12-Lead ECG Interpretation

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BETHEL UNIVERSITY

DISCLOSURE

Kristin E. Sandau, PhD, RN, FAHA, FAAN, CNE
No Relevant Disclosures

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OBJECTIVES

1. Describe how CV nurses enhance collaborative care by providing clinical context to their inpatient's ECG.
2. List 5 examples of ECG knowledge and skills specific to the patient populations in which you provide care.
3. Describe how shared vocabulary for ECGs contributes to safer, interprofessional care.
4. Recognize possible STEMI in 3 sample ECGs.

Not with that rhythm.

Response from an EP MD when asked: *"What do CV nurses need to know about 12-lead ECGs?"*

- wide QRS tachycardia
- SVT
- VT vs SVT
- regular and irregular
- left and right bundle branch block
- ST elevation and depression
- prolonged QT
- pathologic Q waves
- first, second and third degree AV block
- atrial flutter
- atrial tachycardia
- atrial fibrillation
- WPW
- pacemaker rhythms (BiV, DDD, VVI)
- pacemaker malfunction
- sinus pauses

When to take action - when to call the MD/NP/PA, what is an emergency, what can wait….

Tables from AHA: Education related to specific abnormalities on ECG

- "The content of ECG monitoring education needs to match the nature and complexity of the patient population served."
- "Unit nursing leaders and educators are responsible for annually assessing the content of ongoing education on the basis of the ECG monitoring needs of patients in their care…"

Sandau et al. (2017) Update to Practice Standards for ECG Monitoring, p. e321.


AHA SCIENTIFIC STATEMENT

Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings

A Scientific Statement From the American Heart Association

Nurse's Role: Basic 12-Lead Knowledge

- **Clinical Context**
- **Human Oversight of Machine**
- **Shared Vocabulary for Safe, Quality Clinical Collaboration**
- **Situational Awareness – When to take Action!**

Nurse's Role: Clinical Context

8 Reasons for Sinus Tachycardia

A: Airway - hypoxemia

B: Breathing - dyspnea → catecholamines → tachycardia

C: Circulation – compensation for shock; **fluid volume deficit**

D: Drugs – withdrawal of drugs or direct effect of drugs

E: Erythrocytes – anemia

F: Fever – increased O2 demands (fever, hyperthyroidism)

G: Glucose – hypoglycemia

H: Holy Cow that Hurts – pain and/or anxiety

Source: Frank Lodeserto MD, "The Approach To The Most Common Cardiac Dysrhythmia: 8 Causes of Sinus Tachycardia", REBEL EM blog, July 18, 2018. Available at: https://rebelem.com/the-approach-to-the-most-common-cardiac-dysrhythmia-8-causes-of-sinus-tachycardia/

Nurse's Role: Clinical Context

CV med documented start/stop (Example noted by EP MD!)

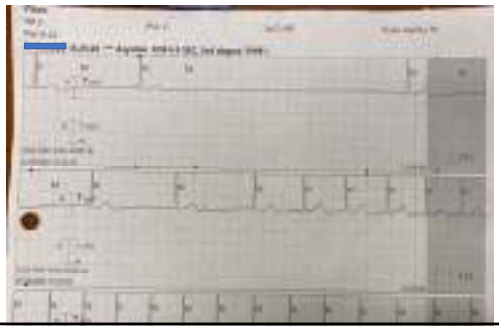
Sandau used with permission of @Toaster_Pastry

Nurse's Role: Clinical Context: Is this Patient's Potassium High or Low?

Nurse's Role: Clinical Context: Is this Patient's Potassium High or Low? (post arrest after ROSC)

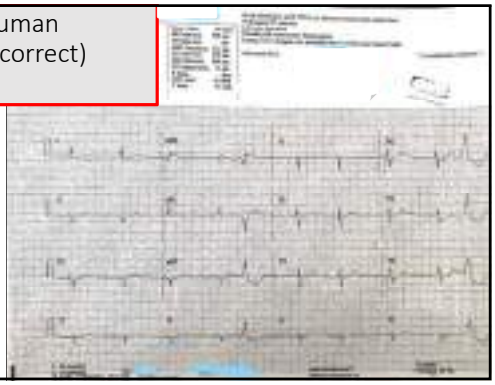
Source: Sam Ghali, MD

Clinical Context: Vagal nerve stimulation?



