

ED Pitfalls Series (1)

Prof. Wang, Tzong-Luen,
MD, PhD, JM, FESC, FACC, FCAPSC

2011-3-15

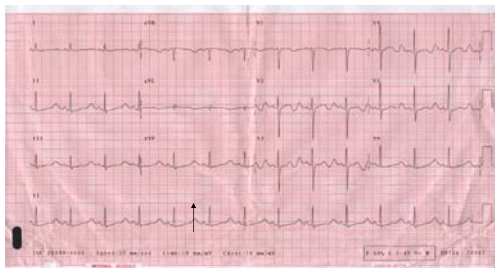
Case 0

- A 32 y/o female was brought to our ED due to vomiting, conscious change, and unsteady gait. Drug overdose was suspected by her family. Vital signs were stable (BP 128/68, PR 88, RR 20, BT 36.5°C and SpO2 97% at room air). PMH included bipolar disease under possible lithium treatment.
- What should ECG show?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 0



2005/11/8

Wang TL: ED Pitfalls (1)

Case 0

- Lithium intoxication
 - Therapeutic level: 0.7-1.2 mEq/L
 - 1.2-2.0 mEq/L: vomiting and diarrhea
 - 2.0-2.5 mEq/L: blurred vision, muscle weakness / fasciculations, dizziness, vertigo, ataxia, confusion, slurred speech, increased DTRs, transient scotomas
 - 2.5-3.0 mEq/L: myoclonic twitches, choreoathetoid movements, incontinence, stupor, ECG: flat/inverted T's U waves, SA/AV block, prolonged QT
 - 3.0-4.0 mEq/L: seizures, cardiac arrhythmias (VT, PVCs, VF)
 - ≥ 4.0 mEq/L: hypotension, peripheral vascular collapse

2005/11/8

Wang TL: ED Pitfalls (1)

Case 1

- A 45-year-old female presented with diarrhea for several days. Vital signs were BP 142/98, PR 147 bpm, RR 20 /min, BT 38°C, SaO2 97%. Breathing sound was clear. Heart sounds revealed irregular-irregular heart beats. Your colleague told you that this is a case of infectious diarrhea.
- What do you think about her?

2005/11/8

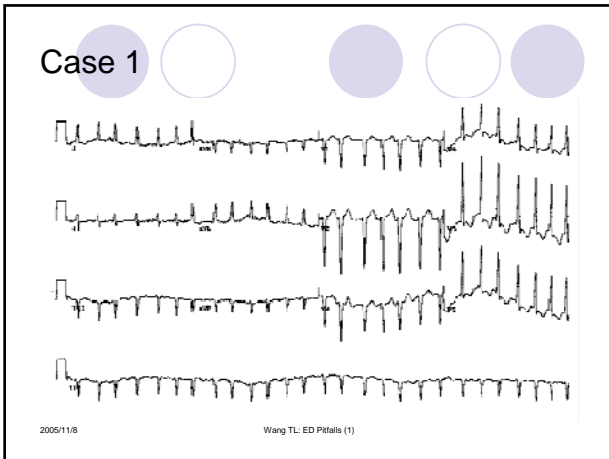
Wang TL: ED Pitfalls (1)

Case 1

- Irregular Rhythm (Pulse)
 - Regular-irregular
 - Irregular-irregular: TWO Big
 - Atrial fibrillation (AF) → Cardiac problem (CHF)
 - Multifocal Atrial Tachycardia (MAT) → Lung problem (COPD)

2005/11/8

Wang TL: ED Pitfalls (1)



- Case 1
- Chronic AF
 - Always cardiomegaly
 - Paroxysmal AF
 - Usually small heart
 - Look for underlying causes before idiopathic AF is diagnosed.
- 2005/11/8 Wang TL: ED Pitfalls (1)

- Case 1
- Secondary AF
 - Also in those with no other risks of heart problem
 - Precipitating factors
 - Hyperthyroidism: beta blocker; anti-thyroid
 - Fever
 - Pain
 - Anxiety
 - Sympathomimetic Agents
 - Vagolytic agents
- Treat underlying
- 2005/11/8 Wang TL: ED Pitfalls (1)

- Case 1
- Thyroid function revealed that increased T3 and free T4, and significantly low TSH. Hyperthyroidism was diagnosed.
 - Propranolol and PTU were then prescribed.
- 2005/11/8 Wang TL: ED Pitfalls (1)

