This curriculum provides hospitals with a solution to an ongoing deficiency that many community hospital share:

“who reads the Serial ECGs when there are no physicians available?”
About this Curriculum:

This curriculum provides nurses with evidence-based education and recommended practices for identifying changes in serial ECGs, and identifying ECG changes consistent with Acute Coronary Syndrome.
Observation Medicine ECG Course

BASIS:

• Current ACC/AHA Guidelines and Recommendations
• Multiple additional recent Evidence-Based Publications
• ECGs from case files of the author, Wayne Ruppert
• Graphic art / images from published textbooks authored by Wayne Ruppert
• Acute Coronary Syndrome
• Acute Coronary Syndrome
• Atrial Fibrillation
• Heart Failure
• QT syndrome abnormalities
Wayne Ruppert, Cardiovascular Coordinator
Bayfront Health Dade City, Dade City, Florida
Community Health Systems
Wayne Ruppert bio:

- Cardiovascular Coordinator 2012-present (coordinated 4 successful accreditations)
- Interventional Cardiovascular / Electrophysiology Technologist, 1995-Present.
- Author of: “12 Lead ECG Interpretation in Acute Coronary Syndrome with Case Studies from the Cardiac Cath Lab,” 2010, TriGen publishing / Ingram Books
- Author of: “STEMI Assistant,” 2014, TriGen publishing / Ingram Books
- Florida Nursing CE Provider # 50-12998
- 12 Lead ECG Instructor, 1994-present (multiple hospitals, USF College of Medicine 1994)
- Website: www.ECGtraining.org
To download this course, go to [www.ECGtraining.org](http://www.ECGtraining.org), select “Downloads PDF” then select download(s) desired:
Copyright 2010, 2011, 2015

All cardiovascular subject-related images, graphics and diagrams were created by the author, Wayne Ruppert, and have been taken from his two published textbooks, “STEMI Assistant” and “12 Lead ECG Interpretation in ACS with Case Studies from the Cardiac Cath Lab,” are Copyright protected, and may not be removed from this PowerPoint presentation. This presentation may not be used as part of a profit-generating program without prior written consent from the author.

Wayneruppert@aol.com
Suggested **Prerequisite Knowledge:**

Basic ECG Rhythm Interpretation Skills.

*This course does not teach how to interpret basic ECG rhythms.* Although it is not necessary to know Basic ECG Rhythms to understand the material in this course, it is strongly suggested that this course be used as “the next level” of education for health care providers who are already proficient in basic single-lead ECG rhythm strip interpretation.
Objectives (Part 1):

• Review what recent evidence-based papers say about “non-physician interpreted ECGs”
• Discuss relevance, indications and evidence-based practices of Serial 12 Lead ECGs
• Risk Stratification in the LRCP and NSTE-ACS patient populations
• Review how to obtain a 12 and 18 lead ECG
• Review how to read the Baseline ECG
Role of the Nurse in Observation Medicine ECG Interpretation

• Patients transferred to Obs Units are typically no longer under care of the ED physician
Role of the Nurse in Observation Medicine ECG Interpretation

• Patients transferred to Obs Units are typically no longer under care of the ED physician
• Smaller community hospitals often do not have in-house physicians at night, on weekends
Role of the Nurse in Observation Medicine ECG Interpretation

• Patients transferred to Obs Units are typically no longer under care of the ED physician
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• Obs Unit nurses typically assess patients, review ECGs and decide if physician must be called
Role of the Nurse in Observation Medicine ECG Interpretation

- Patients transferred to Obs Units are typically no longer under care of the ED physician.
- Smaller community hospitals often do not have in-house physicians at night, on weekends.
- Obs Unit nurses typically assess patients, review ECGs and decide if physician must be called.
- Nurse 12 Lead ECG interpretation competency levels vary significantly.
Role of the Nurse in Observation Medicine ECG Interpretation

• Patients transferred to Obs Units are typically no longer under care of the ED physician
• Smaller community hospitals often do not have in-house physicians at night, on weekends
• Obs Unit nurses typically assess patients, review ECGs and decide if physician must be called
• Nurse 12 Lead ECG interpretation competency levels vary significantly
• This course defines educational standards and competencies for nurses reading ECGs
Nonphysician STEMI ECG Interpretation

“When physicians are not present or not available to interpret an ECG, other methods for interpretation must be used so that timely patient care is not adversely affected. The 2015 ILCOR systematic review examined whether nonphysicians such as paramedics and nurses could identify STEMI on an ECG so that earlier identification of STEMI could be made with acceptable rates of either underdiagnosis (false-negative results) or overdiagnosis (false-positive results).”
Real-time paramedic compared with blinded physician identification of ST-segment elevation myocardial infarction: results of an observational study.