Nurse's Role: Human Oversight of (Incorrect) Machine

Machine interpretation: Atrial fibrillation



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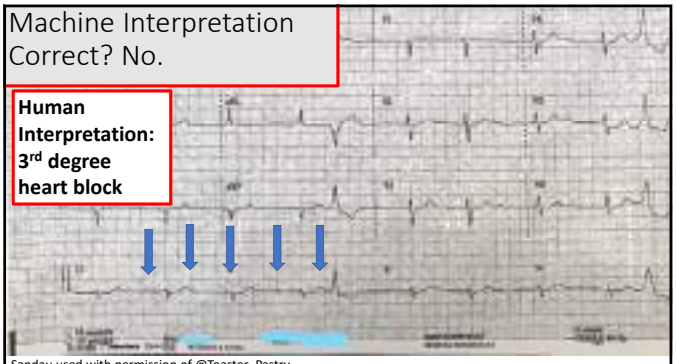
Machine Interpretation Correct? No.

Human Interpretation: 3rd degree heart block



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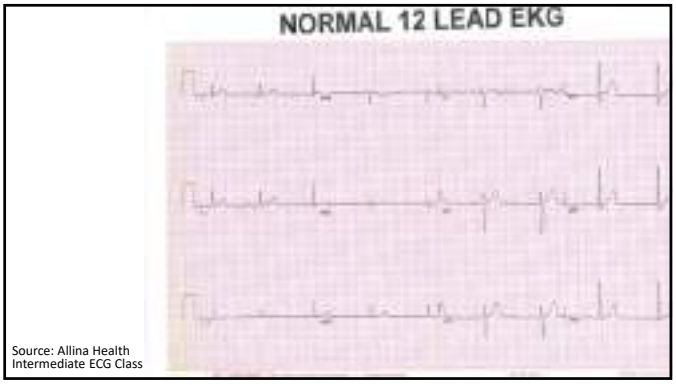
12-Lead Overview



Source: Allina Health Intermediate ECG Class

How to Read an ECG

1. Clinical history
2. Technical quality
3. Rate
4. Rhythm
5. QRS axis

6a. Measure PR

6b. Measure QRS & consider voltage

7. Consider R wave progression in chest leads
8. Evaluate QT
9. Note morphology of U wave (if present)

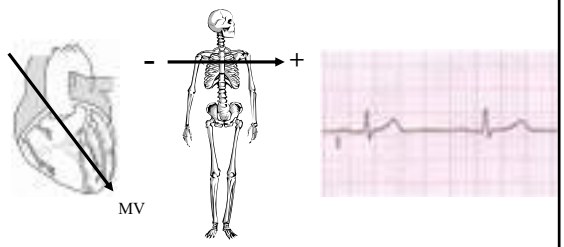
Stroobandt, RX, Barold, SS, & Sinnaeve, AF. *ECG from Basics to Essentials Step by Step*. Wiley Blackwell; 2016.

How to Read an ECG

10. P wave
11. T wave
12. ST segment (depression, elevation)
13. Evaluate for ST Elevation MI (STEMI)
14. Evaluate for Non-ST Elevation MI (NSTEMI)
15. Addition information (look for posterior MI)
16. Consider early repolarization (ST)
17. Does pt have heart failure? (No specific ECG feature indicative, but commonly: a-fib (25%), LBBB, implanted device such as pacer; HF in congestion may show shortened QRS with high voltage in chest leads, poor R wave progression)

Stroobandt, RX, Barold, SS, & Sinnaeve, AF. *ECG from Basics to Essentials Step by Step*. Wiley Blackwell; 2016.