- Case 1
- Two days later, the patient felt dyspnea. Bilateral rales were noted. Chest film revealed lung edema.
 - What is the treatment modality?
- 2005/11/8 Wang TL: ED Pitfalls (1)

- Case 1
- High-Output Heart Failure
 - Profound anemia
 - Thyrotoxicosis
 - Myxedema
 - Paget disease of bone
 - Albright syndrome
 - Multiple myeloma
 - Glomerulonephritis
 - Cor pulmonale
 - Polycythemia vera
 - Obesity
 - Carcinoid syndrome
 - Pregnancy
 - Nutritional deficiencies (eg, thiamine deficiency, beriberi)
- 2005/11/8 Wang TL: ED Pitfalls (1)

Case 1

● Thyroid storm

○ Precipitating factors

- Infection
- Surgery
- Trauma
- Radioactive iodine treatment
- Pregnancy
- Anticholinergic and adrenergic drugs
- TH ingestion
- Diabetic ketoacidosis (DKA)

2005/11/8

Wang TL: ED Pitfalls (1)

Case 1

● Thyroid storm

○ Treatment

- (1) ameliorating hyperadrenergic effects of TH on peripheral tissues with use of beta-blockers (eg, propranolol, labetalol);
- (2) decreasing production of TH with antithyroid medications (eg, propylthiouracil [PTU], methimazole), thereby blocking further synthesis of THs;
- (3) decreasing hormonal secretion from the thyroid, using iodides; and
- (4) preventing further TH secretion and peripheral conversion of T4 to T3, using glucocorticoids.

2005/11/8

Wang TL: ED Pitfalls (1)

Case 1 (comments)

- Don't believe completely what your colleague tells you because to err is human.
- Re-evaluate every patient and integrate the clinical information again and again.

2005/11/8

Wang TL: ED Pitfalls (1)

Case 2

- A 68-year-old male patient consulted our ED due to fever for 2 days. Vital signs were BP 122/64, PR 57 bpm, RR 22 /min, BT 39°C, SaO₂ 95%. Breathing sound was coarse with right rhonchi.
- What do you think about him?

2005/11/8

Wang TL: ED Pitfalls (1)

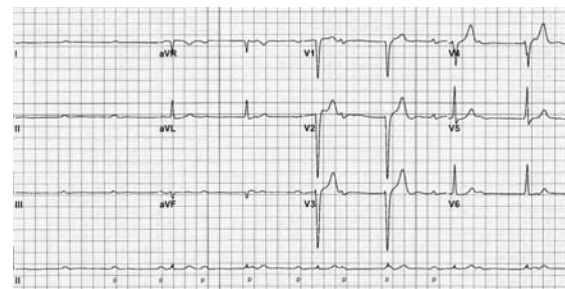
Case 2

- Laboratory findings were leukocytosis (WBC 18,200, band 5%, seg 81%), Hb 12.3, platelet 68K. In addition, BUN 59, Cre 2.4, Na 138, K 5.8, Cl 94 and ABG revealing metabolic acidosis with partial respiratory compensation. CRP was 4.5. CXR revealed RLL pneumonia.
- What else examination should be ordered?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 2



2005/11/8

Wang TL: ED Pitfalls (1)

Case 2 (comments)

- Triage should be made by integration of all available parameters instead of judgment one by one.
- In this case, relative bradycardia in consideration of the presence of fever may be the most important clue!

2005/11/8

Wang TL: ED Pitfalls (1)

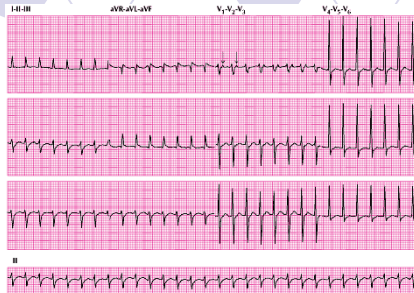
Case 3-1

- A 76 y/o male consulted our ED due to progressive chest discomfort and apprehension in past several hours. BP was 114/68, PR 158, RR 20, SpO2 95%. Bilateral crackles were audible.
- What do you think about him?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 3-1



→ Synchronized Cardioversion 50 J is indicated

2005/11/8

Wang TL: ED Pitfalls (1)

