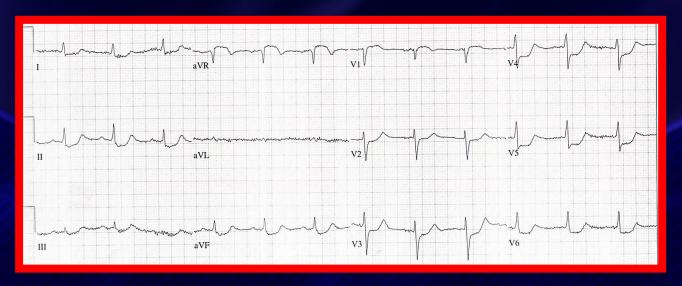
Can't-Miss Findings on the ECG



Amal Mattu, MD, FAAEM, FACEP
Professor and Vice Chair of Academic Affairs
Department of Emergency Medicine
University of Maryland School of Medicine
amalmattu@comcast.net

Amal Mattu, MD, FAAEM, FACEP

Disclosure

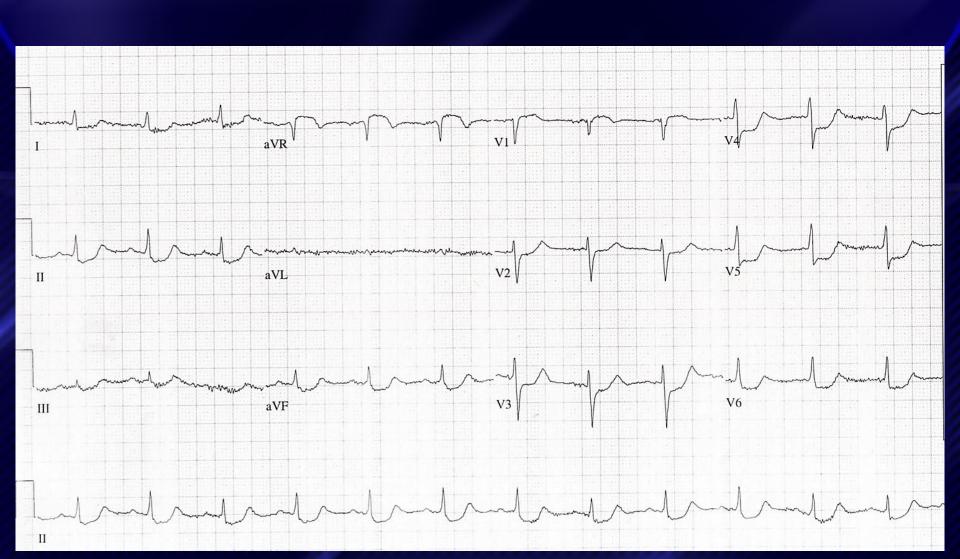
No financial ties to drug or device companies

Part I: "STEMI" Without the STE:

Non-Traditional Predictors of Acute Coronary Occlusion

Amal Mattu, MD, FAAEM, FACEP
Professor and Vice Chair of Academic Affairs
Department of Emergency Medicine
University of Maryland School of Medicine
amalmattu@comcast.net

- 45 yo M presents with chest pain
 - Pain associated with nausea and sweats
 - Hx/o DM, htn, smokes 1 ppd
 - ECG...



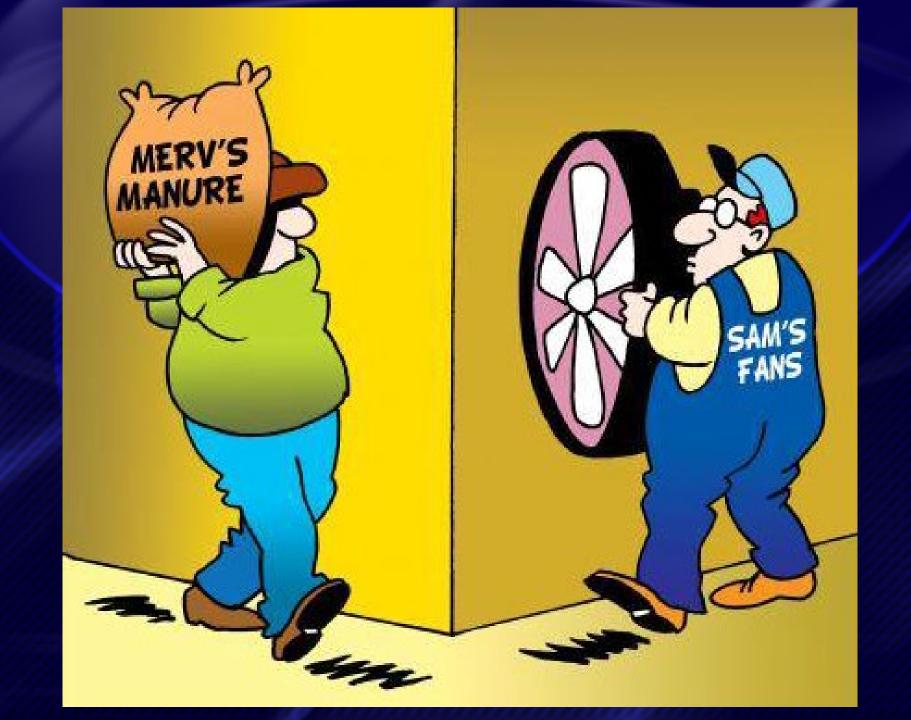
 Emergency physician is residency trained, ABEM-certified

- Emergency physician is residency trained, ABEM-certified
 - 1:10 am: Patient treated with ASA, SLNTG, morphine

- Emergency physician is residency trained, ABEM-certified
 - 1:10 am: Patient treated with ASA, SL
 NTG, morphine
 - 2:15 am: pain persists, SL NTG #3

- Emergency physician is residency trained, ABEM-certified
 - 1:10 am: Patient treated with ASA, SL
 NTG, morphine
 - 2:15 am: pain persists, SL NTG #3
 - 3:30 am: pain persists, TN mildly elevated
 - Repeat ECG ~ unchanged
 - NTG drip
 - Hospitalist paged to admit

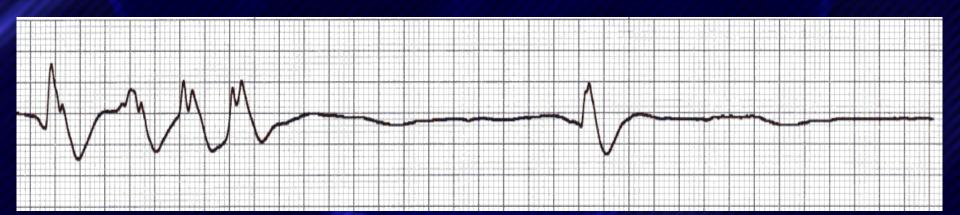
- Emergency physician is residency trained, ABEM-certified
 - 4:30 am: pain persists, repeat ECG unchanged
 - Hospitalist (by phone) recommends cardiology consult



- 5:00 am: patient develops hypotension
 - Cardiology consulted

- 5:00 am: patient develops hypotension
 - Cardiology consulted
- Cardiology arrives at 6:05 am...

- 5:00 am: patient develops hypotension
 - Cardiology consulted
- Cardiology arrives at 6:05 am...as the patient loses pulses

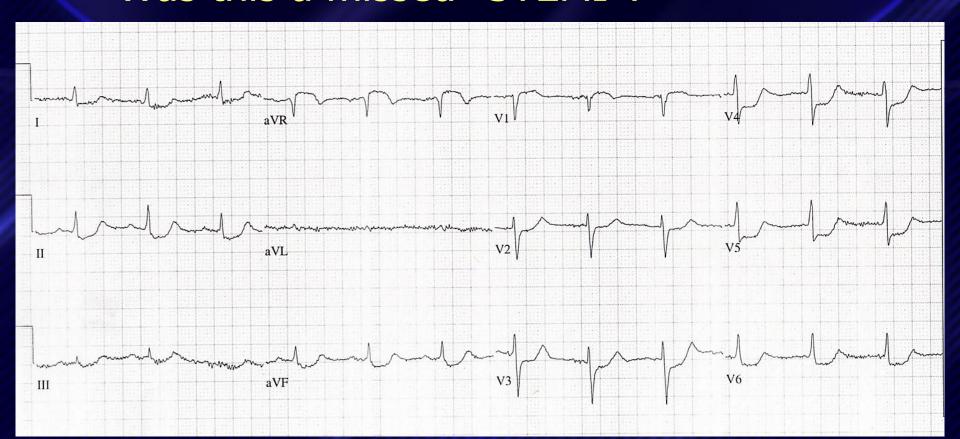


- 5:00 am: patient develops hypotension
 - Cardiology consulted
- Cardiology arrives at 6:05 am...as the patient loses pulses
- Resuscitation attempts are unsuccessful
 - Pronounced dead at 6:45 am

Lawsuit filed



Was this a missed "STEMI"?



Was this a missed "STEMI"?

Was this a missed ACO?

 We are mainly interested in identifying ACOs in order to initiate acute reperfusion therapy (PCI or lytics)

 We are mainly interested in identifying ACOs in order to initiate acute reperfusion therapy (PCI or lytics)

 Problem: STE is just a surrogate marker for ACO

STEMI vs. Non-STE-ACS is a flawed concept

- STEMI vs. Non-STE-ACS is a flawed concept
 - 10-15% of patients with ACS Sx's and STE rule OUT for ACO

- STEMI vs. Non-STE-ACS is a flawed concept
 - 10-15% of patients with ACS Sx's and STE rule OUT for ACO
 - Up to 40% of patients with ACS Sx's and ACOs do NOT have STE
 - These patients typically get cath/PCI after significant delay

ACO, OMI, NOMI

Increasing support to replace <u>STEMI vs.</u>
 <u>Non-STE-ACS</u> with <u>OMI vs. NOMI</u>

- OMI (ACO) needs emergent cath
- NOMI does not

ACO, OMI, NOMI

Increasing support to replace <u>STEMI vs.</u>
 <u>Non-STE-ACS</u> with <u>OMI vs. NOMI</u>

- OMI (ACO) needs emergent cath
- NOMI does not

 Are there ECG findings beyond STE that predict ACO?





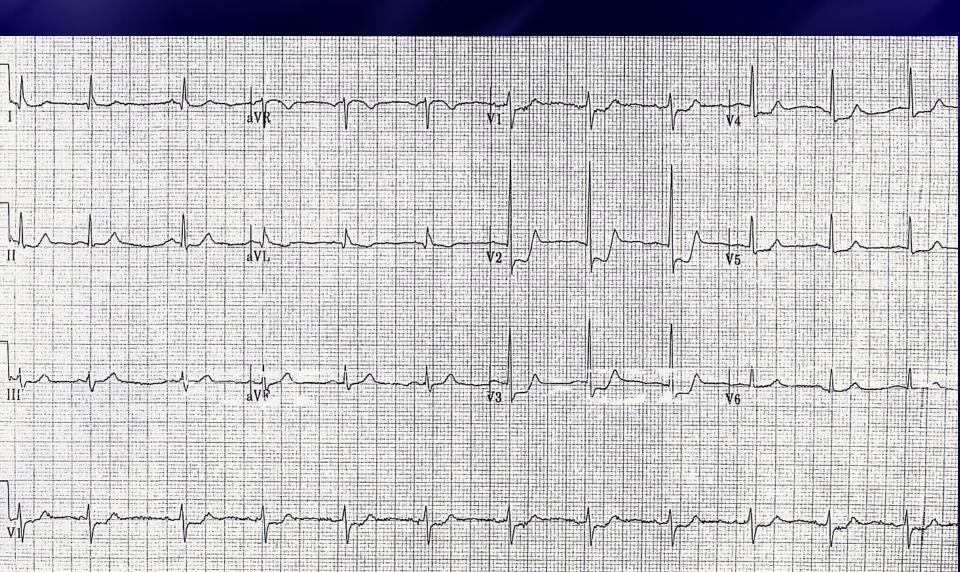
What are the ECG indications for emergent reperfusion?

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)

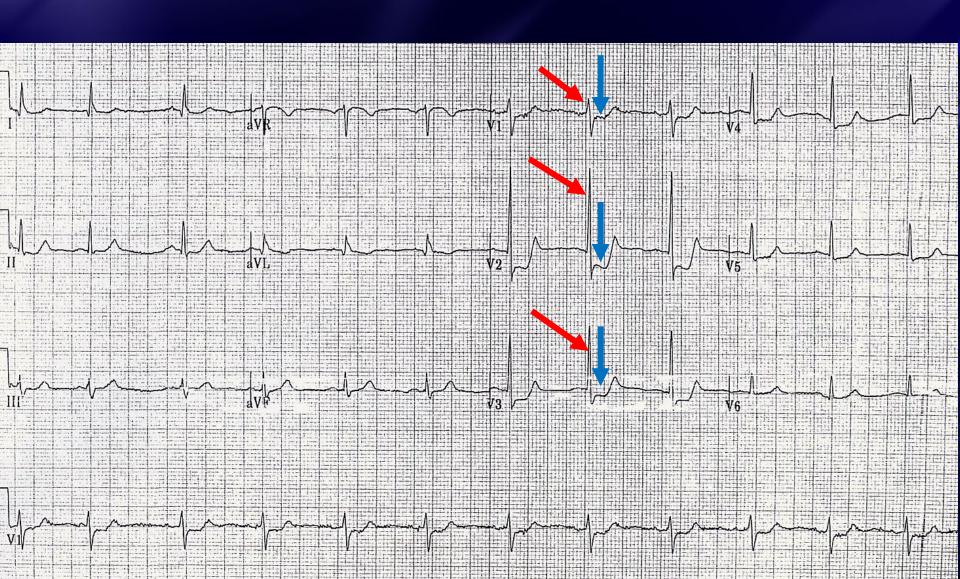
What are the ECG indications for emergent reperfusion?

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI

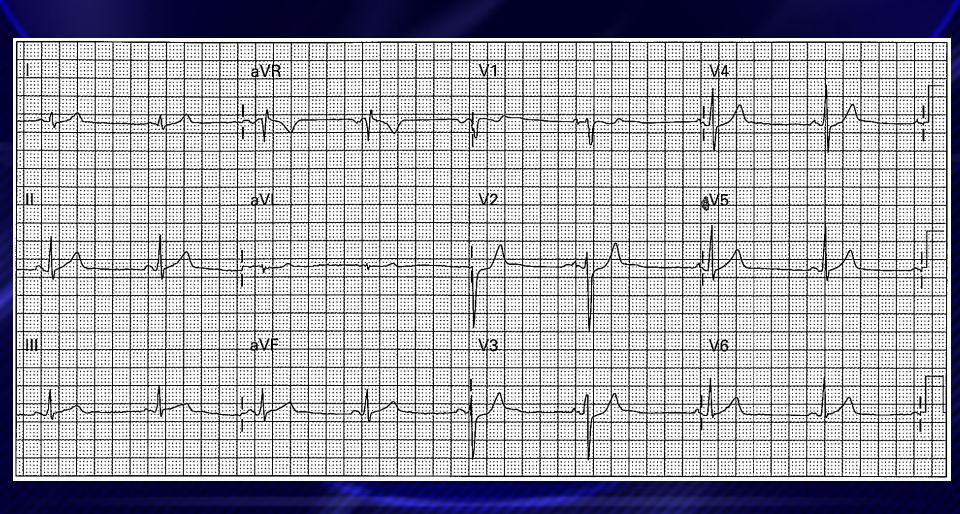
Isolated PMI



Isolated PMI



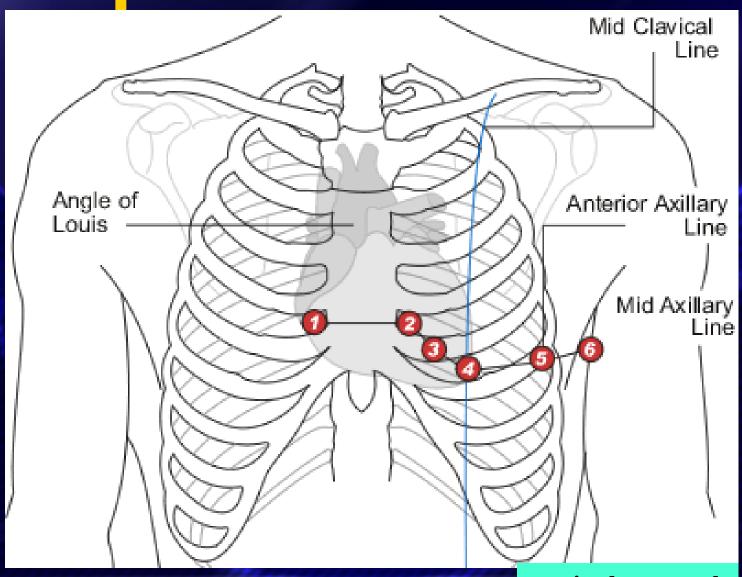
Anteroseptal ischemia or posterior MI?



Anteroseptal ischemia or posterior MI?

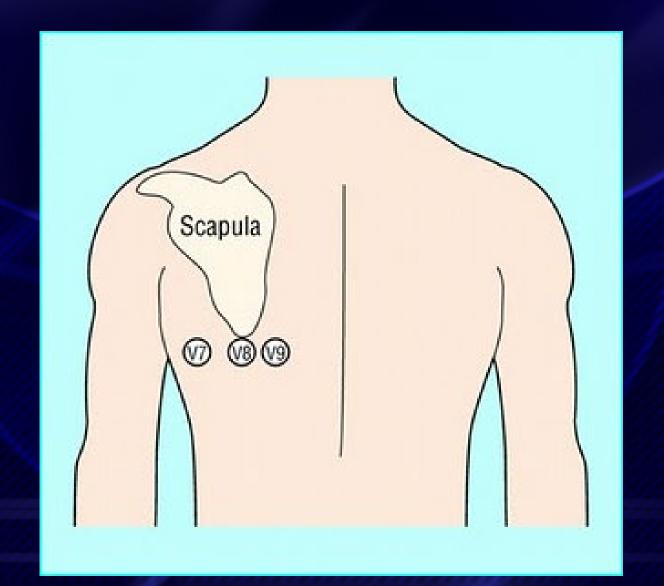


Proper Lead Placement

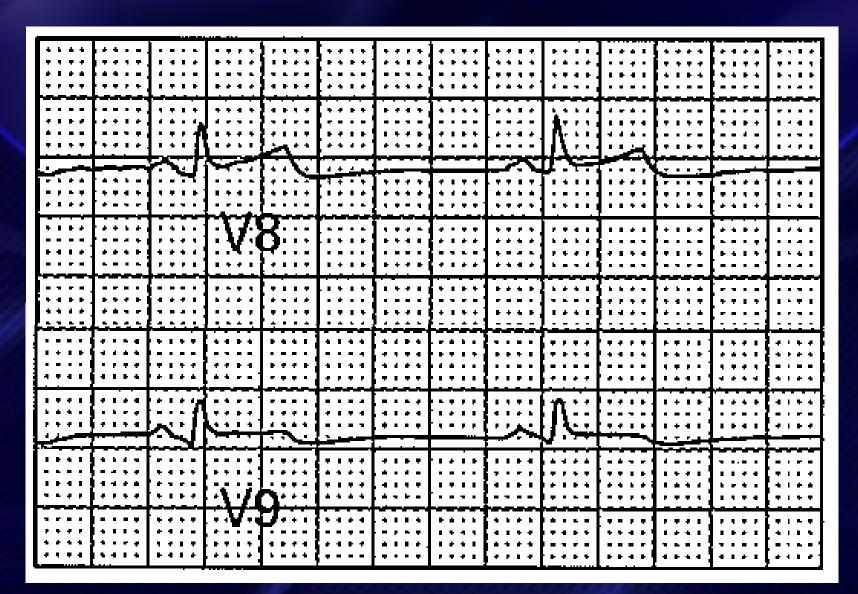


nottingham.ac.uk

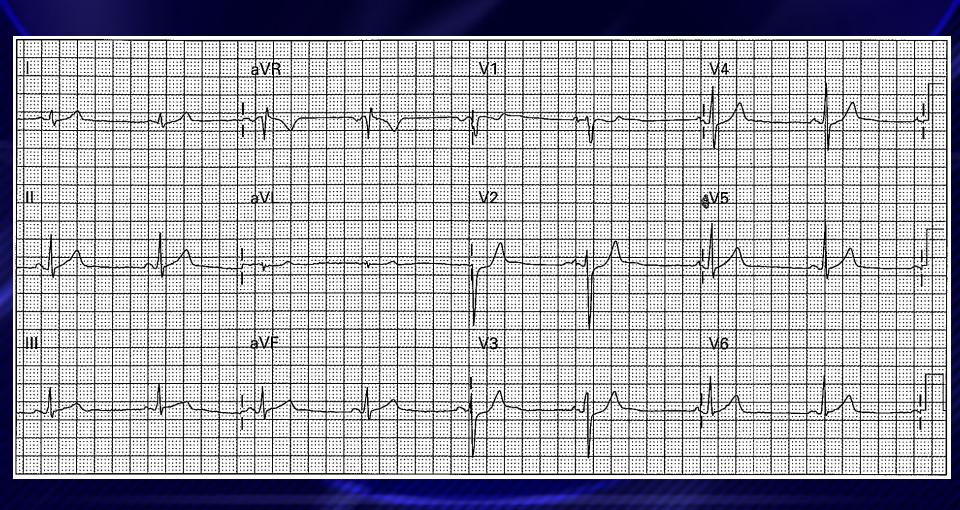
Posterior Lead Placement



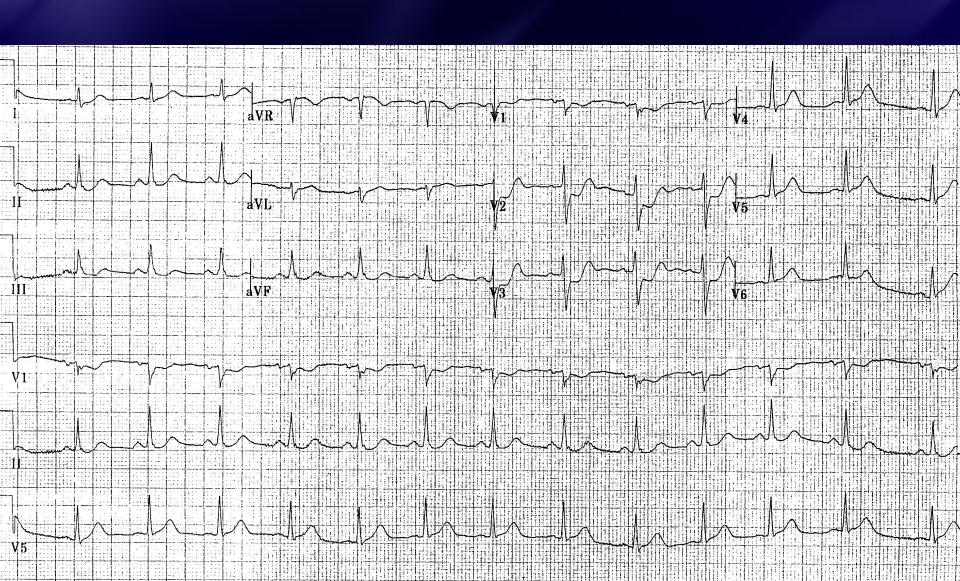
Isolated PMI



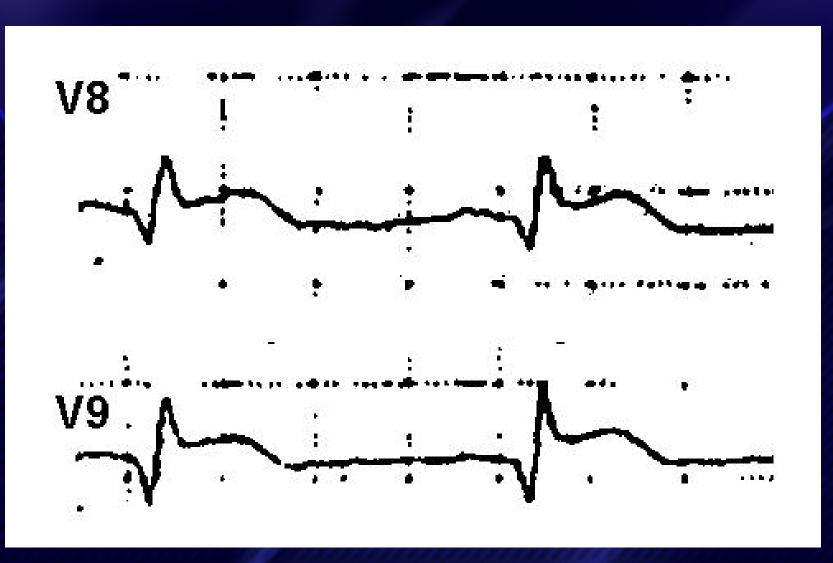
Isolated PMI



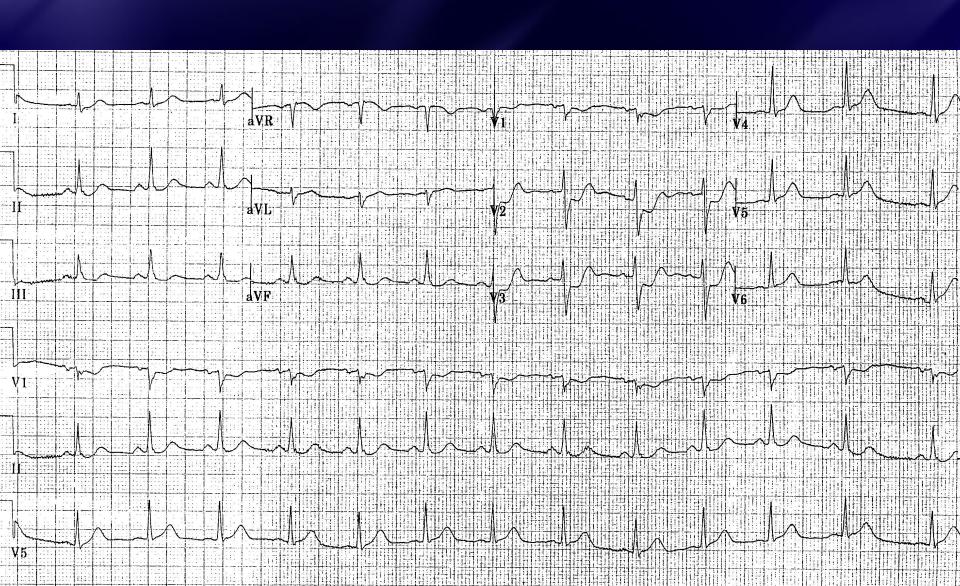
Anteroseptal ischemia...??