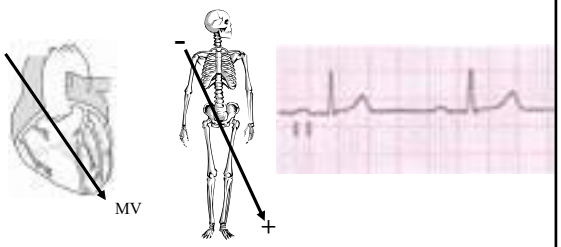
Limb Lead I



Negative Pole = RA Positive Pole = LA

Source: Allina Health Intermediate ECG Class

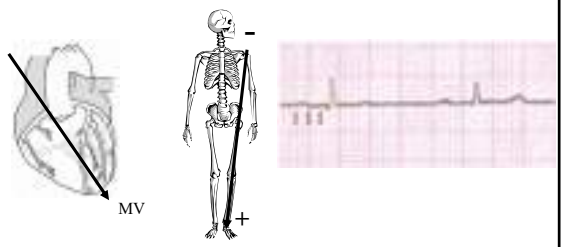
Limb Lead II



Negative Pole = RA Positive Pole = LL

Source: Allina Health Intermediate ECG Class

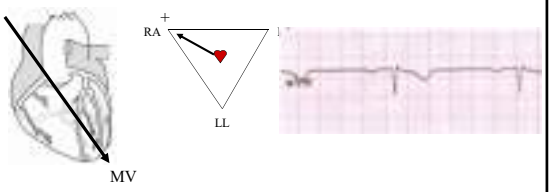
Limb Lead III



Negative Pole = LA Positive Pole = LL

Source: Allina Health Intermediate ECG Class

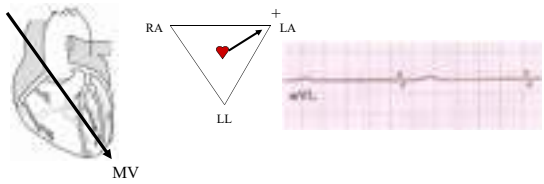
Augmented Lead: aVR



aVR Positive Pole = RA

Source: Allina Health Intermediate ECG Class

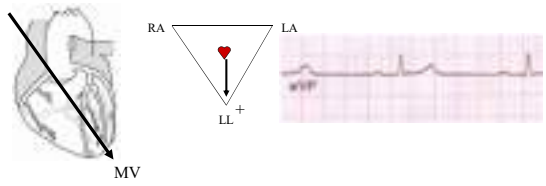
Augmented Lead: aVL



aVL Positive Pole = LA

Source: Allina Health Intermediate ECG Class

Augmented Lead: aVF

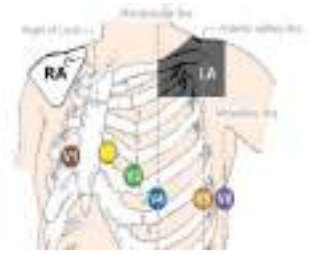


aVF Positive Pole = LL

Source: Allina Health Intermediate ECG Class

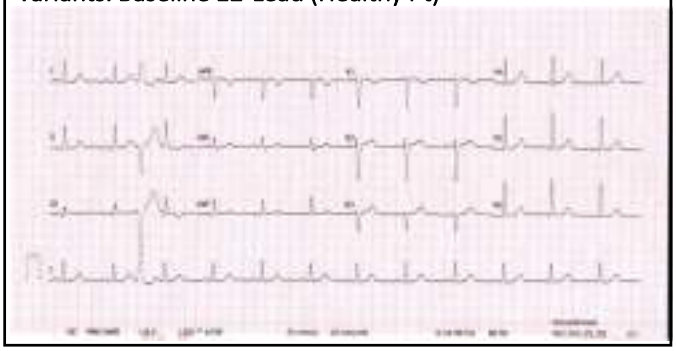
Correct Electrode Placement for Precordial (Chest Leads) (V1 – V6)

Placement of an electrode off its designated anatomic site can alter QRS morphology & can lead to misdiagnosis

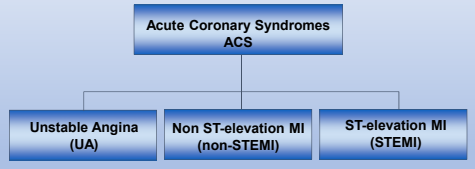


Source: The PULSE Trial. Stephens, K. Funk, M.*, Drew, B. (2009).
*Principal Investigator (Used with permission)

Variants. Baseline 12-Lead (Healthy Pt)



Acute Coronary Syndromes

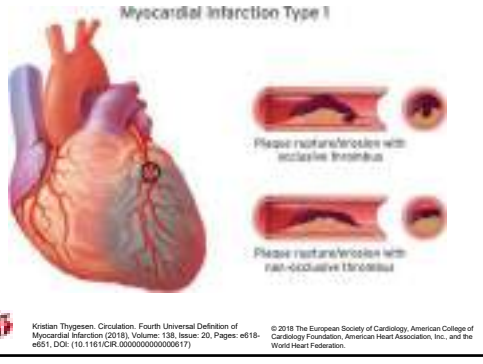


4th Universal Definition of MI

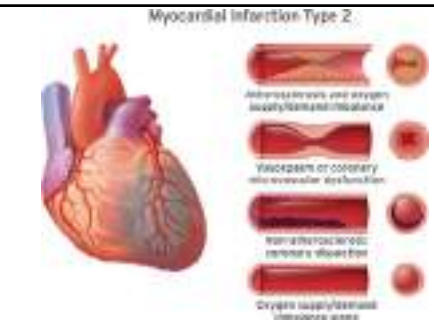
- Type 1 MI: includes typical atherosclerotic plaque rupture
- Type 2 MI: includes conditions in which myocardial necrosis is due to something other than plaque rupture (e.g., demand ischemia from GI bleed, tachycardia, bradycardia)
- (Others listed…)

