APPROACH TO CHEST PAIN & ACS

Clinical

Work-up → ECG | Bio

Date

± Features suggesting ACS → CHEST PAIN : Rest Pain | New Onset (< 2 Months)

Retrosternal Pain

associated

→ DIAPHORESIS | RADIATION | OTHERS

OTHERS → AHF | VA | ↓BP & Shock

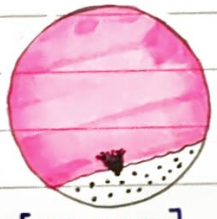
ASCVD R/F

* DM | HTN | DLP (↑LDL)
* Family H/O Premature ASCVD ♂ < 55Y, ♀ < 65Y } FDR
* Active Smoking

ACS = Plaque Rupture → Thrombus

STEMI

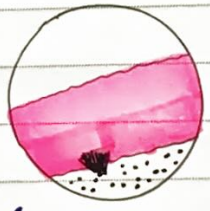
NSTE-ACS (NSTEMI | UA)



[NO FLOW]

Myocardial injury → Tn ↑↑

* Acute
* Single Vessel
* ↓ Collaterals
* ↓ Comorbids
* Young

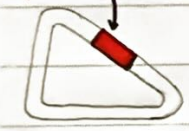


(SOME FLOW) → Myocardial injury

⊕ Tn ↑ → NSTEMI

⊖ Tn Ⓝ → UA

* Sub-Acute
* Multi-Vessel
* ↑ Collaterals
* ↑ Comorbids
* Old



Transmural ischemia → injury currents

ST ↑ → ECG (>20 min.)

Tn ↑↑

THROMBUS → fibrin rich (red)

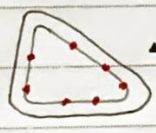
GOALS OF Rx → Reperfusion → 1° PCI / Lysis

ECG

No ST ↑

[ST ↓ ± T ↓]

injury currents



Subendocardial ischemia

Tn ↑ | Ⓝ

platelet rich (white clot)

↓ Thrombus formation → Anticoagulation

± Reperfusion (Lysis C/I)

Biomarkers | ECHO } → Rx

Date

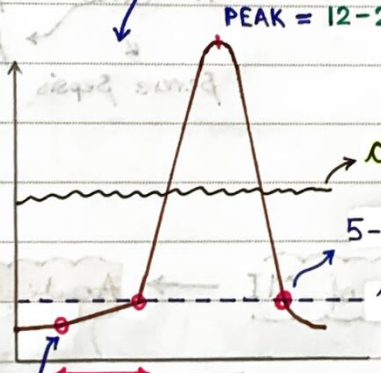
Crescendo

3 STEP Protocol for ACS Work-up

ECG (<10 min.) → ST↑ (vs) No ST↑
- ischemic Δ (New ST↓ ± T↓)
- non-ischemic

IMAGING
- ECHO
  - [RWMA (if new)]
    - {HypoKinetic, AKinetic}
    - based on History
    - correlate ε CORONARY TERRITORY

BIOMARKERS → Tn = Most Sn | Sp of ♡ injury



- T → 7-14 days
- I → 5-10 days

Acute Myocardial injury → cTn = 3-4 Hrs
- if ⊖ → Serial Tn : 3-6 Hourly
- cTn (≥20%) 3-6 Hrs

HSCTn (High Sensitive) → EVERY HOUR

EARLY BIOMARKERS

* Myoglobin
* H-FABP
* IMA → rise in few minutes & returns to baseline ε in 12 Hours

(ischemia modified albumin)

ORPHAN BIOMARKERS

1. CK-MB : relatively specific
   - baseline in <48-72 Hours
   - marker of choice for REINFARCTION
2. LDH : 2 > 1 → ⊖
   - [1 > 2 → MI] → LDH Flip

APPROACH TO CHEST PAIN & ACS

Date

Clinical → Work-up → ECG | Biomarkers | ECHO → Rx

★ Features suggesting ACS → CHEST PAIN : Rest Pain | New Onset (< 2 Months) | Retrosternal Pain | associated → DIAPHORESIS | RADIATION | OTHERS → AHF | VA | ↓BP & Shock

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[NO FLOW]

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NSTE-ACS (NSTEMI | UA)

(SOME FLOW) → Myocardial injury

⊕ Tn ↑ → NSTEMI

⊖ Tn (N) → UA

* Sub-Acute
* Multi-Vessel
* ↑ Collaterals
* ↑ Comorbids
* Old

ECG → No ST ↑ [ST ↓ ± T ↓] → injury currents

Tn ↑ | (N)

platelet rich (white clot)

↓ Thrombus formation → Anticoagulation

± Reperfusion (Lysis C|I)

Crescendo

3 STEP Protocol for ACS Work-up

ECG (< 10 min.) → ST ↑ (vs) No ST ↑

- ST ↑ → ischemic Δ (New ST ↓ ± T ↓)
- No ST ↑ → non-ischemic

IMAGING

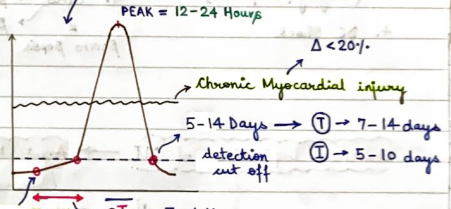
ECHO → [RWMA (if new)] → based on History

- HypoKinetic
- AKinetic

correlate ε CORONARY TERRITORY

BIOMARKERS of ♡ injury

Tn = Most Sn | Sp



Acute Myocardial injury → cTn (≥ 20%) 3-6 Hrs

cTn = 3-4 Hrs

- HSCTn (High Sensitive) → EVERY HOUR
- If ⊖ → Serial Tn : 3-6 Hourly

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(Ischemia modified albumin)