“Paramedic sensitivity was 0.80 (95% CI, 0.64-0.96); specificity was 0.97 (95% CI, 0.94-1.00) with positive likelihood ratio of 25.2 and negative likelihood ratio of 0.21. Overall accuracy was similar for paramedic and physician reviewers (0.94, 0.93, 0.95). Highly trained paramedics in an urban emergency medical services system can identify patients with STEMI as accurately as blinded physician reviewers.”
Additional References; the Nurse Interpreted ECG:

- “Improving nurses' ability to identify anatomic location and leads on 12-lead electrocardiograms with ST elevation myocardial infarction” M Pelter et al. / Euro J Cardiovasc Nurs: 9 (2010) 218-225

Serial ECGs

“The practice of obtaining multiple ECGs at different points in time for the purpose of identifying dynamic changes to waveforms that could signify evolving Acute Coronary Syndrome and/or other potentially dangerous conditions.”
Serial ECGs

• Multiple evidence-based publications spanning several decades have validated the usefulness of Serial ECGs for diagnosing the presence of ACS.
  – Amsterdam et al, AHA *Circulation*. 2010;122:1756-1776
Serial ECGs in the Evaluation of ACS

- Low Risk Chest Pain patients in the Observation Unit
  - Diagnose ACS
Serial ECGs in the Evaluation of ACS

• Low Risk Chest Pain patients in the Observation Unit
  – Diagnose ACS

• NSTE-ACS patients
  – Determine degree of patient condition stability and the need for urgent cardiac catheterization
Patient reports symptoms suggestive of ACS

- Calls 911
- ER Walk-in
- Notifies Nurse (hospital patient)

12 Lead ECG STAT

- 12 Lead ECG obtained, read by ER MD within 10 minutes
- STAT Troponin drawn, sent to lab, results within 60 mins of pt. arrival
- Physician obtains History of Present Illness and Past Medical History
- Physician performs Physical Exam
- Physician calculates ACS Risk Score (HEART or TIMI)
- CP Orders Initiated

ST Elevation

- Any ST Elevation in Posterior or RV Leads
- Troponin Positive

Non-Specific ST-T Depressions

- Non-Diagnostic ECG
- Normal ECG

IMPLEMENT STEMI ALERT:

STAT INTERVENTIONAL CARDIOLOGY

- Patient to Cath Lab STAT
- goal of PCI < 90 minutes

IMPLEMENT NSTEMI Orders INTERVENTIONAL CARDIOLOGY

- Admit to PCU
- Serial ECGs/Troponins
- Anti-coag Therapy
- Anti-plaque therapy
- Serial Risk Scores

Serial ECGs: ST-T Changes

- Serial Troponins Positive

CARDIOLOGY CONSULT

- Dynamic changes but NO ST elev

ST Elevation

Dynamic ECG changes without ST Elevation and/or non-resolving or increasing ACS symptoms

STAT INTERVENTIONAL CARDIOLOGY Consult

- High Risk Strt Score: HEART < 4 TIMI < 3
- Low Risk Strat Score: HEART < 4 TIMI < 2

ST Elevation

Non-Urgent Cardiac Cath (24-48hrs)

- PCI / CAGB Indicated
- Recover patient
- Provide Rehab if indicated
- Provide Referral & Discharge instr
- Discharge Patient

Consider Non-Cardiac causes of Trop Elevation

Consider in-patient Stress Testing or other End-diagnostic study

- CT Coronary Angiography
- Nuclear perfusion
- Cardiac Cath

Consider Discharge with outpatient stress testing (within 72 hours)

- PCI / CAGB Indicated
- Recover patient
- Provide Rehab if indicated
- Provide Referral and Discharge instr
- Discharge Patient

- Serial Troponins Positive

- Serial ECGs: ST-T Changes

- Admit to patient’s CARDIOLOGIST. Admit to HOSPITALIST - if patient does not have a cardiologist.
Download Universal ACS Flowchart

This will download in PNG (photographic image) format. You can edit and make changes using the “Paint” program, which is a free app found on every Windows computer.
Serial ECG Objectives:

• Identify DYNAMIC ST-T Wave changes
• Identify STEMI
• Identify rate / rhythm changes, and all other ECG changes.

