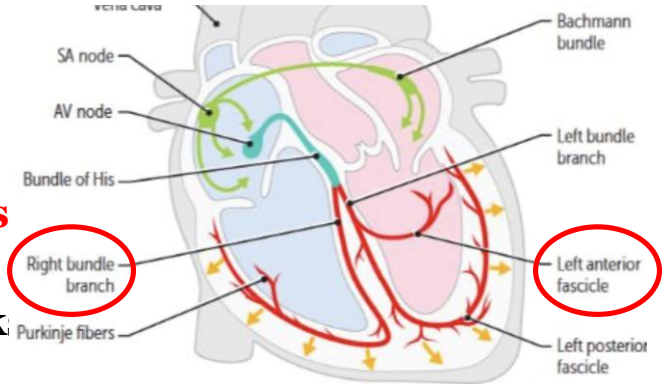
Syncope and EKG Findings

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome") *(includes tachycardia-bradycardia syndrome)*
  - **LBBB,**
  - **RBBB**
  - **Bifascicular blocks**
  - **Trifascicular block**



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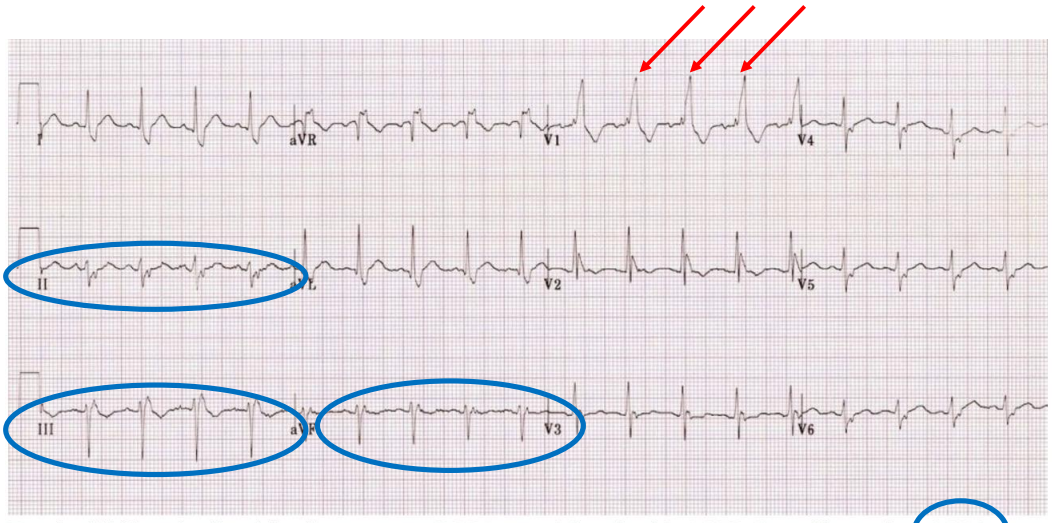
Bifascicular Blocks



Typical bifascicular block pattern: RBBB combined with LAFB (manifested as LAD)

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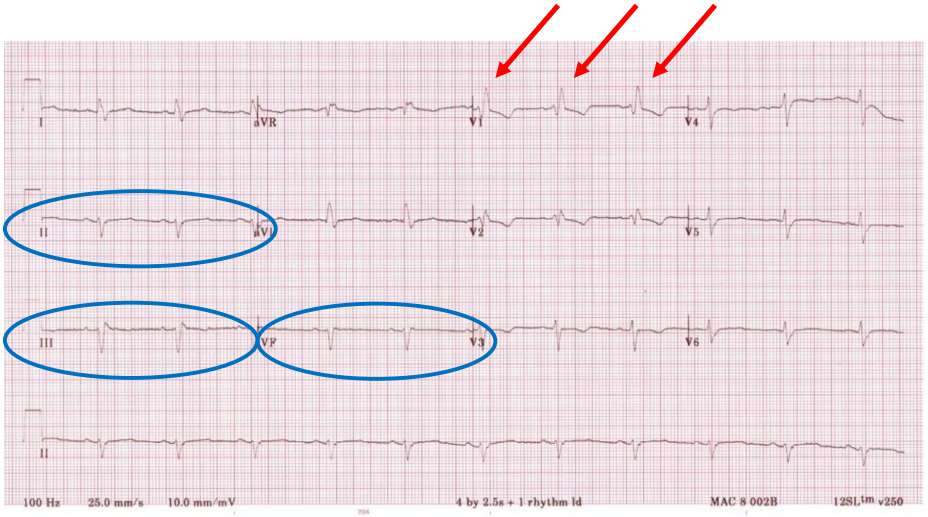
Bifascicular Blocks



RBBB with LAFB

- RBBB pattern in precordial leads with RSR' complex in V1-2
- Prominent LAD indicating LAFB

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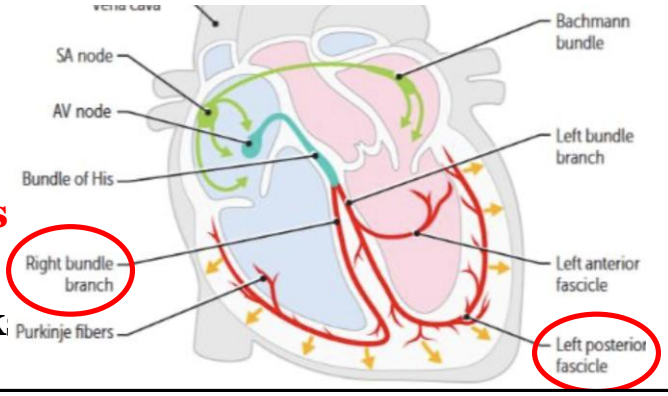
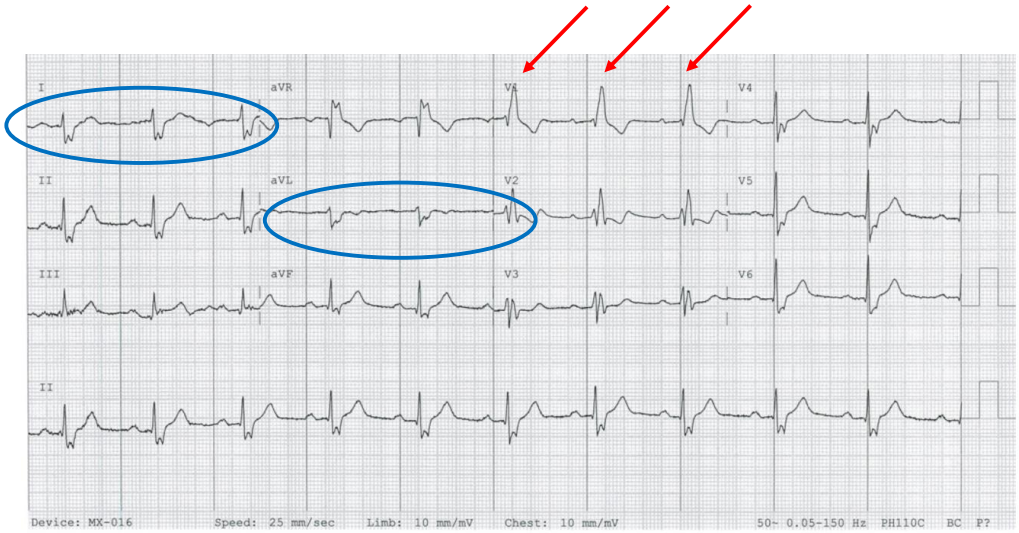
Syncope and EKG Findings

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome")
    (includes tachycardia-bradycardia syndrome)
  - **LBBB,**
  - **RBBB**
  - **Bifascicular blocks**
  - **Trifascicular block**



63

Bifascicular Blocks



RBBB with LPFB and RAD

64

Bifascicular Blocks: Clinical Significance

- Structural heart disease present (50-80%) and extensive fibrosis of the conducting system.

** ***risk of progression to complete heart block***
(with damage to the 3rd fascicle)

➢ **Clinical context is important:**

- Rate of progression to complete heart block is 1-4% per year
- In symptom free patients, these figures are ~1% per year
- *Patients with syncope have a 17% annual risk of progression*
- **Syncope/presyncope in the context of a bifascicular block is an indication for admission and monitoring!!!!**

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Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome") *(includes tachycardia-bradycardia syndrome)*

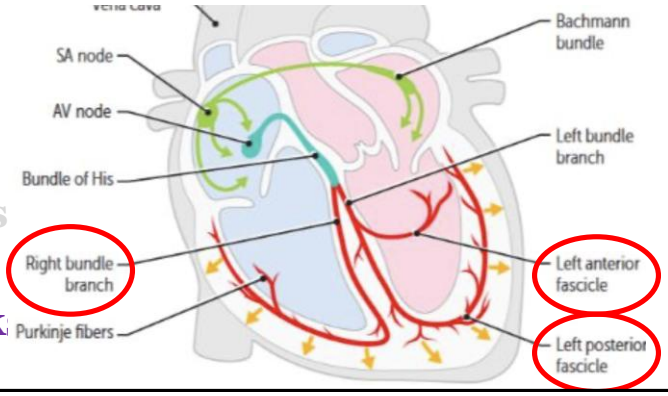
  - **LBBB: no issue** *(except if new + CP = AMI)**
  - **RBBB: no issue** *(except if ST elev V1 = Brugada)**
    OR
  - **Bifascicular blocks = RBBB** + L ant. fascicular block*
    RBBB + L post. fascicular block*
  - **Trifascicular blocks**