ORPHAN BIOMARKERS

1. CK-MB : relatively specific
   baseline in < 48-72 Hours
   marker of choice for REINFARCTION
2. LDH : 2 > 1 → (N)
   [1 > 2 → MI] → LDH Flip

Tn: Peak / AUC ∝ Severity of MI
↳ MORE (I)

Date

Tn ↑↑ → MI

Tn ↑↑ → Non – MI causes

NON – ISCHEMIC

1. Myocarditis
2. ♡ contusion
3. ♡ procedures (Surgery / PCI / CABG)
4. DC Shock

MULTIFACTORIAL

1. CKD
2. PE
3. Severe HF / CMP *
4. SIRS → Severe Burns
   ↓ → Severe Acute Pancreatitis
   Severe Sepsis

Universal Definition of MI → Acute Myocardial Injury d/t ISCHEMIA

rise & fall of BIOMARKERS

Any '1'

* Clinically : ischemic chest pain
* ECG : new ST Δ / new pathological Q-wave
* Imaging : new RWMA (= new loss of viable myocardium)
* Angio / Autopsy : intra-coronary thrombus

1° presents c ischemic symptoms → complications → CAG!

Date

Types of MI :

- I → MOST © | Spontaneous MI (CAD → Plaque # → Thrombus)
- II → ischemic imbalance (Severe Anemia & LVH)
  - ICU patients → ischemic symptoms
- III → sudden death
- IV → Post-PCI
  - IVa : Peri-PCI (<48 Hrs) → Tn↑ = >5x
  - IVb : In-Stent Thrombosis
  - IVc : In-Stent Restenosis
- V → Post-CABG → Tn↑ = >10x

Ischemic Symptoms → ECG Δ (ST↑) | Tn↑↑ → Type-I MI

CAG → Clean / Ⓝ (<50% stenosis) → MINOCA

? Etiology

- * VASOSPASM → Prinzmetal Angina / Cocaine
- * MYOCARDITIS
- * CMP (eg. Stress CMP)

Best Investigation → ♡-MRI

- * Smokers | ♂
- * ischemic cp → early morning | midnight
- * ECG Δ (ST↑) → transient
- * Tn : Ⓝ ↑

Good Response to NTG

CAG : <50% stenosis → Provocative Testing

- * Ach / Ergonovine Test
- * Hyperventilation

Rx → Acute : NTG

Prophylaxis : CCB (VERAPAMIL)

* ~~ASA~~ (avoided)

INITIAL Rx OF ACS

Date

Suspected ACS

→ ECG

ST ↑

→ STEMI Guidelines

* pain control
* loading dose (antiplatelets)
* anti-coagulants
* address complications (if any)

→ CP duration : < 12 Hours

→ TOC : REPERFUSION

* 1° PCI (Best) → DTB : <90 min.
* Lysis → DTN : < 30 min.

No ST ↑

→ RISK → Low - Intermediate

→ OBSERVE

- No New Δ → Manage OP
- New Δ → HIGH RISK

HIGH RISK

* Clinically (CP duration >12 Hrs
* ECG (ischemic Δ)
* Tn (if ↑)

→ ADJUNCTIVE Rx

MORPHINE (if severe anxiety)

OXYGEN (if SpO_2 < 94% / Severe SOB)

NITRATES (Short Acting : NTG → S/L, iV (if BP ↑↑))

~~NTG~~ → ↓BP, RVMI

ANTI-PLATELETS

BETA-BLOCKERS (Advantage : ↓ infarct expansion / ↓ VA risk)

C → Anti-Coagulants

→ Consider STATINS / ACE⊖

C/I →

1. BA / COPD
2. HR < 60
3. 2°/3° AV Blocks
4. PR > 0.24 sec
5. AHF
6. Hemodynamic instability

MI specific C/I →

- Age > 80 Yrs
- SBP < 120 mm Hg
- HR > 110/min.

→ PRE-SHOCK

Date

★ ANTI- PLATELETS

CHEWABLE (Disprin)

ASA → Loading Dose : 150 - 300 mg → immediate release

Maintenance Dose : 75 - 81 mg/d → BABY ASPIRIN

± P_2Y_{12} r⊖ (ADP r⊖)

- CLOPIDOGREL
- PRASUGREL
- TICAGRELOR → Dyspnoea (Q) ; → Active Drug

CLOPIDOGREL → Prodrug → CLOPIDOGREL → 2c19 → Active (15%) ; backdoor → inactive (85%)

* Loading Dose : 300 - 600 mg
* Maintenance Dose : 75 mg/d

PRASUGREL → PRASUGREL → 2c19 → Active (100%)

* 60 mg
* 10 mg/d

TICAGRELOR

* 180 mg
* 90 mg BID

C/I (Prasugrel)

- ABSOLUTE → H/O STROKE / TIA (Q)
- RELATIVE → { Age > 75 Y ; Wt. < 60 Kg } → if using then ↓ DOSE by 50%.