Posterior STEMI!

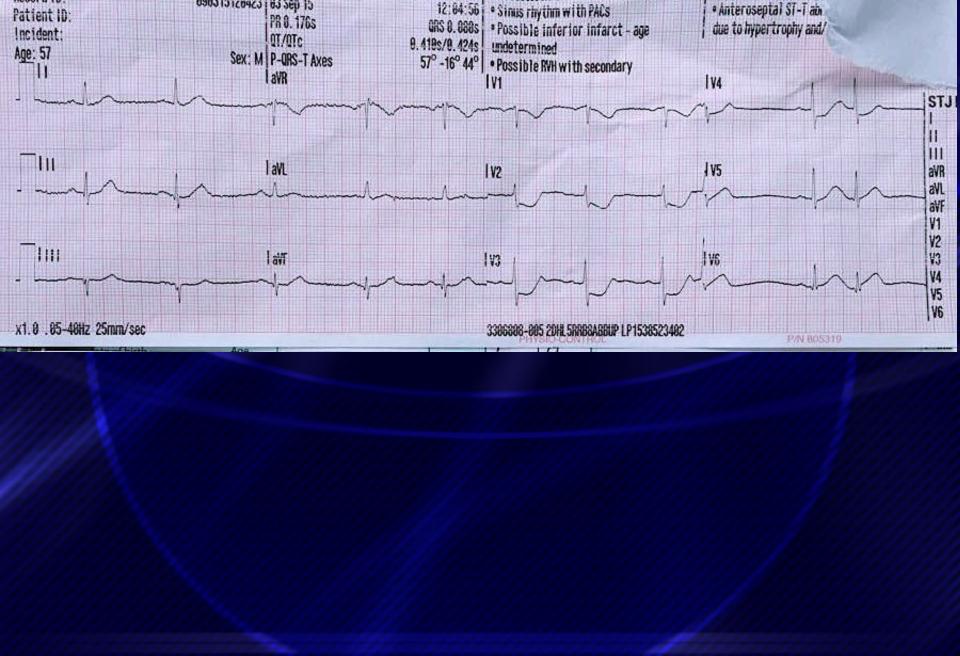


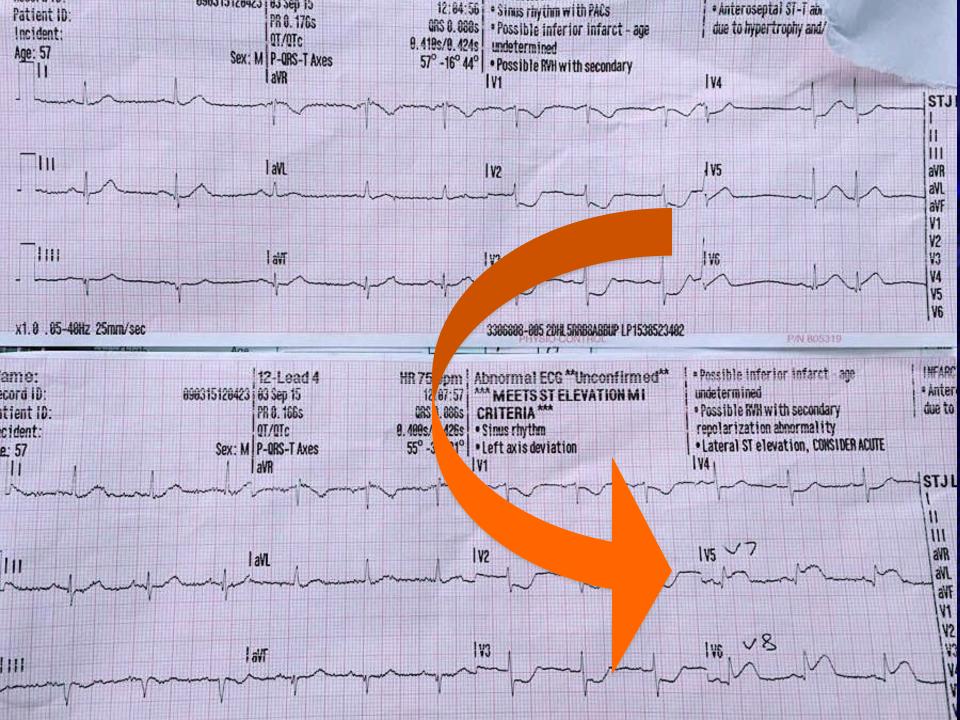
Posterior STEMI!



57 yo M with CP + diaphoresis

- Courtesy Stephen Hammond
 - London paramedic
 - ECG...







- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI
 - Non-STE-ACS with...

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI
 - Non-STE-ACS with...
 - Refractory ischemia (frequent litigation)

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI
 - Non-STE-ACS with...
 - Refractory ischemia (frequent litigation)
 - Developing acute heart failure

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI
 - Non-STE-ACS with...
 - Refractory ischemia (frequent litigation)
 - Developing acute heart failure
 - Electrical instability

(2014 ACC/AHA guidelines—cath w/i 2 hrs, Class IA)

- Concerning Sx's plus...
 - STE in contiguous leads (usual guidelines)
 - Posterior STEMI
 - Non-STE-ACS with...
 - Refractory ischemia (frequent litigation)
 - Developing acute heart failure
 - Electrical instability
 - Hemodynamic instability

(2014 ACC/AHA guidelines—cath w/i 2 hrs, Class IA)



 Other ECG findings now in the US Guidelines...

Published Oct. 2022

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
© 2022 BY THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION
PUBLISHED BY ELSEVIER

VOL. ■, NO. ■, 2022

Online October 11, 2022

EXPERT CONSENSUS DECISION PATHWAY

2022 ACC Expert Consensus Decision Pathway on the Evaluation and Disposition of Acute Chest Pain in the Emergency Department

A Report of the American College of Cardiology Solution Set Oversight Committee

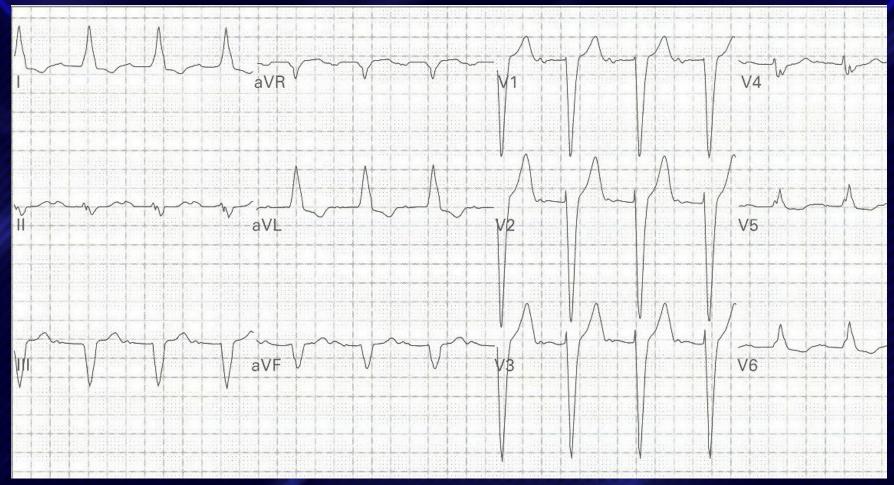
- Now endorsed by the ACC
 - LBBB with Sgarbossa criteria (& modified)
 - Pacers with Sgarbossa criteria (& modified)
 - de Winter T-waves

Normal LBBB



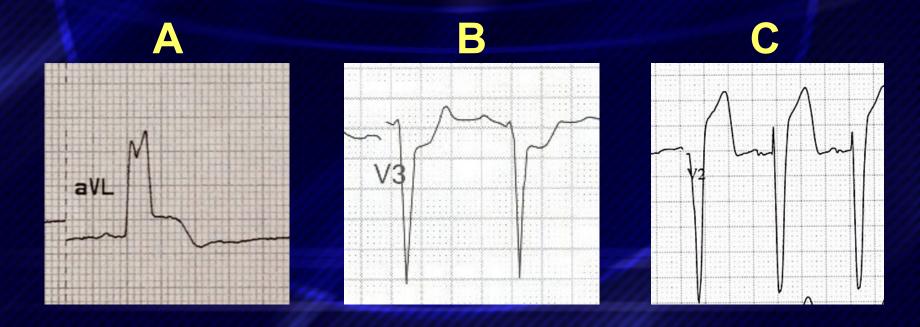
Normal LBBB

Rule of appropriate discordance (true for pacemakers also)



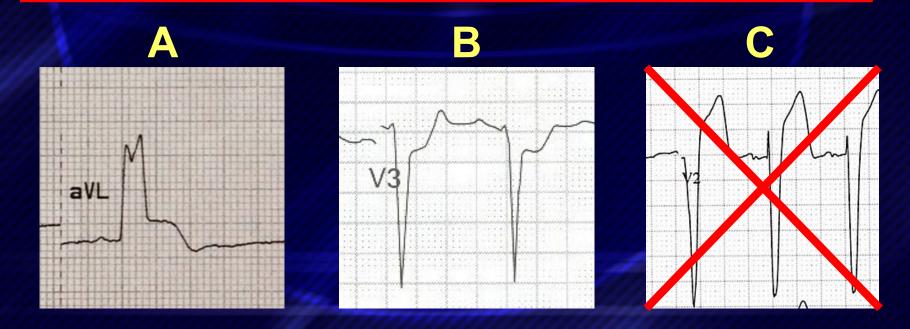
Sgarbossa Criteria in LBBB NEJM 1996

- A -- Concordant ST elevation > 1 mm in any lead
- B -- Concordant ST depression \geq 1 mm in V_1 , V_2 , or V_3
- C -- Discordant ST elevation ≥ 5 mm (less specific)



Sgarbossa Criteria in LBBB NEJM 1996

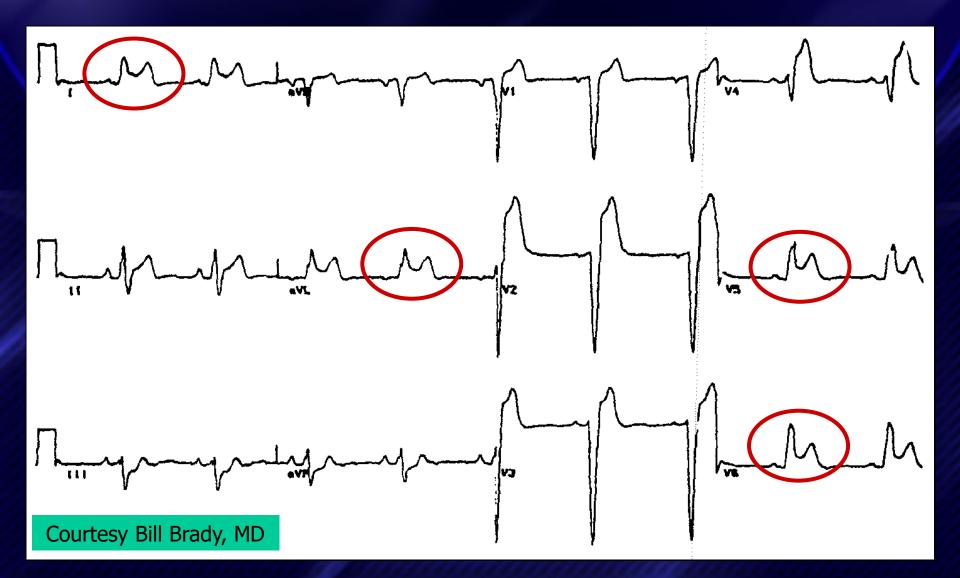
- A -- Concordant ST elevation > 1 mm in any lead
- B -- Concordant ST depression \geq 1 mm in V_1 , V_2 , or V_3
- C -- Discordant ST elevation > 5 mm (less specific)



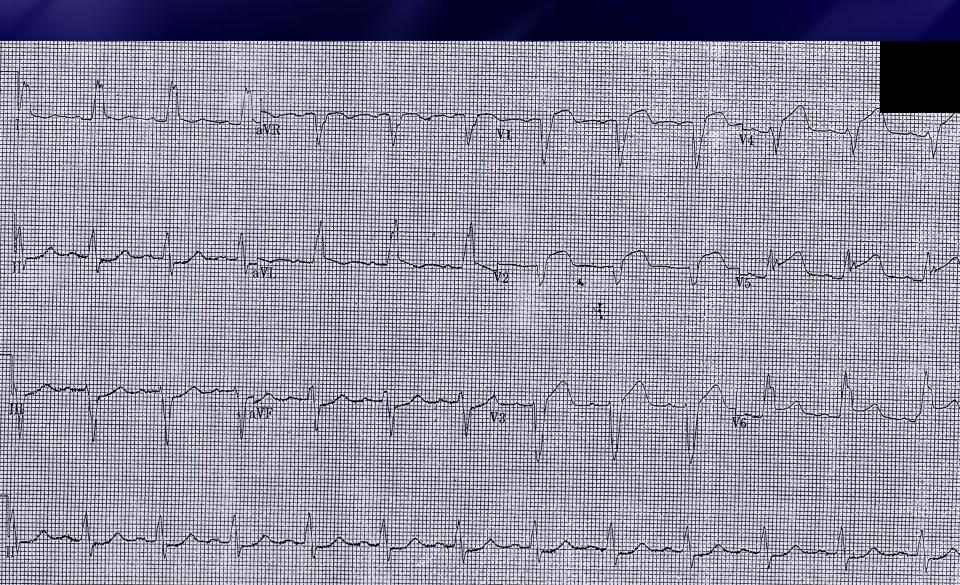
Dx?



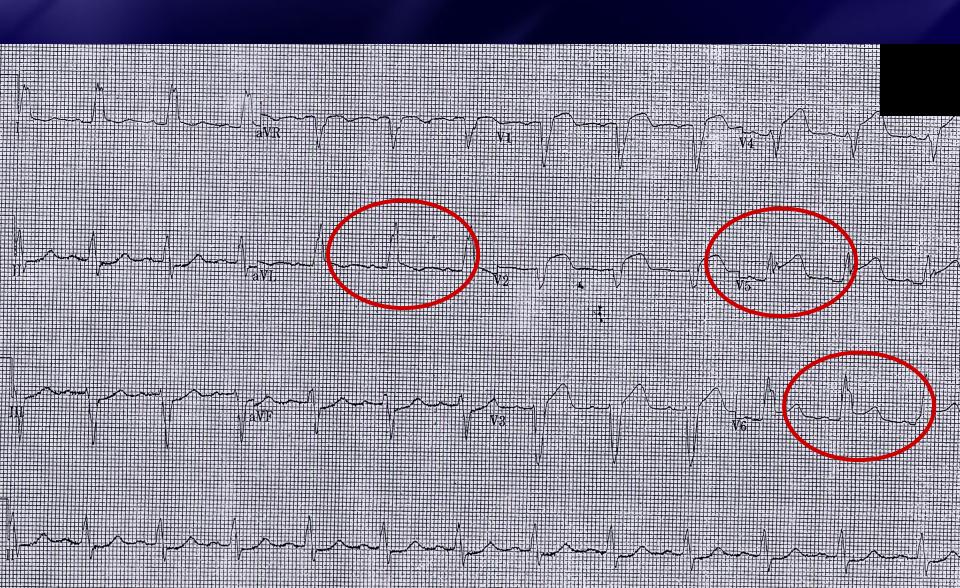
"Sgarbossa A"



Dx?

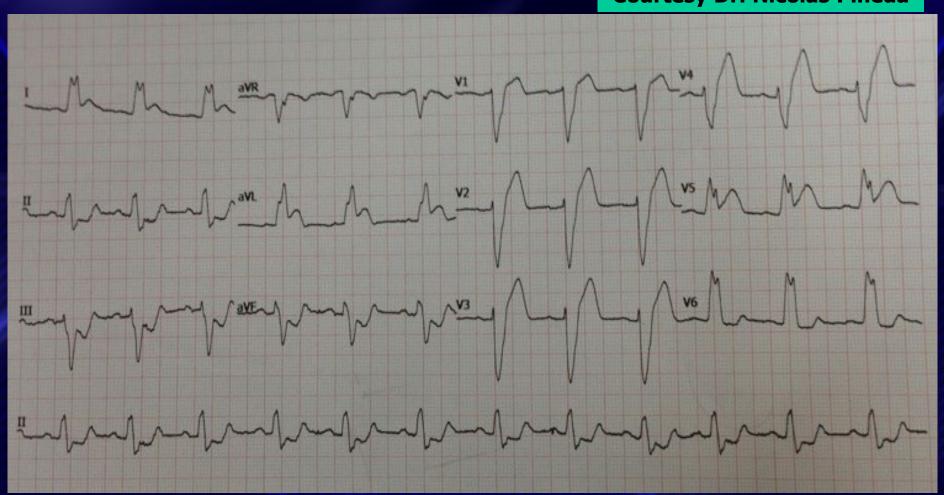


"Sgarbossa A"



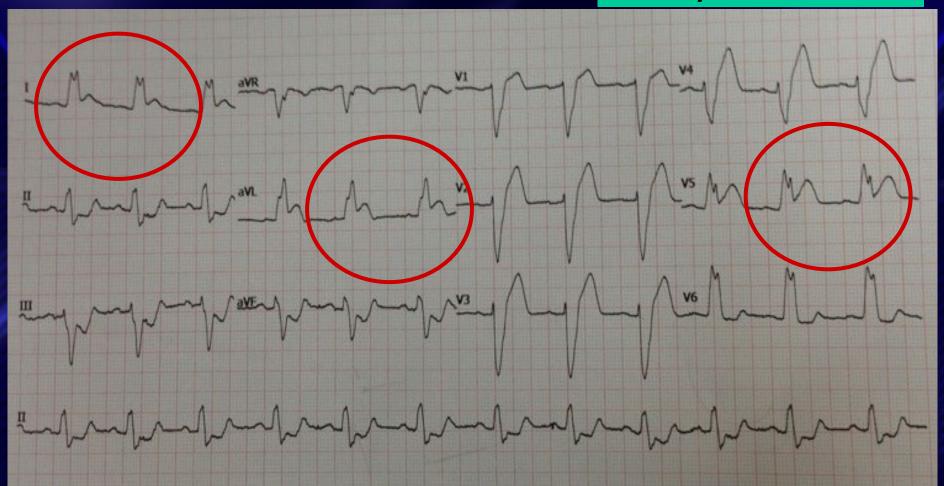
Dx?

Courtesy Dr. Nicolas Pineda

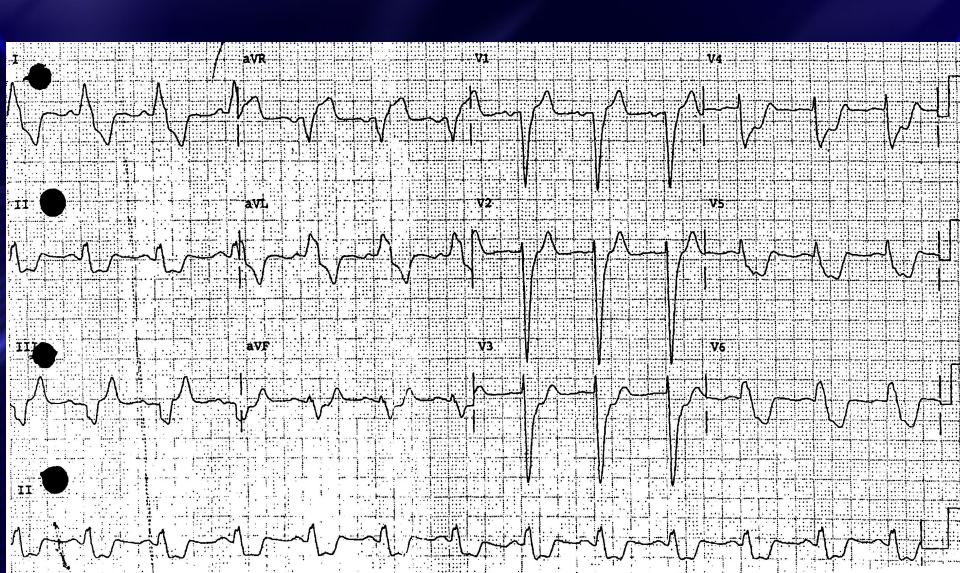


"Sgarbossa A"

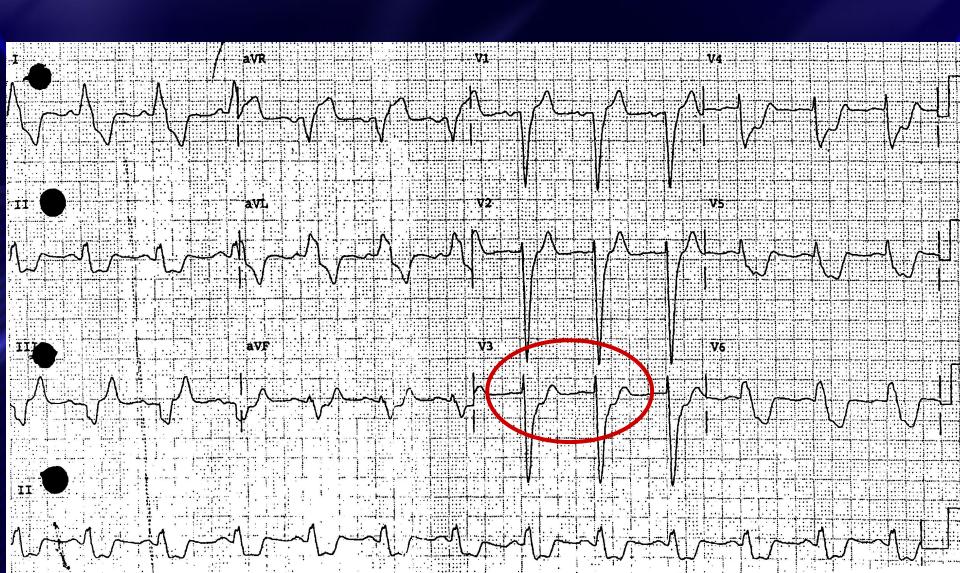
Courtesy Dr. Nicolas Pineda



Dx?



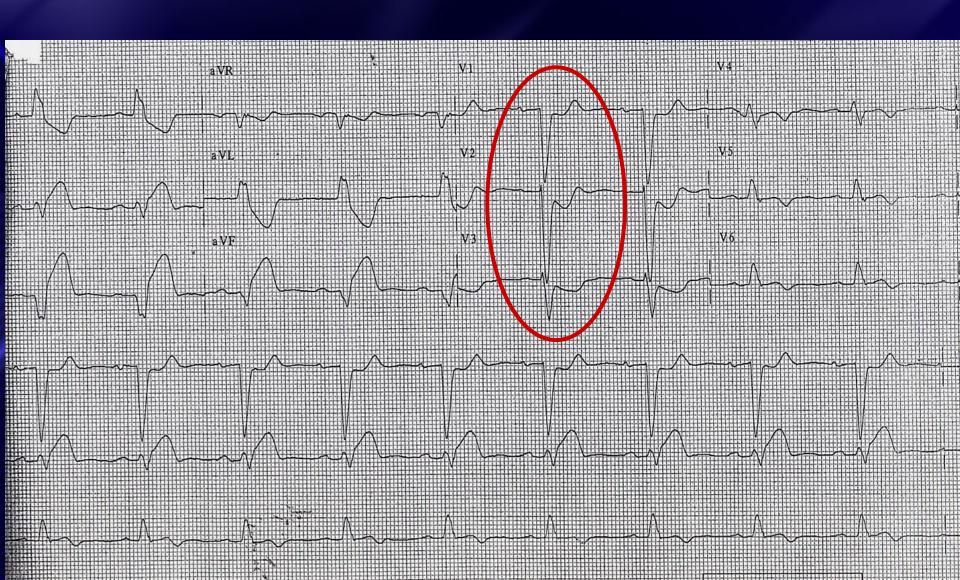
"Sgarbossa B"



Dx?



"Sgarbossa B"



Dx?