• Download Sample “Serial ECGs / Troponins & Management of LRCP Patient” Protocol
Serial ECG Strategy for the Observation Unit:

Patients WITHOUT ACS symptoms:

• “0-3-6” strategy. (0 = ECG upon arrival at ED, then repeat ECGs at 3 and 6 hours).
  Recommendation: DO ECGs and TROPONINS at same time (0-3-6 hours)

• If ACS symptoms develop, do STAT 12 Lead ECG and follow Acute Chest Pain Protocol (download example)
Serial ECG Strategy for the Observation Unit (ACS):

Patients WITH symptoms of ACS:

- Obtain and interpret initial 12 Lead ECG within 10 minutes of patient arrival /symptom onset.
- If available, implement Continuous 12 Lead ECG / ST-segment monitoring. Otherwise . . .
- If initial ECG is negative, but ACS symptoms persist, “repeat ECGs (eg, 5- to 10-minute intervals) have been recommended, because serial changes of ischemia or injury may evolve.” Amsterdam et al, “Testing of Low Risk Patients Presenting to the ED with Chest Pain, Circulation 2010;122:1756-1776”
“Nurse-reviewed SERIAL ECGs” – what are we talking about?
“Nurse-reviewed SERIAL ECGs” – what are we talking about?

- A PHYSICIAN has formally interpreted the FIRST 12 Lead ECG.
“Nurse-reviewed SERIAL ECGs” – what are we talking about?

• A PHYSICIAN has formally interpreted the FIRST 12 Lead ECG.

• This curriculum teaches a NURSE how to COMPARE the 2\textsuperscript{nd}, 3\textsuperscript{rd}, and all subsequently obtained ECGs to the initial PHYSICIAN-INTERPRETED ECG.
“Nurse-reviewed SERIAL ECGs” – what are we talking about?

- A PHYSICIAN has formally interpreted the FIRST 12 Lead ECG.
- This curriculum teaches a NURSE how to COMPARE the 2\textsuperscript{nd}, 3\textsuperscript{rd}, and all subsequently obtained ECGs to the initial PHYSICIAN-INTERPRETED ECG.
- This curriculum reviews commonly noted ECG markers of Acute Coronary Syndrome (ACS)
Before we start, you should know . . .
Sometimes, ECGs LIE to us!
ECGs and USED CAR SALESmen often have MUCH in common!
THE ECG in PERSPECTIVE:

PROBLEMS with ECG:

↓ SENSITIVITY
   (FALSE NEGATIVES)

↓ SPECIFICITY
   (FALSE POSITIVES)
NORMAL ECG.

But......

LETHAL TRIPLE VESSEL DISEASE
PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:

CONDITION:

• ACUTE INFARCTION
• HYPERKALEMIA
• BRUGADA SYNDROME
• PULMONARY EMBOLUS
• INTRACRANIAL BLEED
• MYOCARDITIS / PERICARDITIS
• L. VENT. HYPERTROPHY
• PRINZMETAL'S ANGINA
• L. BUNDLE BRANCH BLOCK
• PACED RHYTHM
• EARLY REPOLARIZATION & "MALE PATTERN" S-T ELEV.
77 Years  Male

Rate  83  . SINUS RHYTHM..........................normal P axis, V-rate 50-99
   . RIGHT BUNDLE BRANCH BLOCK..................QRS>120, terminal axis (90,270)
PR  152  . ANTEROLATERAL INFARCT, ACUTE.............Q >35mS, ST >0.20mV, V2-V6
QRS 412
QTc 485

--AXIS--
P  59
QRS 14
T  33

12 Lead; Standard Placement

- ABNORMAL ECG -
   >>> Acute MI <<<  Unconfirmed Diagnosis

Requested by:
Patient:

- Asymptomatic
- Troponin normal
- Cardiac Cath angiography = “no obstructive CAD.”
- Discharge diagnosis:

**EARLY REPOLARIZATION.** This degree of ST Elevation in early repolarization is VERY RARE: The only such ECG I have seen in approximately 13,000 cardiac catheterizations.
PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:

**CONDITION:**

- Reciprocal Changes of Acute MI
- Non-Q Wave MI (Non-STEMI)
- Ischemia
- Positive Stress Test
- Ventricular Hypertrophy (Strain Pattern)
- Wolff-Parkinson-White
- Old MI (Necrosis vs. Ischemia)
- Digitalis
- R. Bundle Branch Block

J Point
>1mm
Depressed Below P-Q Junction
PROBLEMS WITH SPECIFICITY . . .

T WAVE INVERSION - COMMON ETIOLOGIES:

CONDITION:

- MYOCARDITIS
- ELECTROLYTE IMBALANCE
- ISCHEMIA
- POSITIVE STRESS TEST
- CEREBRAL DISORDER
- MITRAL VALVE PROLAPSE
- VENTRICULAR HYPERTROPHY
- WOLFF-PARKINSON-WHITE
- HYPERVENTILATION
- CARDIOACTIVE DRUGS
- OLD MI (NECROSIS vs. ISCHEMIA)
- DIGITALIS
- R. BUNDLE BRANCH BLOCK
- NO OBVIOUS CAUSE
PROBLEMS WITH SPECIFICITY . . .