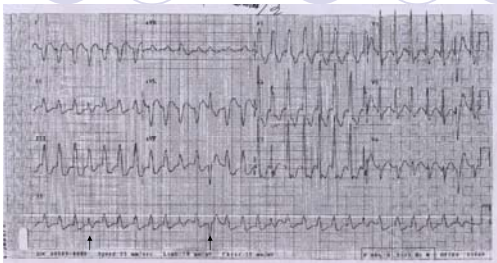
Case 3-2

- A 65 y/o male consulted our ED due to progressive exertional dyspnea for two days. BP was 104/72, PR 174, RR 22, SpO2 92%. Bilateral crackles were audible.
- What do you think about him?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 3-2

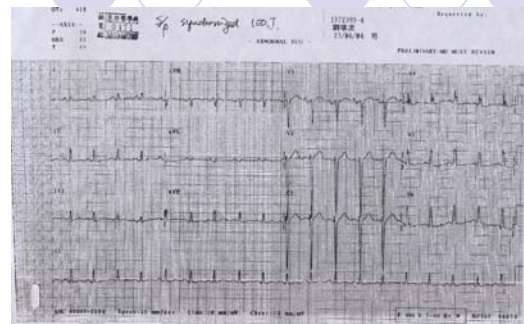


→ Synchronized Cardioversion 100 J is indicated

2005/11/8

Wang TL: ED Pitfalls (1)

Case 3-2



2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

Case 3

- General Rule:

- 100% predicted heart rate = [220 – age (yr)]
- Any tachycardia with pulse rate near or above the 100% predicted heart rate should be considered a rhythm coming from abnormal focus under resting condition. In other words, sinus tachycardia should be excluded.

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

Case 3

- Determinants of instability (unstable tachycardia): Any ONE of the following

- Hemodynamically unstable or Shock
- Ischemic chest pain
- Dyspnea due to heart failure
- Syncope or near-syncope
- Spot BP can not represent average BP for any individuals → Baseline BP should be questioned!!

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

WQT

- 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

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

WQT

- 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)

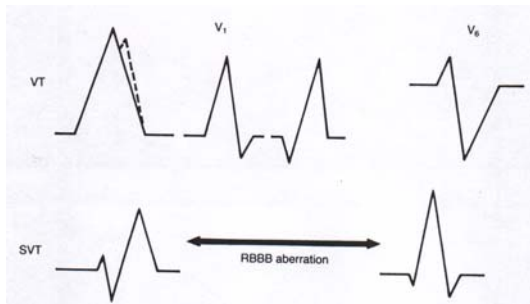
- V1-2: R duration > 30 msec; duration from onset of R to nadir of S > 60 msec; notching in downsloping of S
- V6: QR or QS

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

WQT

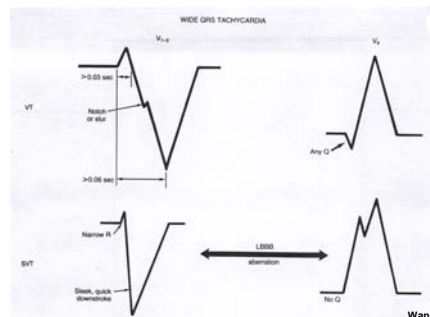


2005/11/8

Wang TL: ED Pitfalls (1)