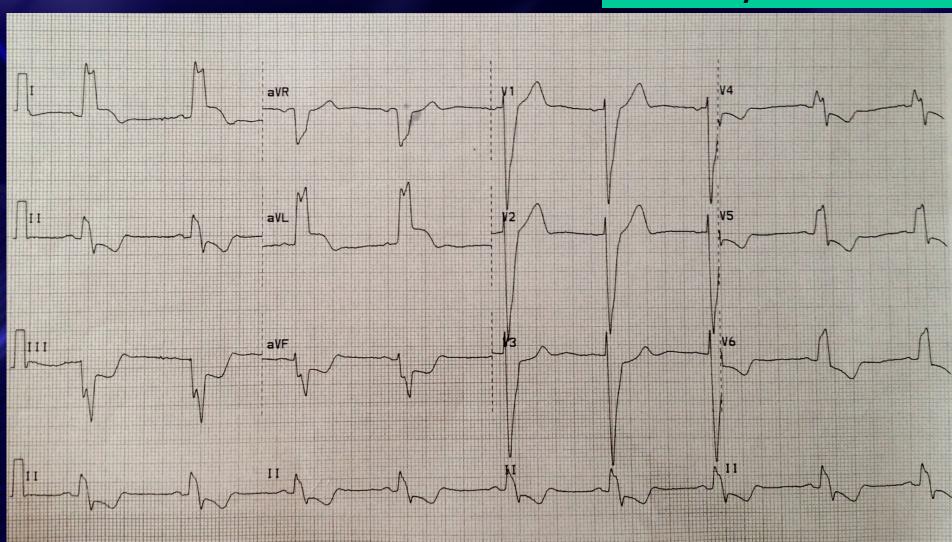


"Sgarbossa B"



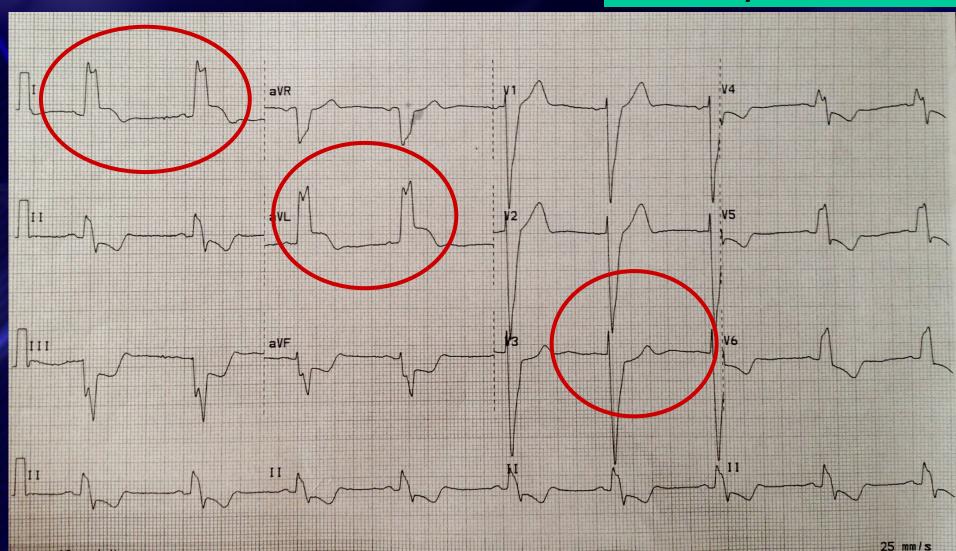
85 yo woman with CP

Courtesy Dr. Eric Klotz



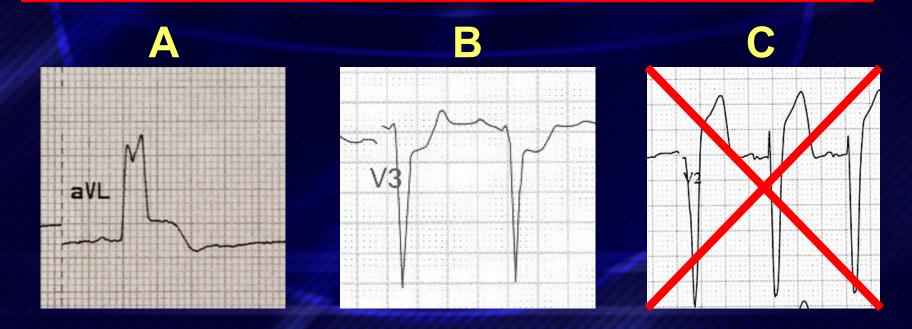
"Sgarbossa A & B"

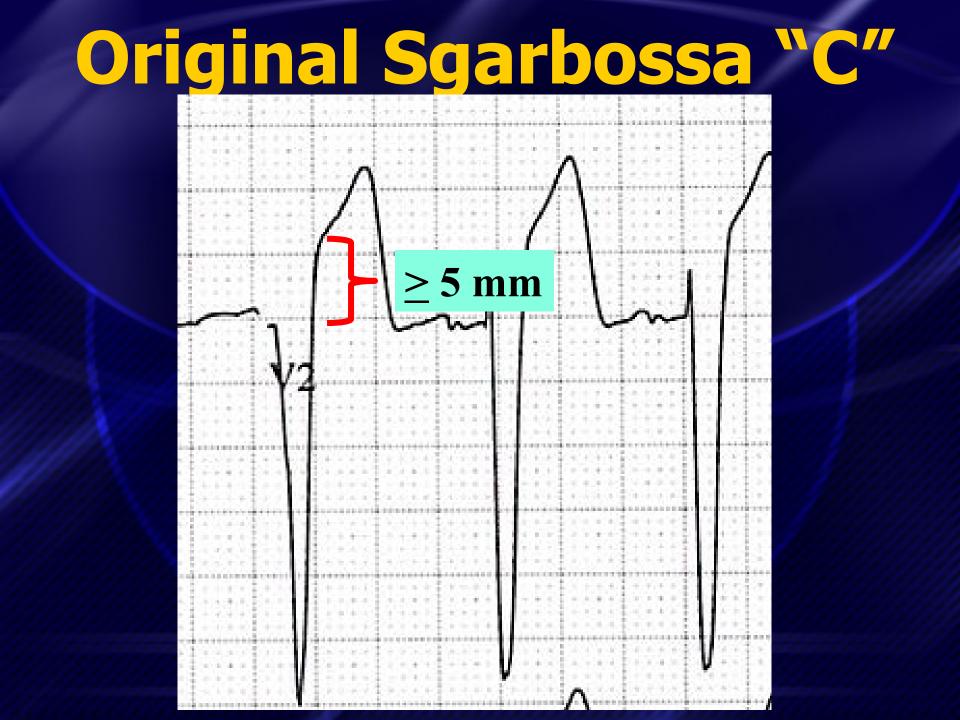
Courtesy Dr. Eric Klotz



Sgarbossa Criteria in LBBB NEJM 1996

- A -- Concordant ST elevation > 1 mm in any lead
- B -- Concordant ST depression \geq 1 mm in V_1 , V_2 , or V_3
- C -- Discordant ST elevation > 5 mm (less specific)

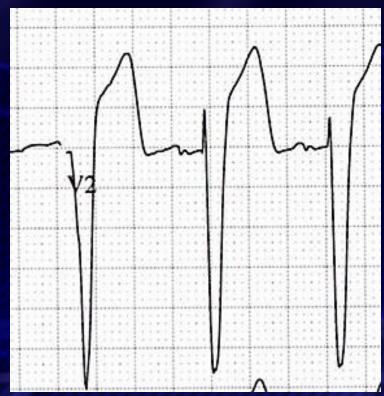




Original Sgarbossa "C"

Sgarbossa criteria "C" is not specific enough

C



Revised Sgarbossa "C"

(Smith, et al. Ann Emerg Med 2012)

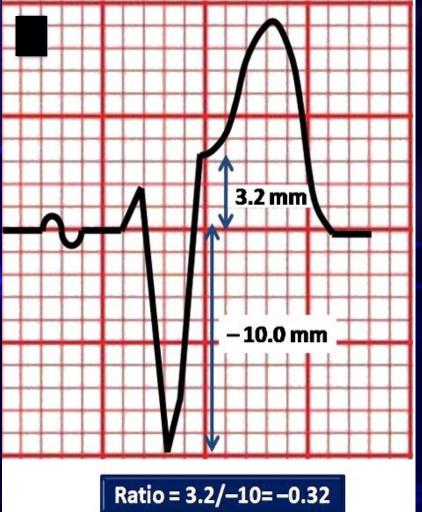
 Maybe the <u>ratio</u> of the ST deviation: size of the QRS is more important (> 25%)





Revised Sgarbossa "C"

(Smith, et al. Ann Emerg Med 2012)

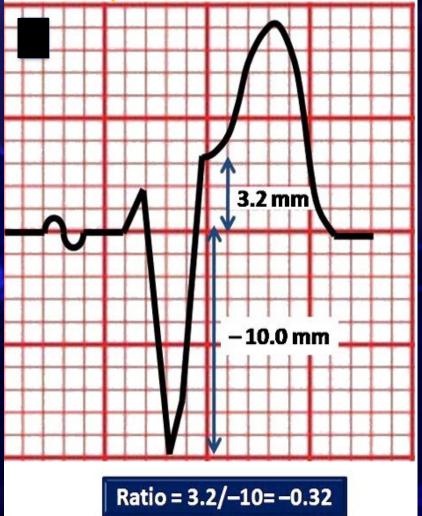


STE/S-wave > 25%

3.2/10 > 0.25

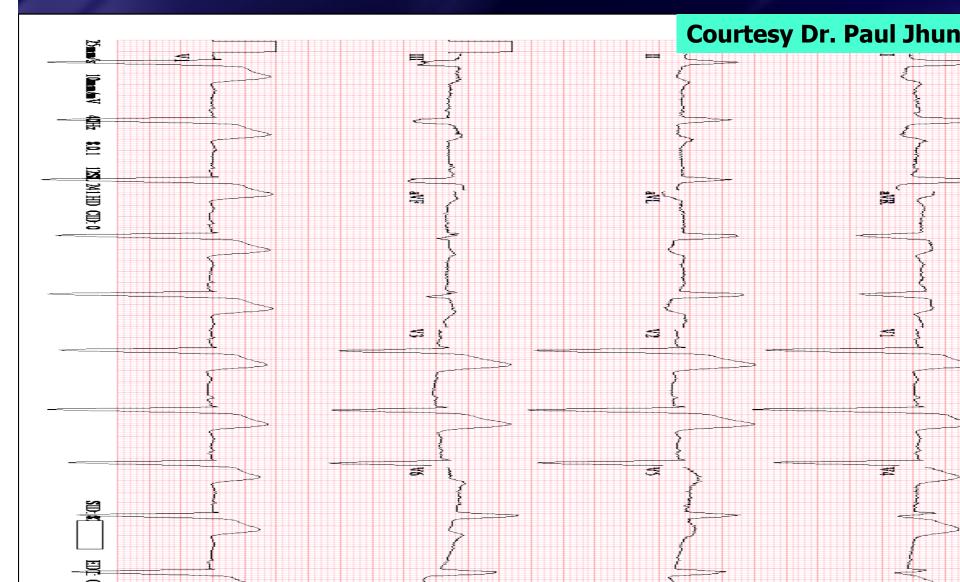
Revised Sgarbossa "C"

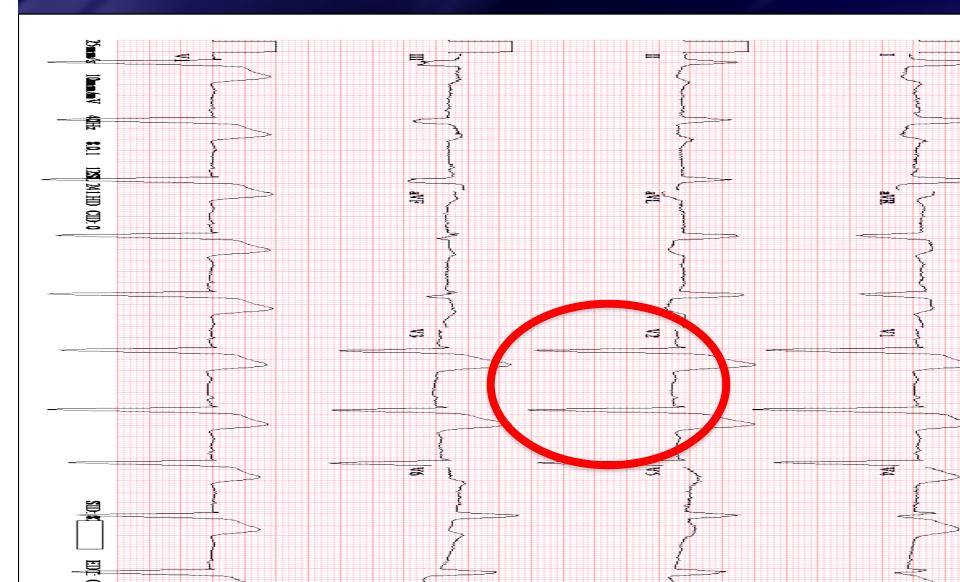
(Validation: Am Heart J 2015)

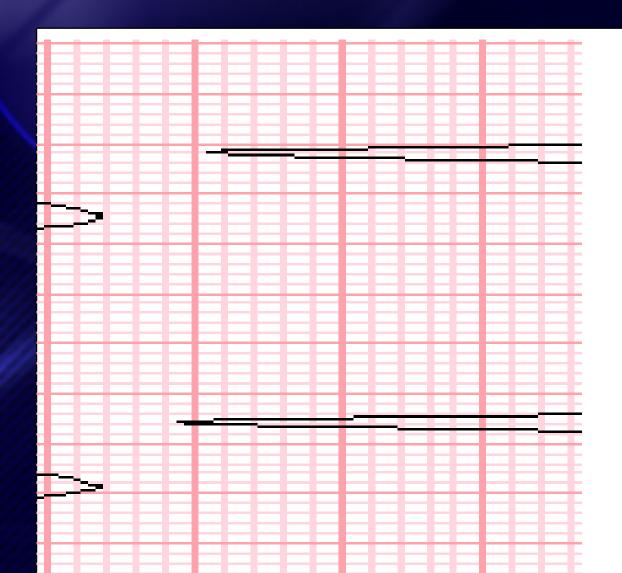


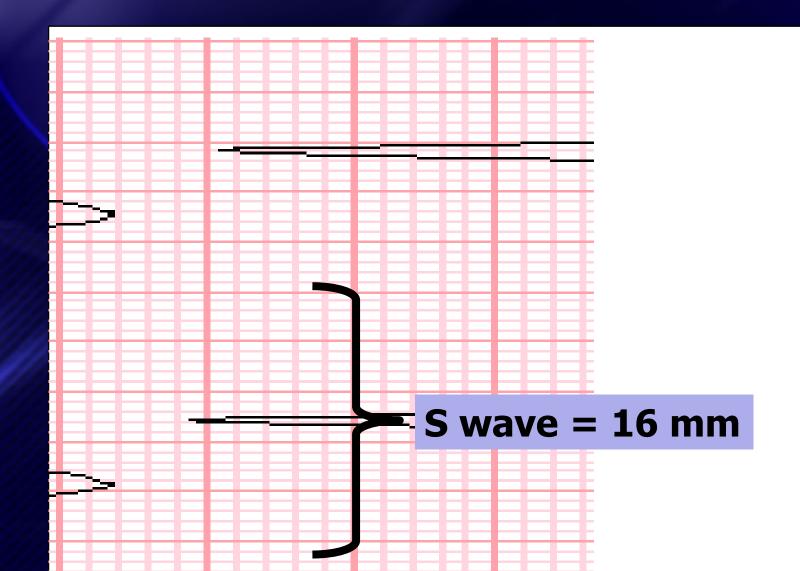
STE/S-wave > 25%

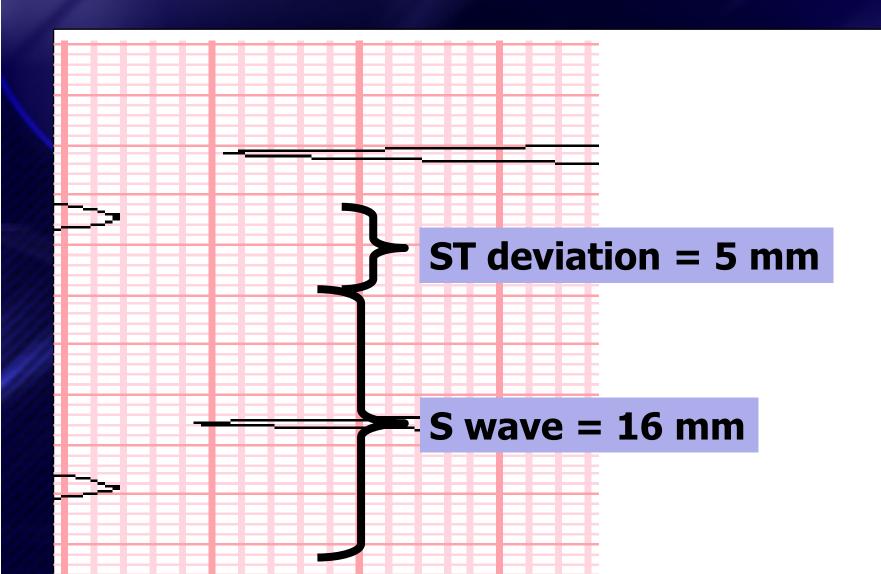
3.2/10 > 0.25

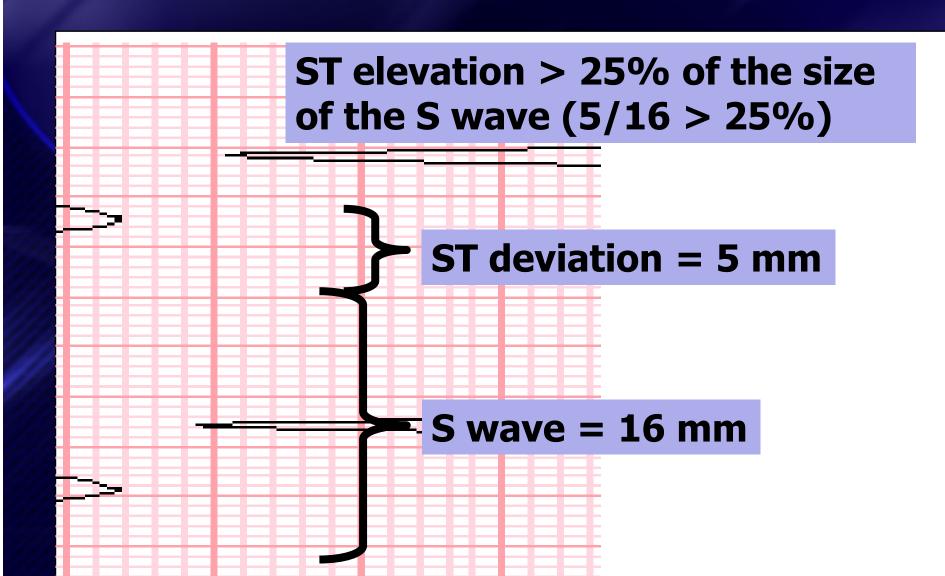






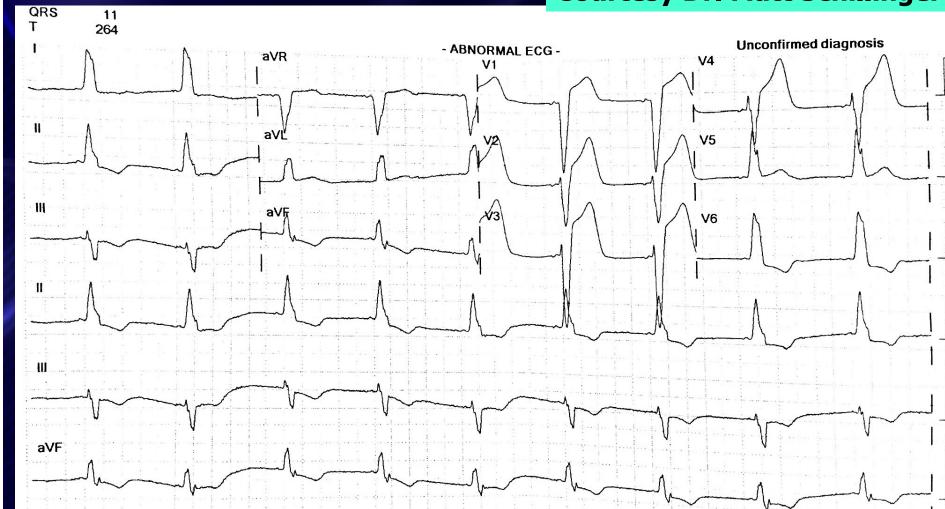






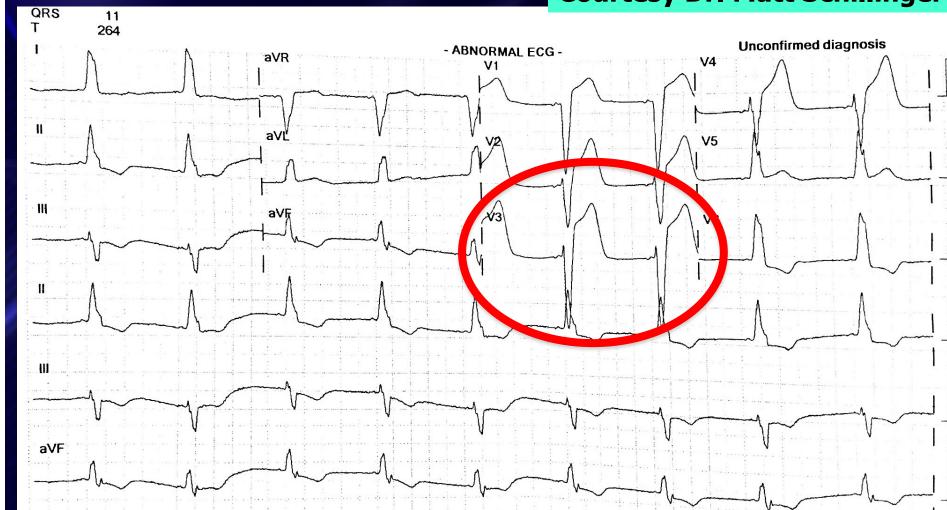
LBBB...anything more?

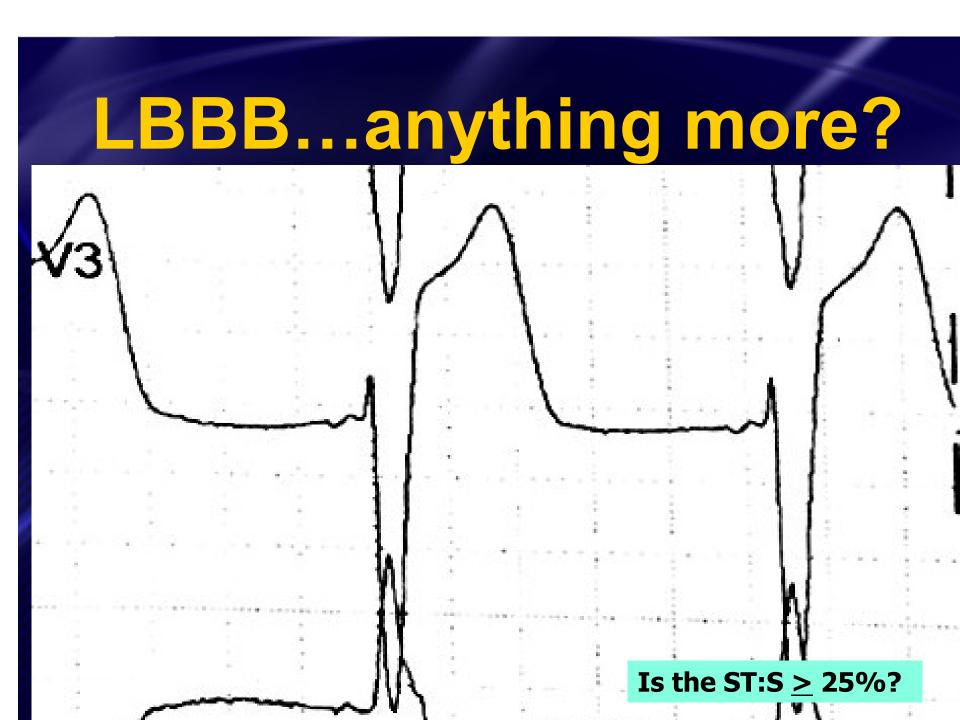
Courtesy Dr. Matt Schillinger



LBBB...anything more?

Courtesy Dr. Matt Schillinger

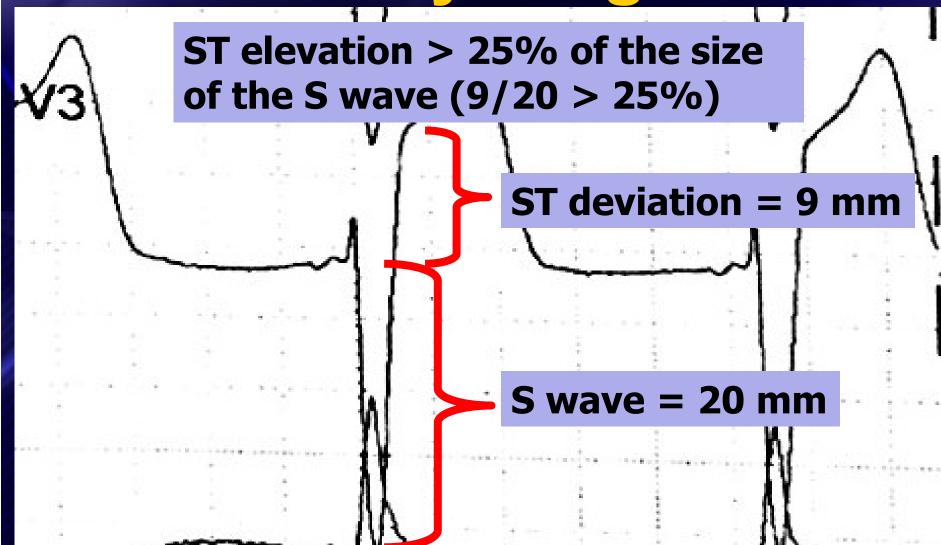




LBBB...anything more? S wave = 20 mm

LBBB...anything more? ST deviation = 9 mm S wave = 20 mm

LBBB...anything more?