HYPER-ACUTE T WAVES - COMMON ETIOLOGIES:

- HYPERKALEMIA
- ACUTE MI
- TRANSMURAL ISCHEMIA
- HYPERTROPHY
Despite the ECG’s problematic issues with Lack of Sensitivity & Lack of Specificity, The 12 Lead ECG remains one of our QUICKEST, most cost-efficient front-line Triage Tools that we have today.
We utilize ACS Risk Stratification to compensate for the ECG’s lack of sensitivity and specificity, to aid us in clinical decision-making and to improve our diagnostic accuracy.
NORMAL ECG.

Advanced TRIPLE VESSEL DISEASE

HEART SCORE: 5
Outcome: Successful Emergency Bypass Surgery
### HEART Score for Chest Pain Patients

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Points</th>
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<tbody>
<tr>
<td>History</td>
<td>Highly suspicious</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Moderately suspicious</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Slightly suspicious</td>
<td>0</td>
</tr>
<tr>
<td>ECG</td>
<td>Significant ST-deviation</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Non specific repolarisation disturbance / LBBB / PM</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td>Age</td>
<td>≥ 65 years</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt; 45 and &lt; 65 years</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≤ 45 years</td>
<td>0</td>
</tr>
<tr>
<td>Risk factors</td>
<td>≥ 3 risk factors or history of atherosclerotic disease*</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1 or 2 risk factors</td>
<td>1</td>
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<tr>
<td></td>
<td>No risk factors known</td>
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<tr>
<td>Troponin</td>
<td>≥ 3x normal limit</td>
<td>2</td>
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<tr>
<td></td>
<td>&gt; 1 and &lt; 3x normal limit</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≤ 1x normal limit</td>
<td>0</td>
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</tbody>
</table>

**Total HEART Score:** = 5

**TIMI Score:** = 2

- **H** = chest pain = 2
- **E** = ECG normal = 0
- **A** = 63 = 1
- **R** = 3 risk factors = 2
- **T** = Trop. NL = 0
Comparison of PREDICTIVE RELIABILITY of the HEART SCORE to the Modified TIMI and GRACE ACS Risk Scores:

- HEART
- TIMI
- GRACE

Percentage MACE

From minimum to maximum score
C-Statistic interpretation:

A score of “1.00” would mean the score predicts outcome with 100% perfection. A score of 0.50 is the same as a “50/50 coin toss.” A score of LESS THAN 0.50 means that the score predicts the opposite outcome.

C-Statistic scores achieved in this study:

HEART: 0.83  
TIMI: 0.75  
GRACE: 0.70
HEART vs. TIMI vs. GRACE

“The overall summary of the HEART Score is that it demonstrates superior predictive power over the TIMI and GRACE Scores in both ends of the scale. Patients with high HEART Scores had higher incidence of needing PCI or CABG, and those with lower HEART Scores had much lower rates of MACE.”
ACS Risk Stratification – Evidence Based Practices:

- Mahler et al. Circulation Outcomes 2015 The HEART Pathway – Randomized Trial
- Backus BE, Six AJ et al. Crit Path Cardiol 2010 Chest Pain in the ER: Validation of HEART Score
- Backus BE, Six AJ et al. Int J Cardiol 2013 Prospective Validation of HEART Score in Emerg Dept
- MacDonald et al. Emerg Med J 2014 Modified TIMI Cannot be Used to ID Low Risk CP in Emerg Dept
ACS Risk Stratification:

Is recommended for:

- **NSTE-ACS**: CLASS 1 Recommendation as per the 2014 AHA/ACC Guidelines for Management of Patients with NSTEMI ACS.
- **Low Risk Chest Pain:**
NOT recommended for STEMI. Per Dr. Barbra Backus, HEART Score Inventor, during an in-person conversation I had with her at the 2015 AHA Scientific Sessions in Orlando, FL:

“Taking time to calculate a Risk Stratification Score in STEMI is delaying reperfusion”
OBTAINING THE 12 LEAD ECG
Obtaining the 12 Lead ECG

STANDARD LEAD PLACEMENT --- 12 LEAD ECG

- PATIENT SHOULD LAY AS FLAT AS POSSIBLE
- LIMB LEADS SHOULD BE PLACED AS DISTALLY AS POSSIBLE
Obtaining the 12 Lead ECG

- Limb leads should be on the limbs.
Obtaining the 12 Lead ECG

• Limb leads should be on the limbs.
• When emergency circumstances dictate that limb leads be placed on patient's torso, the words "LIMB LEADS ON PATIENT'S TORSO" should be noted on the ECG.
Obtaining the 12 Lead ECG

Recent AHA/ACC/HRS literature indicates QRS AMPLITUDE, Q WAVE DURATION, AXIS and WAVEFORM DEFLECTION can be altered when limb leads are placed on the patient's torso (Mason-Likar lead placement).