- MINOCA = Myocardial infarction with non-obstructive coronary arteries: patients with no angiographic obstructive coronary artery disease *(do not have ≥50% diameter stenosis in a major epicardial vessel).*

Thygesen, K. et al. Fourth Universal Definition of Myocardial Infarction. *Circulation.* 2018;*138* (20), e618-e651.

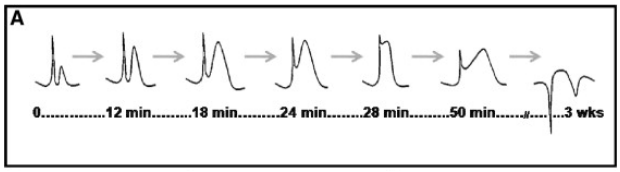


Kristian Thygesen. Circulation. Fourth Universal Definition of Myocardial Infarction (2018). Volume: 138, Issue: 20, Pages: e618-e651. DOI: (10.1161/CIR.0000000000000617)



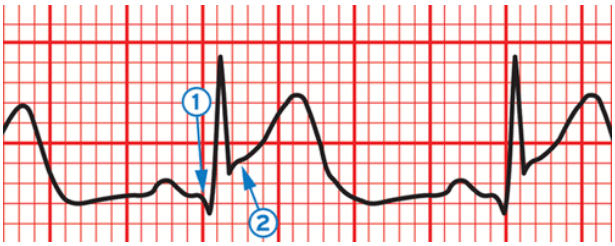
Kristian Thygesen. Circulation. Fourth Universal Definition of Myocardial Infarction (2018), Volume: 138, Issue: 20, Pages: e618-e651, DOI: (10.1161/CIR.0000000000000617)

Evolution of STEMI, ending in Q wave



Nable J & Brady W. The evolution of electrocardiographic changes in ST-segment elevation myocardial infarction. *Am J Emergency Med.* 2019; *27*, 734–74.

ST Elevation



1. Q wave reference point 2. Onset of ST-segment or J-point

Kristian Thygesen. Circulation. Fourth Universal Definition of Myocardial Infarction (2018), Volume: 138, Issue: 20, Pages: e618-e651, DOI: (10.1161/CIR.0000000000000617)

Criteria from Universal Definition of MI

ST-Elevation:

New ST elevation at the J-point in 2 contiguous leads with the cut-point:

≥ 1 mm in all leads other than leads V2- V3, where the following cut-off points apply: ≥ 2 mm in men ≥ 40yrs; ≥ 2.5mm in men < 40yrs, or ≥ 1.5 mm in women regardless of age.

ST-Depression and T Wave Changes:

New horizontal or down-sloping ST-depression ≥ 0.5mm in 2 contiguous leads and/or T inversion > 1mm in 2 contiguous leads with prominent R wave or R/S ratio > 1.

Thygesen, K. et al. Fourth Universal Definition of Myocardial Infarction. *Circulation.* 2018;*138* (20), e618-e651.

Updating Vocabulary

The older terms "transmural" and "nontransmural" infarction have been replaced by the terms:

Q wave infarction and *non-Q wave infarction.*

Why? It wasn't accurate to make assumptions about degree of myocardial wall thickness based on EKG.

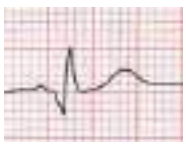
Q-waves, once present after an MI, are permanent.

Fortunately, some Q-wave MIs can be prevented by rapid catheterization lab activation!