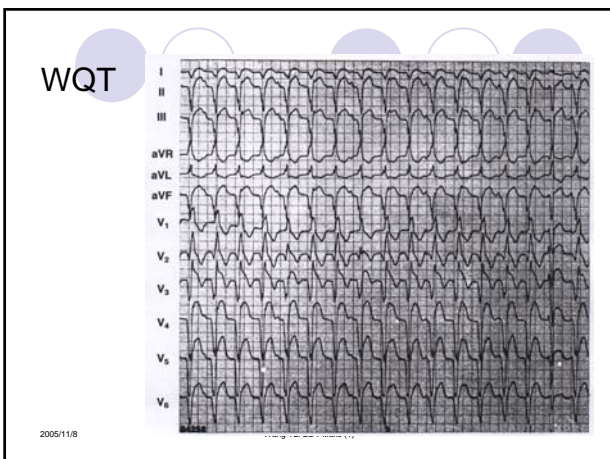
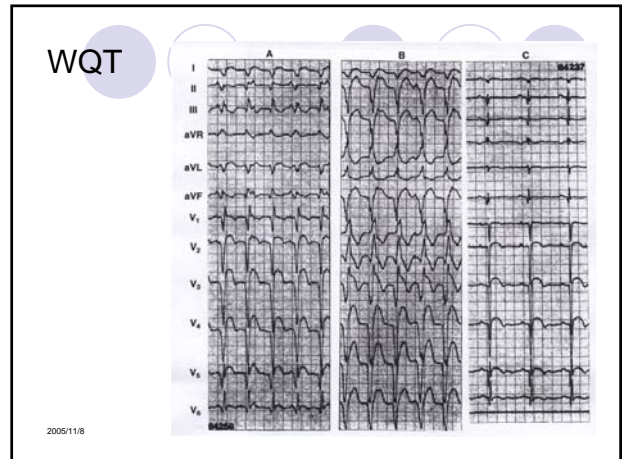
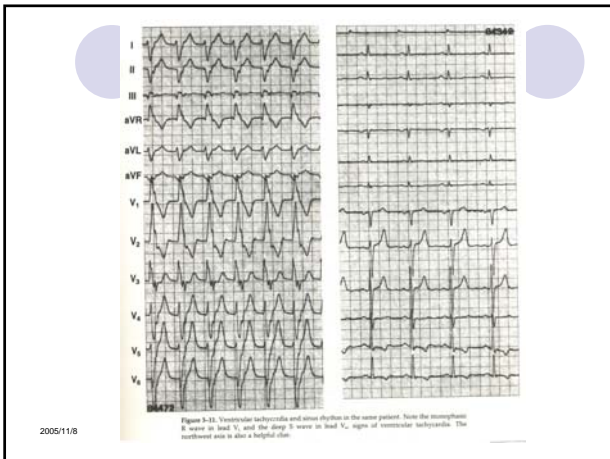
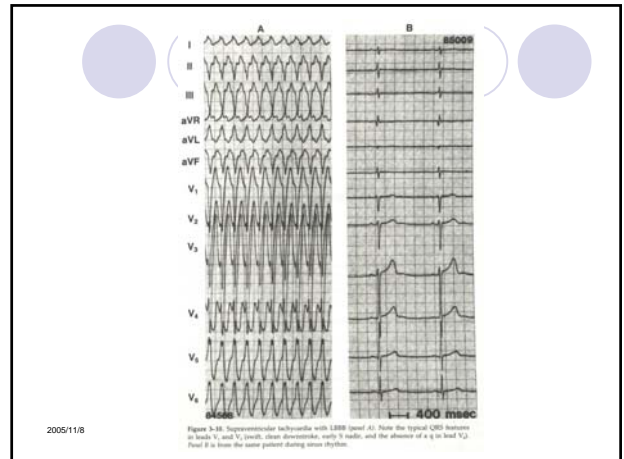
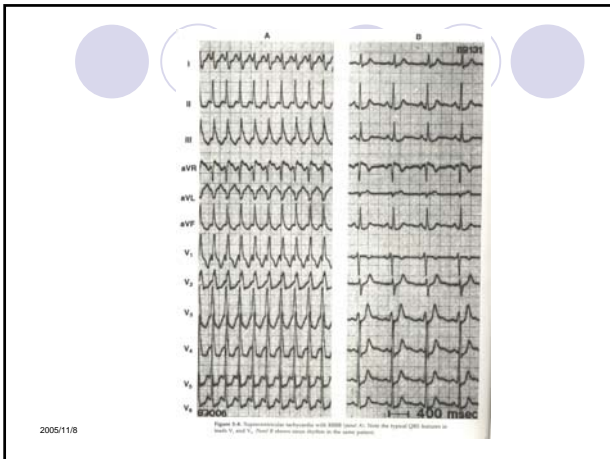
Wang's Rule

WQT



2005/11/8

Wang's Rule



Case 4

- 70 yo man admitted with CHF. Unwell for 1 wk with vomiting. Nil meds. Hyperventilating on admission with O₂ supplementation.
- EUC Na 127, K 5.2, Cl 79, HCO₃⁻ 20, BUN 50, Cr 3.8, glu 95, AG 28
- ABG pH 7.58
pCO₂ 21 mm Hg
pO₂ 154 mm Hg
[HCO₃⁻] 19 mmol/l