Vent Rate: P Duration: PR Interval: QRS Duration:

0 ms 148 ms QT/QTc: 482/461 ms P-R-T Axis: 0 -53 104

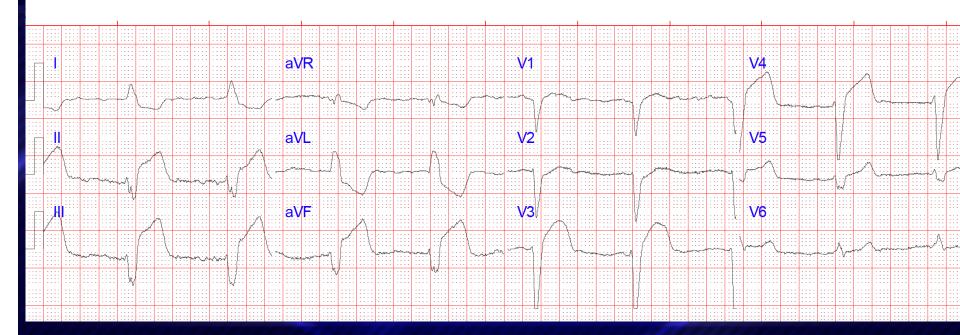
55

0 ms



Atrial fibrillation with slow ventricular response with a competing junctional pacemaker Left axis deviation Left bundle branch block Abnormal ECG *** Unconfirmed ***

Courtesy Adam Thompson, EMT-P





 Vent Rate:
 55

 P Duration:
 0 ms

 PR Interval:
 0 ms

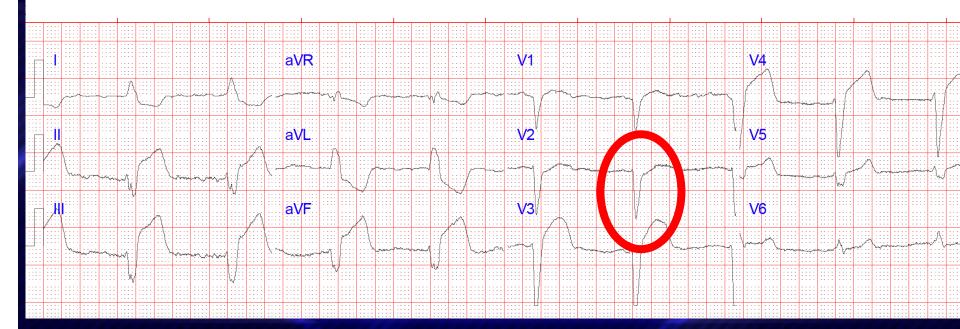
 QRS Duration:
 148 ms

 QT/QTc:
 482/461 ms

 P-R-T Axis:
 0 -53 104

Atrial fibrillation with slow ventricular response with a competing junctional pacemaker Left axis deviation
Left bundle branch block
Abnormal ECG
*** Unconfirmed ***

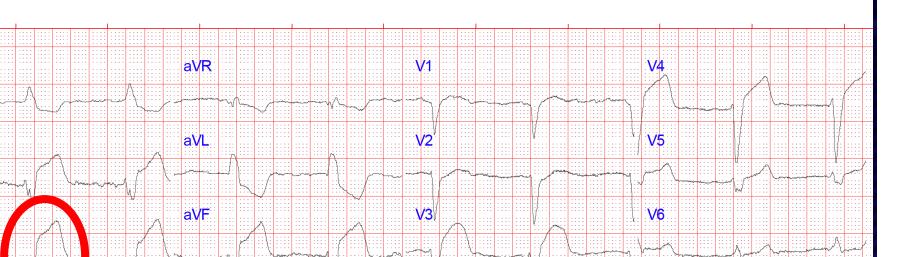
Courtesy Adam Thompson, EMT-P

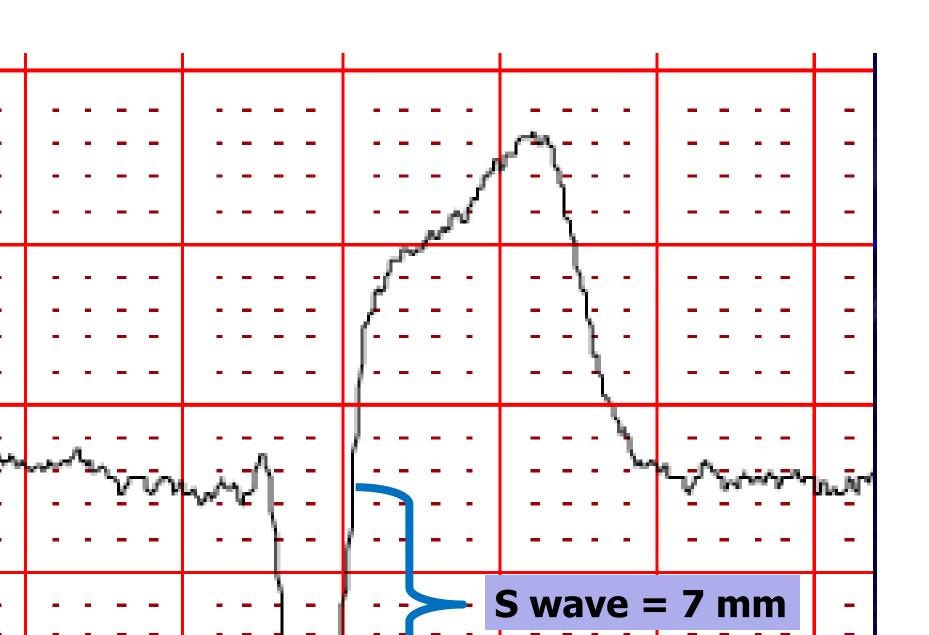


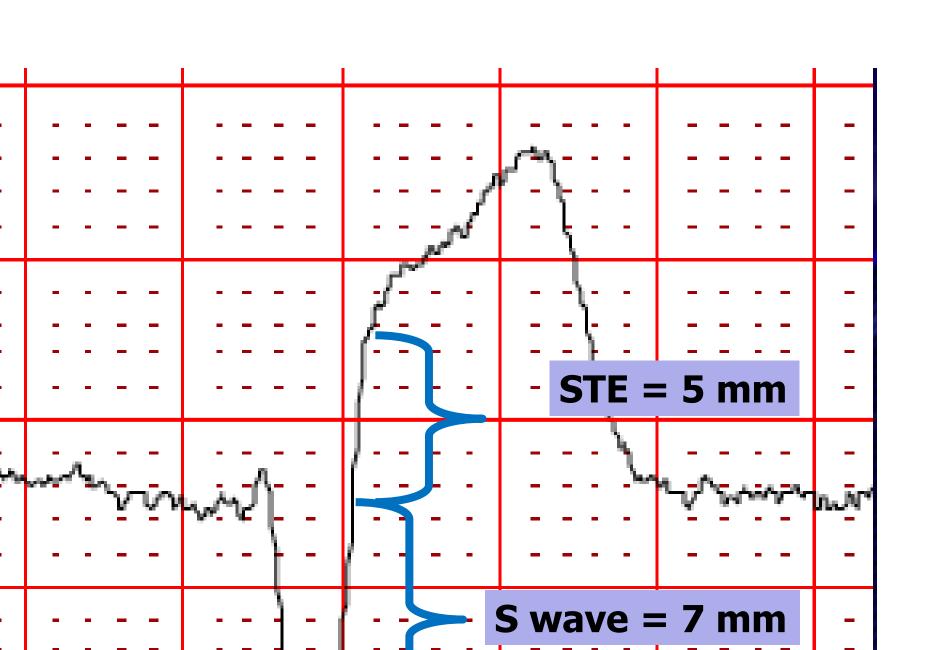


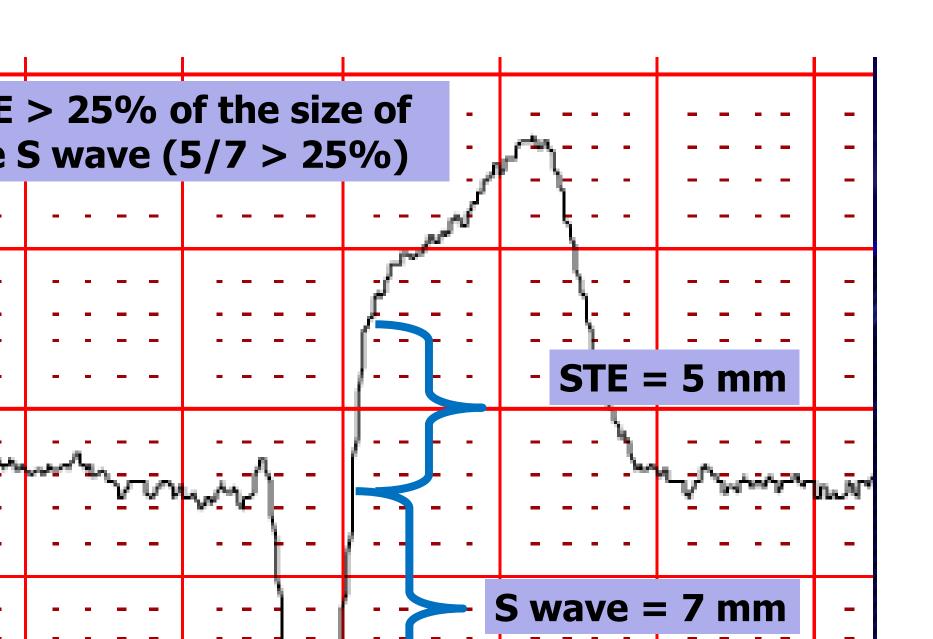
55 0 ms 0 ms 148 ms 482/461 ms 0 -53 104 Atrial fibrillation with slow ventricular response with a competing junctional pacemaker Left axis deviation
Left bundle branch block
Abnormal ECG
*** Unconfirmed ***

Courtesy Adam Thompson, EMT-P







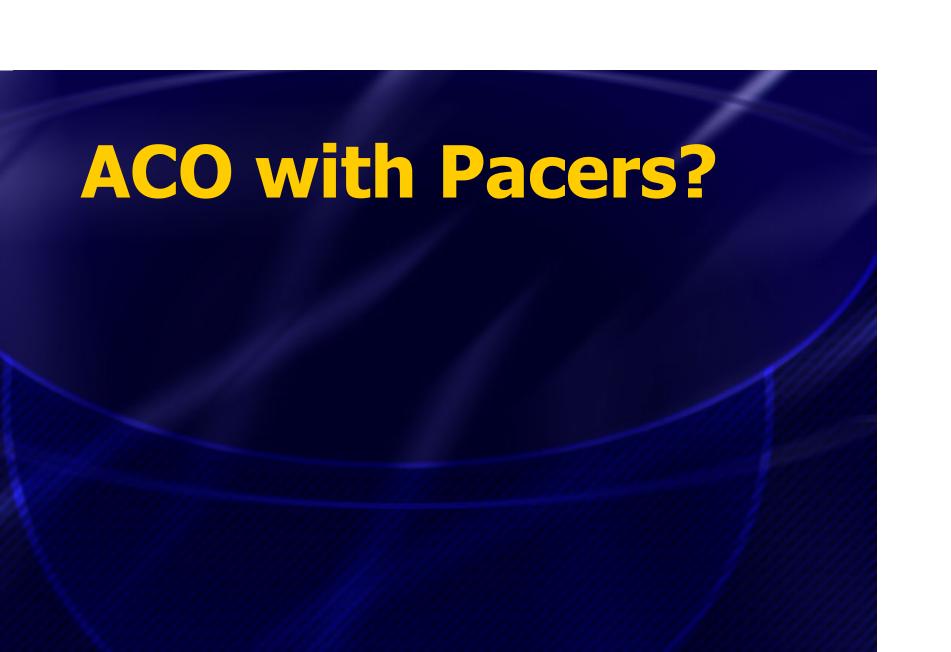


Modified Sgarbossa Criteria in LBBB

- -- Concordant ST elevation > 1 mm in any lead
- -- Concordant ST depression ≥ 1 mm in V_1 , V_2 , or V_3
- -- Discordant ST elevation w/ ST:S ≥ 25% in any lead







ACO with Pacers?

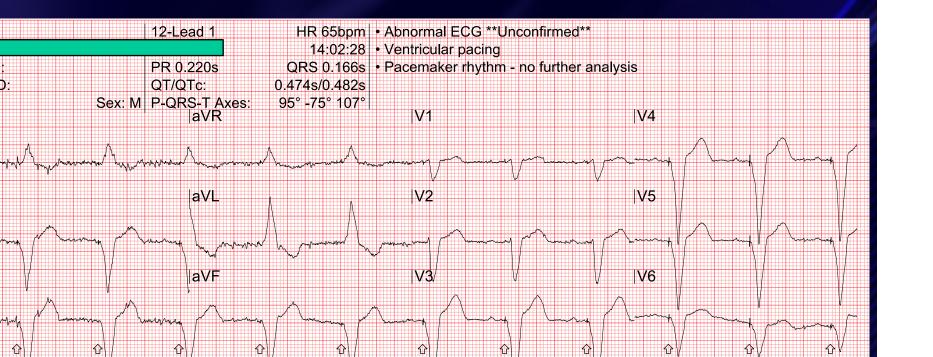
October 2021

CARDIOLOGY/ORIGINAL RESEARCH

Electrocardiographic Diagnosis of Acute Coronary Occlusion Myocardial Infarction in Ventricular Paced Rhythm Using the Modified Sgarbossa Criteria

neth W. Dodd, MD*; Deborah L. Zvosec, PhD; Michael A. Hart, MD; George Glass III, MD; Laura E. Bannister, MBChB; chard M. Body, MBBS; Brett A. Boggust, BA; William J. Brady, MD; Anna M. Chang, MD; Louise Cullen, MBBS, PhD; Gómez-Vicente, MD; Maite A. Huis in 't Veld, MD; Rehan M. Karim, MD; H. Pendell Meyers III, MD; David F. Miranda, MD; Gary J. Mitchell, MD; Charles Reynard, MBBS; Clifford Rice, MD; Bayert J. Salverda, BA; Samuel J. Stellpflug, MD; ishal M. Tolia, MD; Brooks M. Walsh, MD; Jennifer L. White, MD; Stephen W. Smith, MD; on behalf of the PERFECT of investigators is provided in Appendix F1, available at http://www.



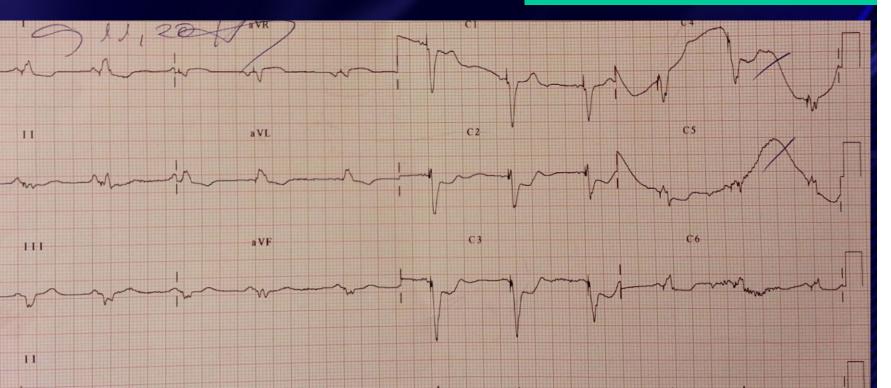


"Sgarbossa A" **Courtesy Dr. Jim Campagna** (New York) aVF

"Sgarbossa A" **Courtesy Dr. Jim Campagna** (New York) aVF

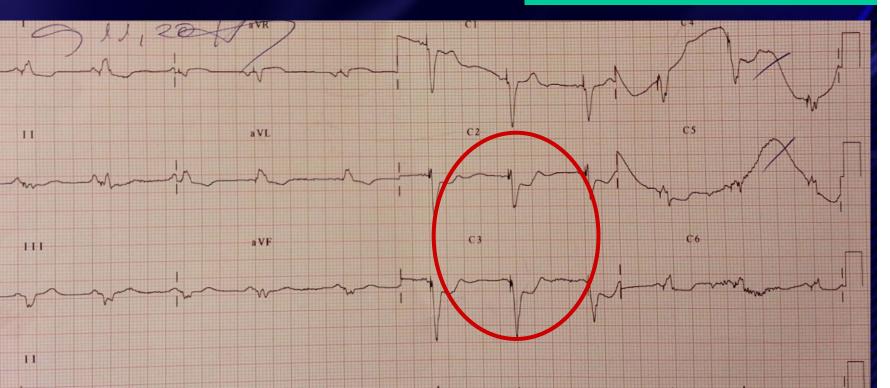
"Sgarbossa B"

Courtesy Dr. Santiago Harris



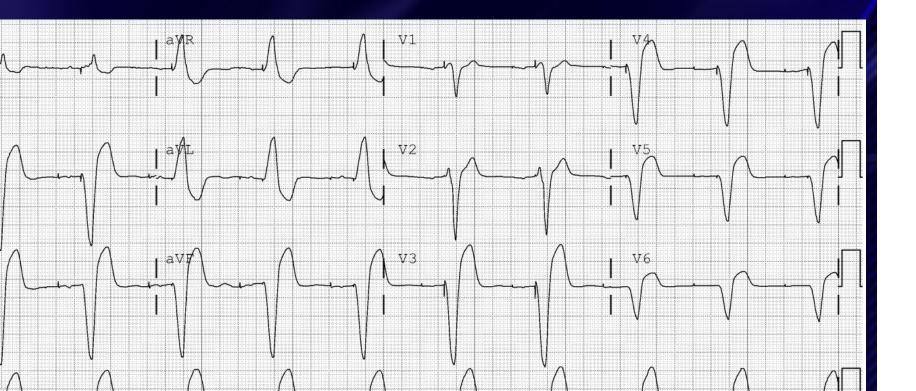
"Sgarbossa B"

Courtesy Dr. Santiago Harris



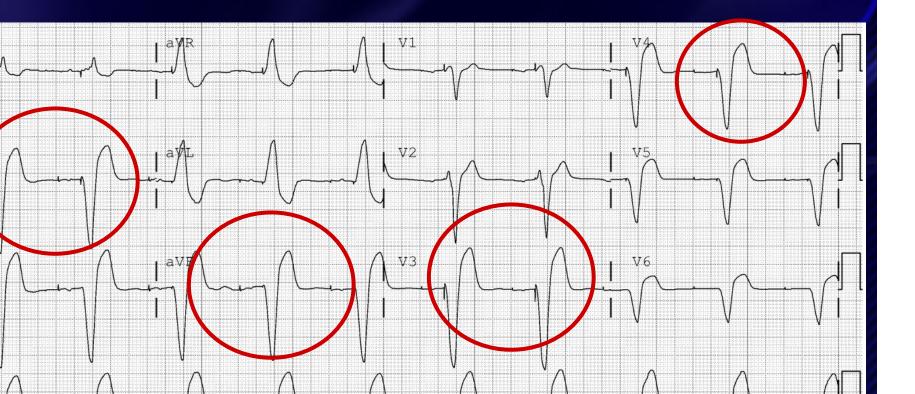
Modified "Sgarbossa C"

Courtesy Dr. Patrick Bruss



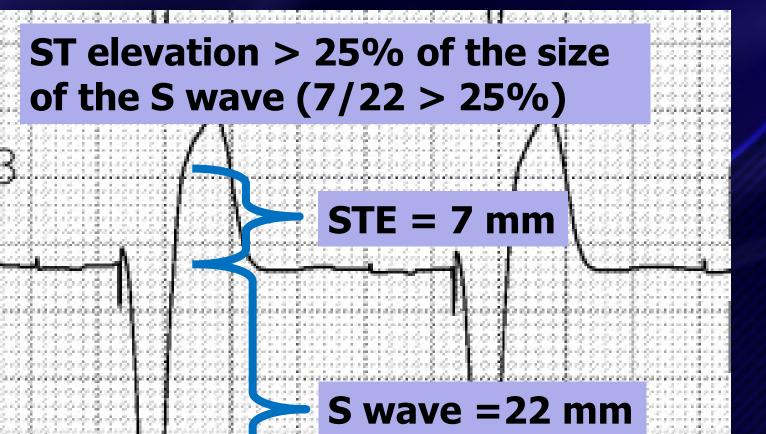
Modified "Sgarbossa C"

Courtesy Dr. Patrick Bruss



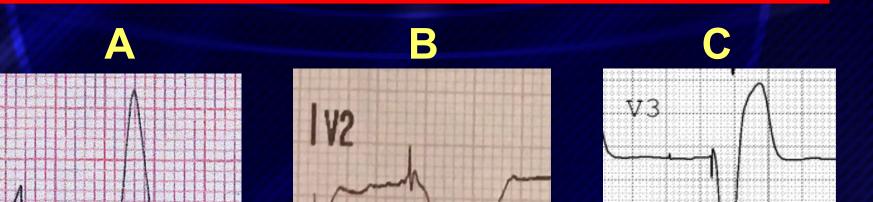
Modified "Sgarbossa C"

Modified "Sgarbossa C"



Modified Sgarbossa Criteria in RV Pacers

- -- Concordant ST elevation > 1 mm in any lead
- -- Concordant ST depression ≥ 1 mm in any of $V_1 V_6$
- -- Discordant ST elevation w/ ST:S > 25% in any lead



2017 ESC STEMI Guidelines Indications for Emergent CLA

undle branch block

- titeria that can be used to improve the diagnostic accuracy of STEMI LBBB⁵⁰:
- Concordant ST-segment elevation ≥1 mm in leads with a positive
- QRS complex
- Concordant ST-segment depression ≥ I mm in V₁-V₃
- Discordant ST-segment elevation ≥5 mm in leads with a negative
- QRS complex
- ne presence of RBBB may confound the diagnosis of STEMI

entricular paced rhythm

Published Oct. 2022

Electrocardiogram Findings Suggestive of Ischemia

CRITERIA

uivalents

ossa Criteria

STEMI

Criteria:

- Horizontal ST-segment depression in V₁-V₃
- Dominant R-wave (R/S ratio >1) in V₂
- Upright T waves in anterior leads
- Prominent and broad R-wave (>30 ms)

Confirmed by:

ST-segment elevation of ≤0.5 mm in at least 1 of leads V₇-V₉*

le branch block or ventricular paced rhythm with A total score ≥ 3 points is required:

- Concordant ST-segment elevation ≥1 mm in leads with a positive QRS complex (5 points)
- Concordant ST-segment depression ≥ 1 mm in leads V_1 - V_3 (3 points)
- Discordant ST-segment elevation ≥5 mm in leads with a negative QRS complex (2 points)

If there is discordant ST-segment elevation \geq 5 mm, consider ST/S ratio < -0.25

le branch block or ventricular paced rhythm with Positive if any of the following are present: -modified Sgarbossa Criteria

- Concordant ST-segment elevation of 1 mm in leads with a positive QRS complex
- Concordant ST-segment depression of 1 mm in V₁-V₃
- ST-segment elevation at the J-point, relative to the QRS onset, is at least 1 mm and has an amplitude of at least 25% of the preceding S-wave

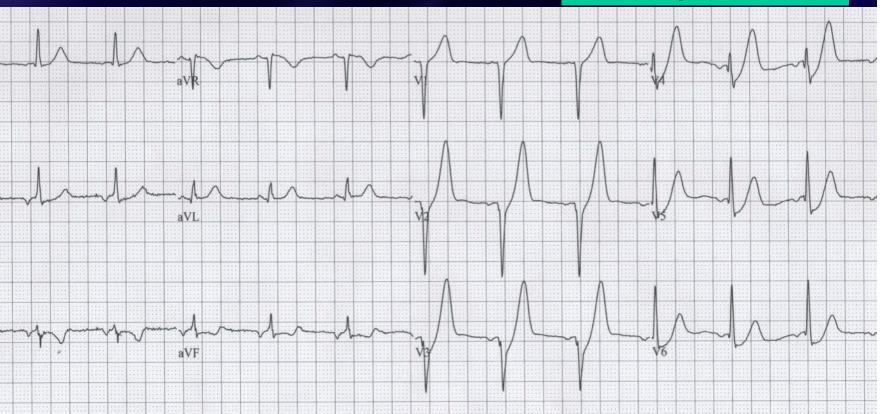
DO NOT BREATHE UNDER THE WATED

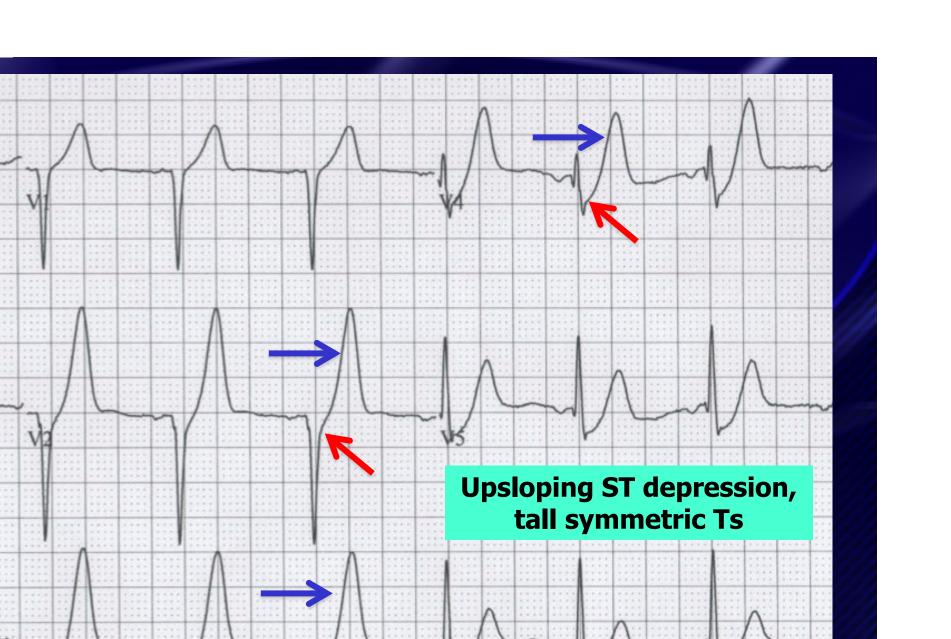
de Winter T Waves

- High-Risk ECG Patterns in ACS—Need for Guideline Revision (Birnbaum, et al. J Electrocardiol 2013)
- Acute occlusion of the proximal LAD
- Urgent cath should be "strongly considered"