Pathologic if:

- Abnormally wide (> 0.2 sec)
- Abnormally deep (> 1/3 of the R wave…)

- Deep and wide = MI
- Deep but not wide = ventricular hypertrophy (if no conduction defect)



Q Wave MI

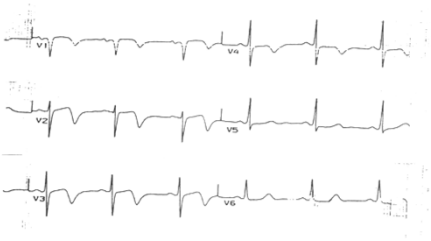
(in the absence of LBBB and Left Ventricular Hypertrophy)

- **Any Q wave in leads V2-V3 (**> 0.02 seconds)
- **Any large Q wave in 2 contiguous leads** (≥ 0.03 seconds and ≥ 1mm deep)

(Same criteria above applies for supplemental leads V7-V9)

ST Depression

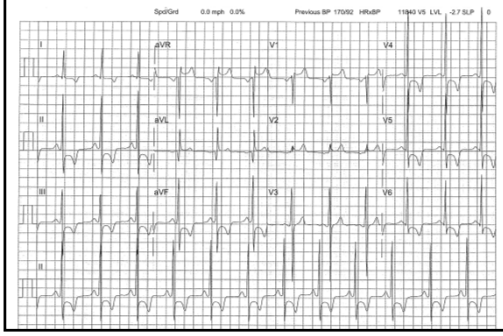
T Wave Inversion



Shared Vocabulary: MI Imposters and Distractors

- Pre-existing LBBB - compare with previous ECG to see if Q wave is new; (new LBBB with CP needs evaluation for as a STEMI equivalent!)
- Paced rhythms - wide QRS; look for pacer spikes
- Pericarditis - Diffuse ST elevation; ST depression on aVR; ST morphology is often more concave; can have PR depression; no reciprocal changes
- Myocarditis – may occur with pericarditis (but focal myocarditis may have regional ST changes that mimic MI)
- Early repolarization – usually benign & in young athletes; no reciprocal changes
- Stress induced cardiomyopathy – ST and T wave changes; positive cardiac markers; apical hypokinesis; angiogram to rule out STEMI
- LV aneurysm – consider this when persistent ST changes after an MI
- LV hypertrophy – Specific criteria but often large amplitude QRS

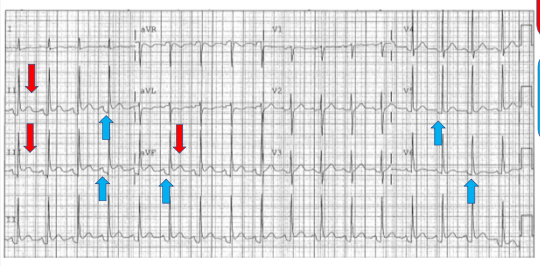
Left Ventricular Hypertrophy



LVH Characteristics (different criteria are available such as ESTES criteria)

High amplitude of QRS

Pericarditis

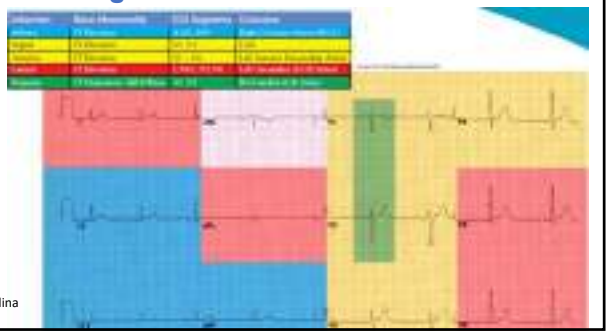


Look for wide spread ST Elevation in most leads

Look for DEPRESSED PR Interval to indicate PERICARDITIS

Ask them their symptoms? Is it worse with breathing or laying flat?

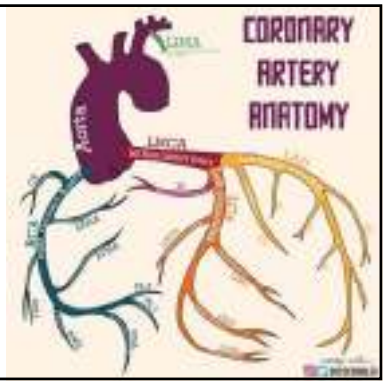
Localizing Infarction on the 12 Lead ECG



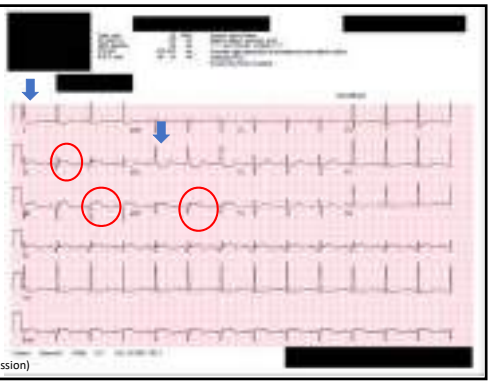
Source: Allina Health

Reading 12-Leads for ACS

- I See All Leads Perfectly!
- Inferior: RCA
- (Septal): (LAD or Posterior)
- Anterior: LAD
- Lateral: Circumflex
- Posterior (tall R waves in V1-2)