* Admit/Cardiology

66

Syncope and EKG Findings

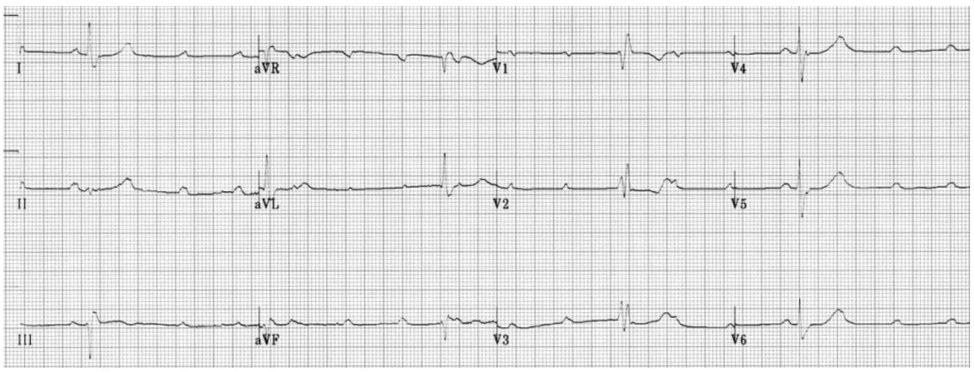
- **Bradycardias, conduction abnormalities (blocks)**
  - Sinus node dysfunction ("sick sinus syndrome") *(includes tachycardia-bradycardia syndrome)*
  - **LBBB**
  - **RBBB**
  - **Bifascicular blocks**
  - **Trifascicular block**



67

Trifascicular Blocks:

1) "True" Trifascicular: RBBB + LAFB + 3rd AV Block



True Trifascicular Block:

- Right bundle branch block
- Left axis deviation (Left anterior fascicular block)
- Third degree heart block

* Admit/Cardiology

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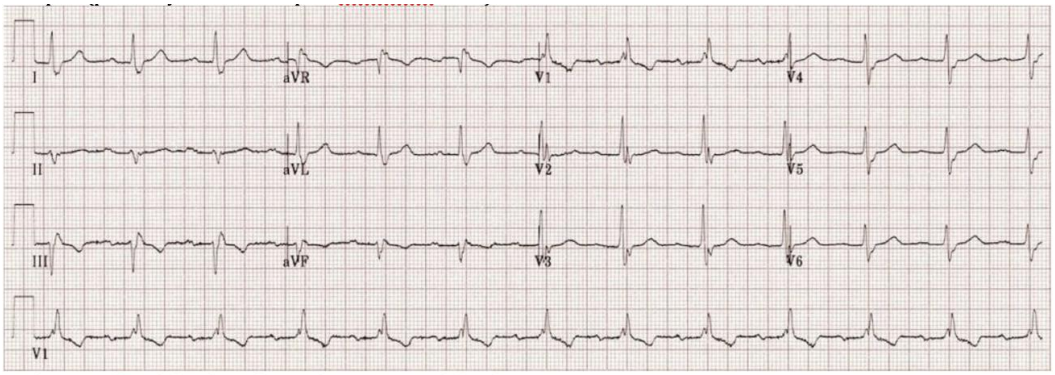
Trifascicular Blocks:

1)"True" Trifascicular: RBBB + LAFB + 3rd AV Block

2)"Incomplete" Trifascicular: RBBB + LAFB + 1st AV Block



Bifascicular block + first degree AV block

- Right bundle branch block
- Left axis deviation (= left anterior fascicular block)
- First degree AV block

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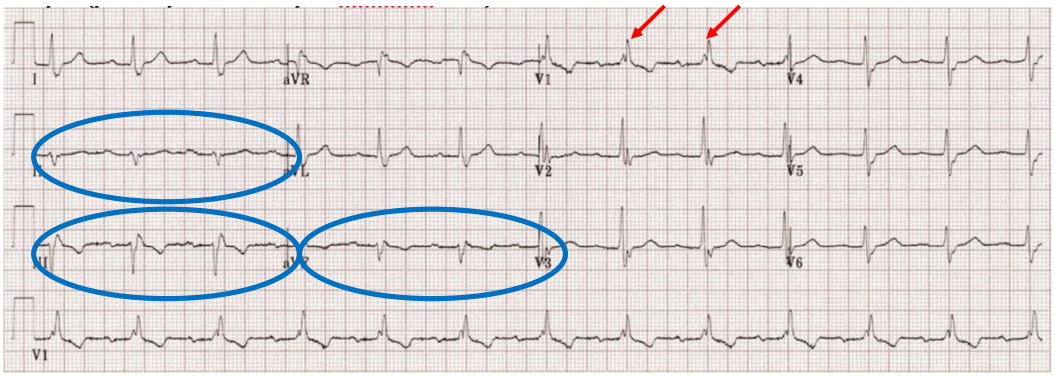
Trifascicular Blocks:

1)"True" Trifascicular: RBBB + LAFB + 3rd AV Block

2)"Incomplete" Trifascicular: RBBB + LAFB + 1st AV Block



Bifascicular block + first degree AV block

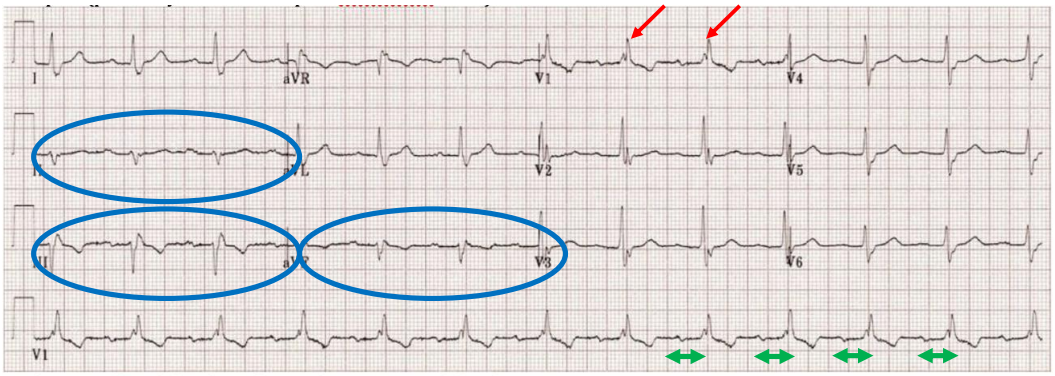
- Right bundle branch block
- Left axis deviation (= left anterior fascicular block)
- First degree AV block

70

Trifascicular Blocks:

1)"True" Trifascicular: RBBB + LAFB + 3rd AV Block

2)"Incomplete" Trifascicular: RBBB + LAFB + 1st AV Block



Bifascicular block + first degree AV block

- Right bundle branch block
- Left axis deviation (= left anterior fascicular block)
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71

Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

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    OR
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    RBBB + L post. fascicular block*
  - **Trifascicular blocks***

* Admit/Cardiology

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Syncope and EKG Findings

- **Bradycardias, conduction abnormalities (blocks)**
- Atrial and ventricular tachycardias
- Wolff-Parkinson-White (WPW)
- Prolonged QTc/Long QT syndrome
- Brugada Syndrome
- Hypertrophic Cardiomyopathy
- Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

* Admit/Cardiology

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Syncope and EKG Findings

- **Bradycardias, conduction abnormalities (blocks)**
- Atrial and ventricular tachycardias
- Wolff-Parkinson-White (WPW)
- Prolonged QTc/Long QT syndrome
- Brugada Syndrome
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* Admit/Cardiology

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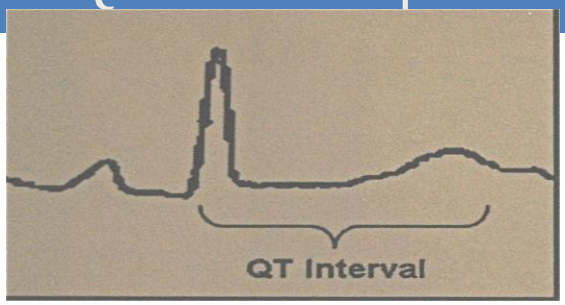
Long QT Syndrome (LQTS)

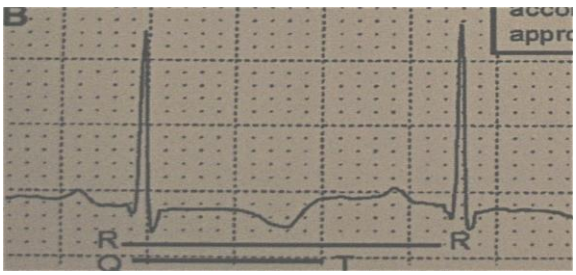
- **Acquired**
  - Meds, toxins, electrolyte disturbances, ACS, CNS events, HIV
- **Congenital: Autosomal dominant**
  - Associated with 11 genes, 600 mutations
  - Prevalence: estimates 1/2000-7000
  - Median age of sudden death = 32 years
  - Mortality =20% in first year after syncope
    - 50% mortality within 5 years

In series of 31 pts. with LQTS, 64% presented with syncope 40% of the patients were not identified at first presentation!
MacCormick JM, et al. Ann Emerg Med, July 2009

75

LQTS: Men > 460msec, Women > 440msec





Bazett Formula

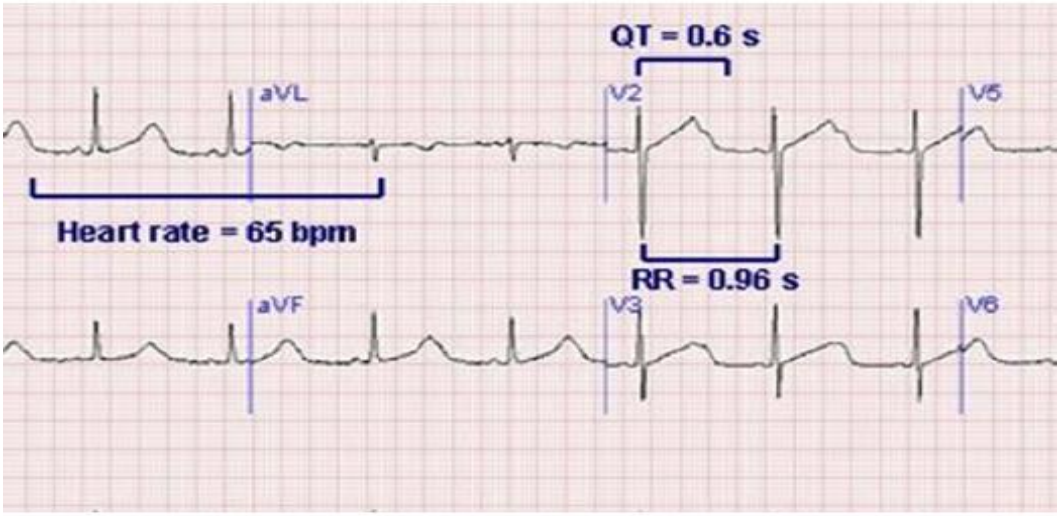
$$QTc = \frac{QT}{[RR]^{0.5}}$$

* In leads II, V5

Rapid Bedside
If QT is < 1/2 of R-R interval is OK*
*only for HR 60-100

76

Long QT Syndrome



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Brugada Syndrome

- First described in 1992
- Originally thought to be a disease of men of Southeast Asian descent
  - In Philippines: *"Bangungut"*
    "scream followed by sudden death during sleep"
  - In Japan: *"Pokkuri"*
    "unexpected sudden death at night"
  - In Thailand: *"Lai Tai"* - "death during sleep"
  - In Laos - one death per 1000 inhabitants!!!