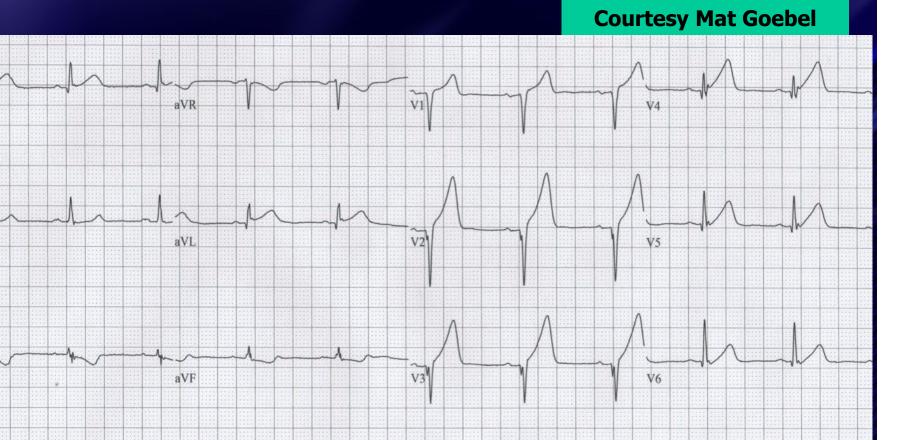
de Winter T Waves

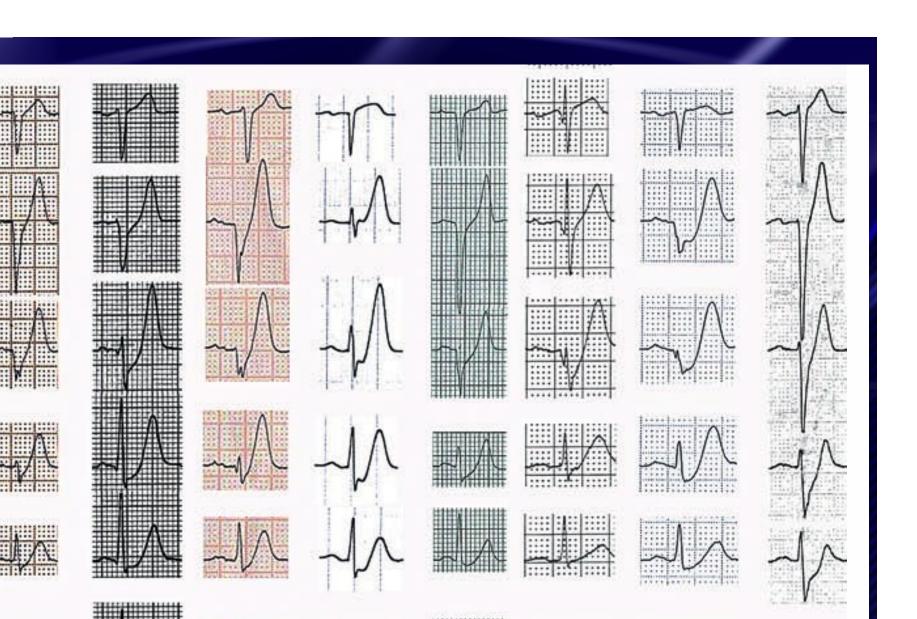
Courtesy Mat Goebel

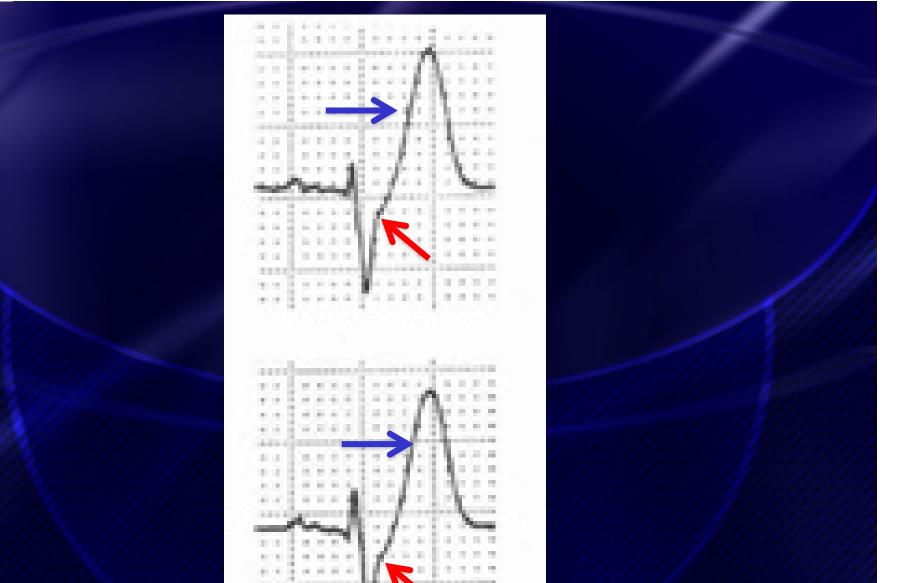




90 min later







Key Point

de Winter T-waves

- Although no STE, high concern for decompenstation
 - Active Sx's
 - Unstable LAD stenosis
 - Treat aggressively, get serial ECGs,
 may evolve → STEMI







Published Oct. 2022

Electrocardiogram Findings Suggestive of Ischemia

CRITERIA

uivalents

ossa Criteria

STEMI

Criteria:

- Horizontal ST-segment depression in V₁-V₃
- Dominant R-wave (R/S ratio >1) in V₂
- Upright T waves in anterior leads
- Prominent and broad R-wave (>30 ms)

Confirmed by:

ST-segment elevation of ≤0.5 mm in at least 1 of leads V₇-V₉*

le branch block or ventricular paced rhythm with A total score ≥ 3 points is required:

- Concordant ST-segment elevation ≥1 mm in leads with a positive QRS complex (5 points)
- Concordant ST-segment depression ≥ 1 mm in leads V_1 - V_3 (3 points)
- Discordant ST-segment elevation ≥5 mm in leads with a negative QRS complex (2 points)

If there is discordant ST-segment elevation \geq 5 mm, consider ST/S ratio < -0.25

le branch block or ventricular paced rhythm with Positive if any of the following are present: -modified Sgarbossa Criteria

- Concordant ST-segment elevation of 1 mm in leads with a positive QRS complex
- Concordant ST-segment depression of 1 mm in V₁-V₃
- ST-segment elevation at the J-point, relative to the QRS onset, is at least 1 mm and has an amplitude of at least 25% of the preceding S-wave

WARNING

No Swimming If you can't swim

ហាមចំពោះអ្នកដែលមិនចេះហែលទឹក

Cereal ECG Testing



Serial ECG Testing

- Failure to repeat the ECG...
 - If the first ECG is poor quality
 - If ongoing concerning Sx's
 - ACC/AHA guidelines recommend serial ECGs every 15-30 min for the first hour if there are concerning Sx's and initial ECG is non-dx'ic

Serial ECG Testing

- Failure to repeat the ECG...
 - If the first ECG is poor quality
 - If ongoing concerning Sx's
 - ACC/AHA guidelines recommend serial ECGs every 15-30 min for the first hour if there are concerning Sx's and initial ECG is non-dx'ic

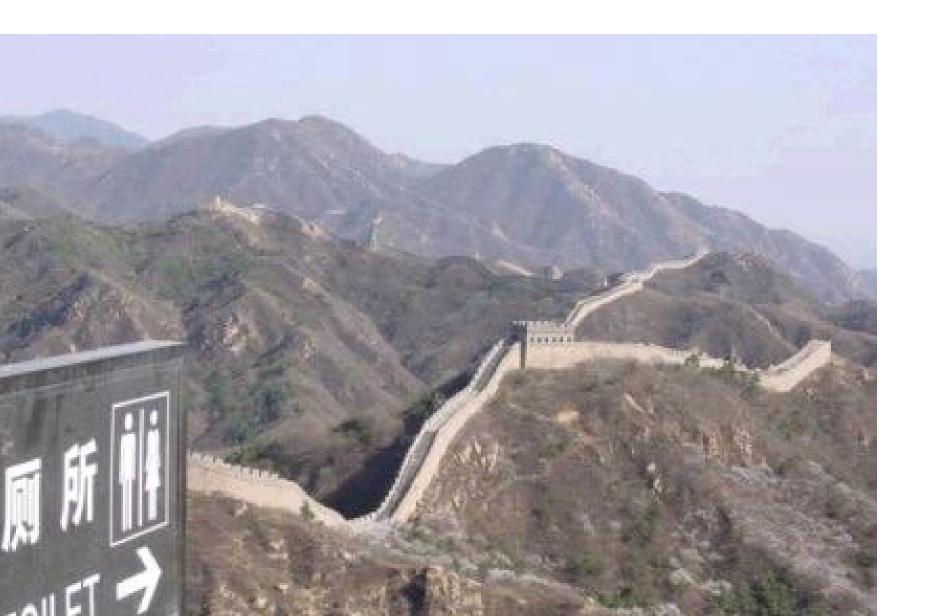


 "STE" as the sole predictor of an ACO is a flawed concept

- "STE" as the sole predictor of an ACO is a flawed concept
- Don't forget about refractory ischemia as an indicator (in current guidelines) for cath lab activation

- "STE" as the sole predictor of an ACO is a flawed concept
- Don't forget about refractory ischemia as an indicator (in current guidelines) for cath lab activation
- Learn to look for these other ECGs

- "STE" as the sole predictor of an ACO is a flawed concept
- Don't forget about refractory ischemia as an indicator (in current guidelines) for cath lab activation
- Learn to look for these other ECGs



Part II: Mimics of Myocardial Ischemia



Amal Mattu, MD, FAAEM, FACEP
Professor and Vice Chair of Academic Affairs



Why is this important?

- Missed ACS accounts for 20% of malpractice dollars paid out in EM
- 25-50% of cases involve ECG misreads

Why is this important?

- Missed ACS accounts for 20% of malpractice dollars paid out in EM
- 25-50% of cases involve ECG misreads
- Significant "cost" associated with missed ACS, but also significant cost associated with over-reads

Causes of STE

ute myocardial injury (ACO High voltage (e.g. LVH, WPW, trauma) athlete's heart, etc.)

ly repolarization

ntricular aneurysm

o/pericarditis

sospasm

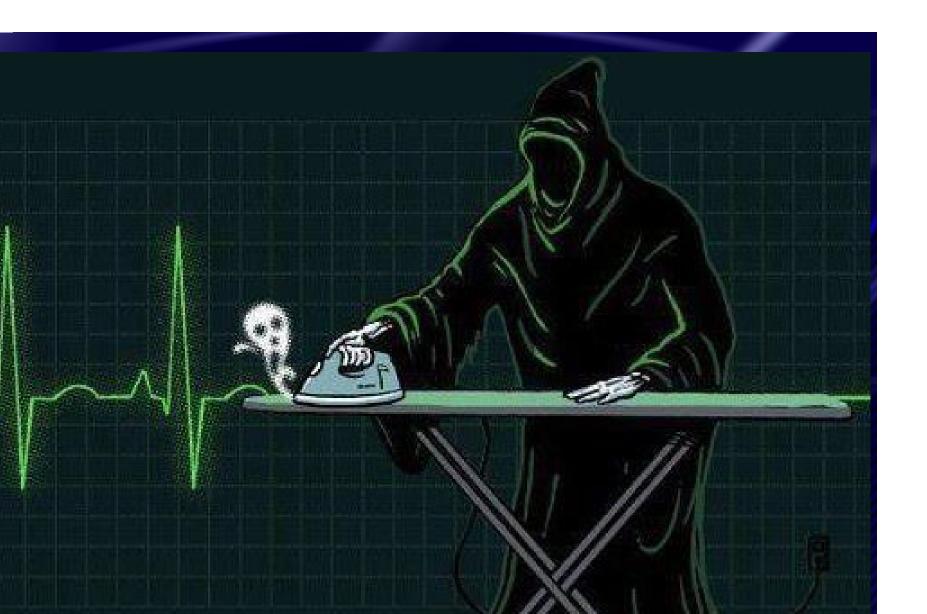
bal ischemia (e.g. EPI, Na+ channelopathies, e.g. section, massive GIB, etc.) TCAs, hyperK+, Brugada, etc.

Post-cardioversion (stunning)

Hypothermia

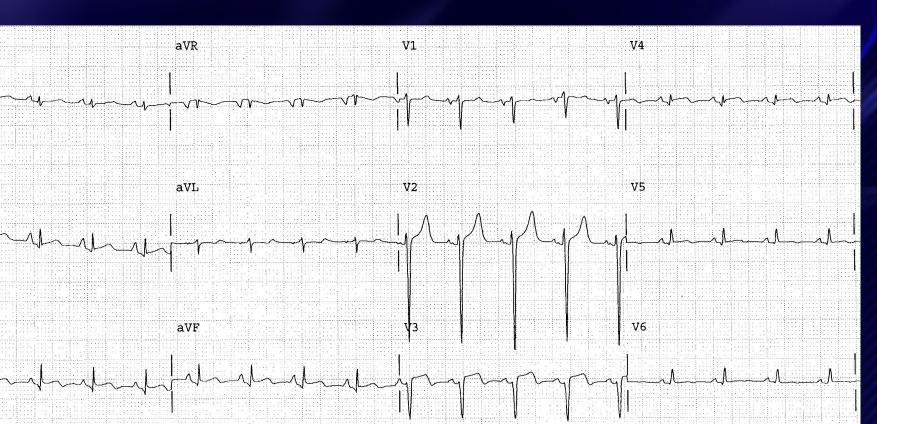
Tako tsubo

Intracranial abnls

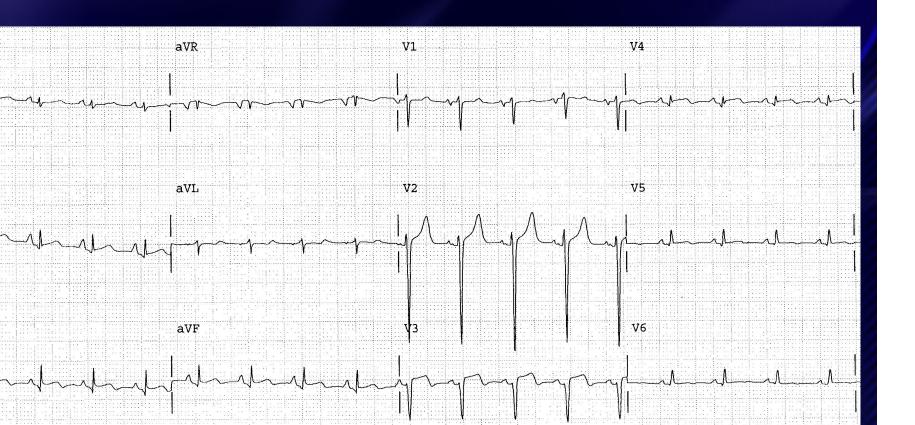




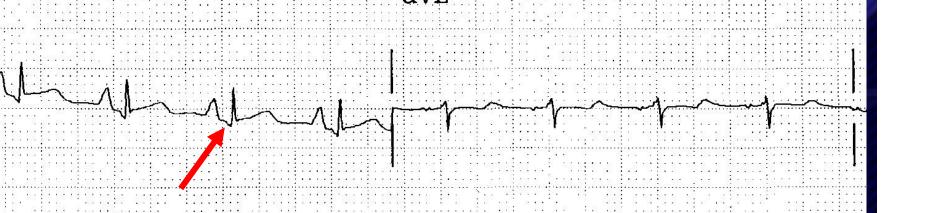
Case #1: 45yo M with sharp CP



STEMI or Acute Pericarditis?



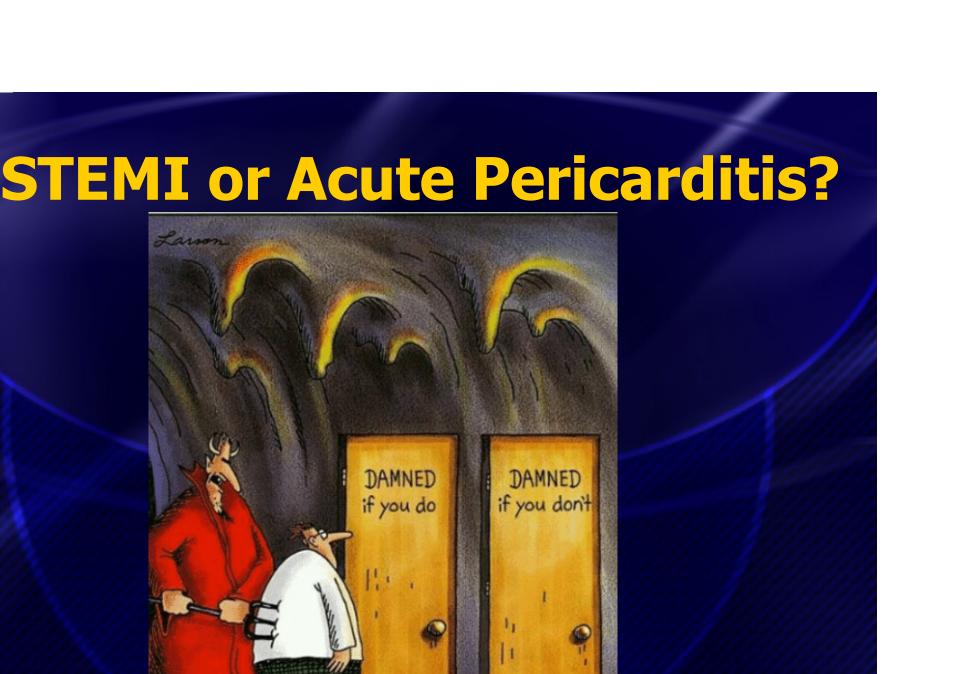
STEMI or Acute Pericarditis?



aVF

STEMI or Acute Pericarditis?

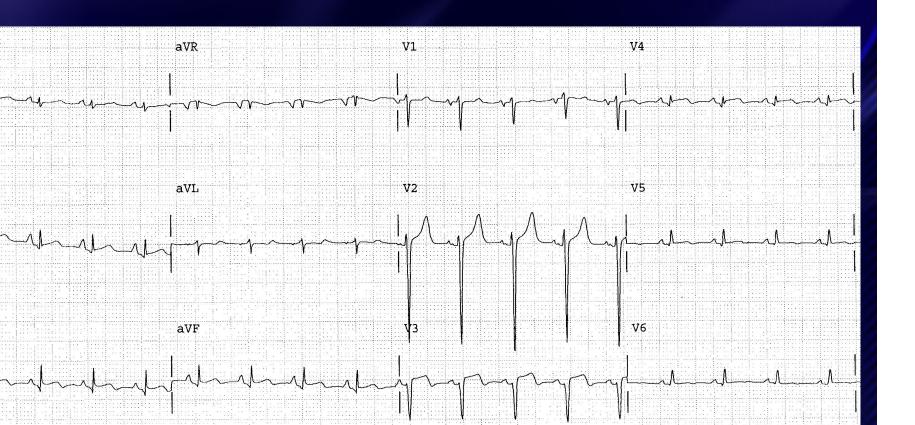
- Distinction is often difficult
- STEMI sometimes misdiagnosed as pericarditis
- Pericarditis sometimes misdiagnosed as STEMI
 - 15-20% of "inappropriate" referrals for PCI



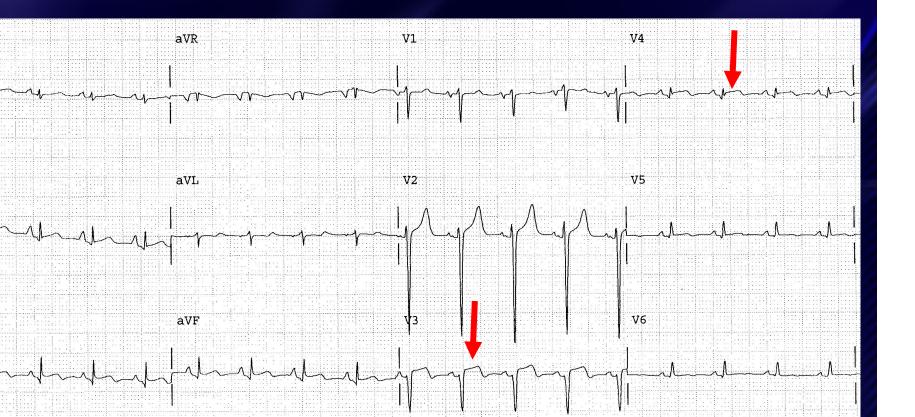
- 1. Factors that strongly suggest STEMI
 - STD except in V1 or aVR
 - (STD in V1 or aVR is allowed in AP)
 - -STE in III > II
 - Horizontal or convex upwards STE
 - Q-waves that you know are new

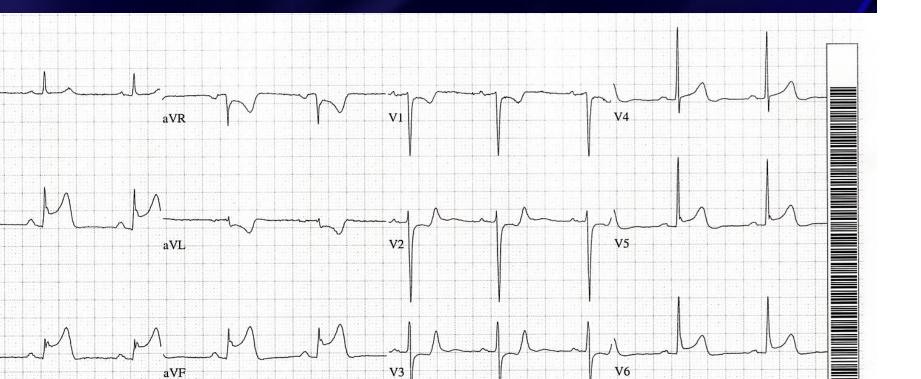
- 1. Factors that strongly suggest STEMI
 - STD except in V1 or aVR
 - (STD in V1 or aVR is allowed in AP)
 - -STE in III > II
 - Horizontal or convex upwards STE
 - Q-waves that you know are new
- 2. Factors that suggest AP
 - PR depression in multiple leads

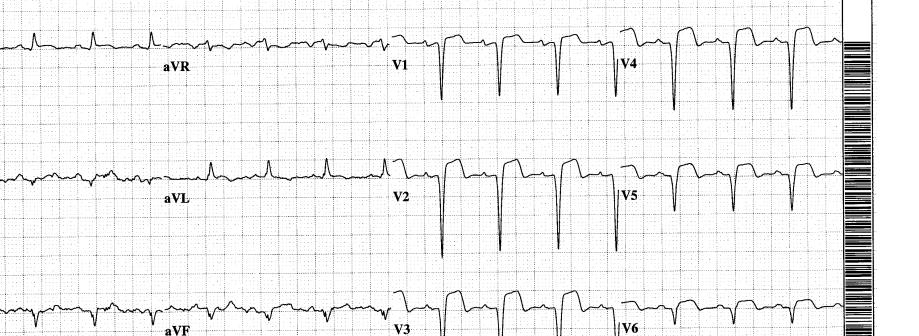
When in doubt, get serial ECGs!