Therefore every effort should be made to place limb leads on the limbs.
Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

affected by monitoring lead placement; however, tracings that use torso electrodes differ in important ways from the standard 12-lead ECG. In addition to body position differences that affect the ECG, monitoring electrodes placed on the trunk do not provide standard limb leads, and distortion of the central terminal alters the augmented limb leads and the precordial leads. Tracings with Mason-Likar and other alternative lead placement may affect QRS morphology more than repolarization compared with the standard ECG; these differences can include false-negative and false-positive infarction criteria. Motion artifact of the limbs is a particular problem for routine recording in neonates, infants, and
Recommendations for the Standardization and Interpretation of the Electrocardiogram
Part I: The Electrocardiogram and Its Technology

*Recommendations*
ECGs recorded with torso placement of the extremity electrodes cannot be considered equivalent to standard ECGs for all purposes and should not be used interchangeably with standard ECGs for serial comparison. Evaluation of the effect of torso placement of limb leads on waveform amplitudes and...
Leads V1 & V2 on 12 Lead ECG:

• Proper lead placement of precordial Leads V1 and V2 are 4th intercostal space on opposite sides of the sternum.
• Incorrect placement of Leads V1 and V2 will result in: reduction of R wave amplitude (resulting in poor R wave progression) leading to misdiagnosis of previous anterior / septal infarction.
Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

...the often profound alterations in waveforms that can result from precordial electrode misplacement. A common error is superior misplacement of $V_1$ and $V_2$ in the second or third intercostal space. This can result in reduction of initial R-wave amplitude in these leads, approximating 0.1 mV per interspace, which can cause poor R-wave progression or erroneous signs of anterior infarction. Superior displacement of the $V_1$ and $V_2$ electrodes will often result in $rSr'$ complexes with T-wave inversion, resembling the complex in lead aVR. It also has been shown that in patients with low diaphragm position, as in obstructive pulmonary disease...
Initial 12 Lead ECG

• Obtain and interpret within 10 minutes of patient presentation
Initial 12 Lead ECG

• Obtain and interpret within 10 minutes of patient presentation

• **Interpreted by physician / advanced practitioner**
Initial 12 Lead ECG

• Obtain and interpret within 10 minutes of patient presentation
• Interpreted by physician / advanced practitioner
• Determines presence of STEMI and/or other imminent life-threatening condition
Initial 12 Lead ECG

• Obtain and interpret within 10 minutes of patient presentation
• Interpreted by physician / advanced practitioner
• Determines presence of STEMI and/or other imminent life-threatening condition
• Should be compared to any previously recorded ECGs in the patient’s medical records
Initial 12 Lead ECG, continued:

- Additional Serial ECGs should be compared to the BASELINE ECG for determining the presence of Dynamic J Point, ST-Segment and T Wave Changes
Initial 12 Lead ECG, continued:

- Additional Serial ECGs should be compared to the BASELINE ECG for determining the presence of Dynamic J Point, ST-Segment and T Wave Changes

- Serves as “footprint” for determining ECG lead(s) to be used during Continuous ECG Monitoring
  - Ischemia
  - QT interval
V1 - V4 View the anterior-septal wall of the left ventricle

V1, V2 - Anterior / Septal
V3, V4 - Anterior
LEADS V1 - V3 view the POSTERIOR WALL

via RECIPROCAL CHANGES.
HOW EKG VIEWS INDICATIVE CHANGES

EXAMPLE:

AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL

PATIENT'S BACK

PATIENT'S CHEST

EKG sees S-T ELEVATION

ECG LEAD V2
HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL

PATIENT'S BACK

PATIENT'S CHEST

RV

LV

EKG sees S-T DEPRESSION

ECG LEAD V2
V5 - V6 VIEW THE LATERAL WALL of the LEFT VENTRICLE

- **RV**: Right Ventricle
- **LV**: Left Ventricle
- **V1, V2, V3, V4, V5, V6**: Electrocardiogram leads
- **Spine**: Reference point

### ECG Summary

- **RUPPERT, WAYNE**
  - ID: 7445683659
  - Date: 05-Oct-2006
  - Institution: Johns Hopkins Univ.