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Brugada Syndrome

- Now believed to be responsible for 40-60% of patients with "idiopathic V fib"
  - Second only to MVA cause of death in young adults in some countries
- Mutation of SCN5A cardiac Na+ channel on Chromosome 3 ***("channelopathy")***
- Recurrent episodes of polymorphic V tach

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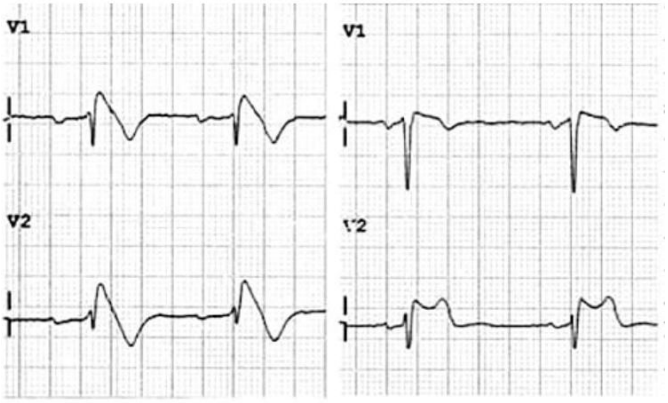
Brugada Syndrome: EKG

- **RBBB** with ST elevation V1-3



TYPE 1 ECG TYPE 2 ECG

Type I - "coved-shaped" ST
***is diagnostic**

Type II - "concave-shaped" ST
*is non-diagnostic, But suggests dx in appropriate patient

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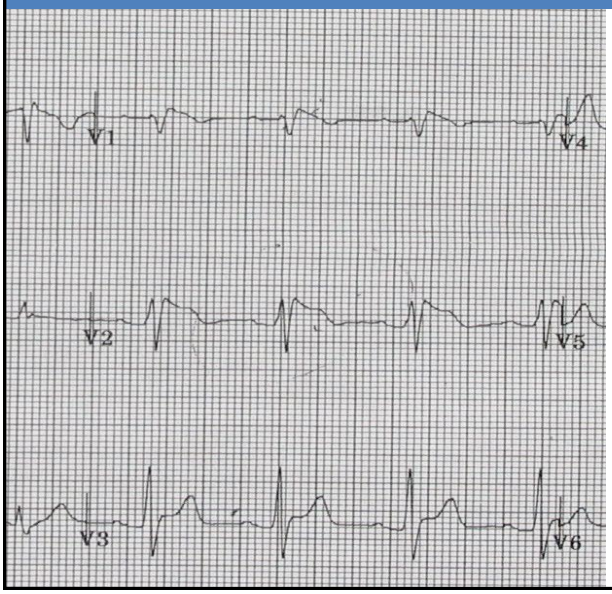
Brugada Syndrome: EKG



- Look at V1- 3
- Type I

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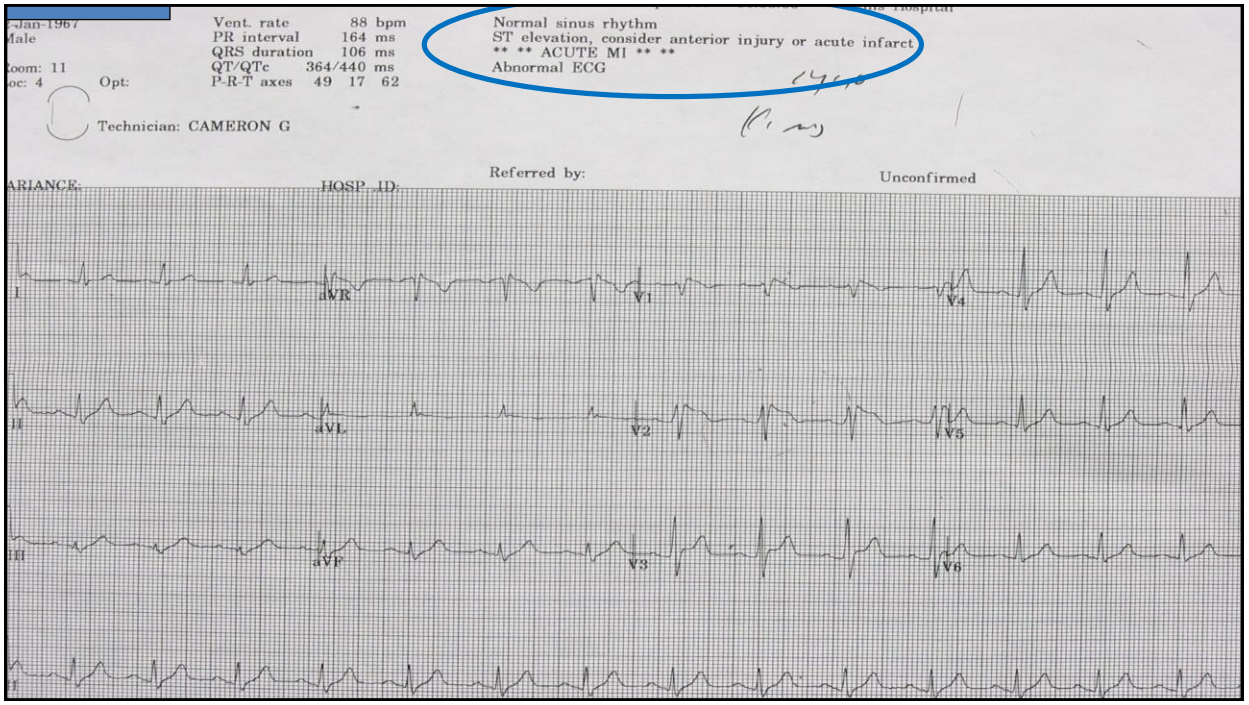
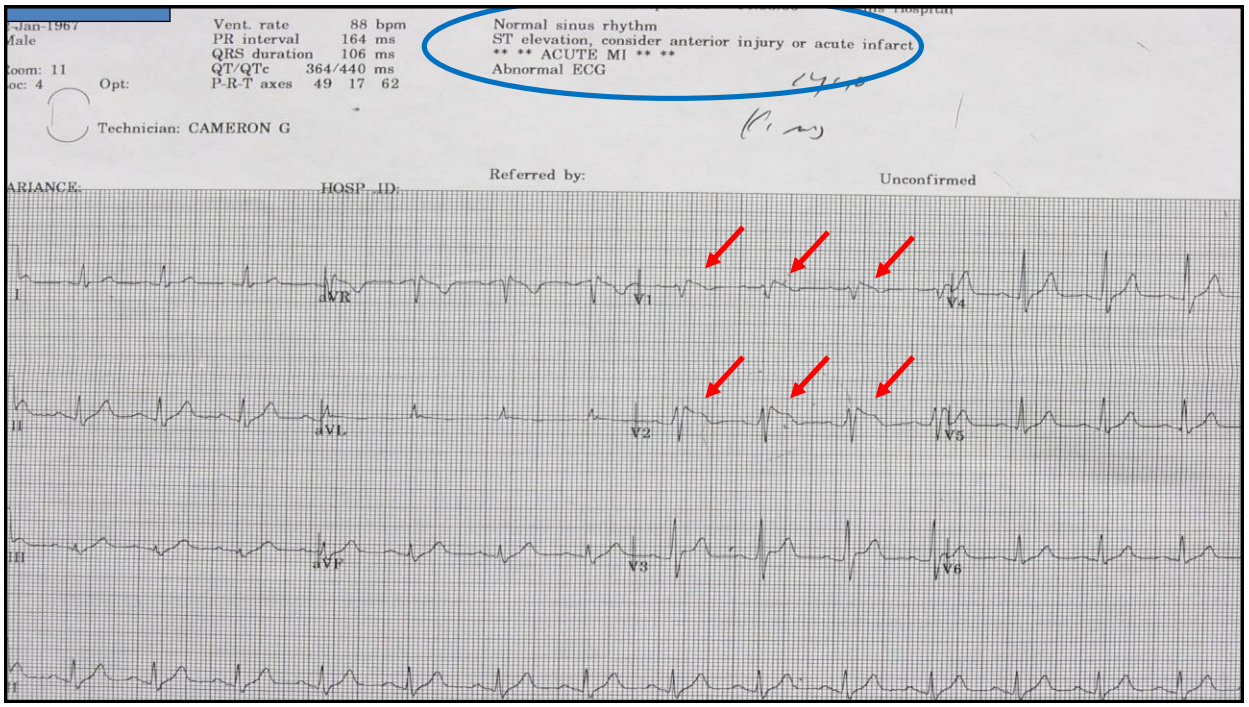