★ ANTI - COAGULANTS

1. UFH ($t_{1/2}$ ↓) → if PCI < 48 Hrs
2. LMWH (ENOX) → $t_{1/2}$ ↑ → if PCI not planned < 48 Hrs

} → if No H/O HIT

ENOXAPARIN → 1mg/kg S.C BD

3. FONDAPARINUX → $t_{1/2}$ = 17 Hrs
4. BIVALIRUDIN → Direct Thrombin ⊖ → $t_{1/2}$ = 3-5 min. → ∴ during PCI (continuous infusion)

} → used if H/O HIT

Date

WHEN TO DO CAG → URGENT (< 24 Hrs) → ST Δ / Tn ↑

EMERGENT (< 2 Hrs)

* Recurrent / Refractory cp
* AHF / ♡ Shock
* Recurrent VA
* Mechanical complications (Ac. MR / Ac. VS rupture)

DEFINITIVE Rx

CP

ECG = STEMI [< 10 min.]

cp < 12 Hrs

REPERFUSION

ESTIMATED DTB

< 120 min. → 1° PCI (ideal DTB < 90 min.)

> 120 min

LYSIS (Ideal DTN ⇒ < 30 min.)

OUTCOMES

SUCCESS → PCI (< 24 Hr) → Pharmacoinvasive Strategy

FAILURE → RESCUE PCI (asap / imm.)

if cp +++
ECG : poor resolution of ST ↑ (< 50 %)

(ECG done @ 60-90 min. from beginning of Lysis)

COMPLICATIONS → DEATH

OUT OF HOSPITAL : MCC → VA

IN HOSPITAL : MCC → ♡ SHOCK / AHF

AHF / ♡ SHOCK → TOC : Emergency Reperfusion

Date

PUMP FAILURE

LV ↔ RV : JV Distension, ↓ BP

LV → Ant. Wall MI = LVF

LAD → Pulmonary Edema

* CREPITATIONS
* PCWP ↑↑

Rx

1. ↓ PRELOAD
   NTG / DIURETICS
2. ↓ AFTERLOAD
   IABP → [MI + ♡ shock]
   ↑ diastolic pressure
   ↑ CBF
   ↓ afterload → ↑ CO → ≃ 0.5 - 1 L/min.
   if PCI delayed d/t some reason
3. ↑ CONTRACTILITY
   INOTROPES ± V-A ECMO
   - BP (n) → VD INOTROPES
     - DOBUTAMINE ($\beta_1 \pm \beta_2$)
     - MILRINONE (PDE-3 ⊖)
     - LEVOSIMENDAN
   - BP ↓ → NON-VD INOTROPES
     - * NA
     - * DOPA → Tachycardia

RV → Inf. Wall MI (RVMI) = RVF

RCA → ↓ PBF

* No crepitations (clear chest)
* PCWP (n) / ↓

Rx

1. OPTIMIZE PRELOAD (Avoid ↓ Preload)
   iV Fluids (NS) : Target JVP → 10-14 mm Hg
2. ↓ AFTERLOAD → RV
   Pulm. VD (inhaled NO / iV EPOPROSTENOL)
3. ↑ CONTRACTILITY
   iNOTROPES ± V-A ECMO

MECHANICAL COMPLICATIONS

I. ACUTE MR

Inf. MI → Papillary Muscle dysfunction → POSTEROMEDIAL

Single Blood Supply (Post. Descending A.) branch of RCA

* PULMONARY EDEMA (Asymmetric)
* SYSTOLIC MURMUR → APEX (PSM) → rare
* PCWP ↑↑↑

II. ACUTE VS RUPTURE

Ant. MI >> Inf. MI → MORE DANGEROUS

* PULMONARY EDEMA
* PSM → LC Sternal border

III. FREE WALL RUPTURE

TAMPONADE

* SOB | Clear Chest
* Pulseless Electrical Activity / Asystole

C/I of THROMBOLYSIS

Date

Absolute

- Any prior ICH or H/o Stroke of Unknown Origin
- Intracranial Neoplasm, Aneurysm, AVM
- Ischemic Stroke (<3 Months)
- Closed Head Trauma (<3 Months)
- Intracranial or Intraspinal Surgery (<2 Months)
- Active Internal Bleeding or Known Bleeding Diathesis (except menses)
- Suspected Aortic Dissection → Tearing | Ripping CP → back; unequal pulse | BP b/w arms
- For STK, prior Rx <6m
- Severe Uncontrollable HTN

Relative

- BP > 180/110 at presentation
- Ischemic Stroke >3 Months prior
- Other Intracranial Diseases
- CPR >10 min
- Major Surgery <3 Weeks
- Internal bleed <2-4 Weeks or active PUD
- Non-compressible Vascular Punctures <24H (LP | Liver Bx)
- Current use of Anticoagulants
- Pregnancy or ~~<1 Week Post - Partum~~
- ~~TIA < 6 months~~
- ~~Infective Endocarditis~~
- ~~Advanced Liver Disease~~