- **Age**: 38 Yrs
- **Gender**: Male

<table>
<thead>
<tr>
<th>Lead</th>
<th>V1</th>
<th>AVR</th>
<th>V2</th>
<th>V3</th>
<th>AVF</th>
<th>V4</th>
<th>V5</th>
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**Observations**

- Vent. Rate: 68 bpm
- P-R Int.: 160 ms
- QRS: 100 ms

**Diagnosis**

- **Normal Sinus Rhythm**
- Normal EKG
- Very Healthy Athletic EKG!
Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

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<tr>
<th>RUPPERT, WAYNE</th>
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<th>JOHNNS-HOPKINS UNIV.</th>
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<tr>
<td>38 Yrs MALE</td>
<td>Vent. Rate:</td>
<td>Normal EKG</td>
<td>Normal EKG</td>
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<td></td>
<td>P-R Int.:</td>
<td></td>
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<td>QRS:</td>
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 Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

OCCLUSION of OBTUSE MARGINAL ARTERY

- LEFT MAIN CORONARY ARTERY
- AV NODE
- CIRCUMFLEX ARTERY
- RBB
- LV

1st OBTUSE MARGINAL ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM CIRCUMFLEX ARTERY.

AREA OF EKG VIEWED BY LEADS I and aVL

LEFANTERIOR DESCENDING ARTERY

OCCLUSION of RAMUS ARTERY

- LEFT MAIN CORONARY ARTERY
- AV NODE
- CIRCUMFLEX ARTERY
- RAMUS ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM LEFT MAIN CORONARY ARTERY

AREA OF EKG VIEWED BY LEADS I and aVL

LEFT ANTERIOR DESCENDING ARTERY

OCCLUSION of DIAGONAL ARTERY

- LEFT MAIN CORONARY ARTERY
- AV NODE
- CIRCUMFLEX ARTERY

1st DIAGONAL ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM LEFT ANTERIOR DESCENDING ARTERY

AREA OF EKG VIEWED BY LEADS I and aVL

LEFT ANTERIOR DESCENDING ARTERY
LEADS II, III, and aVF VIEW
INFERNIOR WALL of the LEFT VENTRICLE

RUPPERT, WAYNE
ID: 7445683659
05-OCO-2006
JOHNS-HOPKINS UNIV.
38 Yrs
MALE
Vent. Rate: 68
P-R Int.: 160 ms
QRS: 100 ms
NORMAL SINUS RHYTHM
Normal EKG
Very Healthy Athletic EKG!

I
AVR
V1
V4
II
AVL
V2
V5
III
AVF
V3
V6

FED by the RCA (75 - 80% pop) or the CIRCUMFLEX (10 - 15%)
Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His)
In STEMI with ST-Segment Elevation in Lead AVR, this is indicative of Left Main Coronary Artery Occlusion...
OCCLUSION of the LEFT MAIN CORONARY ARTERY

LEFT MAIN CORONARY ARTERY

AV NODE

LBB

LV

CIRCUMFLEX ARTERY

LEFT ANTERIOR DESCENDING ARTERY

AREA OF INFARCT

RV

RBB

ANTERIOR VIEW
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ST ELEVATION in LEADS I, aVL, V1 - V6
- ST ELEVATION in aVR GREATER THAN 0.5 mm
- ST ELEVATION in aVR GREATER THAN LEAD V1
- LEFT ANTERIOR FASCICULAR BLOCK PATTERN

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION
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ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION
TOTAL OCCLUSION of the LEFT MAIN CORONARY ARTERY
ECG Clues... for IDENTIFYING STEMI CAUSED BY LEFT MAIN CORONARY ARTERY occlusion:

- **ST ELEVATION** in ANTERIOR LEADS (V1 - V4) and LATERAL LEADS (V5 & V6)
- **ST DEPRESSION** or ISOELECTRIC **J POINTS** may be seen in V LEADS....mainly V2 and/or V3 caused by COMPETING FORCES of ANTERIOR vs. POSTERIOR WALL MI. **++**
  
  → NOTE: it is very unusual to see ST DEPRESSION in V LEADS with isolated ANTERIOR WALL MI when caused by occluded LAD.

- **ST ELEVATION** in AVR is GREATER THAN ST ELEVATION in V1 **++**
- **ST ELEVATION** in AVR GREATER THAN 0.5 mm
- **ST ELEVATION** in LEAD I and AVL (caused by NO FLOW to DIAGONAL / OBTUSE MARGINAL BRANCHES )* 
- **ST DEPRESSION** in LEADS II, III, and AVF. (in cases of LMCA occlusion of DOMINANT CIRCUMFLEX, leads II, III, and AVF may show ST ELEVATION or ISOELECTRIC J POINTS) **++**
- **NEW / PRESUMABLY NEW RBBB**, and/or **LEFT ANTERIOR FASCULAR BLOCK** **++**

* Kurisu et al, HEART 2004, SEPTEMBER: 90 (9): 1059-1060
+ Yamaji et al, JACC vol. 38, No. 5, 2001, November 1, 2001:1348-54

Yamaji et al, JACC vol 38, No 5, 2001: 1348-54

In patients without STEMI, ST Elevation in AVR, when seen with global indications of ischemia (ST Depression in 8 leads or more), is indicative of advanced multi-vessel disease or significant Left Main Coronary Artery stenosis.
“In patients with:
  - Angina at rest
  - ST Elevation in AVR and ST Depression in 8 or more ECG leads (global ischemia), it is reported with a 75% predictive accuracy of 3-vessel or left main coronary artery stenosis” . . .