82



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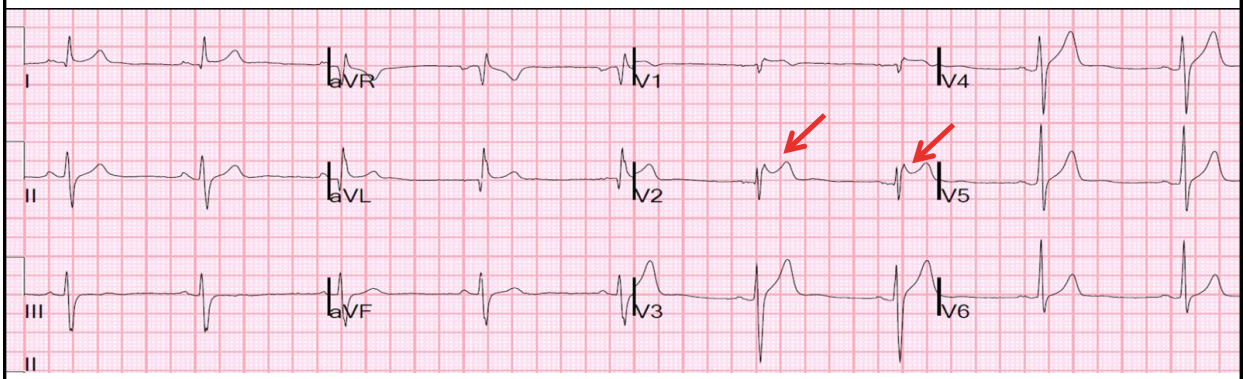
Brugada Syndrome: EKG

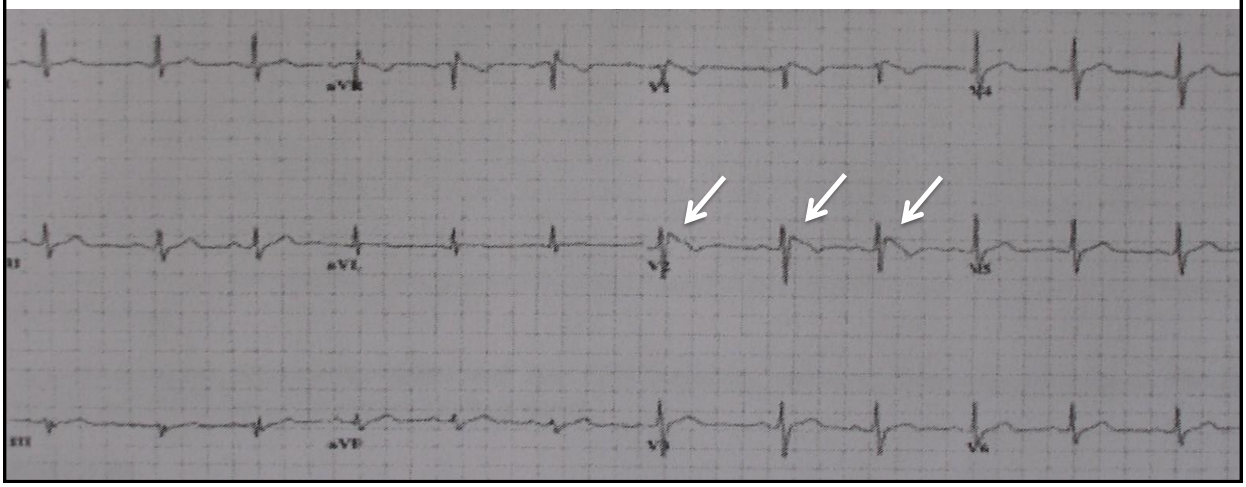
- Type II - incomplete RBBB; "concave-shaped" ST, V1-3



Note "saddleback" in V2

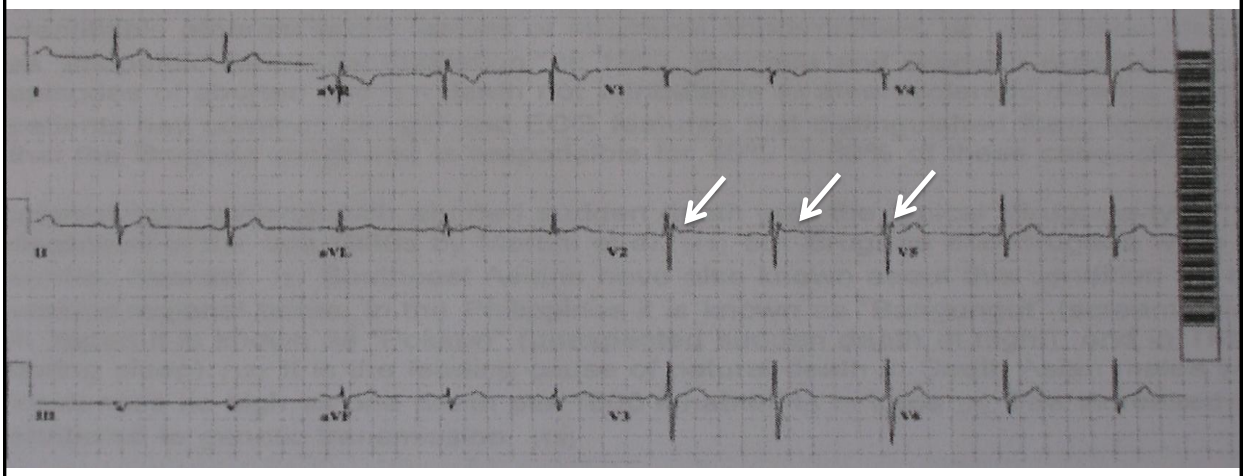
84

30 y/o AA Female, Chest Tightness, Palpitations, Near-syncope. Previous Hx of Previous Syncopal Episodes



85

9 Years Earlier…



Courtesy A. Mattu, Univ Maryland.

86

Hypertrophic Cardiomyopathy (HCM)

- First described in mid-19th century
- Previous names:
  - Hypertrophic obstructive cardiomyopathy (HOCM)
  - Idiopathic hypertrophic subaortic stenosis (IHSS)
- Characteristics:
  - Thickened myocardium
  - without ventricular dilation
  - absence of conditions that result in hypertrophy (HTN, Aortic stenosis)
- Incidence: approx. 1 in 500 persons
- Annual mortality rate =
  =1-2% in unselected pts with HCM

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Hypertrophic Cardiomyopathy (HCM)

- Genetics: Autosomal dominant with variable penetrance
  - 11 mutant genes, > 500 mutations
- Variable manifestations
  - ==> asymmetric ventricular hypertrophy
  - Most pronounced in anterior ventricular septum
  - Increase occurs most commonly during periods of growth (ie. adolescence)
- Presentation:
  - May be asymptomatic
  - Chest pain
  - Symptoms of LVOT obstruction (SOB, DOE, syncope)
  - Sudden death

Most common cause of sudden death in athletic endeavors!

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Hypertrophic Cardiomyopathy (HCM)

- PE: murmur noted in 30-40% only
  - Increases with Valsalva
- Chest x-ray: heart with normal size
- EKG: most are abnormal!!!!
  - 1) Large amplitude QRS complex (c/w LVH) ***==>Most common***
  - 2) Deep, narrow Q waves in: ***==>Most specific***
    - Inferior leads (II, III, AVF) and/or
    - Lateral leads (I, aVL, V5-6)
  - 3) ST changes are common ***➔But non- specific***

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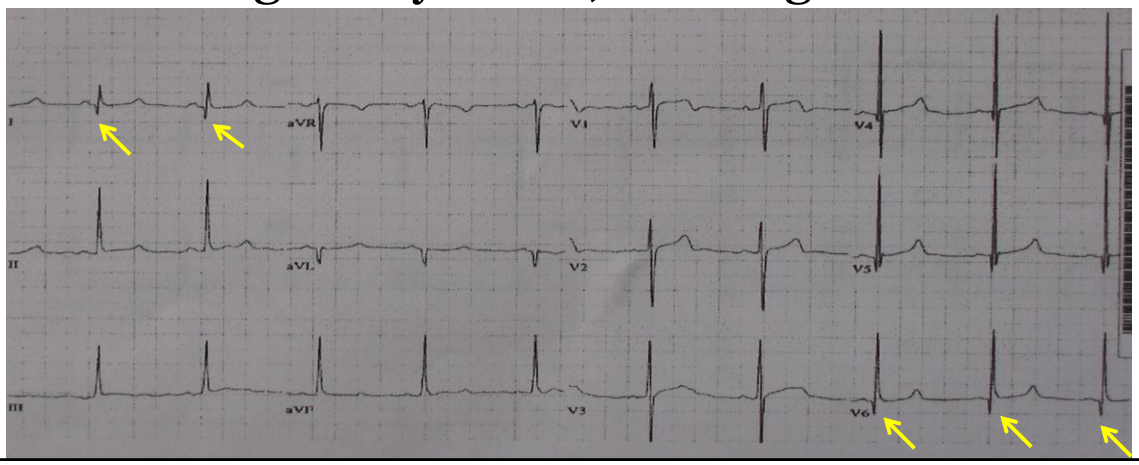
HCM - LVH, Q Waves in I, aVL, V5-6

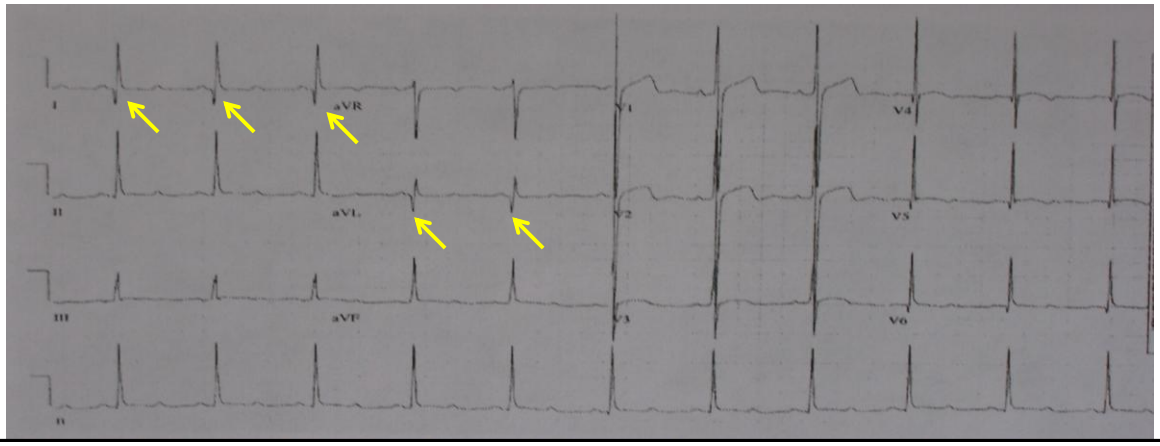
- 30 y/o male lightheaded, palpitations after running. 2 days later, running => SCD.