THROMBOLYTICS

1. STREPTOKINASE → 1.5 mU iV infusion (30 – 60 minutes)

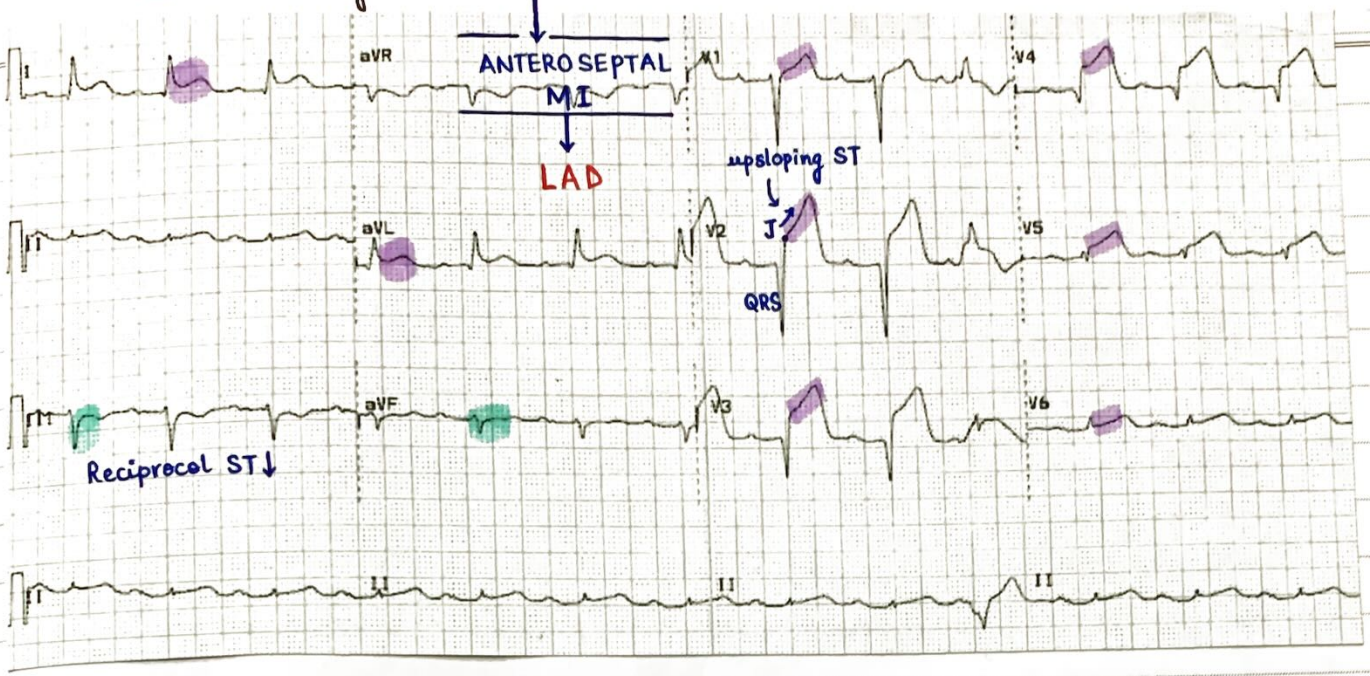
2. rtPA (ALTEPLASE) :

BOLUS	½ Hr. INFUSION	1 Hr. INFUSION	TOTAL
0.15 mg/Kg	0.5 mg/Kg	0.35 mg/Kg	1 mg/Kg
Max. 15 mg	Max. 50 mg	Max. 35 mg	Max. 100 mg

3. RETEPLASE (Double Bolus) → 10 U —30 min.→ 10 U

4. TENECTEPLASE (Single Bolus) → 0.5 mg/Kg
   Max. 50 mg

CP → New Onset Resting → ECG → ST ↑ → STEMI Guidelines



Sequence of ECG Δ → STEMI

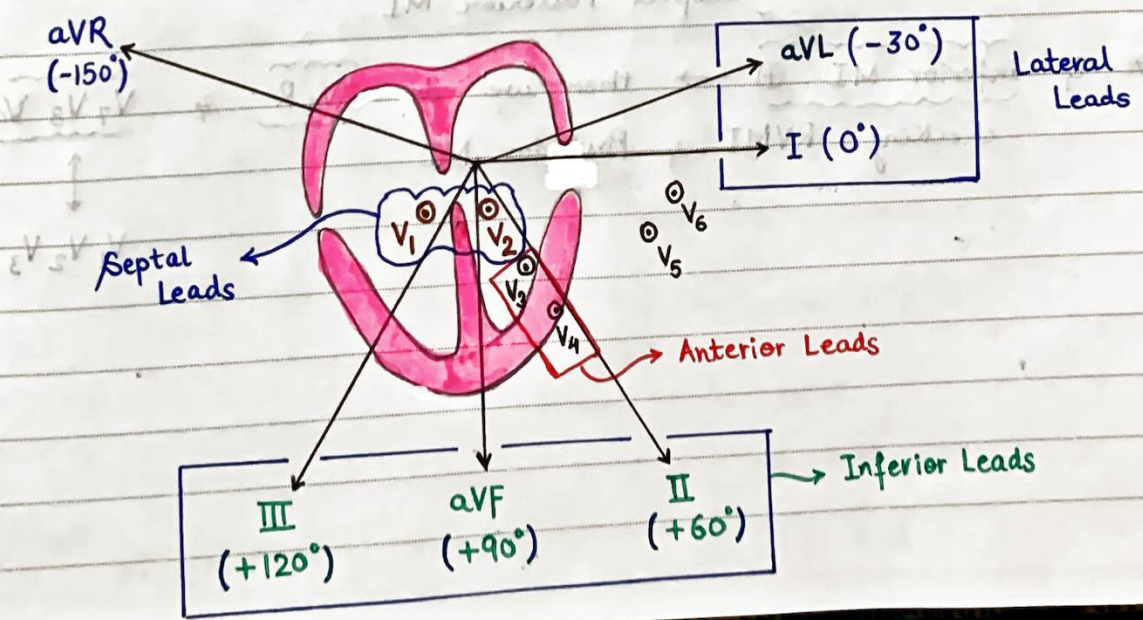
1. **TALL - T** : → Tall | Symmetrical | Tented

2. **ST ↑** : → d/t Transmural ischemia
   - → PARDEE SIGN

3. **T- inversion**

4. **Pathological Q-Waves** = OLD MI
   - 2mm deep
   - 1mm wide

ST ↑
- Nature → CONVEX | TOMBSTONE
- Associated Δ
  - * RECIPROCOL ST ↓
  - * Pathological Q-Wave