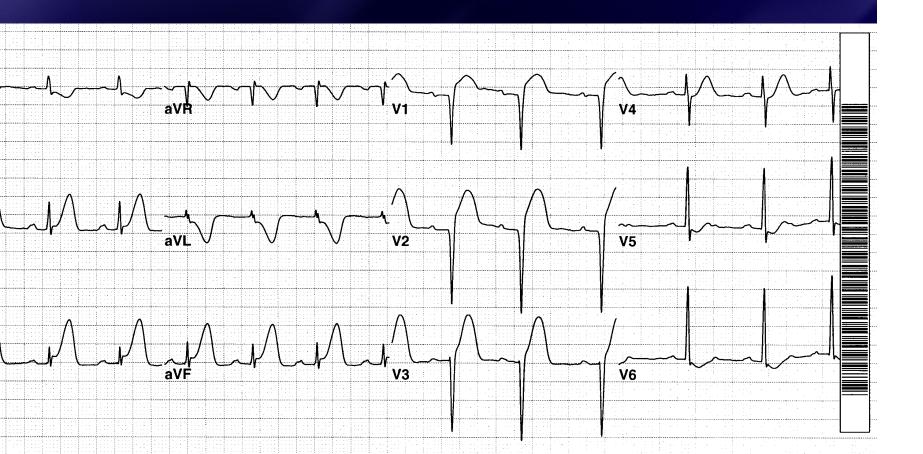


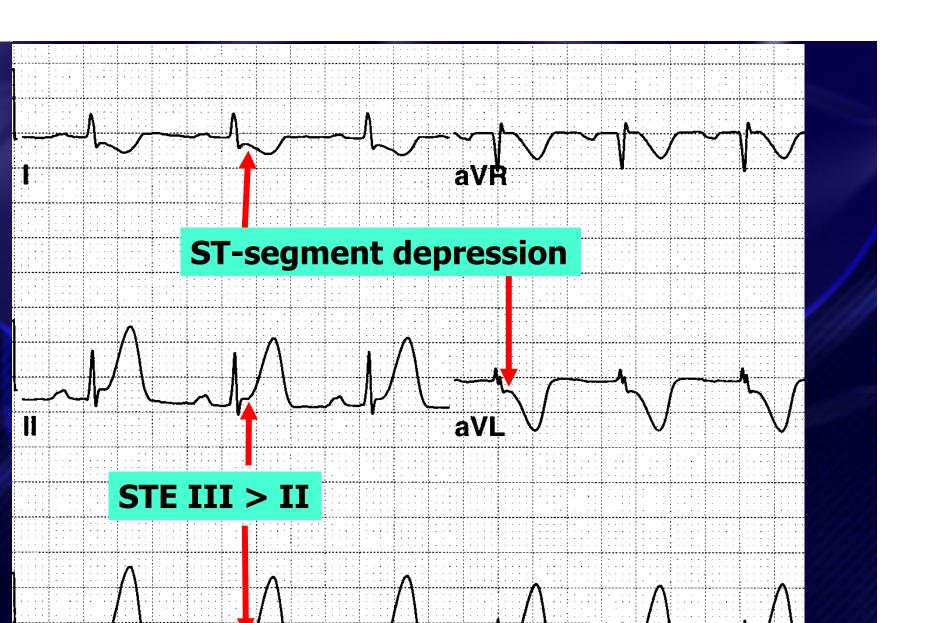
STEMI

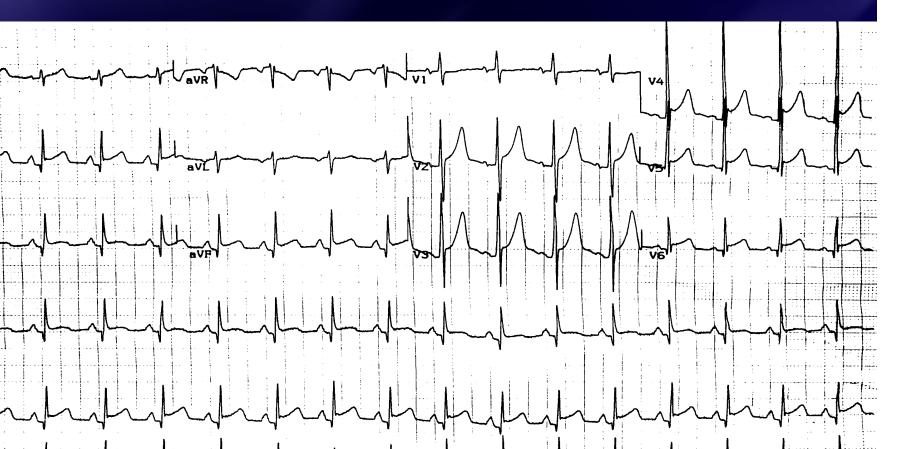


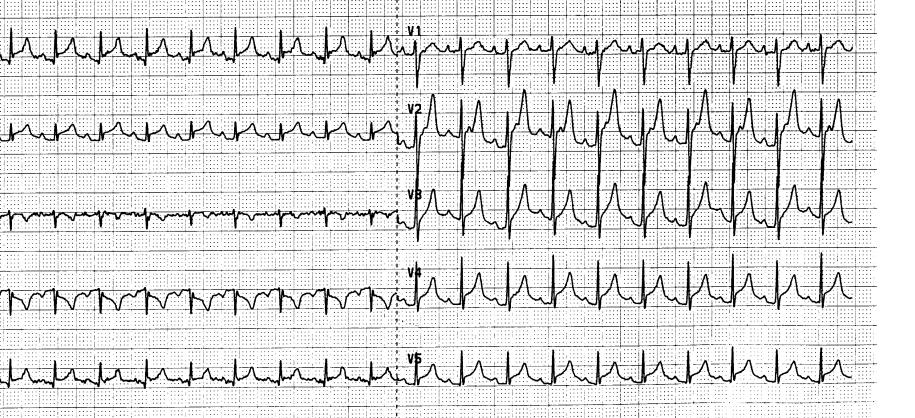


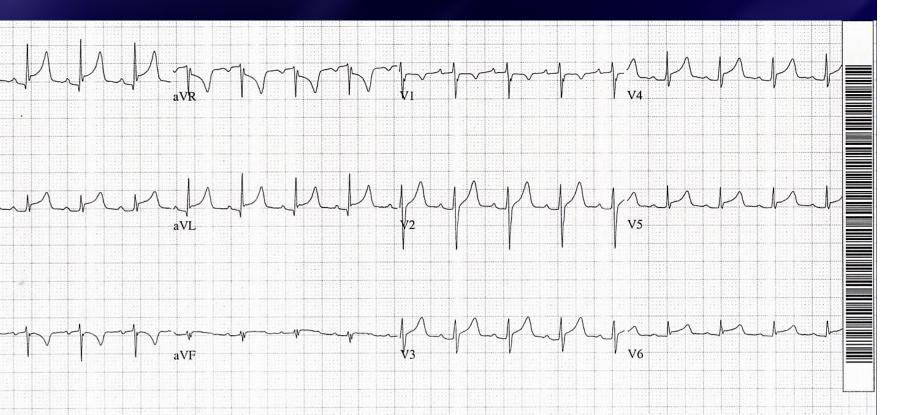






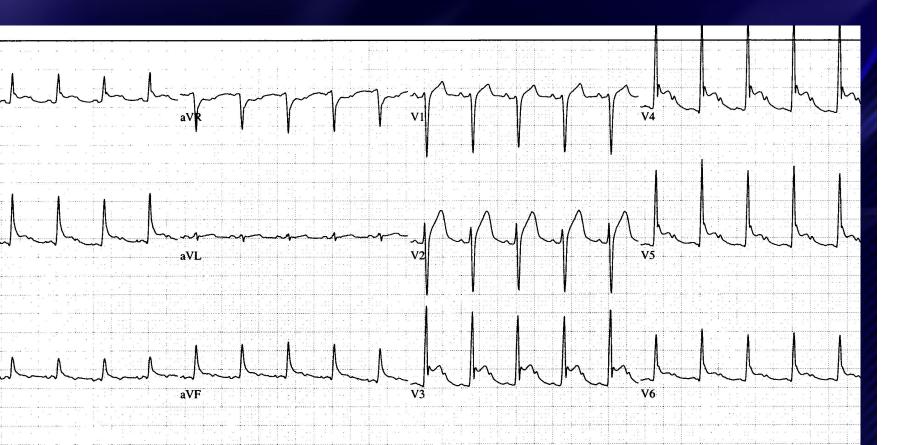




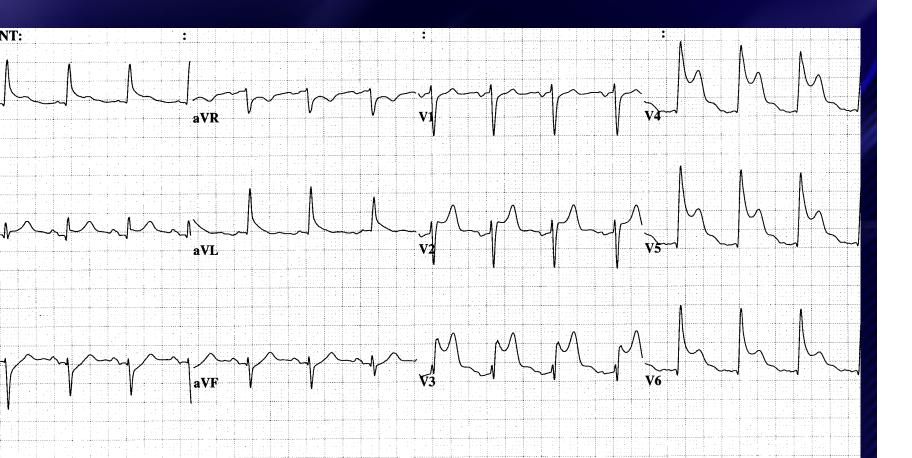


STEMI or AP? aVL **V**5



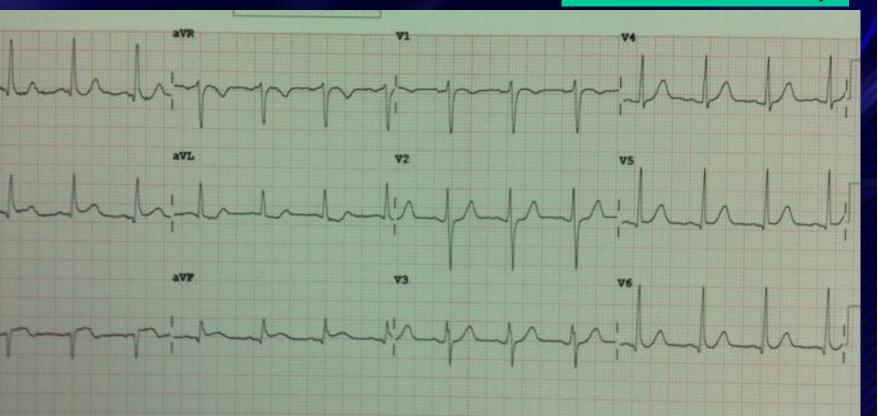


When in doubt, get serial ECGs!



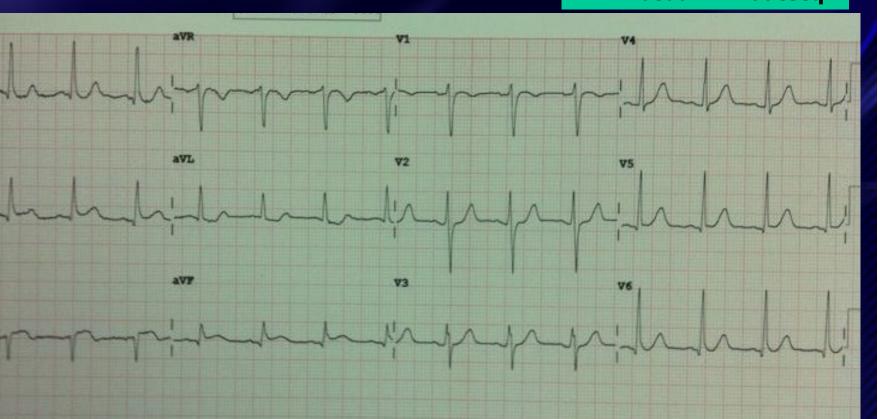
30yo man with 3 hrs. central CP

Dr. Hasdan AlMaateeq



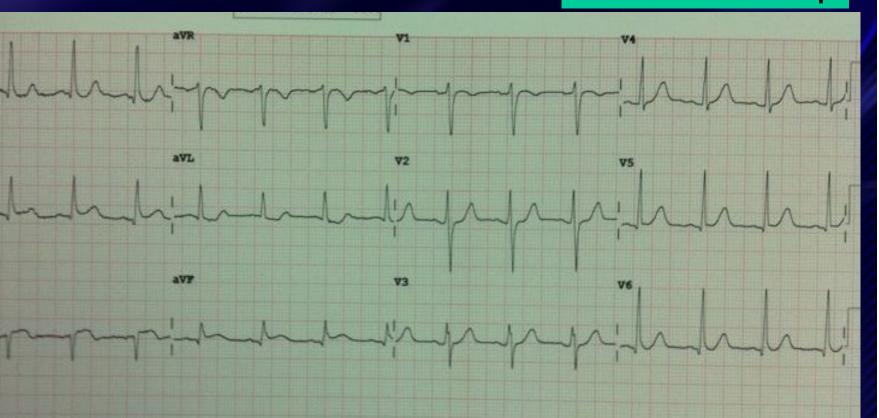
Consultant: "Pericarditis"

Dr. Hasdan AlMaateeq

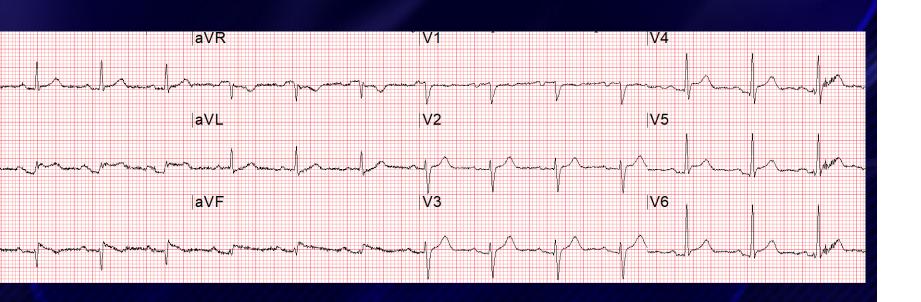


Dx: STEMI

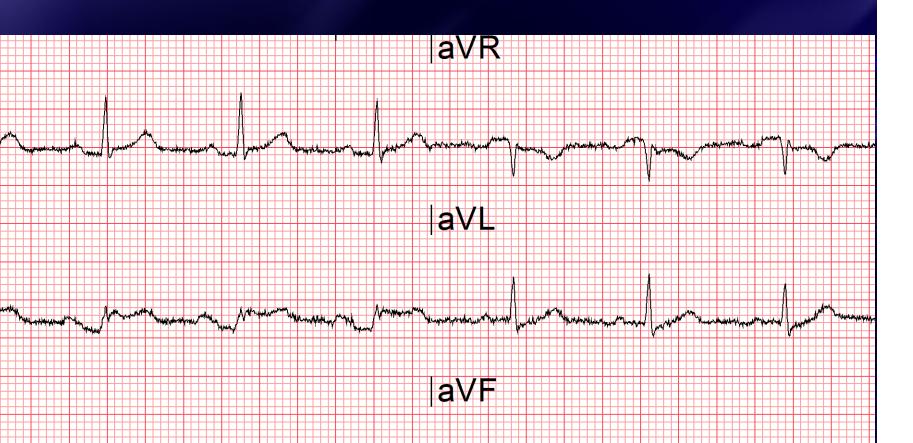


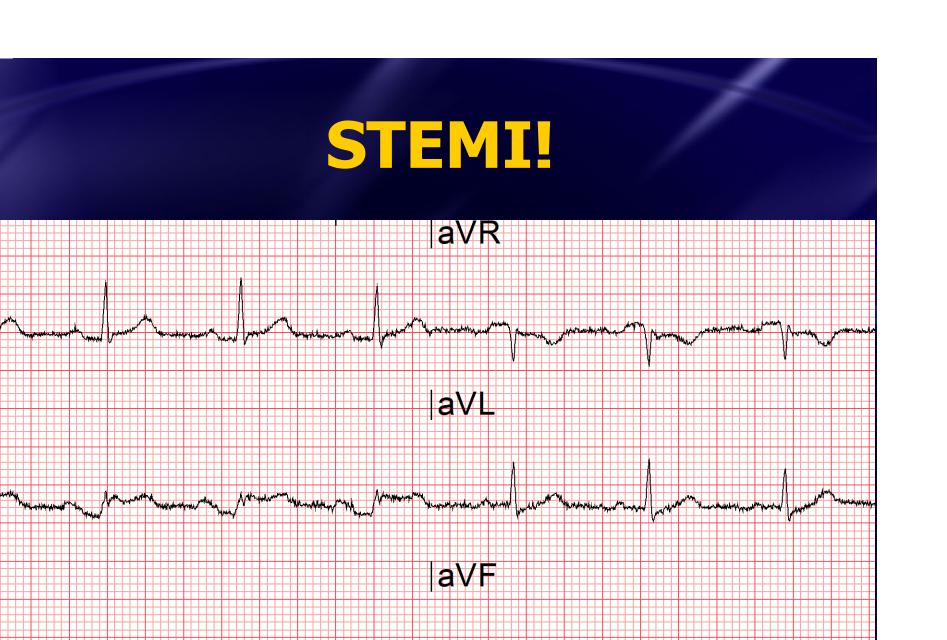


Elderly woman with CP



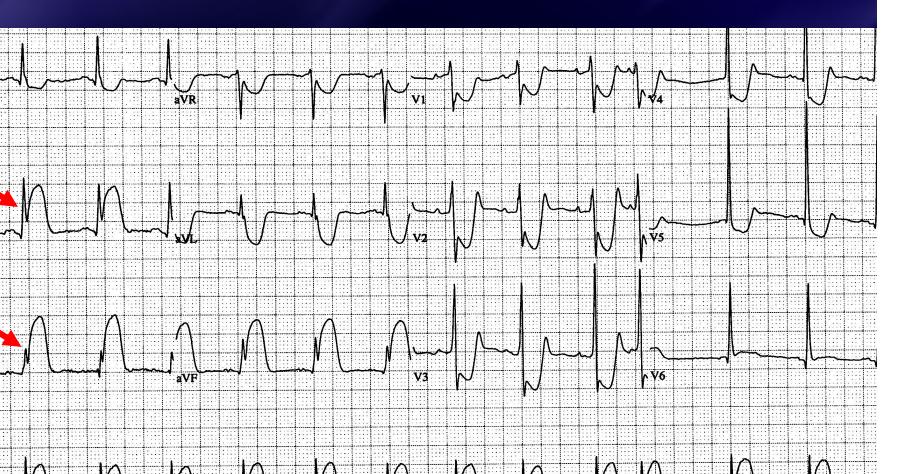
Elderly woman with CP



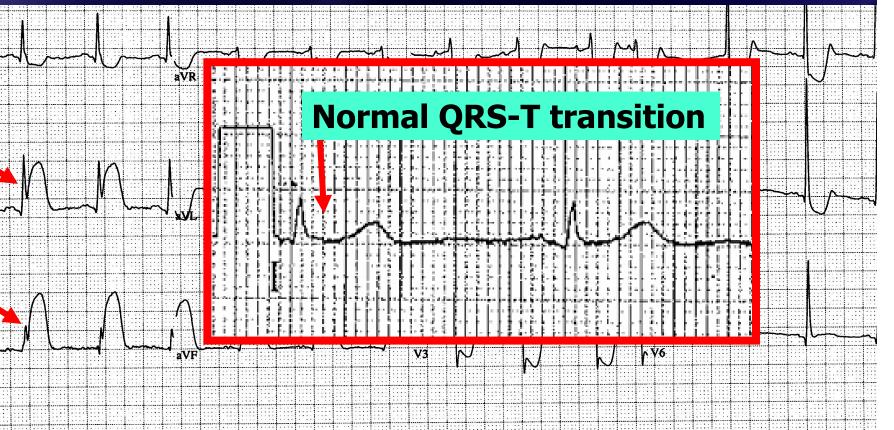


- Additional factors that favor STEMI
 - R-T sign ("checkmark sign")
- Additional factors that favor pericarditis (after above has been evaluated)
 - Spodick sign: downsloping of the TP

"R-T" or "Checkmark" -> ACS



"R-T" or "Checkmark" -> ACS



STEMI vs. Pericarditis

Courtesy Dr. Baruch Fertel

Black

 Vent. rate
 62 bpm

 PR interval
 160 ms

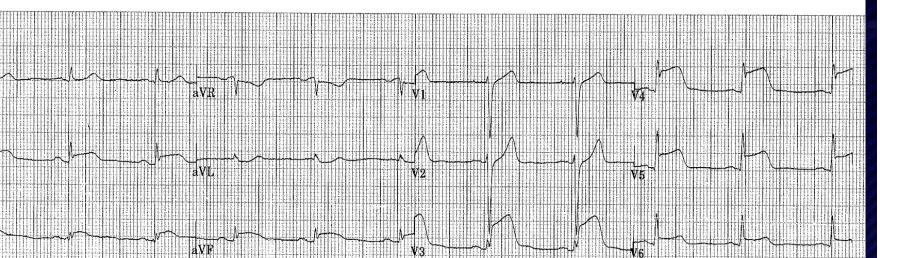
 QRS duration
 90 ms

 QT/QTc
 406/412 ms

 P-R-T axes
 64 48 59

Normal sinus rhythm Acute pericarditis Abnormal ECG Stemi VS Renculis

Technician: KMT



STEMI vs. Pericarditis

Courtesy Dr. Baruch Fertel

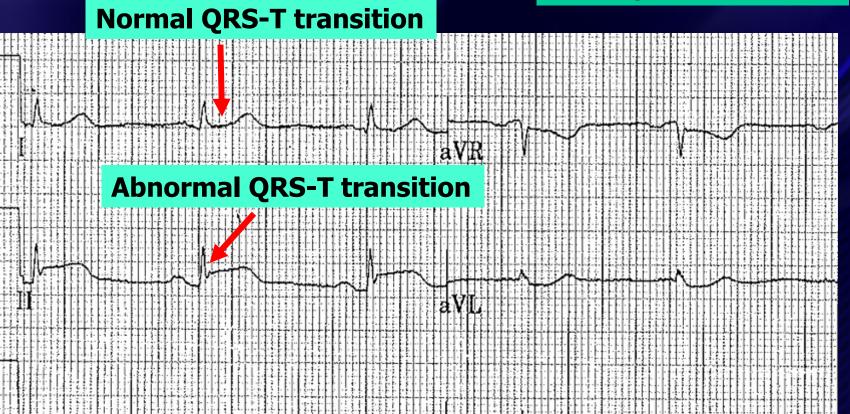
Normal sinus rhythm Acute pericarditis Abnormal ECG

Stemi VS Renauls

Deffet 57

Acute Pericarditis?

Courtesy Dr. Baruch Fertel



"R-T" or "Checkmark"

Courtesy Dr. Baruch Fertel





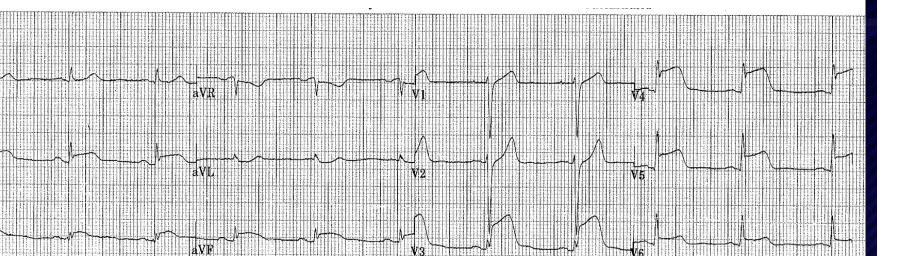
Courtesy Dr. Baruch Fertel

Vent. rate 62 bpm
PR interval 160 ms

PR interval 160 ms QRS duration 90 ms QT/QTc 406/412 ms P-R-T axes 64 48 59 Normal sinus rhythm Acute pericarditis Abnormal ECG

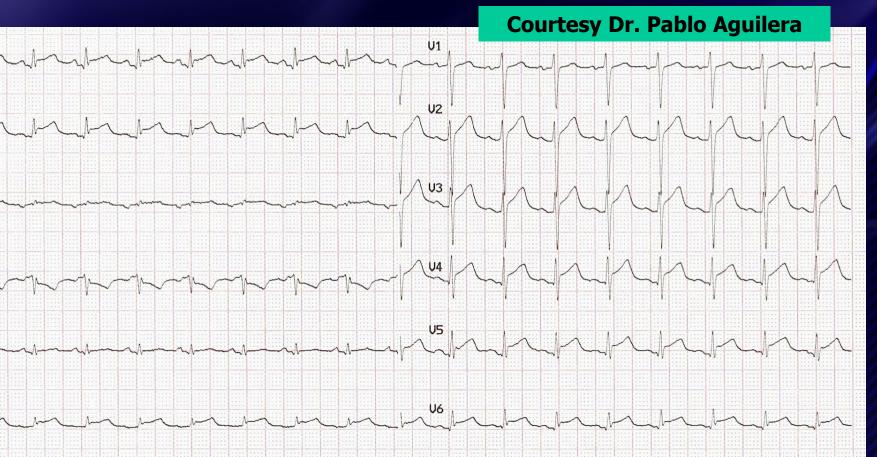
Stemi VS Renculis

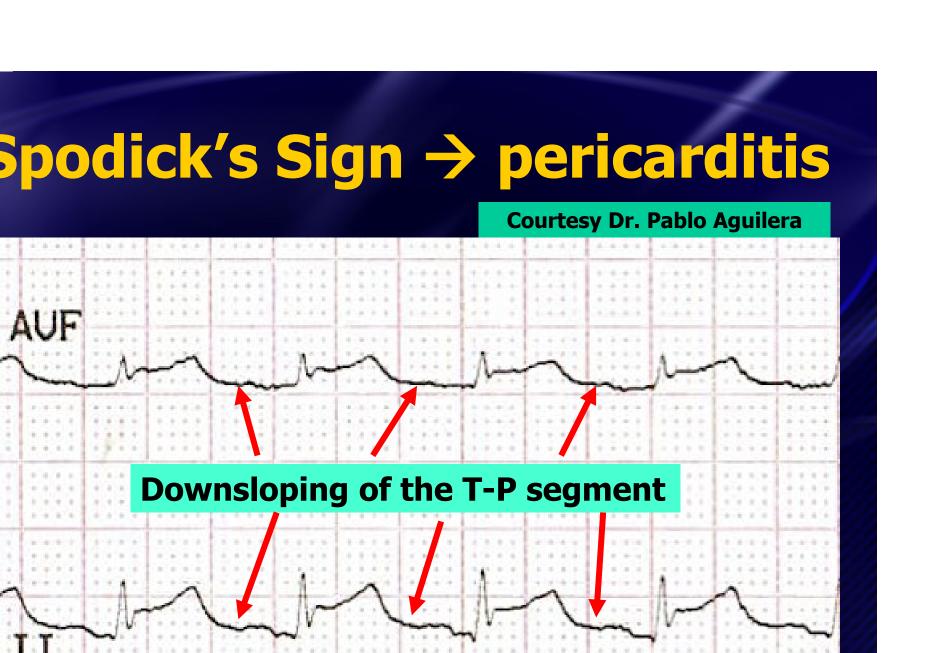
Technician: KMT



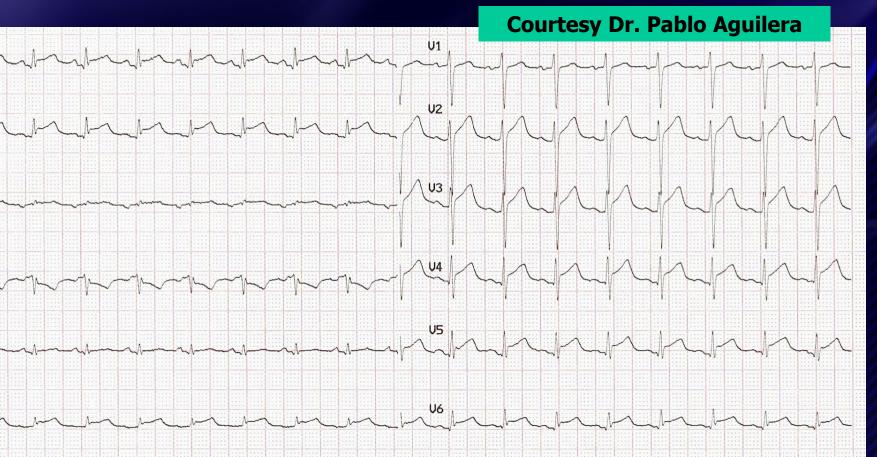
"R-T" or "Checkmark"