90

HCM - LVH, Q Waves in I, aVL, V5-6

- 29 y/o male 3rd ED visit for lightheaded, palpitations with exertion.



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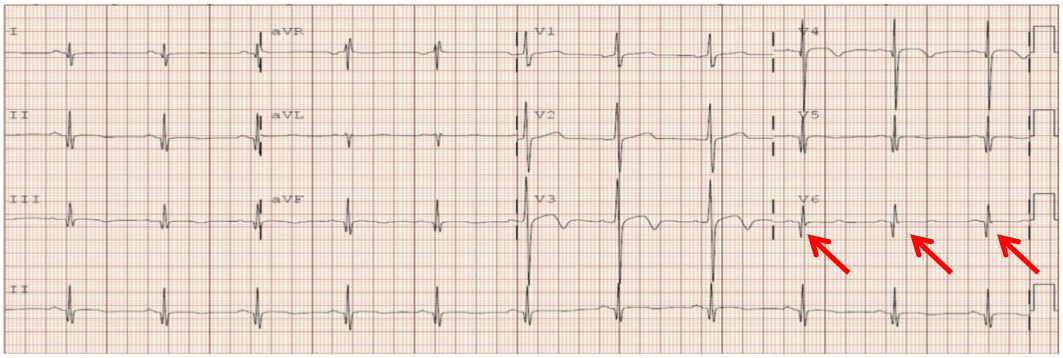
HCM - LVH, Q Waves in I, aVL, V5-6

- 34 y/o male with CP and lightheadedness after biking 1-2 hours.



Q waves are defined as 25% of the height of the ensuing R wave

Beck S et al. Ann Emerg Med. May 2017

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Hypertrophic Cardiomyopathy (HCM)

- Treatment: often medical (B-blockers)
- Complications:
  - 10-40% develop atrial fibrillation
  - Increase incidence of WPW

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Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

- Described in 1982 *(Marcus et al)*
- Progressive loss of R ventricle myocardium ***(replaced with fibrofatty tissue ➔ thinning AND.. Ventricular arrhythmias***
- Autosomal dominant *(but incomplete penetrance)*
- Prevalence: 1/ 2000-5000 (Italy, Germany)
  - Veneto region: 20% of deaths in young people

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Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

- Presentation: palpitations or effort-induced syncope
- When: 2nd – 4th decade of life.

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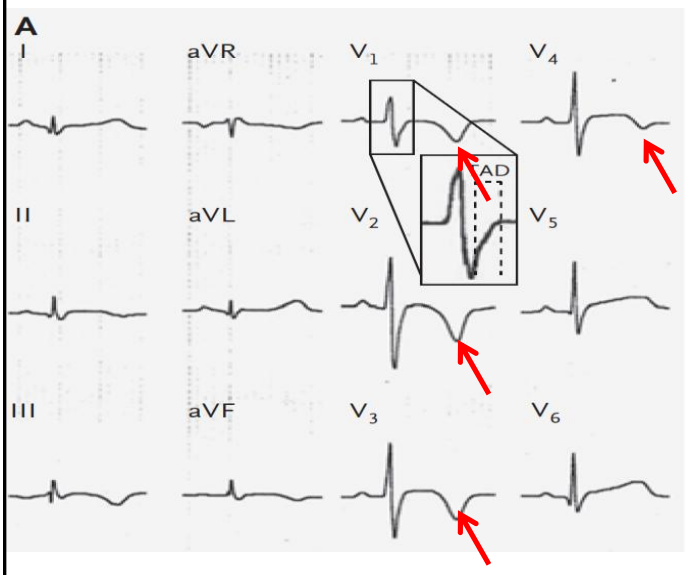
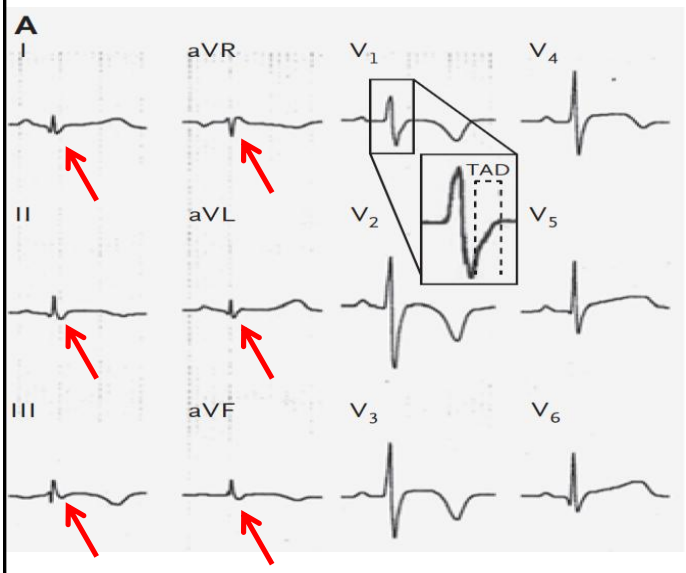


Triad…

- **T wave inversion V1– V4**

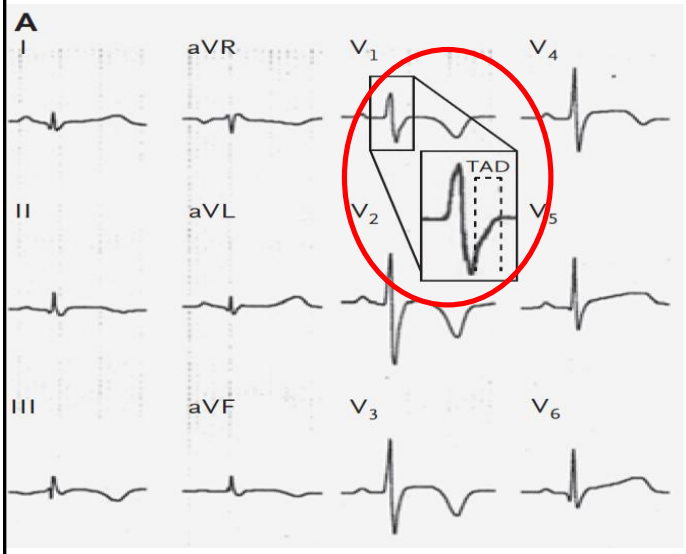
96



Triad…

- **T wave inversion V1– V4**
- **Low voltage limb leads**

97



Triad…

- **T wave inversion V1– V4**
- **Low voltage limb leads**
- **Terminal activation duration (TAD)* is prolonged (normal < 55msec)**

TAD – nadir of S wave to the end of depolarization

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Syncope and EKG Findings

1st Degree A-V Block, Mobitz 1, Mobitz 2 and 3rd Degree A-V Block*

- SSS/Tachy-brady, conduction abnormalities (blocks)
- Atrial and ventricular tachycardias
- Wolff-Parkinson-White (WPW)
- Prolonged QTc/Long QT syndrome
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* Admit/Cardiology

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Syncope: The Evaluation

- I. The History-

  Step 1: Risk Factors
  Step 2: The episode
  Step 3: What are the meds?
  Step 4: "How are you feeling"?

II. The Physical Exam

III. The EKG (and "sniper" diagnostics)

Decision Time: Admit or discharge?

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Syncope

European Society of Cardiology Guideline 2009

- **Reflex (neurally mediated) syncope**
  - Vasovagal
  - Situational (cough, sneeze, micturition)
  - Carotid sinus syncope
  - Atypical forms
- **Syncope due to orthostatic hypotension**
  - 1º autonomic failure (eg. Parkinson's)
  - 2º autonomic failure (eg. Diabetes)
  - Drug induced orthostatic hypotension
  - Volume depletion
- **Cardiogenic**
  - Arrhythmia
  - Structural heart disease

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The Bottom Line - and Where Do We Go from Here?

- 650 ED patients with syncope prospectively evaluated
- Results: 495 (76%) diagnosed in ED
  - **Vasovagal syncope** **234/650 (47%)**
  - **Hypotension** **156/650 (32%)**
  - Neuro/psychiatric 41/650 (8%)
  - Cardiac (AMI, PE, AS) 29/650 (6%)
  - Arrhythmia 26/650 (5%)
- 155(24%) unexplained syncope

Sarasin FP, et al. Heart 2002; 88: 363-67

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Unexplained Syncope: Evaluation

In-patient *VS* Out-patient

Will a clinical decision rule (CDR) help?