2005/11/8 Wang TL, ED Pitfalls (1)

Structured assessment of acid-base disorders

- Predict diagnosis from history, examination & initial investigations
ABG analysis
- Confirmatory tests
- Treat underlying disorder

2005/11/8

Wang TL, ED Pitfalls (1)

Systematic ABG analysis (Boston approach)

1. Check arterial pH
2. $[\text{HCO}_3^-]$ & pCO_2 analysis
3. Calculate AG
4. Check "clues"
5. Assess compensatory responses
6. Assess delta ratio
7. Formulate acid-base diagnosis

2005/11/8

Wang TL, ED Pitfalls (1)

1. Arterial pH

- Principle – The body does not fully compensate for primary acid-base disorders.
- Whichever side of 7.40 the pH is on, the process which caused it to shift to that side is the primary abnormality ie
 - $\text{pH} < 7.4 \rightarrow$ acidosis
 - $\text{pH} > 7.4 \rightarrow$ alkalosis

2005/11/8

Wang TL, ED Pitfalls (1)

2. $[\text{HCO}_3^-]$ & pCO_2 analysis

- Both $[\text{HCO}_3^-]$ & pCO_2 are low \rightarrow metabolic acidosis or respiratory alkalosis
- Both $[\text{HCO}_3^-]$ & pCO_2 are high \rightarrow metabolic alkalosis or respiratory acidosis
- $[\text{HCO}_3^-]$ & $\text{pCO}_2 \rightarrow$ a mixed disorder **must** be present

2005/11/8

Wang TL, ED Pitfalls (1)

3. AG

- $\text{AG} > 20 \text{ mmol/l}$ \rightarrow metabolic acidosis regardless of pH or $[\text{HCO}_3^-]$
- AG may be elevated in alkalosis but tends to be $< 20 \text{ mmol/l}$

2005/11/8

Wang TL, ED Pitfalls (1)

4. "Clues"

- Hyperglycemia DKA if ketones present
- Hypokalemia Suggests metabolic alkalosis
- Hyperkalemia Suggests metabolic acidosis
- Hyperchloremia Common with normal AG metabolic acidosis
- Elevated creatinine Uraemic acidosis or hypovolaemia
- Elevated creatinine (ketones with low/normal creatinine urea give false) Consider ketoacidosis interfere with lab measurement & elevated result)

2005/11/8

Wang TL, ED Pitfalls (1)

5. Assessment of compensatory responses

6 rules

- Acute respiratory acidosis
The $[\text{HCO}_3^-]$ will increase by 1 mmol/l for every 10 mm Hg elevation in pCO_2 above 40 mm Hg
- Chronic respiratory acidosis
The $[\text{HCO}_3^-]$ will increase by 4 mmol/l for every 10 mm Hg elevation in pCO_2 above 40 mm Hg

2005/11/8

Wang TL, ED Pitfalls (1)

5. Assessment of compensatory responses (continued)

- Acute respiratory alkalosis
The $[\text{HCO}_3^-]$ will decrease by 2 mmol/l for every 10 mm Hg decrease in pCO_2 below 40 mm Hg
- Chronic respiratory alkalosis
The $[\text{HCO}_3^-]$ will decrease by 5 mmol/l for every 10 mm Hg decrease in pCO_2 below 40 mm Hg

2005/11/8

Wang TL, ED Pitfalls (1)

5. Assessment of compensatory responses (continued)

- Metabolic acidosis
Expected $\text{pCO}_2 = 1.5 \times [\text{HCO}_3^-] + 8 \quad (\pm 2)$
- Metabolic alkalosis
Expected $\text{pCO}_2 = 0.7 \times [\text{HCO}_3^-] + 20 \quad (\pm 5)$
- If the actual pCO_2 or $[\text{HCO}_3^-]$ is different from the predicted values, a 2nd acid-base disorder must be present

2005/11/8

Wang TL, ED Pitfalls (1)

6. Delta ratio

- Delta ratio = $\Delta \text{AG} / \Delta [\text{HCO}_3^-]$
Guideline
DR < 0.4 → normal AG acidosis
DR 0.4-0.8 → combined high AG & normal AG acidosis
DR 1-2 → high AG acidosis
DR > 2 → pre-existing elevated $[\text{HCO}_3^-]$ ie metabolic alkalosis or compensation to chronic resp acidosis