Date

★ Pitfalls of ECG → * RV, * Posterior LV, * Atrium

Gold Standard → V_4R, V_7 V_8 V_9, Esophageal Leads

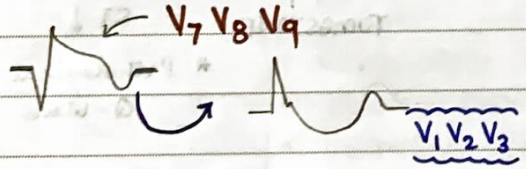
★ ST ↑ → II / III / aVF → Localize → Inferior MI → Culprit Artery → Post. Descending Artery → RCA / LC_X

$\{V_1\ V_2 / V_3\ V_4\}$ ± I / aVL ± V_5 V_6 → Septal MI > Anteroseptal → LAD

Anterior MI → LAD

V_4R → RVMI → RCA

V_7 V_8 V_9 → Posterior MI → PLV → RCA / LC_X → Post. LV branches

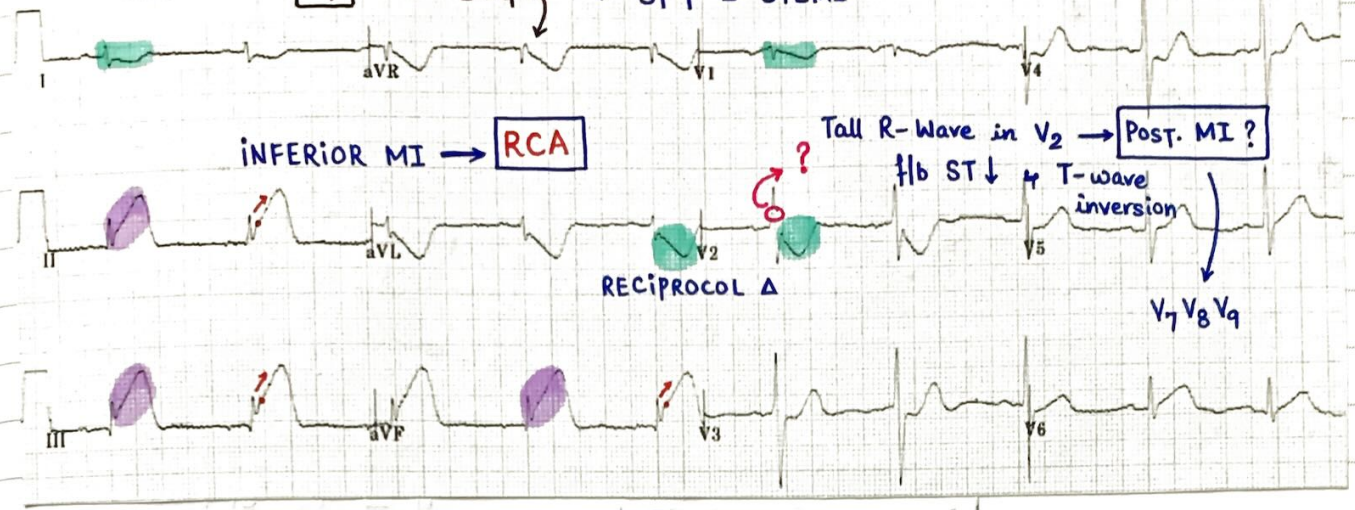


I / aVL ± V_5 / V_6 → Lateral MI → LC_X

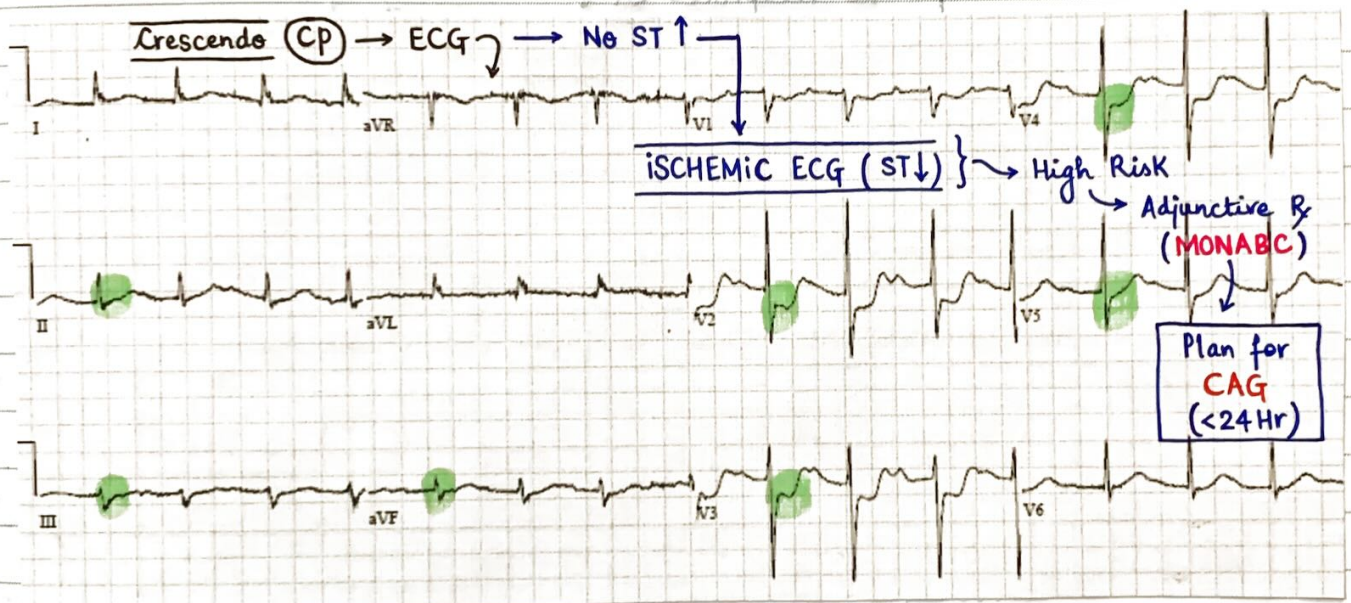
* if inferior MI ⊕ → suspect Posterior MI → then we do V_4R & V_7 V_8 V_9 for checking RVMI & Posterior MI ↔ V_1 V_2 V_3

