Top 10 Pitfalls in ECG Reading at Emergency Department

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Top 10 Pitfalls

- Dynamic ST-T change is the king!
- Hyperacute T is NOT Himalaya high!
- PR segment is good enough to be a baseline!
- Discordant ST deviation says nothing!
- Pseudonormalization of T inversion becomes a disaster!
- Reciprocal changes are always FALSE.
- RBBB is NOT right-sided problem!
- Wide QRS is NOT wider than ST-T.
- Wide QRS in any lead(s) excludes a narrow rhythm.
- Comparison with old ECG should be routine.
Pitfall 1
Dynamic ST-T change is the king!

- Factors affecting the ST-T and U wave configuration include:
  - Intrinsic myocardial disease (e.g., myocarditis, ischemia, infarction, infiltrative or myopathic processes)
  - Drugs (e.g., digoxin, quinidine, tricyclics, and many others)
  - Electrolyte abnormalities of potassium, magnesium, calcium
  - Neurogenic factors (e.g., stroke, hemorrhage, trauma, tumor, etc.)
  - Metabolic factors (e.g., hypoglycemia, hyperventilation)
  - Atrial repolarization (e.g., at fast heart rates the atrial T wave may pull down the beginning of the ST segment)
  - Ventricular conduction abnormalities and rhythms originating in the ventricles

Types of ST Depression
AHA Criteria

- Upsloping
  - ≥ 1 mm (0.08 sec after QRS)
  - 30% to 40% error rate

- Horizontal
  - ≥ 1 mm (0.08 sec after QRS)
  - Very low error rate

- Downsloping
  - ≥ 1 mm (0.08 sec after QRS)
  - 5% to 10% error rate
Pitfall 1
Dynamic ST-T change is the king!

[ECG graph]

Pitfall 1
Dynamic ST-T change is the king!

[ECG graph]
Pitfall 1
Dynamic ST-T change is the king!
Pitfall 2
Hyperacute T is NOT Himalaya high!

- Hyperacute T  $\rightarrow$ VF Risk
- ST elevation
- Q wave formation  $\rightarrow$ New or Recent
- ST elevation decline
- T inversion
- (ST depression)

Pitfall 2
Hyperacute T is NOT Himalaya high!
Pitfall 2
Hyperacute T is NOT Himalaya high!

- A 62-year-old man complained of burning pain from epigastrium to throat, which he had never before experienced. He was otherwise healthy. His physical examination was normal.
Hyperacute T is NOT Himalaya high!

- **ECG** (Type 3)
  - No ST elevation
  - T waves: aVL, are larger than the entire QRS (hyperacute T wave), and, in V4-V6, are also large, which is abnormal but by no means diagnostic. It is also easily missed, as it was by 9 of 10 cardiologists at a later conference. However, you can find these abnormalities if you look for them. This difference in amplitude is not a result of differing QRS and T-waves axes, which are similar.

Hyperacute T is NOT Himalaya high!

- The emergency physician misread the ECG as normal. The patient experienced immediate and complete pain relief after receiving an antacid and viscous xylocaine. As he wanted to be discharged, he suffered cardiac arrest from ventricular fibrillation.
Pitfall 2
Hyperacute T is NOT Himalaya high!

Pitfall 3
PR segment is NOT a good baseline!
Atrial Depolarization

Ventricular Depolarization

Ventricular Repolarization

Atrial Repolarization?
Pitfall 3
PR segment is NOT a good baseline!

How to Measure
ST-Segment Deviation

J point plus 0.04 second

TP baseline
ST-segment deviation
Pitfall 3
PR segment is NOT a good baseline!
Pitfall 4
Discordant ST deviation says nothing!

- **WANG**’s rule
  - Narrow vs. Wide QRS Complex Rhythm
  - Wide QRS Complex Rhythm \( \not\sim \) BBB
    - Traditional RBBB / LBBB
    - VPC / VT
    - Pacemaker Rhythm
    - WPW Syndrome
  - Always Discordant ST Deviation
Pitfall 4
Discordant ST deviation says nothing!
Pitfall 4
Discordant ST deviation says nothing!
Pitfall 5
Pseudonormalization of T inversion

- Hyperacute T → VF Risk
- ST elevation
- Q wave formation → New or Recent
- ST elevation decline
- T inversion → Reperfusion
- (ST depression)

A 48-year-old woman presented with CP one week after successful thrombolytic therapy for an inferior AMI. She had discontinued her medications and continued smoking.
Pitfall 5
Pseudonormalization of T inversion

Better or Worse?
Pitfall 5
Pseudonormalization of T inversion

- ECG (Type 1b)
  - At 20:19
  - Q waves and T-wave inversions: II, III, aVL are indicative of a previous Q-wave MI.
  - ST elevation: <1 mm; II, III, and aVF, new since 1 week, is diagnostic of inferior AMI (previous ECG not shown).
  - ST depression: V2-V3 is diagnostic of posterior AMI.
  - The most recent previous ECG showed no residual ST elevation, but it was not sought for comparison. Thus this ECG was erroneously considered nondiagnostic of AMI.
Pitfall 5
Pseudonormalization of T inversion

- **ECG (Type 1a)**
  - At 21:59
  - ST elevation: II, III, and aVF; and requisite reciprocal ST depression: aVL, make this diagnostic of inferior AMI.
  - ST depression: V1-V3 is not anterior ischemia. In the presence of inferior AMI, it is almost always diagnostic of posterior AMI.
  - Notice “pseudonormalized” (upright) T waves: III, aVF, diagnostic of reocclusion.