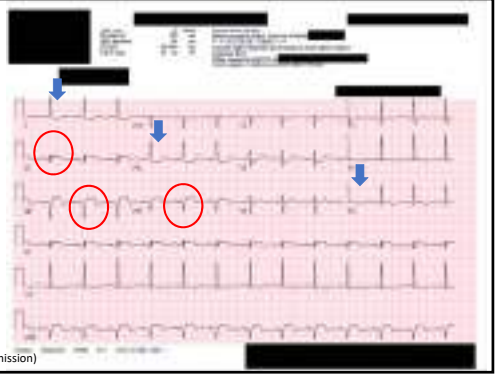


#1
STEMI: Inf MI (pre-PCI)



Source: Sandau (used with permission)

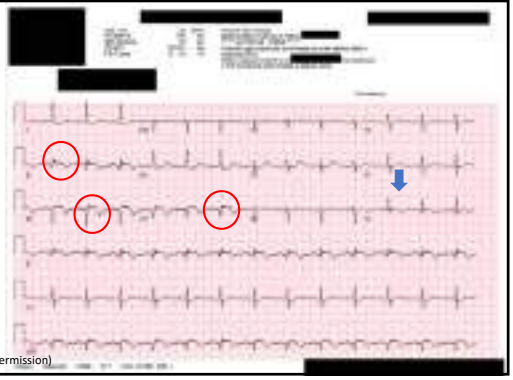
#2
STEMI: Inf MI (post-PCI)



Source: Sandau (used with permission)

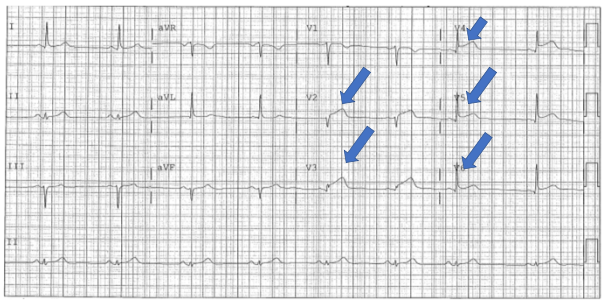
#3
STEMI: Inf MI (1 day post-PCI)

Discharged home with plan for staged intervention for Cx

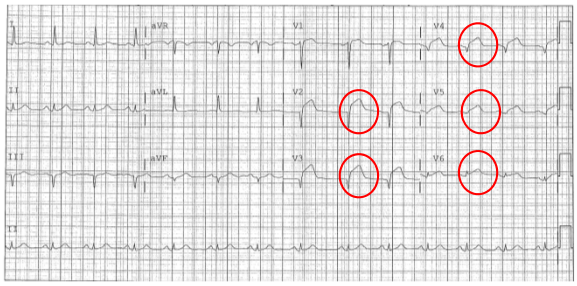


Source: Sandau (used with permission)

The Case of the Missed ECG Changes: @1743



The Case of the Missed ECG Changes: @0400



Twitter for ECG Education?

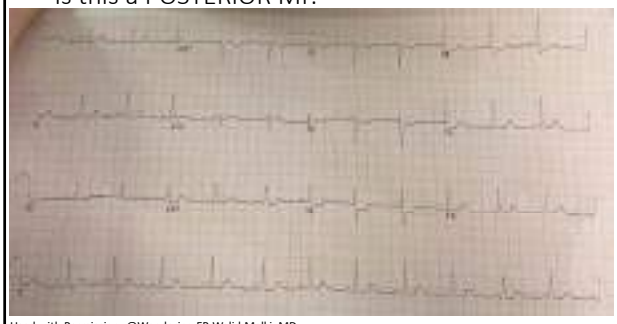
Some Guidelines:
- Carefully evaluate source of any teaching material.
- Do not support (and do report) any images with identifiers.
- Your institution may have specific guidelines about posts.
- Only support those who are respectful to patients and health care providers.
- Credit sources.

Used with Permission: @Wandering ER Walid Malki, MD

POSTERIOR MI:

- Can be overlooked on a 12 lead.
- Look for ST depression and tall R waves in V1-V2.
- Consider augmenting ECG leads to continue across to the back…so V6 continues to newly placed V7, V8, and V9 to be evaluate for a suspected posterior MI.