Date

New Onset CP → ECG → ST ↑ = STEMI



Crescendo CP → ECG → No ST ↑



* To Know if its RCA territory infarct or LCx territory infarct

↓

Look for ST ↑ → Where it is MORE

in II or III

↙ RCA ↘ LCx

↓

check for Reciprocol ST ↓

↓

Where it is MORE

in I or aVL

↓ LCx ↓ RCA

Date

ST ↓
- Myocardial Ischemia (subendocard.)
- Post-MI (V_1 V_2)
- Digitalis Effect → Hockey Stick ST↓
- ↓K^+ / ↓Ca^{2+}
- Repolarisation abⓝ : LVH | LBBB | RV Pacing

ST ↑

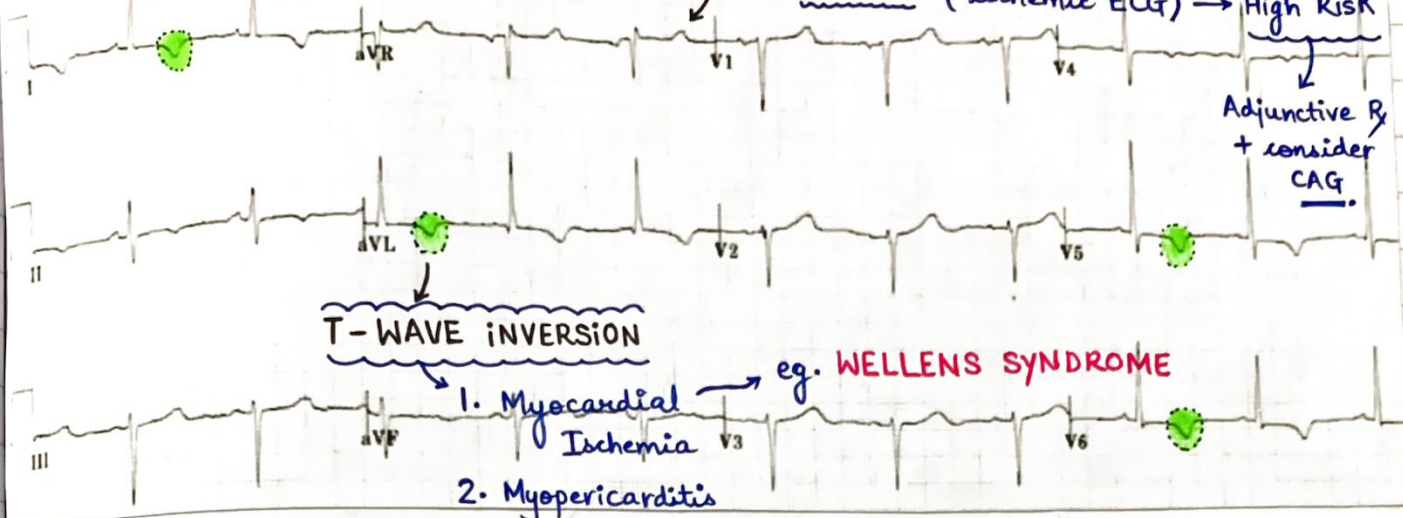
1. STEMI
2. ACUTE PERICARDITIS
   * H/O URI | (CP) → pleuritic (↑ c deep inspiration)
     ↳ ↓ c leaning forward | radiates to TRAPEZIUS
   * ECG : ST↑ → multifocal | global
     - → concave / saddle back
     - → no reciprocol ST ↓
     - → Associated Δ : PR↓
   * cTn → Ⓝ

   Sequence
   i) ST ↑
   ii) Ⓝ
   iii) T-Wave inversion
   iv) Ⓝ
3. Coronary VASOSPASM → Prinzmetal, Cocaine intoxication
4. REPOLARIZATION ABNORMALITIES : LVH | LBBB | RV Pacing | ERS* | Brugada Sx
   Early Repolarisation Sx
   * Young | Healthy ♂
   * incidental ST ↑
5. OTHERS : CMP | LV Aneurysm Q | ♡ contusion | Post-ROSC | PE | ↑K^+ ↑Ca^{2+} *
   - CMP → HCM, STRESS → (TAKOTSUBO)*
   - LV Aneurysm → Persistent ST ↑ → Post-MI → 2D-ECHO
   - Post-ROSC Q → Transient ST ↑ (< 8 min.)
6. ST ↑ in aVR Q → LMCA Disease (Left Main Coronary Artery) → (+ ST↑ in V_1 + ST ↓ in >5 leads)

Salvador Dali's Moustache

Date

Acute CP (New Onset) → ECG → No ST↑ (ischemic ECG) → High Risk → Adjunctive Rx + consider CAG.