Answer: *Perhaps…risk stratify?*

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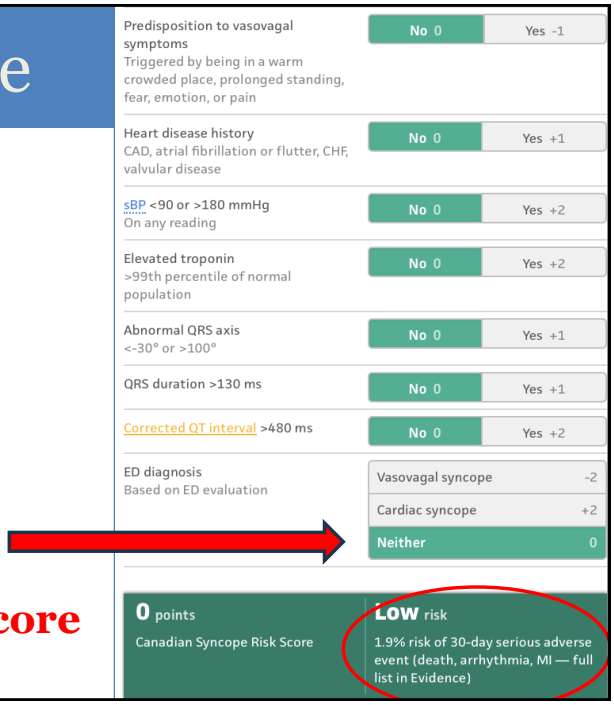
CDR's for Syncope

- SF Syncope Rule
- Boston
- OESIL - Italy
- EGSYS - Italy
- ROSE – Scotland
- STePs (2008)
- Syncope Risk score
- **Canadian Syncope Risk score**



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Unexplained Syncope: Evaluation ACC/AHA 2017

A. ECHO → ***...if structural heart dz is suspected (Class IIa)***

B. EST → ***...if associated with exertion (Class IIa)***

C. Non-invasive ECG monitoring
- Holter, Event recorders
- Implantable loop recorders

→ ***...if you suspect arrhythmia (Class IIa)***

D. Tilt-table testing → ***...useful for suspect vasovagal (Class IIa)***

E. Carotid artery studies →

105

Anderson KL, et al. Ann Emerg Med October 2012; 60:478-484.

323 ED pts admitted to "observation unit"

267 had ***"normal"*** EKG

235 underwent ECHO

Result: # of abnormal ECHO studies=

0, Zero, Zip, nada, etc....

106

Unexplained Syncope: Evaluation ACC/AHA 2017

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B. EST → ***...if associated with exertion (Class IIa)***

C. Non-invasive ECG monitoring
- Holter, Event recorders
- Implantable loop recorders

→ ***...if you suspect arrhythymia (Class IIa)***

D. Tilt-table testing → ***...useful for suspect vasovagal (Class IIa)***

E. Carotid artery studies →

107

108

Unexplained Syncope: Evaluation ACC/AHA 2017

A. ECHO → ***...if structural heart dz is suspected (Class IIa)***

B. EST → ***...if associated with exertion (Class IIa)***

C. Non-invasive ECG monitoring
- Holter, Event recorders
- Implantable loop recorders

→ ***...if you suspect arrhythmia (Class IIa)***

D. Tilt-table testing → ***...useful for suspect vasovagal (Class IIa)***

E. Carotid artery studies → ***No, no no!!! (Class III)***

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- 155(24%) unexplained syncope

Sarasin FP, et al. Heart 2002; 88: 363-67

110

Reflex (Neurally Mediated) Syncope- Vasovagal Syncope – Most Common

- 20-40% of the population have an episode in lifetime[1,2]
- Theory: Failure (abnormal) autonomic NS to maintain BP & HR
  - Starts with excessive peripheral pooling (500-800ml blood)
  - Subsequent paradoxical rise in vagal activity
  - Can be "situational" (eg. defecation, urination, cough)

[1]Salari N, et al Global Epidemiology June 2024, 100136
[2]M Tajdini, et al. *European Heart J*, November 2023

111

Reflex (Neurally Mediated) Syncope- Vasovagal Syncope – Most Common

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  - Can be "situational" (eg. defecation, urination, cough)

35% of patients will have syncope recurrences
- not associated with increased mortality,
+ associated with injury and reduced quality of life

Raj SR, et al. JACC: Clinical Electrophysiology, 2022

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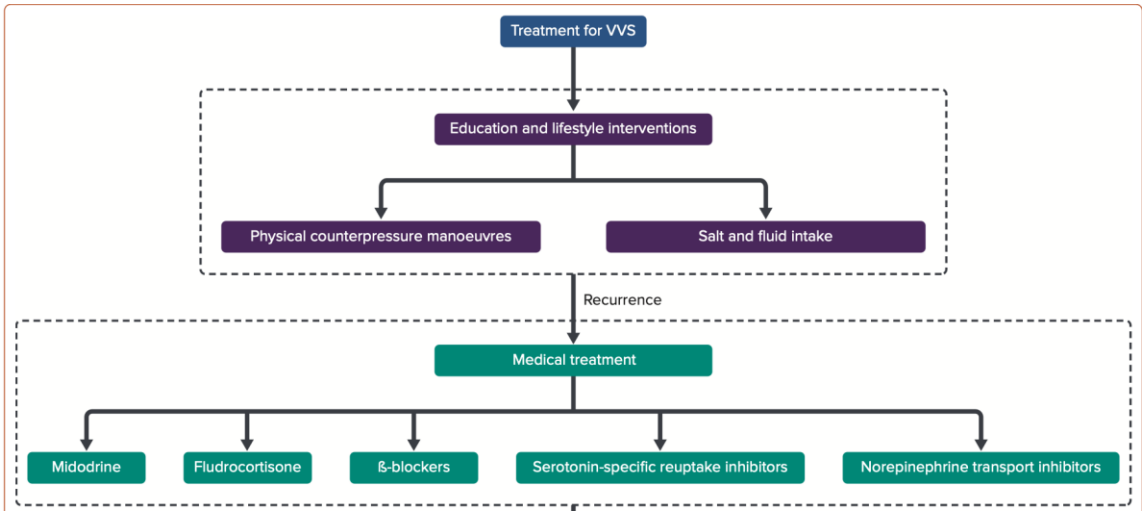
Recurrent Vasovagal Syncope: Management



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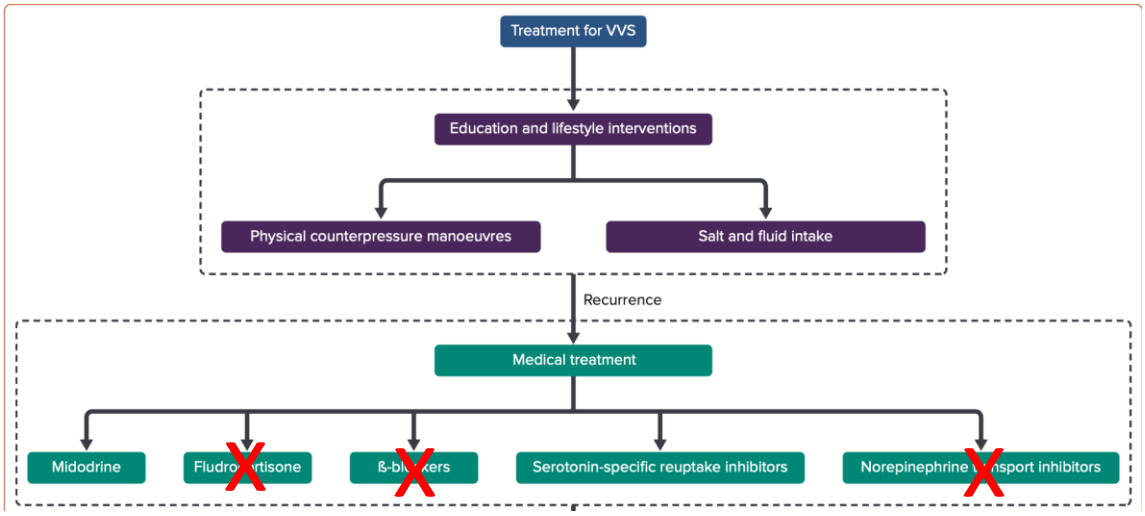
Recurrent Vasovagal Syncope: Management



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ARS Question 2: Which One of the Following Does NOT Decrease Recurrent Episodes of Vasovagal Syncope?

A. Midodrine

B. B-blockers

C. SSRI

D. Closed loop stimulation pacing

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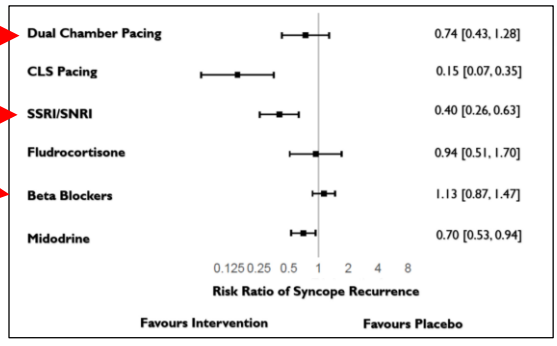
ARS Question 2: Which One of the Following Does NOT in Decrease Recurrent Episodes of Vasovagal Syncope?