Is this a POSTERIOR MI?



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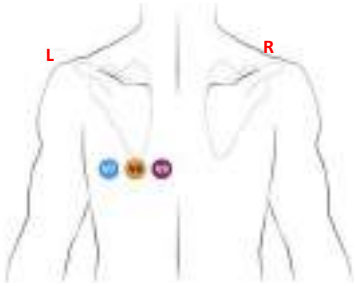
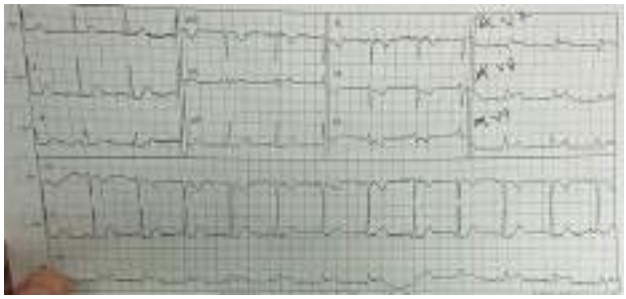
Additional electrode placement for leads to evaluate for POSTERIOR MI



Posterior view of patient

POSTERIOR MI: Documenting Leads V7, V8, V9



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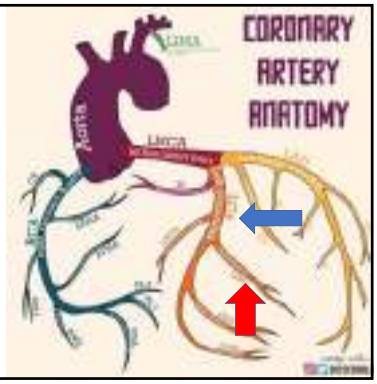
Posterior MI

- CODE STEMI – to cath lab
- Culprit: Cath showed **OM1** and **L circumflex** occlusion



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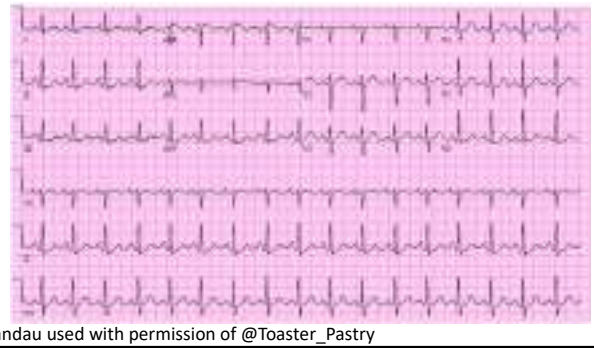
Atrial Activity

58 y/o woman who WALKS in. For yrs, she's been told "panic disorder"

Sandau used with permission of @Toaster_Pastry

Same pt, HR now



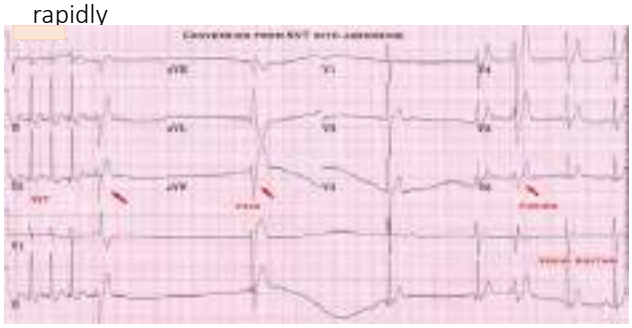
Sandau used with permission of @Toaster_Pastry

Adenosine: Correct Administration

- IV port nearest heart (not in IV tubing)
- RAPID bolus – as fast as possible, followed by 20mL normal saline flush (as fast as possible)
- Consider using 3-way stop-cock
- If no response after 1-2 minutes, repeat with 12mg dose

6mg over 1-3 seconds!