Spodick's Sign -> pericarditis



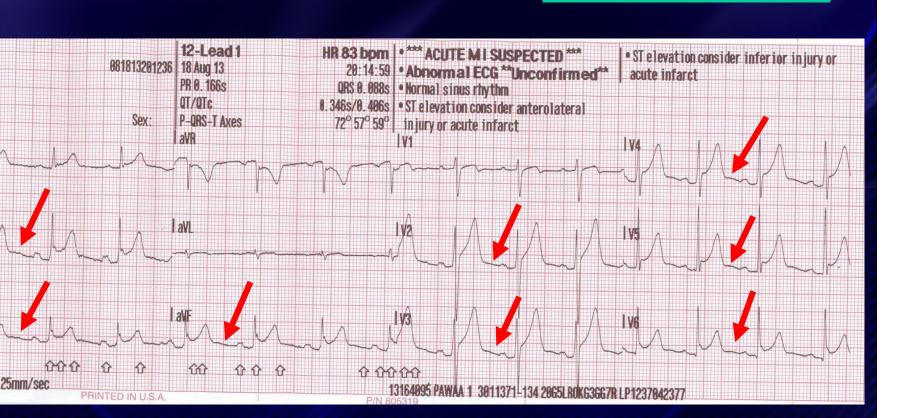


Spodick's Sign -> pericarditis

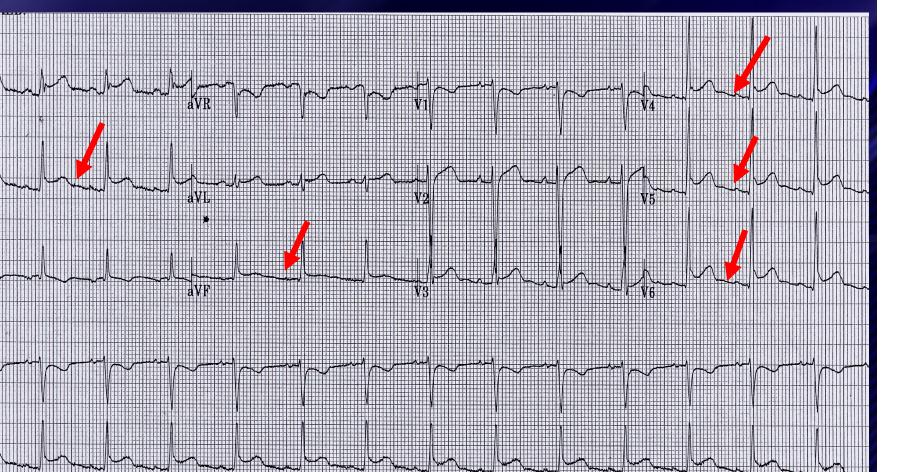


Spodick's Sign

Courtesy Larry Moore



Spodick's Sign



But remember...don't use Spodick sign until after all prior steps have failed to rule IN STEMI!!!

Black

 Vent. rate
 62 bpm

 PR interval
 160 ms

 QRS duration
 90 ms

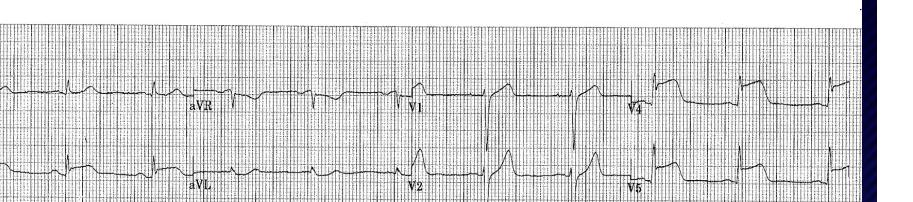
 QT/QTc
 406/412 ms

 P-R-T axes
 64 48 59

Normal sinus rhythm Acute pericarditis Abnormal ECG Stemi VS Renculas

Technician: KMT

Courtesy Dr. Baruch Fertel



But remember...don't use Spodick sign until after all prior steps have failed to rule IN STEMI!!!

Black

 Vent. rate
 62 bpm

 PR interval
 160 ms

 QRS duration
 90 ms

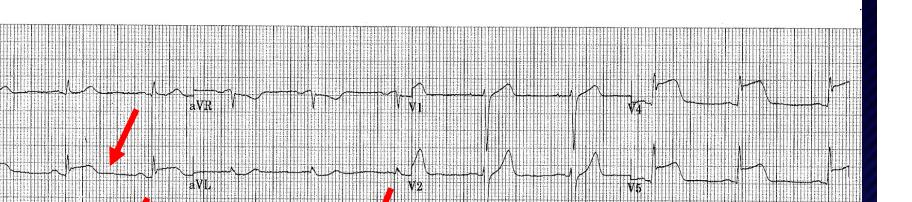
 QT/QTc
 406/412 ms

 P-R-T axes
 64 48 59

Normal sinus rhythm Acute pericarditis Abnormal ECG Stemi VS Rencula

Technician: KMT

Courtesy Dr. Baruch Fertel





STEMI or Acute Pericarditis?





The Journal of Emergency Medicine, Vol. 58, No. 4, pp. 562–569, 2020 © 2020 Elsevier Inc. All rights reserved. 0736-4679/\$ - see front matter

https://doi.org/10.1016/j.jemermed.2020.01.017



J Emerg Med 2020

EVALUATION OF SPODICK'S SIGN AND OTHER ELECTROCARDIOGRAPHIC FINDINGS AS INDICATORS OF STEMI AND PERICARDITIS

Michael D. Witting, MD, MS,* Kami M. Hu, MD,* Aaron A. Westreich, MD,† Semhar Tewelde, MD,*

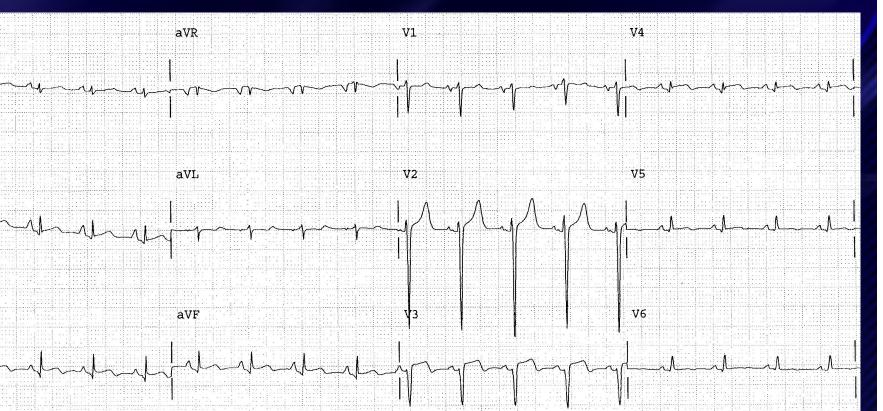
STEMI or Acute Pericarditis?

ECG Finding	Odds Ratio for STEMI
T depression (ignoring V1 or aVR)	31
TE in III > II	21
orizontal or convex upward STE	6
bsence of PR depression	12

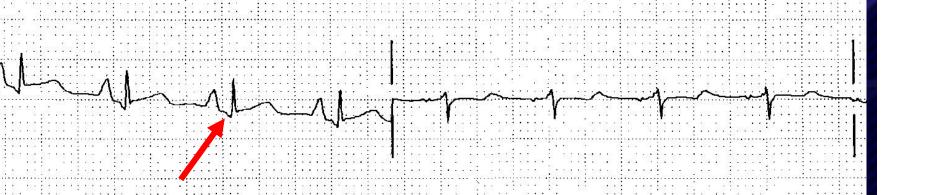
STEMI or Acute Pericarditis?

- 12% of STEMIs had PR depression
- 5% of STEMIs had Spodick's sign

STEMI...despite PR depression!



STEMI...despite PR depression!



Key Points

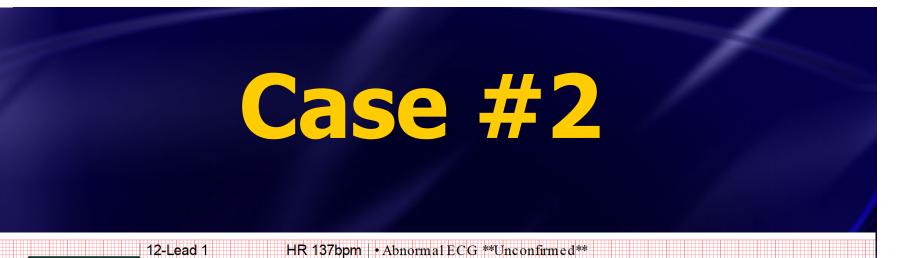
- Pericarditis vs. STEMI
 - Look first for factors that rule IN
 STEMI before you look at PRs
 - ST depression (aside from aVR and V1)
 - STE III > II
 - Horizontal or convex upward STE

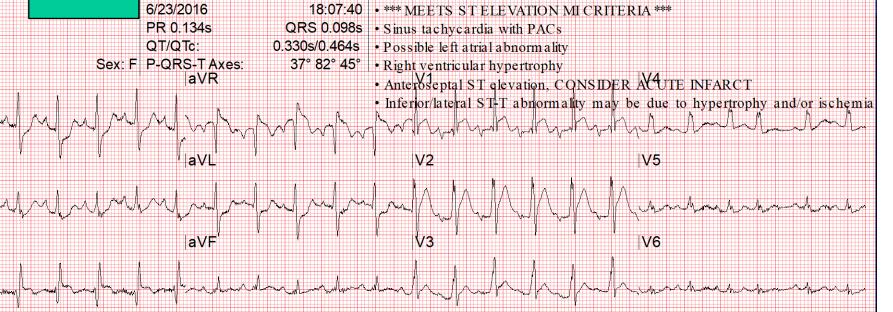
Key Points

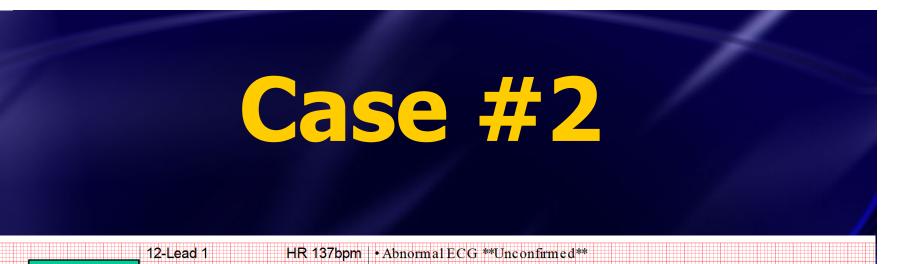
- Pericarditis vs. STEMI
 - -"Checkmark" sign and Spodick sign can be used AFTER the above
 - PR depression and Spodick sign (T-P downsloping) are not specific to pericarditis

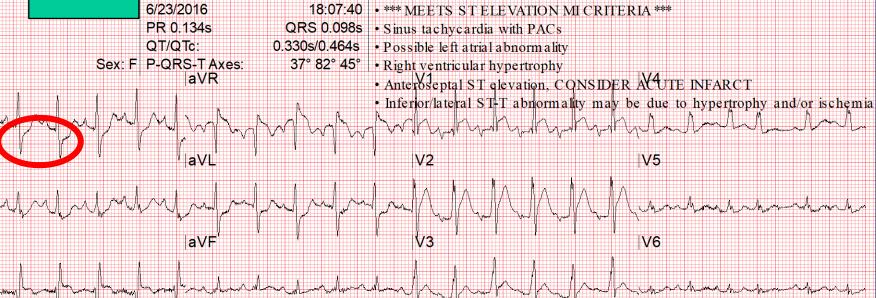


- 80 yo M BIBA for CP + dyspnea
 - Exam: looks sick, tachycardic, tachypneic,
 BP 105/50, pox 95%
 - **ECG...**









DDx of Rightward Axis

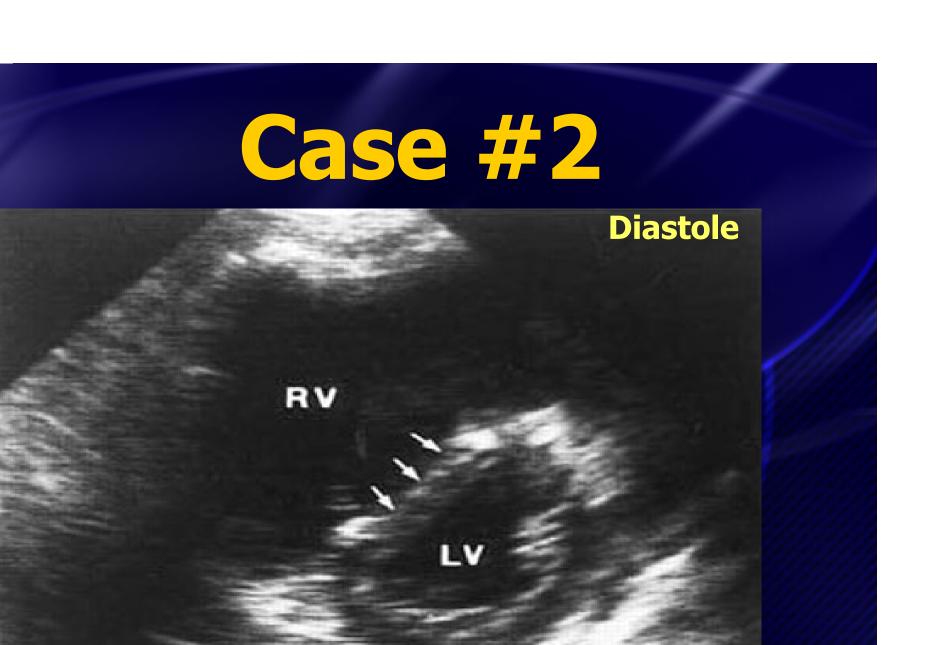
- Ventricular ectopy
- RVH
- LPFB
- Chronic pulm htn/COPD
- Acute pulm htn (e.g. PE)
- Old lateral MI
- Sodium channel blocking drugs
- HyperK⁺
- Michlaged leads

DDx of Rightward Axis

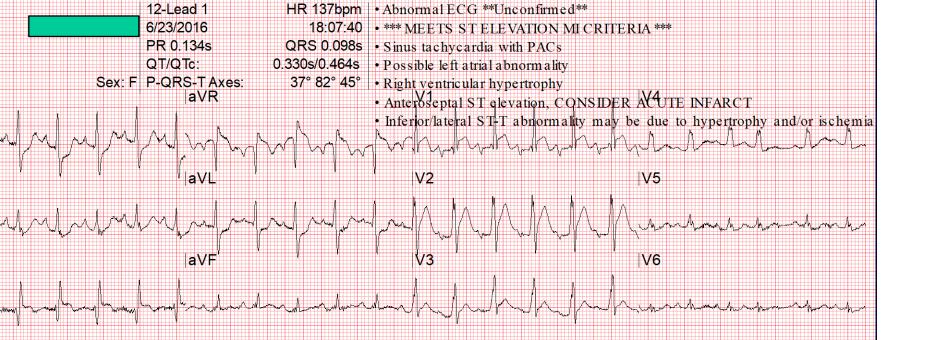
- Ventricular ectopy
- RVH
- LPFB
- Chronic pulm htn/COPD
- Acute pulm htn (e.g. PE)
- Old lateral MI
- Sodium channel blocking drugs
- HyperK⁺
- Michlaged leads

DDx of Rightward Axis + STE mimicking STEMI

- Ventricular ectopy
- RVH
- LPFB
- Chronic pulm htn/COPD
- Acute pulm htn (e.g. PE)
- Old lateral MI
- Sodium channel blocking drugs
- HyperK⁺
- Michlaged leads





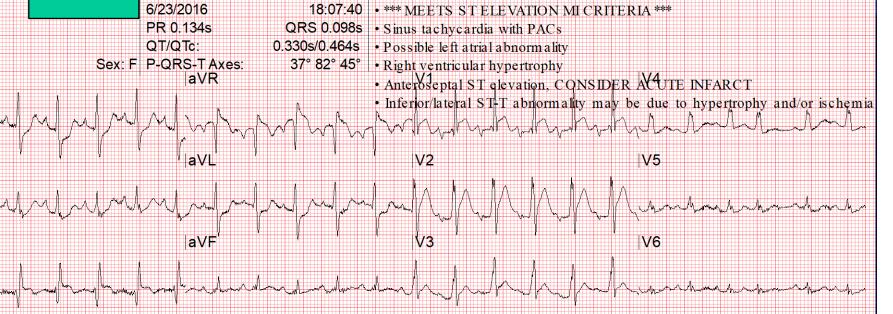


ECG findings assoc. with (or redicting) HD instability, M&M

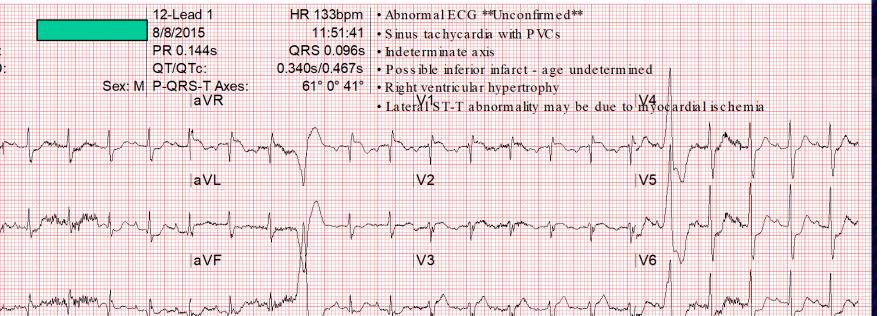
ECG findings assoc. with (or redicting) HD instability, M&M

- Note that these are not necessarily specific for PE
 - TWIs in right precordial leads
 - ST elevation and depression
 - Especially STE in V₁-V₂, aVR, III
 - Tachycardia (sinus, afib)









Massive **Dr. Devin Dorai** Malaysia

Brought from O'Hare airport, had cath → clean; saddle PE

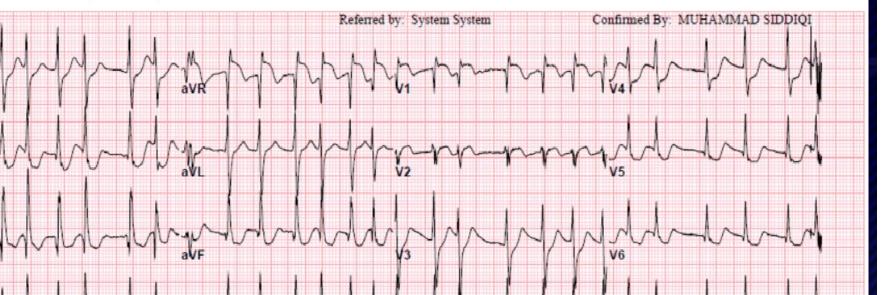
Vent. rate 159 BPM
PR interval * ms
QRS duration 100 ms
QT/QTc 276/448 ms
P-R-T axes * 91 -65

Courtesy Dr. Sam Barnett EM-2, Chicago

Technician:System System Test ind:(Not Selected)

963 (56 yr)

Black



24 yo M para., pleur. CP, hypotensive -> saddle PE

 Vent. rate
 169 bpm

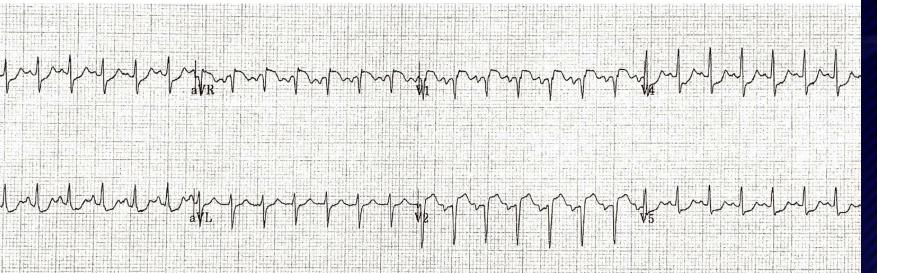
 PR interval
 86 ms

 QRS duration
 76 ms

 QT/QTc
 286/479 ms

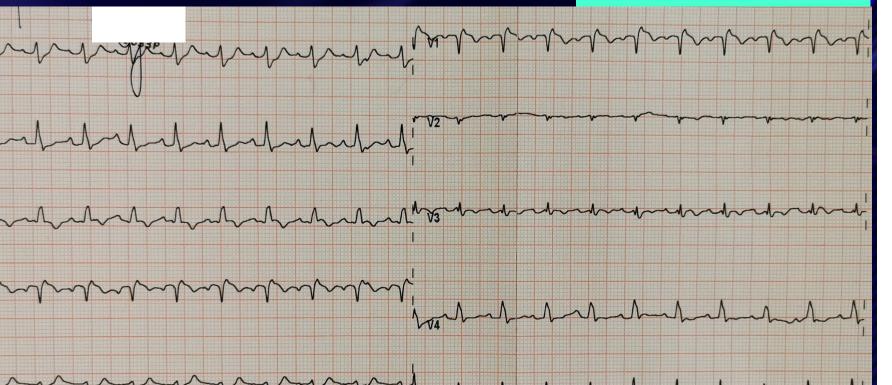
 P-R-T axes
 68 90 -2

Sinus tachycardia with short PR
Rightward axis
ST elevation, consider anterior injury or acute infarct
** ** ACUTE MI / STEMI ** **
Abnormal ECG

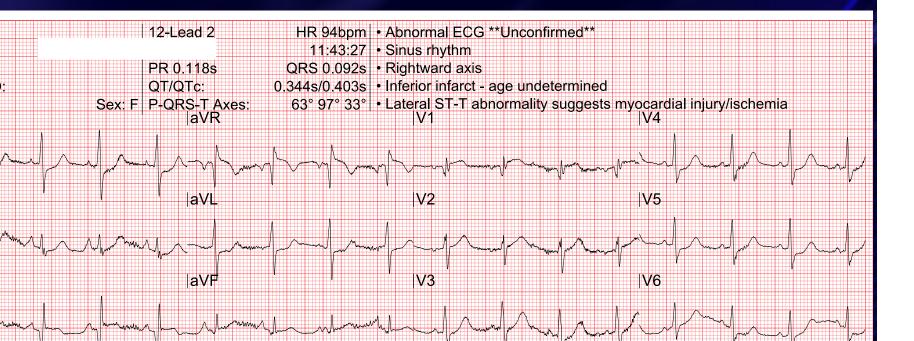


40 yo W with CP + syncope

Courtesy Dr. Olga Bogacz Warsaw, Poland







Key Points

- ECG findings for PE
 - Sinus tachycardia
 - Atrial/ventricular dysrhythmias
 - Signs of right heart strain
 - Rightward axis
 - IRBBB
 - TWIs (esp. anterosental + inferior leads)

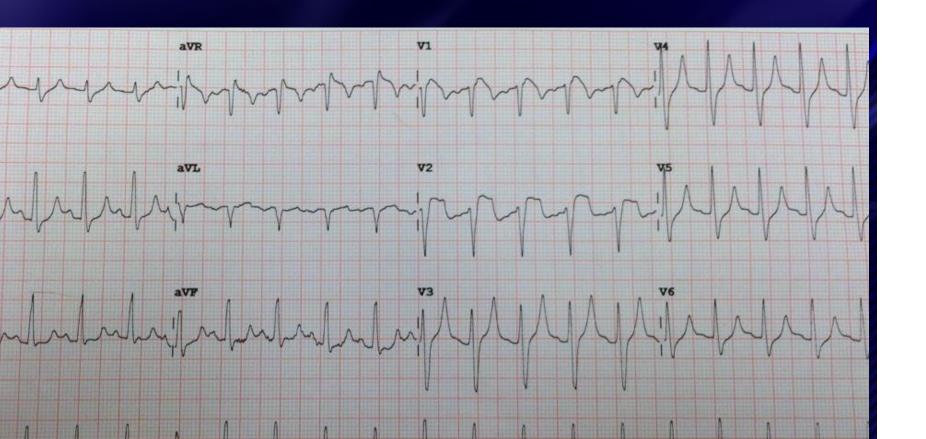
Key Points

- ECG findings for PE
 - Sinus tachycardia
 - Atrial/ventricular dysrhythmias
 - Signs of right heart strain
 - Rightward axis
 - IRBBB
 - TWIs (esp. anterosental + inferior leads)