A. Midodrine

B. B-blockers

C. SSRI

D. Closed loop stimulation pacing



Kaza N, et al. Open Heart 2024; 11: e002669

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Recurrent Vasovagal Syncope: Medical Management

- **Midodrine:** 2 RCT, placebo-controlled studies: 179 patients

Methods: 133 pts with aver. 6 syncope episodes in the prior year
(median age, 32 years; 73% female)

Results @ 1year:	Midodrine	placebo
(+) syncopal episode	28/66 (42%)	41/67 (61%)

RRR = 0.69 (95% CI, 0.49 to 0.97; P = 0.035)
NNT= 5

Sheldon R, et al . Ann Intern Med 2021; 174: https://doi.org/10.7326/M20-5

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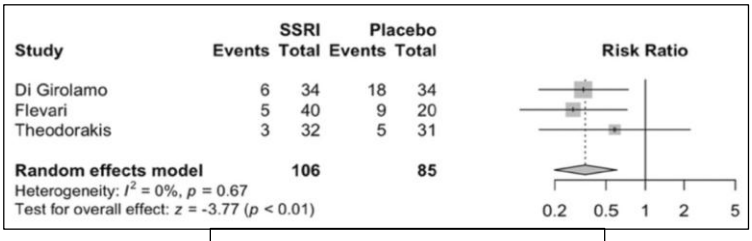
Recurrent Vasovagal Syncope: Medical Management

- **Midodrine:** 2 RCT, placebo-controlled studies: 179 patients
- **SSRI/SNRI:** 3 RCT, placebo-controlled studies: 204 patients
  Paroxetine and **fluoxetine**



13% Vs. 37%; NNT= 4

Raj P et al. Clinical Autonomic Research (2023) 33:811–819

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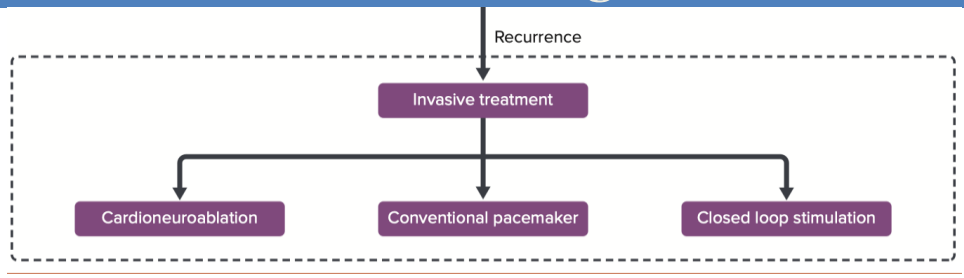
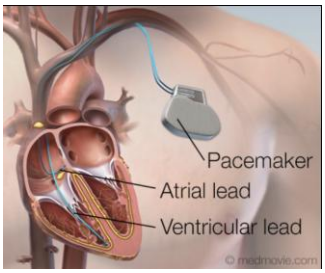
Recurrent Vasovagal Syncope: When Medical Management Fails....



Sensor in right atrium identifies reduced right ventricular filling, triggering the CLS algorithm ➔ ...increase the pacing rate



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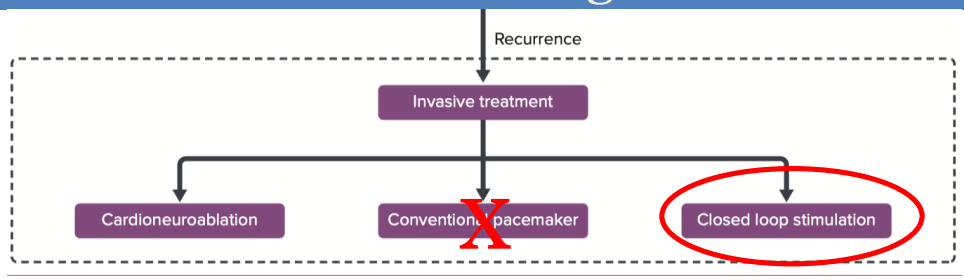
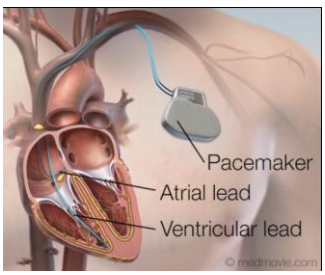
Recurrent Vasovagal Syncope: When Medical Management Fails....



Sensor in right atrium identifies reduced right ventricular filling, triggering the CLS algorithm ➔ ...increase the pacing rate



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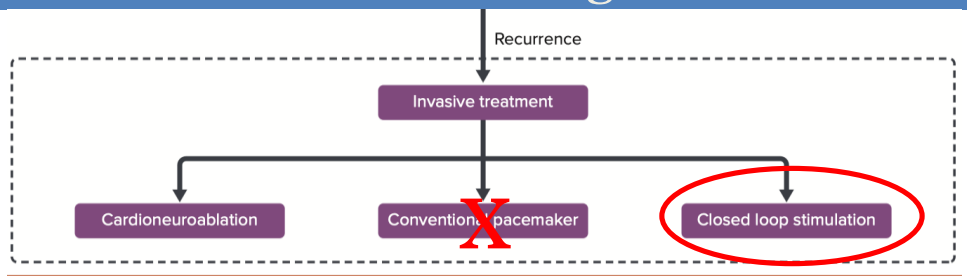
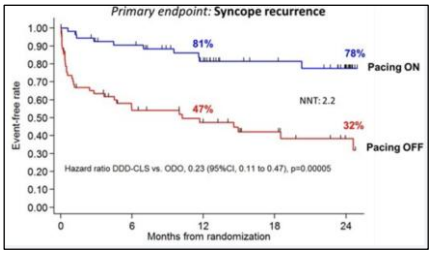
Recurrent Vasovagal Syncope: When Medical Management Fails....



4 RCT trials: 345 patients[1]



2

[1]Kaza N, et al. Open Heart 2024; 11: e002669
[2]Brignole M et al. European Heart Journal, 2021; 42: 508–516

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Last Word on Vasovagal Syncope: In the Office... Be Prepared

- At risk: young > old, women> men (1.5x)
  Note: average of age of 1st episode = 14
- Painful procedures
  - blood draws
  - Vaccination
    - Tdap, meningococcal, **HPV**

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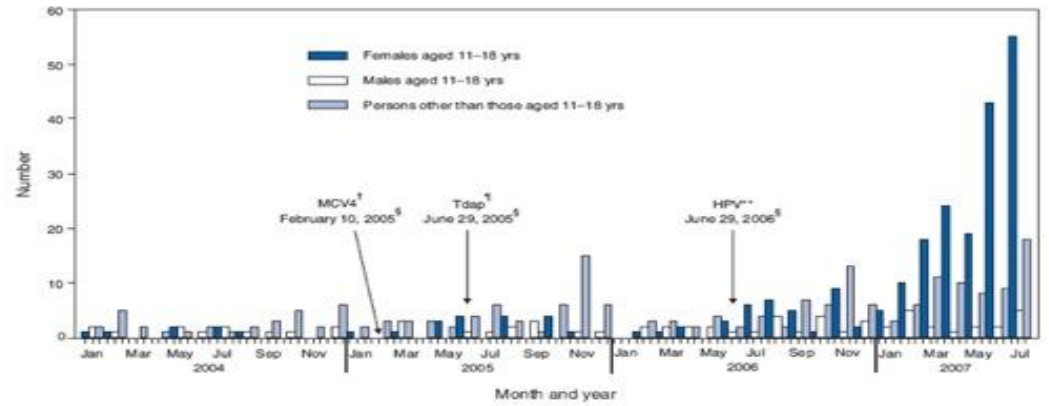
Watch Out for HPV Vaccine Syncope

FIGURE. Number of postvaccination syncope* episodes reported to the Vaccine Adverse Event Reporting System, by month and year of report — United States, January 1, 2004–July 31, 2007



* Includes persons aged ≥5 years who had syncope onset after vaccination on the same date.
† Meningococcal conjugate vaccine.
§ Date on which the Advisory Committee on Immunization Practices decided to add this newly licensed adolescent vaccine to the Vaccines for Children Program.
¶ Tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.
** Quadrivalent human papillomavirus recombinant vaccine. HPV is licensed only for females.

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Syncope

- Definition *- very useful*
- Pathophysiology *- very useful*
- H & P elements *- that are useful*
- Tests/
  Clinical Policies *- use EKG +"sniper diagnostics"*
- EKG's *- that are worrisome!*
- The outpatient evaluation

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Thank You for Your Time and Consideration!!

Post Lecture ARS Questions.....

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ACEP (2007) and AHA/ACC (2017) Policies States Which of the Following Tests Should Be Performed in <u>All Patients with Syncope</u>?

A. EKG
B. EKG + CBC
C. EKG + CBC + troponin
D. EKG + CBC + troponin + head CT
E. Head CT

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Which One of the Following Does NOT Decrease Recurrent Episodes of Vasovagal Syncope?

A. Midodrine
B. B-blockers
C. SSRI's
D. Closed loop stimulation pacing

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Supplemental Slides

128

The Role of Echo in the Evaluation of Syncope: A Prospective Study. Sarasin FP, et al. Heart 2002; 88: 363-67.

- 155 patients with unexplained syncope
  - All get ECHO
- Result: # of abnormal ECHO studies=

0, Zero, Zip, nada, etc…

129

Echocardiography in the Evaluation of Patients with Syncope. Recchia D, et al. J Gen Intern Med 1995; 10: 649

- 128 patients ***admitted patients*** with unexplained syncope
  - All get ECHO
- Result: # of abnormal ECHO studies=

0, Zero, Zip, nada, etc…

130

Holter Monitoring for Syncope: Diagnostic Yield in Different Patient Groups.

Kuhne M, et al. QJ Med 2007; 100: 771-7.

Age group (yrs)	# pts. without structural HD	Diagnostic Holter (%)
<40	39	0 (0%)
40 - 50	29	0 (0%)
51 - 60	53	2 (4%)
61 - 70	59	2 (3%)
71 - 80	153	12 (8%)
81 - 90	100	7 (7%)
> 90	18	5 (28%)

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"Old" ACC/AHA 2006 Statement.. On Tilt-table Testing

- **Sensitivity 26%-80%**
- **Specificity is approximately 90%.**

"In patients with a negative evaluation, ie, no evidence of ischemia and a structurally normal heart, the pretest probability that the diagnosis is neurocardiogenic syncope is high, so head-up tilt-table testing contributes little to establishing the diagnosis."