Adenosine administration: IV closest to heart, rapidly

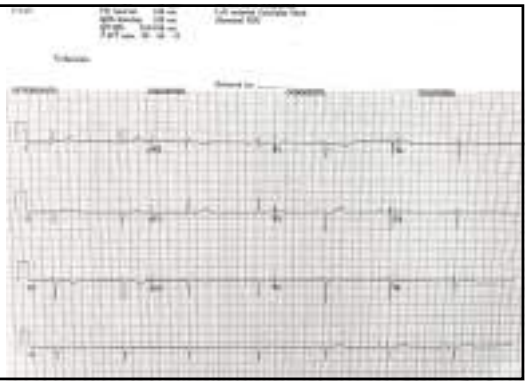


Patient 2mo post LVAD

Courtesy: S. Schroeder, used with permission

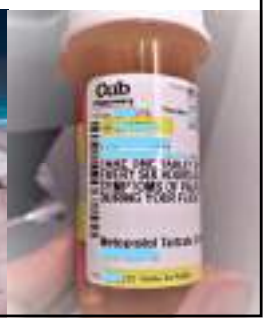
Two days post elective cardioversion for A-flutter: 70+ y/o female at office visit: "dizzy, unsteady."

"Reduce which medication?"

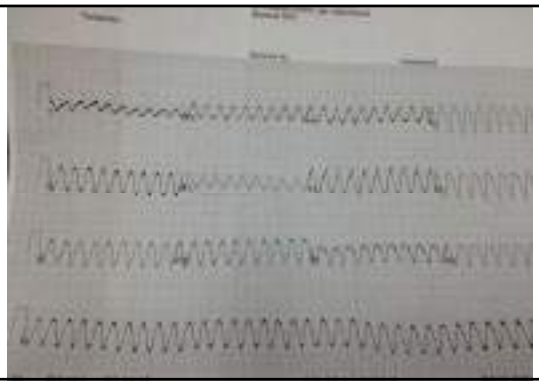


Same patient with recent atrial flutter (now in SR) wants to vacation overseas…

"Pill in a pocket"



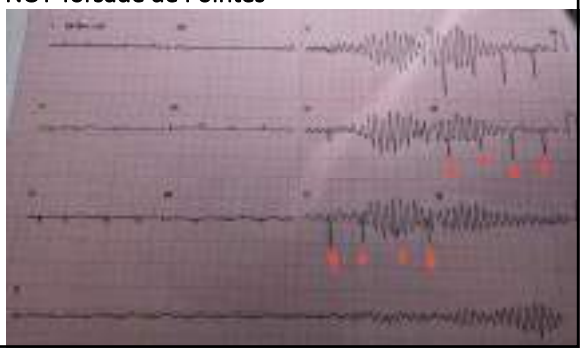
Ventricular Activity



Is this Torsade de Pointes (TdP)?

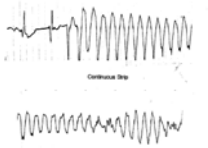
Source: J. Santos, MD

No. It is NOT Torsade de Pointes (TdP)



Source: J. Santos, MD

True Torsade de Pointes (TdP): Who is at Risk & How to Avoid



Rare but potentially fatal polymorphic ventricular tachycardia may be avoided by recognizing a patient's QTc is becoming prolonged, often as a result of a medication. *A call to the prescriber often results in holding or changing the QT-prolonging medication.*
A list of medications from https://www.crediblemeds.org/ is available through the More Details box on Excellian.net
But you don't have to memorize these medications!
At Allina, our QTc Best Practice Alert (BPA) will prompt you…

Summary

1. CV nurses enhance collaborative care by providing clinical context to their inpatient's ECG.
2. The appropriate ECG knowledge and skills for a CV nurse should match the patient population in which care is provided:
   Example:
   - ALL: Possible STEMI recognition
   - Cath lab and post EP: new heart blocks post-ablation, anti-tachy pacing, etc.
3. Shared vocabulary for ECGs contributes to safer, interprofessional care.
4. All CV nurses should be able to recognize possible STEMI in ECGs.

Limitations

What an ECG cannot tell us:

- How patient is tolerating a rhythm
- Clinical context
- Coronary artery: exact location & degree of occlusion…

What we did not cover today:

- Lots!
- Reciprocal changes, LBBB and RBBB, axis deviation, etc.
- Treatment
- New cardiac devices!
- New procedures & meds!
- What additional classes and skills coaching are available that match your patient population (ask your CNS, educator, manager, director, VP)
- Study on your own (resources to follow)

Want to Learn More?

Twitter:
#FOAMed
#EPEEPS
#ECG
#ECGPeeps
#Cardiology
#EmergencyMedicine

ecgweekly.com

Recorded webinar (free) by Kristin Sandau for AACN
https://www.aacn.org/education/webinar-series

References and Resources

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Thank you!

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One of my mentors, the late Maureen Smith, APRN, CNS from United Hospital (Aug. 2009)