Pitfall 6
Reciprocal changes are always FALSE.

- For the patients with STEMI over the same location, some have ST depression over other leads whereas others do not.
- If reciprocal changes are a pure vector phenomenon, there should not be absence of reciprocal changes in early repolarization.
- The only ECG diagnosis depending upon reciprocal changes is posterior MI.
Pitfall 6
Reciprocal changes are always FALSE.
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Reciprocal changes are always FALSE.

• Typical Early Repolarization
  • ST elevation
    • Predominantly present in precordial leads; most commonly in lead V3 (80%); and in order of decreasing frequency: V4>V2>V5
    • Upwardly concave ST segment
    • “J-point” elevation
    • Frequent “J waves”
  • Up to 5 mm
  • ST segment typically < 25% of the height of the T wave in V5-V6
  • ST segments often drop with exercise or tachycardia

Pitfall 6
Reciprocal changes are always FALSE.

• Typical Early Repolarization
  • Tall R waves and early QRS transition
  • Tall, peaked, symmetric T waves
  • T-wave amplitude in V6 is typically >V1
  • No reciprocal ST depression
  • Younger patients
  • Rarely manifests in limb leads without also being in precordial leads (rarely in lateral limbs [aVL, I]; maybe aVR [50%])
  • Humpback in V2 in right precordial early repolarization
Pitfall 6
Reciprocal changes are always FALSE.

Pitfall 7
RBBB Is NOT Right Problem!

- A 68 y/o female patient was brought to our ED due to persistent chest oppression and diaphoresis for more than 2 hours. BP was 96/48, PR 98, RR 20, SpO2 91%, and minimal bilateral basal crackles were audible. PMH included renal insufficiency and diabetes mellitus.
- What is your impression and initial management?
Pitfall 7
RBBB Is NOT Right Problem!

- ECG: RBBB; susp. Atrial Flutter with 4:1 AVB
- O2 and aspirin were given.
- Cardiac enzymes revealed CK 452, CKMB 38, TnI 8.92. AMI with Killip II was diagnosed.
- Is fluid resuscitation indicated for her deteriorating hemodynamics? Should she treated as RV infarct with hypotension?
Pitfall 7
RBBB Is NOT Right Problem!

- RBBB in AMI
  - Incidence: 3-29%
  - 37.8% new RBBB, 34.1% old RBBB, and 28.1% with an indeterminate time of origin
  - New-onset RBBB → 50% permanent RBBB
  - More high incidence of heart failure, pacemaker due to AVB, and 1-year mortality
  - Early mortality:
    - New RBBB (43%-76%) > Intermediate RBBB
    - New RBBB > New LBBB

Pitfall 7
RBBB Is NOT Right Problem!

- RBBB in AMI
  - Always means LAD proximal lesions instead of RCA
Pitfall 7
RBBB Is NOT Right Problem!

- Narrow QRS
- Wide QRS: “BBB” in widest definition
  - Always associated with discordant repolarization abnormalities (ST-T changes)
  - Examples:
    - RBBB / LBBB
    - Ventricular Pacing
    - VT
    - WPW

Pitfall 7
RBBB Is NOT Right Problem!

- New-onset LBBB → Treat as AMI
- Any “BBB” that obscures ST elevation with clinically high suspicion of MI → Treat as AMI
- Undetermined LBBB/RBBB
  - Discordant ST-T changes → Undetermined
    - Exceptions: ST elevation above 5 mV
  - Concordant ST-T changes → Consider AMI
Pitfall 7
RBBB Is NOT Right Problem!

Pitfall 8
Wide QRS is NOT wider than ST-T.

- This 73-year-old man presented at 00:45 complaining of abdominal pain, nausea, vomiting, and bloating (atypical symptoms) that began at midnight, with no CP or dyspnea.
Pitfall 8
Wide QRS is NOT wider than ST-T.

Pitfall 8
Wide QRS is NOT wider than ST-T.
Pitfall 9
Any wide QRS exclude narrow rhythm.

Pitfall 10
Routine Comparison with Old ECG

• First judgment if dynamic changes (+)
• Reasonable evolulational changes or not
• If new-onset LBBB or RBBB (+)
• As supplemental criteria for D/D between VT or SVT with aberrant conduction
Pitfall 10
Routine Comparison with Old ECG

- Favor VT:
  - AV dissociation
  - Fusion beat
  - Capture beat
  - Absence of RS in any precordial leads
  - Onset of R to Nadir of S longer than 100 msec
  - Morphologic Criteria

Pitfall 10
Routine Comparison with Old ECG

- Favor VT: (RBBB morphology)
  - V1-2: monophasic or biphasic
  - V6: Q wave, R-to-S ratio < 1, QS, QR or monophasic R

- Favor VT: (LBBB morphology)
  - V1-2: R duration > 30 msec; duration from onset of R to nadir of S > 60 msec; notching in downsloping of S
  - V6: QR or QS
Pitfall 10
Routine Comparison with Old ECG

Wang’s Rule

Pitfall 10
Routine Comparison with Old ECG

Wang’s Rule
Pitfall 10
Routine Comparison with Old ECG

Tetralogy of Fallot