- Wagner et al, 2009 ACC/AHA Standardization and Interpretation of the ECG, Part VI, ACS.
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION
Critical Triple Vessel Disease = STAT Coronary Artery Bypass Surgery

**SUB-TOTAL OCCLUSION if CIRCUMFLEX ARTERY.**

**PROXIMAL OCCLUSION of the RIGHT CORONARY ARTERY.**

**RIGHT CORONARY ARTERY filling retrograde via COLLATERAL ARTERIES.**

**COLLATERAL CIRCULATION from SEPTAL PERFORATORS to RCA DISTRIBUTION.**
### ANTICIPATED COMPLICATIONS of GLOBAL ISCHEMIA with POSSIBLE NSTEMI -- INTERVENTIONS to be CONSIDERED:

<table>
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<tr>
<th>Patients with CHEST PAIN at REST and this ECG presentation have a 75% incidence of severe LMCA STENOSIS and/or TRIPLE - VESSEL DISEASE -- in such cases Coronary Artery Bypass Surgery (CABG) is frequently indicated.</th>
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<tr>
<td>PREHOSPITAL: if patient has no hospital preference consider transport to Chest Pain Center WITH Open Heart Surgery capabilities IF nearby.</td>
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<td>HOSPITAL: consider use of SHORT-ACTING intravenous GP IIb/IIIa receptor agonists</td>
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<tr>
<td>- ACTIVE CHEST PAIN</td>
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<td>- ISCHEMIA - CONSIDER DYSRHYTHMIAS</td>
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Excerpt from **STEMI Assistant**
O.S.:

PROXIMAL LATERAL or PROXIMAL ANTERIOR

BASILAR SEPTUM (Bundle of His region)

ANTERIOR / SEPTAL

ANTERIOR

INFERIOR

PROXIMAL LATERAL or PROXIMAL ANTERIOR

ANTERIOR / SEPTAL

LATERAL

INFERIOR

INTERIOR

ANTERIOR

LATERAL

III

aVF

V1

V2

V3

V4

V5

V6
A standard 12 LEAD EKG Does NOT show the RIGHT VENTRICLE
The standard 12 Lead ECG does NOT show the RIGHT VENTRICLE . . . .
To see the RIGHT VENTRICLE, it is necessary to OBTAIN a RIGHT-SIDED ECG . . .
To do a RIGHT-SIDED EKG...

MOVE leads V4, V5, and V6 to the corresponding placement on the RIGHT SIDE of patient's chest...
Right Ventricular Lead Placement

- After initial 12 Lead obtained:
- Reposition leads V1, V2 & V3 to the V4R, V5R & V6R locations on the patient’s R chest wall.
- **ST elevation >0.5 mv ABNORMAL**
Leads V4R, V5R, & V6R "see" the RIGHT VENTRICLE.
INDICATIONS for OBTAINING a RIGHT-SIDED ECG . . .
ALL INFERIOR WALL STEMI Patients:

ST-Elevation Leads II, III & AVF = OBTAIN RIGHT-SIDED ECG
RIGHT DOMINANT

75 - 80 % POPULATION

INFERIOR WALL
**Distal** Right Coronary Artery Occlusion

- **Zone of INFARCTION**
  - Distal RCA occlusion:
    - approx. 20-25% of LV function

- **POSTERIOR VIEW**
  - Inferior MI

- **LV**
- **RV**
- **A-V NODE**
- **SA NODE**
- **RIGHT CORONARY ARTERY**
Proximal Right Coronary Artery Occlusion
75 – 80% of the population have a DOMINANT Right Coronary Artery (RCA).

A dominant RCA nearly always supplies blood to the INFERIOR WALL.
75 – 80% of the population have a DOMINANT Right Coronary Artery (RCA).

A dominant RCA nearly always supplies blood to the INFERIOR WALL.