2005/11/8

Wang TL, ED Pitfalls (1)

Alternative approach to delta ratio

- Calculate AG
- If AG elevated, add DAG to $[\text{HCO}_3^-]$
- If $\text{DAG} + [\text{HCO}_3^-] > 24 \rightarrow$ metabolic acidosis
- If $\text{DAG} + [\text{HCO}_3^-] < 24 \rightarrow$ coexisting normal AG metabolic acidosis

2005/11/8

Wang TL, ED Pitfalls (1)

Case 4

- Systematic assessment
pH : Alkalemia
Pattern : Low pCO_2 & low $[\text{HCO}_3^-] \rightarrow$ resp alkalosis with metabolic compensation
Clues : High AG \rightarrow metabolic acidosis
Compensation: For chronic resp alkalosis (5 for 10 rule)
Expected $[\text{HCO}_3^-] = 24 - 5(40-21/10) \approx 14$ mm Hg
Actual $[\text{HCO}_3^-]$ is higher at 19 mmol/l ie presence of metabolic alkalosis
Delta ratio : $\Delta \text{AG} = 28 - 12 / 24 - 19 = 16 / 5 = 3.2$
 \rightarrow metabolic alkalosis or compensation to chronic resp acidosis

2005/11/8

Wang TL, ED Pitfalls (1)

Case 4

- Evaluation :
 - Triple (or ?quadruple) acid-base disorder
 - Resp alkalosis due to hyperventilation asssd with CHF
 - High AG metabolic acidosis due to ARF
 - Metabolic alkalosis due to vomiting
 - Possible chronic resp acidosis from CO₂ retention

2005/11/8

Wang TL: ED Pitfalls (1)

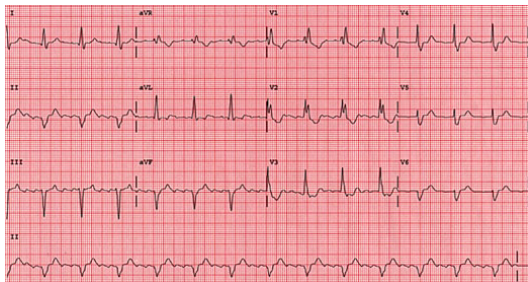
Case 5

- 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?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 5



2005/11/8

Wang TL: ED Pitfalls (1)

Case 5

- 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 be treated as RV infarct with hypotension?

2005/11/8

Wang TL: ED Pitfalls (1)

Case 5

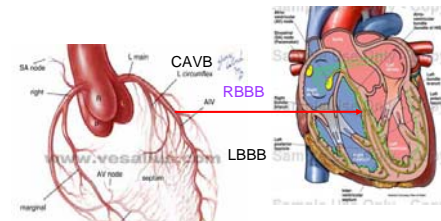
- RBBB in AMI
 - Incidence: 3-29%
 - 37.8% new RBBB, 34.1% old RBBB, and 28.1% with an indeterminate time of origin
 - New-onset RBBB → 50% permanent RBBB
 - More high incidence of heart failure, pacemaker due to AVB, and 1-year mortality
 - Early mortality:
 - New RBBB(43%-76%) > Intermediate RBBB
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

2005/11/8

Wang TL: ED Pitfalls (1)

Case 5

- RBBB in AMI
 - Always means LAD proximal lesions instead of RCA



2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

Case 5

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

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

Case 5

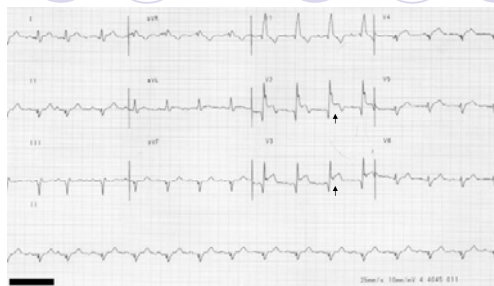
- New-onset LBBB → Treat as AMI
- Any "BBB" that obscures ST elevation with clinically high suspicion of MI → Treat as AMI
- Undetermined LBBB/RBBB
 - Discordant ST-T changes → Undetermined
 - Exceptions: ST elevation above 5 mV
 - Concordant ST-T changes → Consider AMI

2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule

Case 5



2005/11/8

Wang TL: ED Pitfalls (1)

Wang's Rule