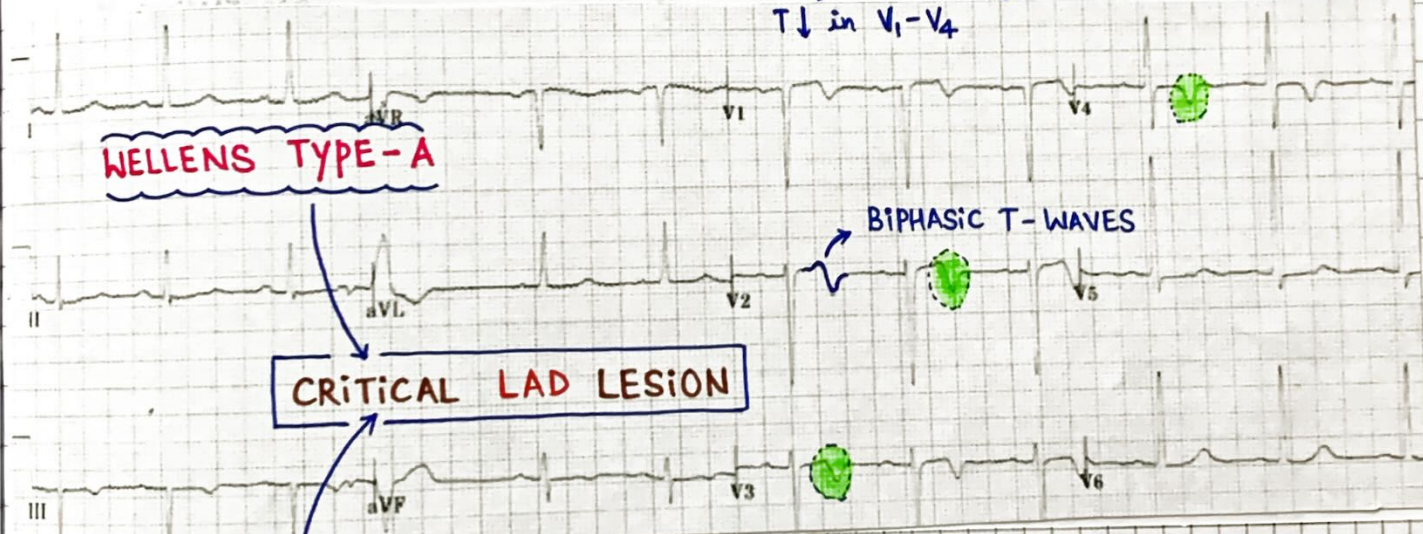


T-WAVE INVERSION

1. Myocardial Ischemia → eg. WELLENS SYNDROME
2. Myopericarditis
3. CMP (HCM | Stress | ARVC)
4. ↓K+
5. Repolarisation abⓝ : LVH | LBBB | RV Pacing
6. OTHERS : MVP | PE | ↑ICP

PE → T↓ in V_1-V_4

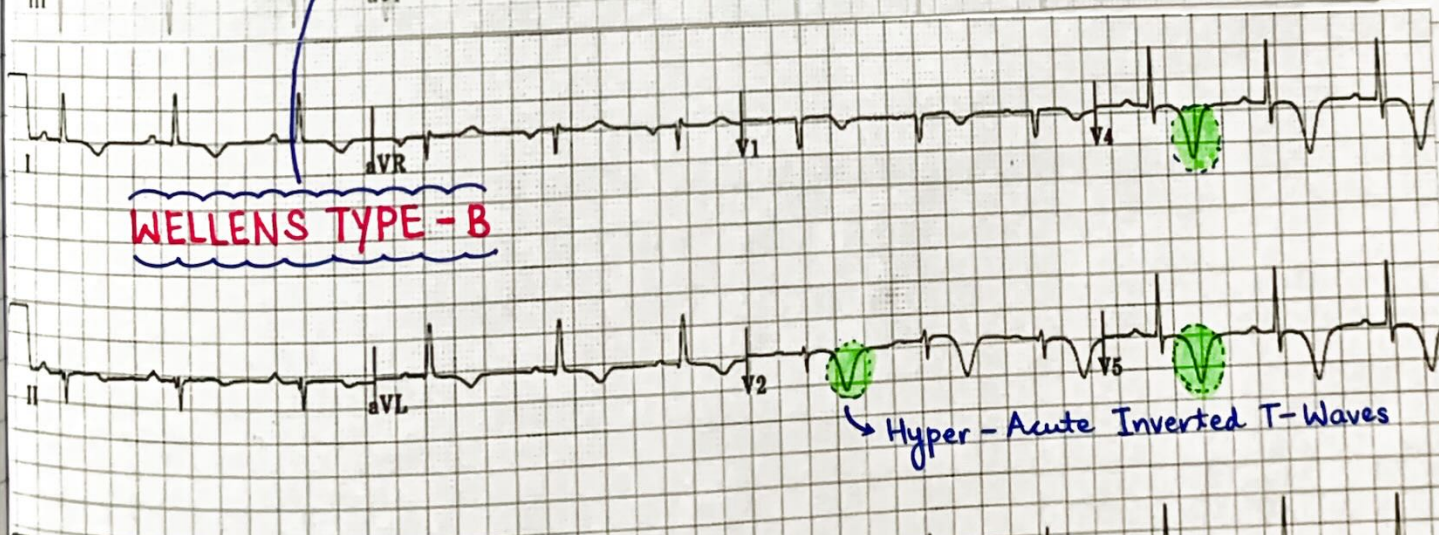
↑ICP → eg. SAH → CEREBRAL T-WAVE



WELLENS TYPE-A

BIPHASIC T-WAVES

CRITICAL LAD LESION



WELLENS TYPE-B

Hyper-Acute Inverted T-Waves

Date

ST ↓ → Myocardial Ischemia (subendocardial)
→ Post-MI (V_1V_2)
→ Digitalis Effect → Hockey Stick ST↓
↓K^+/↓Ca^{2+}
→ Repolarisation abⓝ : LVH | LBBB | RV Pacing