In other words... in a patient with a normal evaluation who has a negative tilt table test, the most likely diagnosis is still neurocardiogenic syncope

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Recurrent Vasovagal Syncope: Management

- Physical counterpressure maneuvers
  - PC Trial: 223 pts - decreased syncope episodes (2006)
- Increased fluid and salt intake
- Midodrine 5mg tid

These do NOT work…
-Beta-blockers (see POST trial, Circulation, 2006)
-fludrocortisone (POST 2 trial, J Am Coll Cardiol. 2016)
-pacemaker *(providing not prolonged asystole)*
(see Vasovagal Pacemaker Study II, JAMA, 2003)

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Note on Pacemakers:
1) Useful in (Spontaneous) Brady/Asystole

- Methods: 77 pts with either:
  - >3 sec asystole + syncope or
  - > 6 sec without syncope
  - All receive pacer, randomly assigned to:

- Results:

	Pacer "on"	Pacer "off"
syncope in 2 yrs	25%	57%

ISSUE-3 trial, Circulation, published ahead of print, 5/7/12

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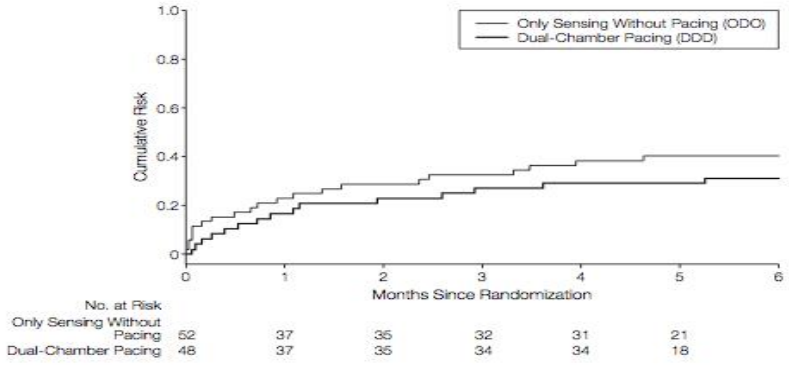
Note on Pacemakers:
1) Useful in (Spontaneous) Brady/Asystole
2) Not Useful in Vasovagal Syncope

Figure 2. Time to First Recurrence of Syncope



Relative risk reduction of 30.2% (95% confidence interval, −33.2% to 63.4%; log-rank $P = .14$).

VPS II trial
JAMA 2003
100 patients

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Excellent Reference

Europace (2013) **15**, 1389–1406
doi:10.1093/europace/eut272

HRS/EHRA/APHRS CONSENSUS STATEMENT

Executive summary: HRS/EHRA/APHRS expert consensus statement on the diagnosis and management of patients with inherited primary arrhythmia syndromes

Silvia G. Priori, (HRS Chairperson)[1], Arthur A. Wilde, (EHRA Chairperson)[2], Minoru Horie, (APHRS Chairperson)[3], Yongkeun Cho, (APHRS Chairperson)[4], Elijah R. Behr[5], Charles Berul[6], Nico Blom[7]*, Josep Brugada[8], Chern-En Chiang[9], Heikki Huikuri[10], Prince Kannankeril[11]‡, Andrew Krahn[12], Antoine Leenhardt[13], Arthur Moss[14], Peter J. Schwartz[15], Wataru Shimizu[16], Gordon Tomaselli[17]†, Cynthia Tracy[%18]

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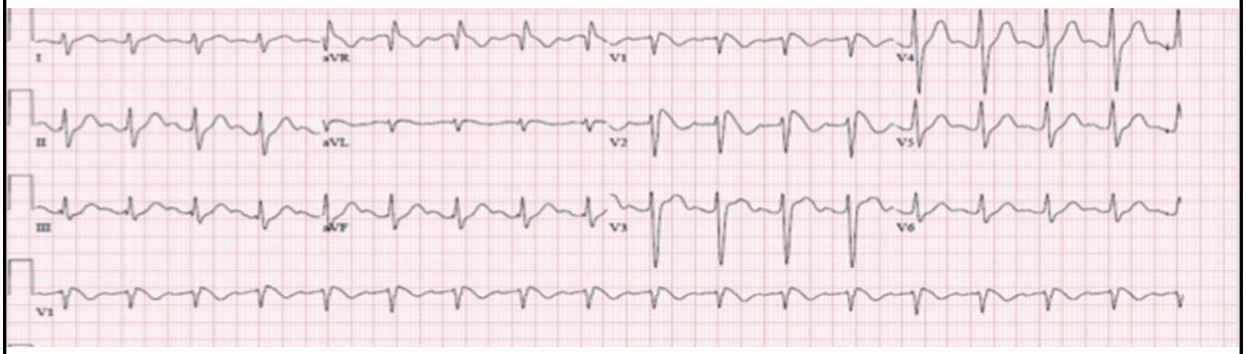
47-year-old Male Unresponsive, Found with Empty Bottles of Amitriptyline and Cyclobenzaprine



Kim HS, et al Ann Emerg Med, May 2017

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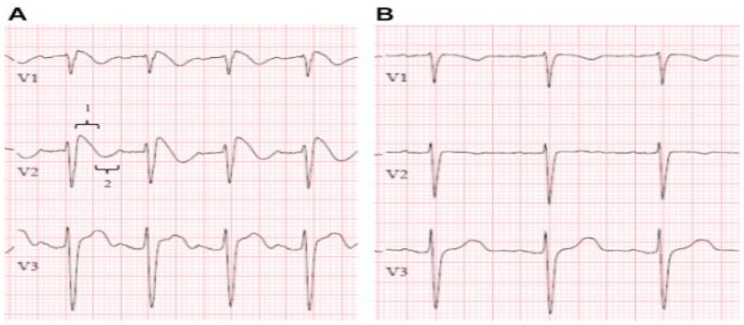
47-year-old Male Unresponsive, Found with Empty Bottles of Amitriptyline and Cyclobenzaprine



A. Before treatment

B. After Na bicarb

Kim HS, et al Ann Emerg Med, May 2017

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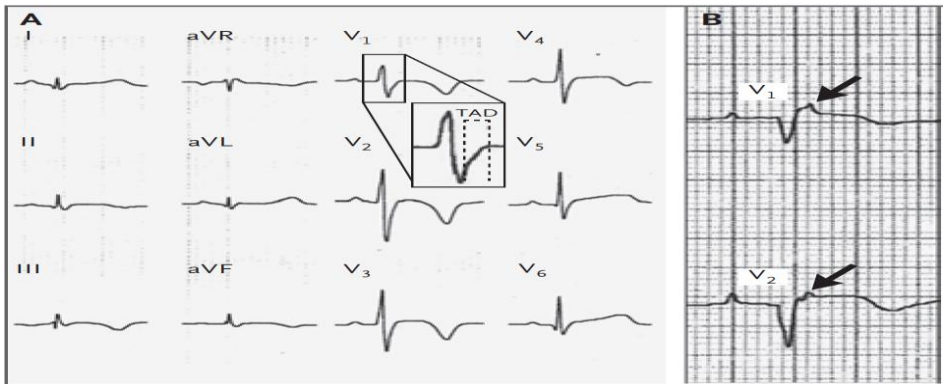
Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)



- **"Epsilon wave"** *(small-amplitude distinct potentials between the end of the of the QRS and the beginning of the T wave)* **is late manifestation**

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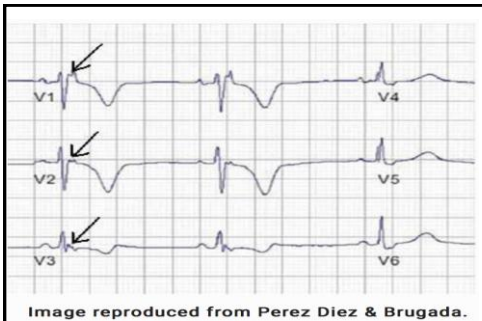
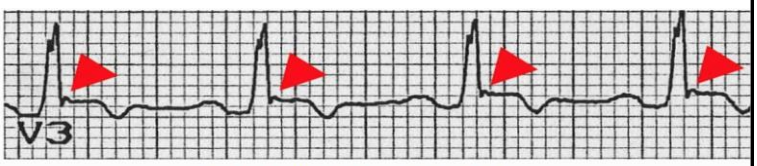


Image reproduced from Perez Diez & Brugada.



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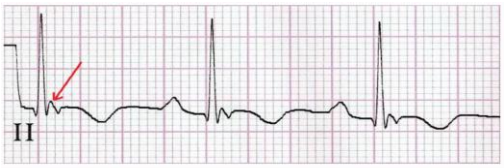

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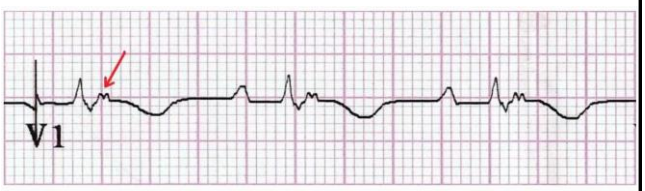

Image reproduced from heartpearls.com.

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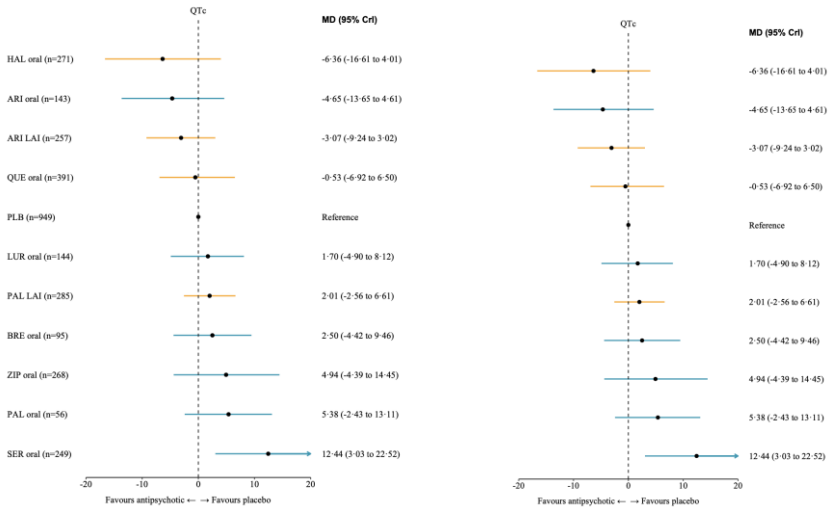
Antipsychotics and QTc



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