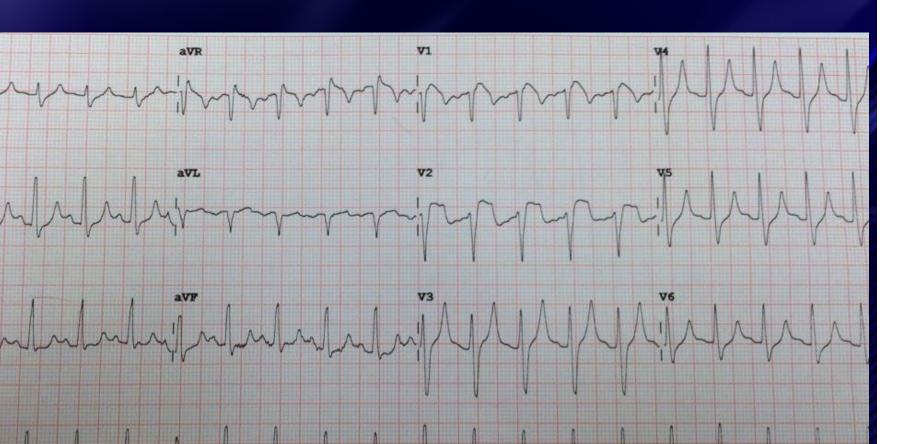


- Courtesy Dr. Jon Kenyon
 - Kaiser Permanente, San Francisco

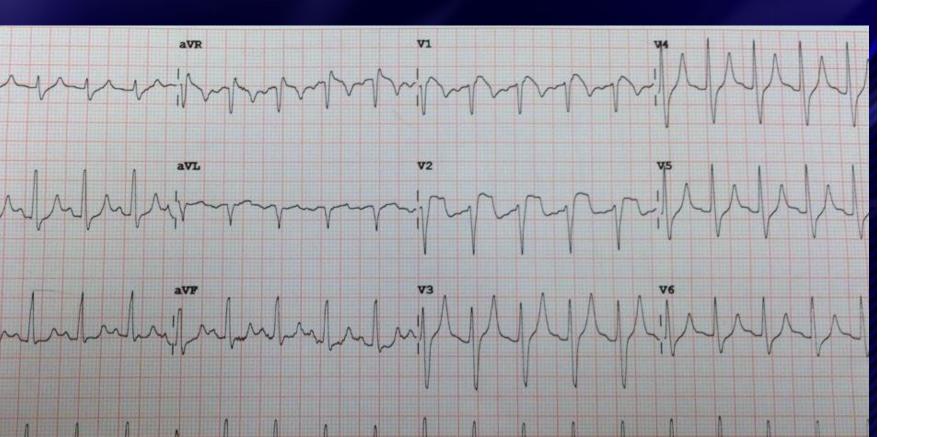
- Patient (age ~ late 40s) presents with nausea, vomiting x 12 hours
 - 1 hour of burning epigastric pain
 - History of DM
 - **ECG...**



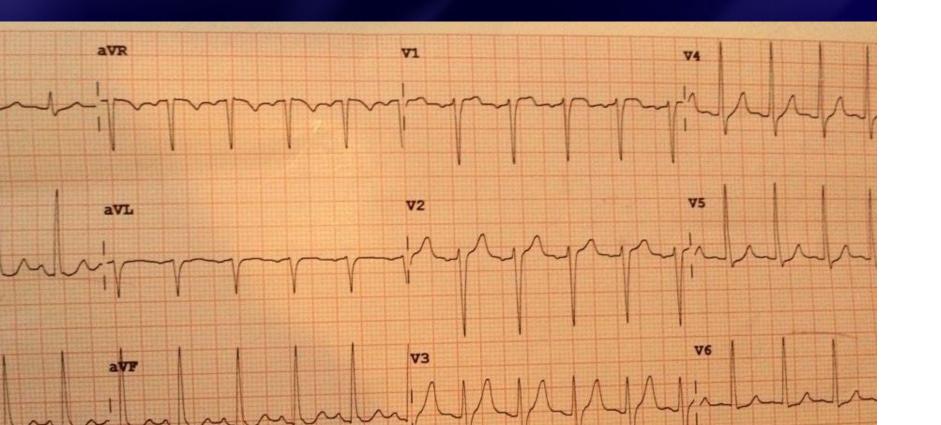
Cath lab activation?



K+ 7.3 mEq/L



After treatment



DDx of Rightward Axis + STE mimicking STEMI

- Ventricular ectopy
- RVH
- LPFB
- Chronic pulm htn/COPD
- Acute pulm htn (e.g. PE)
- Old lateral MI
- Sodium channel blocking drugs
- HyperK⁺
- Michlaged leads



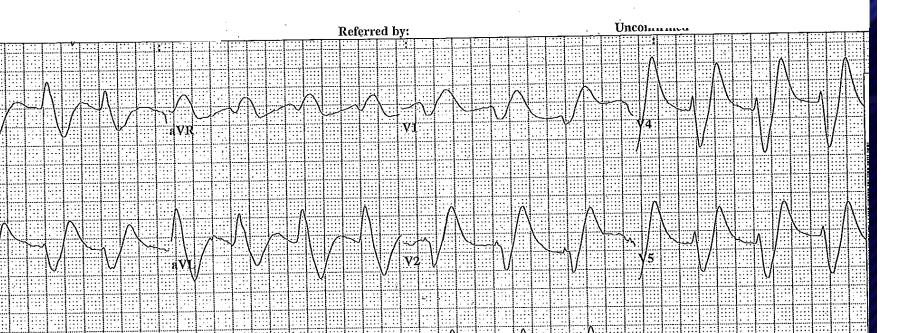
Vent. rate 143 BPM
PR interval * ms
QRS duration 162 ms
OT/OTc 262/404 ms

P-R-T axes

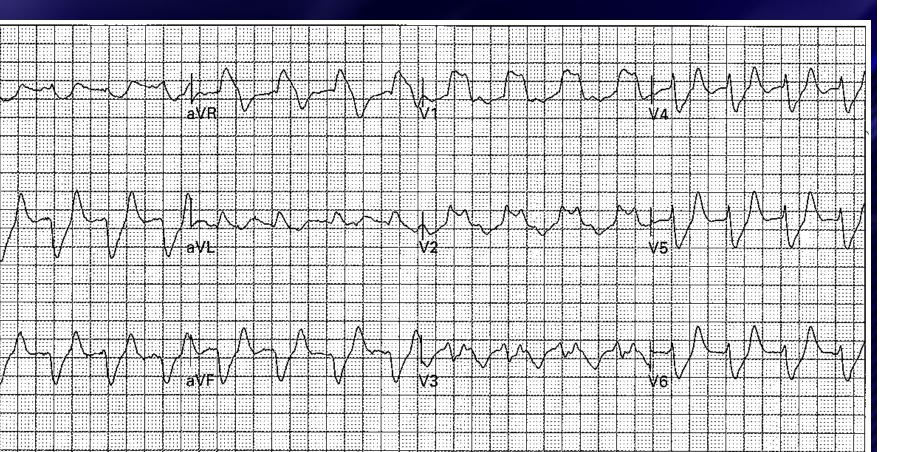
* 99

13

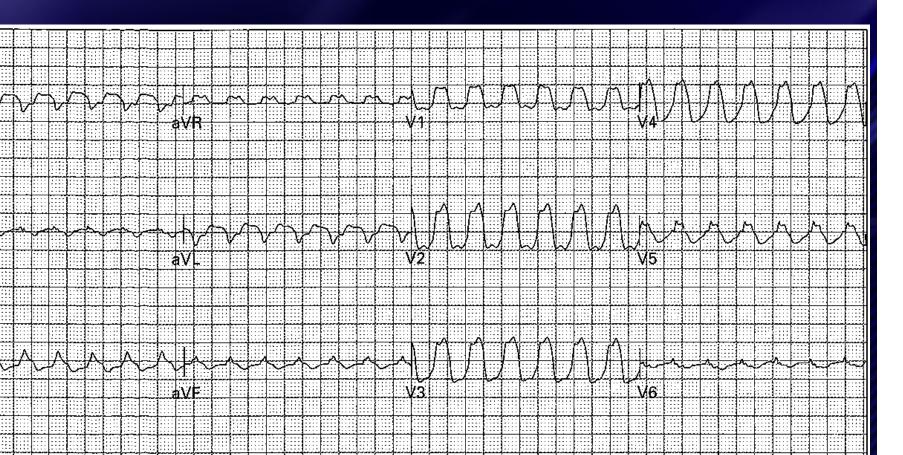
Non=specific intra=ventricular conduction-block Lateral infarct, possibly acute Inferior injury pattern Anterior injury pattern *** ** ** * ACUTE MI ** ** ** Abnormal ECG



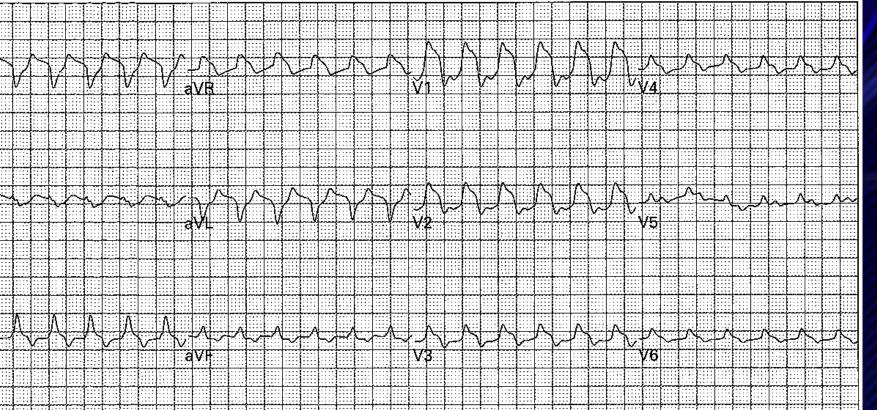
Hyperkalemia



Hyperkalemia



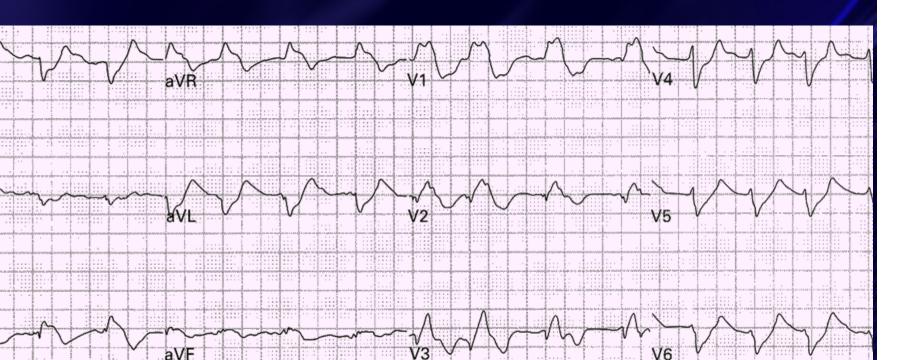
Hyperkalemia (Computer: "STEMI")

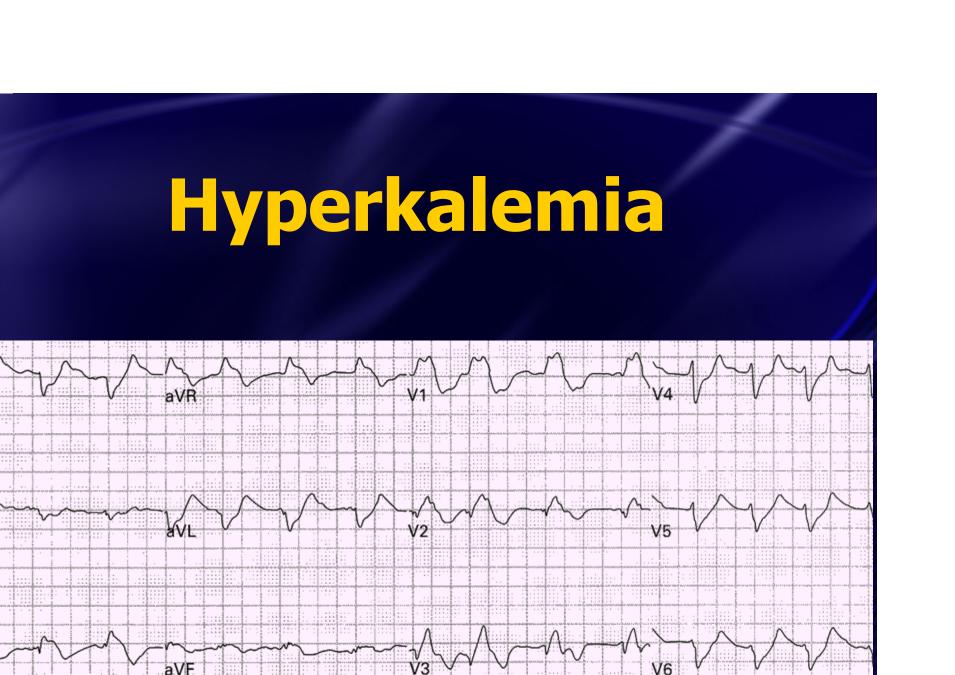


Hyperkalemia (Computer: "STEMI")

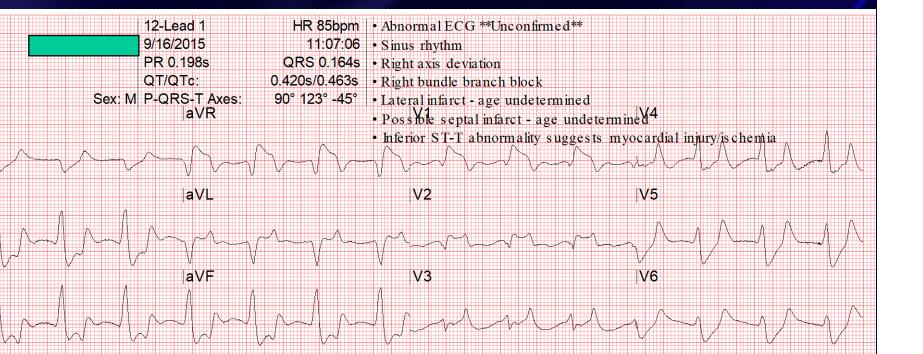


63 yo post-syncope Computer: "STEMI" Transferred for cath









K⁺ 7.6 mEq/L (DKA)

BPM Vent. rate 116 PR interval 152 ms QRS duration 132 ms QT/QTc P-R-T axes 394/547 ms * 91

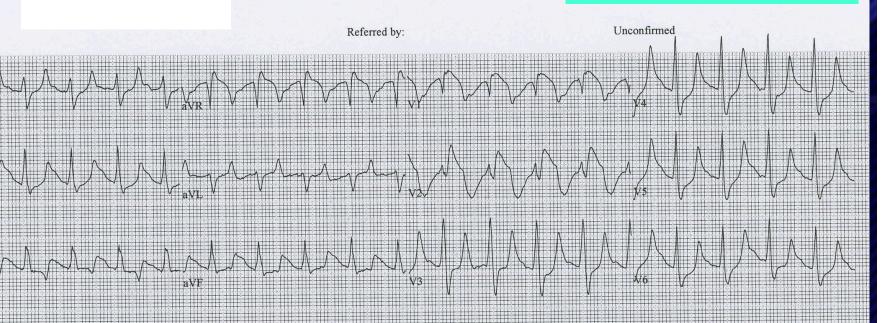
*** Age and gender specific ECG analysis ***

Sinus tachycardia Rightward axis

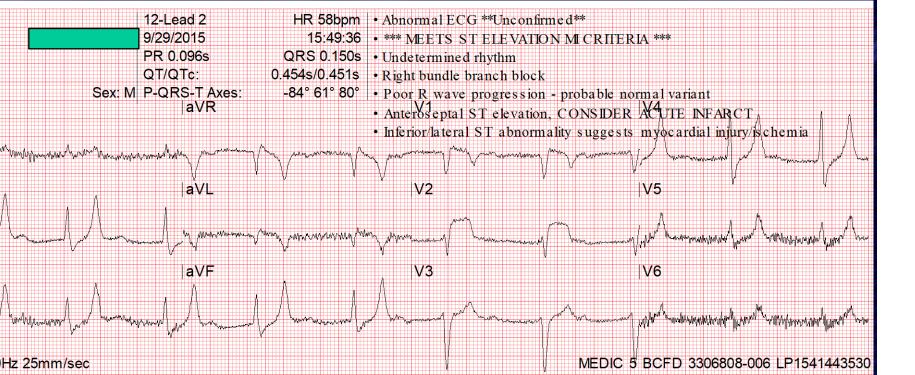
Nonspecific intraventricular block ST elevation, consider anterior injury or acute infarct ** ** ACUTE MI / STEMI ** **

Abnormal ECG

Courtesy Dr. Doug Sward

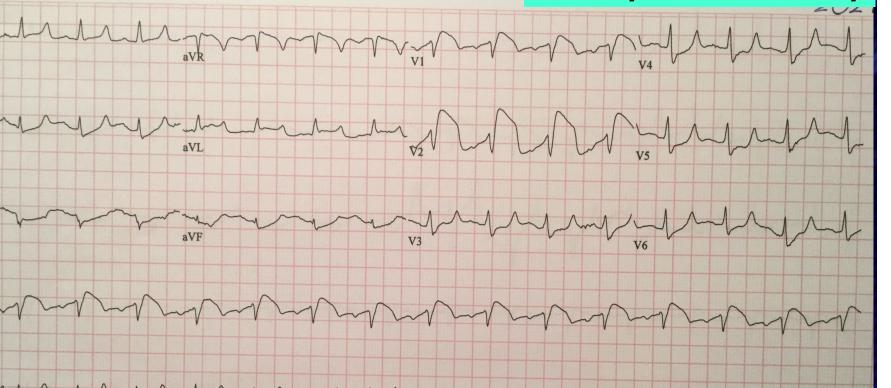






K+ 6.8 mEq/L





K+ 9.4 mEq/L

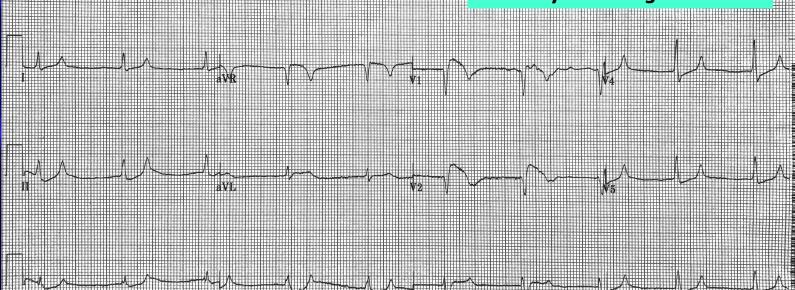
Vent. rate 59 bpm
PR interval * ms
QRS duration 114 ms
QT/QTc 446/441 ms
P-R-T axes * 50 39

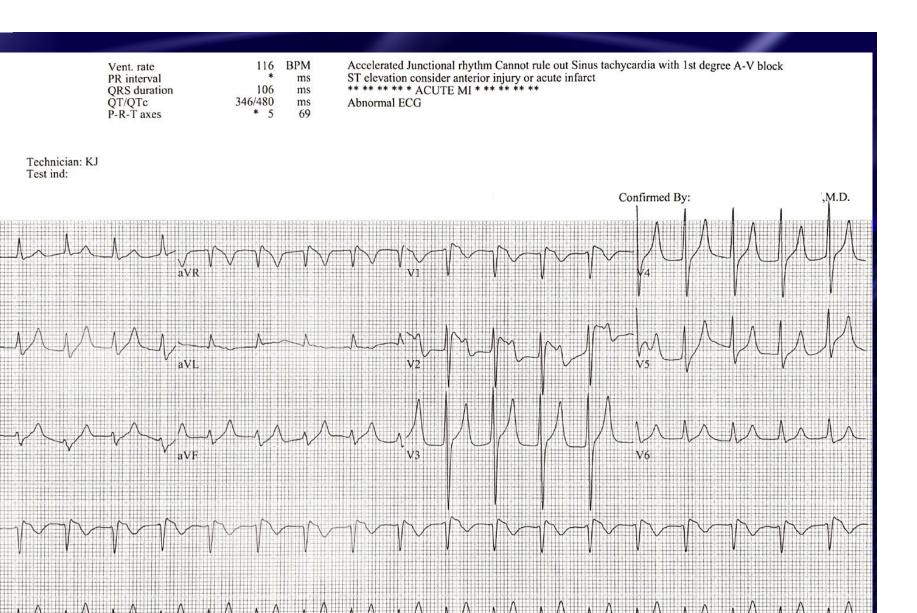
Technician: SKLIPPL1

Junctional rhythm
ST elevation, consider anterior injury or acute infarct
** ** ACUTE MI / STEMI ** **
Abnormal ECG

get ? brugada

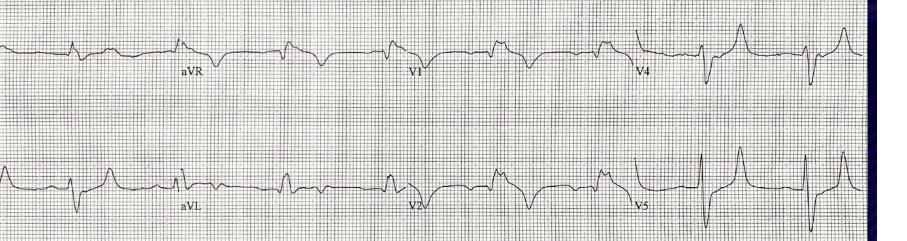
Courtesy Dr. George Kochman





42 yo W with malaise and SOB

Courtesy Dr. Nikki Cali



42 yo W with malaise and SOB

 Vent. rate
 52
 BPM

 PR interval
 242
 ms

 QRS duration
 150
 ms

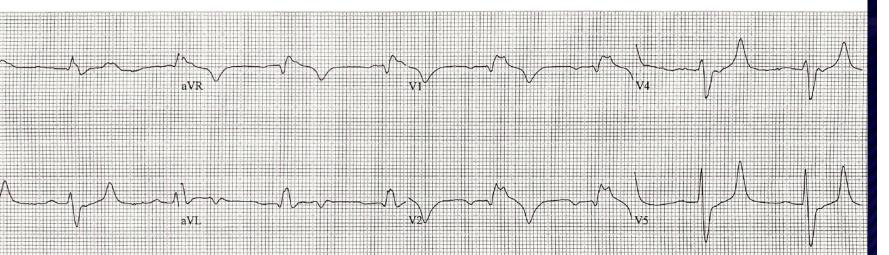
 QT/QTc
 606/563
 ms

 P-R-T axes
 84
 -62
 53

*** Age and gender specific ECG analysis ***
Sinus bradycardia with 1st degree A-V block
Possible Left atrial enlargement
Right bundle branch block
Left anterior fascicular block
*** Bifascicular block ***

Anteroseptal infarct, possibly acute
** ** ACUTE MI / STEMI ** **
Abnormal ECG
No previous ECGs available

Unconfirmed





 Vent. rate
 52
 BPM

 PR interval
 242
 ms

 QRS duration
 150
 ms

 QT/QTc
 606/563
 ms

 P-R-T axes
 84
 -62
 53

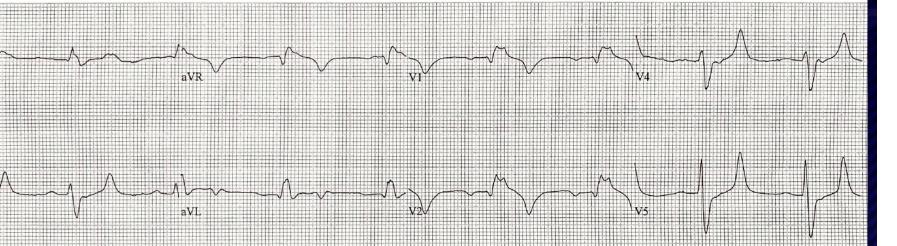
*** Age and gender specific ECG analysis ***
Sinus bradycardia with 1st degree A-V block
Possible Left atrial enlargement
Right bundle branch block
Left anterior fascicular block
*** Bifascicular block ***

Anteroseptal infarct, possibly acute
** ** ACUTE MI / STEMI ** **
Above and ECC

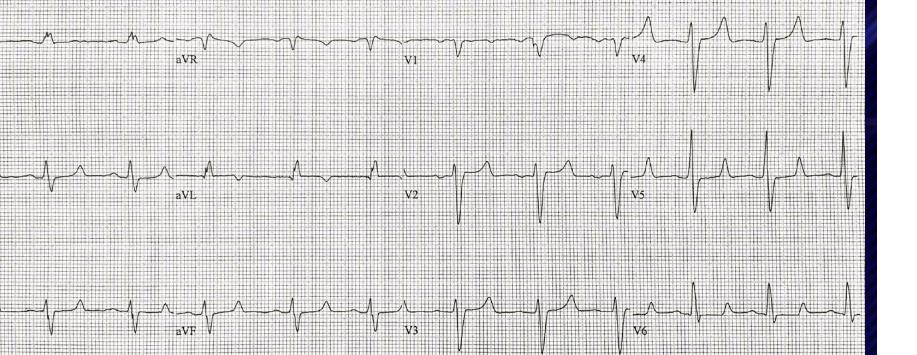
Abnormal ECG

No previous ECGs available

Unconfirmed



after 1 hr of tx





Key Points

- Beware hyperkalemia!!
 - Peaked Ts
 - Widening of the QRS
 - Prolonged PR
 - Flattening and eventual loss of Ps
 - Tachycardias
 - Bradys, AV blocks and sinus pauses



- Beware hyperkalemia!!
 - STE common in V1-V2, aVR

Key Points

 Large PEs and hyperK⁺ can often mimic STEMI with STE (esp. rightward leads)

 STEMIs don't tend to produce a rightward axis