The RCA nearly ALWAYS supplies blood to the RIGHT VENTRICLE!
RIGHT VENTRICULAR STEMI is indicated when ST Segment Elevation of 0.5mv is present.
IN EVERY CASE of INFERIOR WALL STEMI

You must first RULE OUT RIGHT VENTRICULAR MI BEFORE giving any:

- NITROGLYCERIN
- Diuretics
Nitroglycerin & Diuretics are CLASS III CONTRINDICATED in RIGHT VENTRICULAR MI ! ! *

They precipitate SEVERE HYPOTENSION

* A.H.A. ACLS 2010 / 2015
ST Depression in V1 – V4
LEADS V1 - V3 view the POSTERIOR WALL

via RECIPROCAL CHANGES.
Posterior Lead ECG Lead Placement

- After initial 12 Lead obtained:
- Reposition leads V4, V5 & V6 to the v7, v8 & V9 locations on the patient’s back.
- ST elevation >0.5 mv ABNORMAL
ST Elevation of 0.5mv or more in POSTERIOR LEADS (V7-V9) is consistent with POSTERIOR WALL STEMI
ST Depression in V1 – V4

Could indicate:
• Anterior Ischemia
• Anterior Infarction (NSTEMI)
• Posterior Wall STEMI
ST Depression in V1 – V4

Could indicate:
• Anterior Ischemia
• Anterior Infarction (NSTEMI)
• Posterior Wall STEMI

👉 Obtain an a POSTERIOR LEAD ECG to rule out POSTERIOR WALL STEMI !
The STANDARD 12 Lead ECG does NOT directly view the POSTERIOR WALL...
Leads V7, V8 & V9 directly "see" the Posterior Wall
Suggested Routine Practice –
OBTAIN 18 LEAD ECG when the following presents:

- INFERIOR WALL STEMI
- ST DEPRESSION in any of the ANTERIOR LEADS (V1 – V4)
To do an 18 Lead ECG with a STANDARD 12 Lead ECG machine,

FIRST, do you 12 Lead ECG in the traditional manner,

and then you will REPOSITION the CHEST LEADS like this . . . .
HOW TO REPOSITION 6 CHEST LEADS to OBTAIN 3 R VENTRICLE and 3 POSTERIOR LEADS

MOVE:
V1 to V4R
V2 to V5R
V3 to V6R

MOVE:
V4 to V7
V5 to V8
V6 to V9

LEAD PLACEMENT V4R, V5R, V6R

1/2 BETWEEN V7 & V9

PARASPINAL LINE

HORIZONTAL PLANE
34 years  Vent. rate  58 bpm  Sinus bradycardia
Male  Asian  PR interval  146 ms  RSF or QR pattern in V1 suggests right ventricular conduction delay
Room:  QT/QTc  372/365 ms  Cannot rule out Anteroseptal infarct, age undetermined
Opt:  P-R-T axes  29  32  50  Abnormal ECG

DOS:

Technician: WR

Referred by:

RIGHT VENTRICLE  POSTERIOR WALL

40 Hz  25.0 mm/s  10.0 mm/mV  4 by 2.5s + 3 rhythm leads
Common Factors that Affect the ECG:

- Heart Rate
- Body Temperature
- Hydration / Fluid Volume Status
- Electrolytes
- Medications
- Conduction System Disorders
- Myocardial Ischemia / Infarction / Necrosis
- Valvular function / Hypertrophy
- Congenital abnormalities / conditions
- Cardiomyopathies
The BASELINE ECG should be OBTAINED and INTERPRETED by a PHYSICIAN within TEN MINUTES of the patient’s initial presentation.
The *NORMAL* 12 Lead ECG (pertaining to ACS):

- Heart Rate 60-99
- QRS width <120ms
- J Points iso-electric
- ST Segments: slight positive inclination
- T waves upright (except Lead AVR)
- QRS deflection: varies (compare to BASELINE ECG or previously recorded ECGs)
The BASELINE ECG:

You should review the Baseline ECG and note the following:

- Physician interpretation / notes
- Heart Rate
- QRS duration (width)
- J Points / ST-Segments / T waves in EACH LEAD
- QRS Deflections of each lead.
- Computerized Interpretation
Non-Physician Review of 2nd, 3rd & all additional (Serial) ECGs:

- Compare the following items on each subsequently recorded ECG to the BASELINE ECG:
  - Heart rate
  - QRS duration (width)
  - QRS amplitude (height)
  - J Points, ST Segments and T Waves of each lead
  - QRS deflections of each lead
  - Computerized interpretation
The NORMAL 12 Lead ECG:

38 yr Male
Room:ER

Vent. rate 64 BPM
PR interval 130 ms
QRS duration 96 ms
QT/QTc 396/408 ms
P-R-T axes 40 11 6

Normal sinus rhythm
Normal ECG
No previous ECGs available
End of “Serial ECG Interpretation Part 1” (20th Congress ECG Session 2):

Curriculum continues in “Serial ECG Interpretation Part 2” (20th Congress ECG Session 3)

Oct 26, 2017 - 11:30am-12:30pm
See you tomorrow! 😊
For more information:

Author’s contact information:

Wayne W Ruppert
Wayneruppert@bayfronthalth.com
Office: 352-521-1544

Workshops available.