ST ↑

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2. ACUTE PERICARDITIS
   * H/O URI | CP → pleuritic (↑ ε deep inspiration)
     ↓ ε leaning forward | radiates to TRAPEZIUS
   * ECG : ST ↑ → multifocal | global
     → concave | saddle back
     → no reciprocal ST ↓
     → Associated Δ : PR ↓
   * cTn → Ⓝ

Sequence
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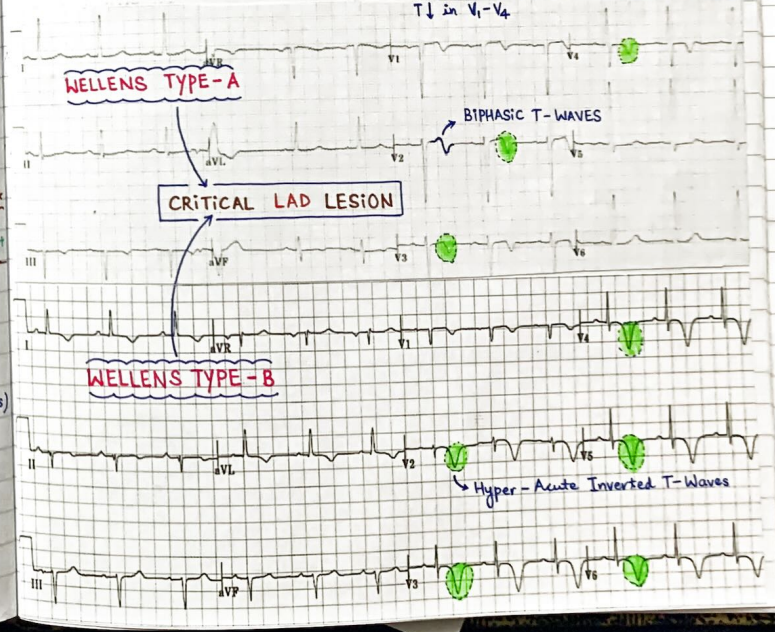


Date

STABLE ISCHEMIC ♡ DISEASE

FEATURES

* CP → <10 min. duration (ischemic)
  - ↑ on exertion
  - ↓ c rest / NTG (<30s – 5min.)

3/3 → Typical
2/3 → Atypical
1/3 → Non-♡ CP

* Chronic CP (>2 months)

WORK-UP

CORONARY IMAGING

- invasive CAG
- CCTA → 100% NPV

STRESS TEST

STRESS
- PHYSICAL (Treadmill)
- PHARMACOLOGICAL
  - DOBUTAMINE
  - MICROVASCULAR DILATORS (Steal!) → ADENOSINE

TEST

- TM Only ↔ {ECG} → ST Δ
- IMAGING → LOCALIZE ISCHEMIA

ECHO	SPECT	PET	CMR
TM / Pharma (DOBUTAMINE)	TM / Pharma (ADENOSINE)	Pharma: ADENOSINE	Pharma: ADENOSINE

RWMA ←→
PERFUSION DEFECTS ←→
Quantitative BF / Microvascular fn ←→

SPECT

- Th^{201}
  - * K^+ analogue
  - * Redistribution
  - * 70 KeV
  - * $t_{1/2}$ = 72 Hrs
- Tc^{99m} (SESTAMIBI, TETROFOSMIN)
  - * 140 KeV
  - * $t_{1/2}$ = 6Hrs

PET tracers → 511 KeV

- Rb^{82} → 75-90s
- H_2O^{15} (O^{15} water) → 2 min.
- $N^{13}H_3$ (Ammonia) → 10 min.

↑ cost
↓ $t_{1/2}$

Date

PROBABILITY OF CAD

- ✗ ← LOW
- ♂ > 40y | ♀ > 50y
- Old | comorbids ↔ High → Typical
- Int.
- Young | NO comorbids ↔ Atypical
- Low

INTERMEDIATE

→ NON-INVASIVE TEST

- CCTA
- Stress Test
  - ECG
  - imaging

Indications for Stress ECG

* Intermediate probability of CAD
* Able to Walk
* No Significant Baseline ECG Δ
  * LBBB
  * WPW Syndrome
  * ST ↓ >1mm
  * Any ST ↓ ē LVH | Digoxin

HIGH

→ SEVERE ANGINA (Class III | IV)

- YES → CAG → Revascularisation
- NO → CCTA | Stress Imaging → LMS Disease ?
  - Yes → CAG-R (regardless of Angina)
  - No → Medical Rx (vs) CAG-R

TM PROTOCOL → Bruce Protocol : 7 stages ↔ 3 minutes each

END POINTS ?

* **TARGET HR** (85% of Max. HR) → [220 − Age]
* **HIGH RISK** → ECG
  - 1. ST ↓ >2mm
  - 2. ST ↑
  - 3. VA
  - 4. aVR ⇝ ST ↑ (= LMS Disease)
  - 5. ST ↓ persisting >5 min. into recovery...
* **Physiological**
  1. < 6 min.
  2. ↓ SBP >10 mm Hg
  3. Limiting Angina

Date

MANAGEMENT OF SIHD

I. ↓ SYMPTOMS

{ ANTI-ANGINALS } ⟷ SURVIVAL

1. Short Acting NITRATES (NTG PRN) + βB ⟷ (Alternative) ND-CCB
   - βB → Cardioselective
   - ND-CCB → * VERAPAMIL, * DILTIAZEM
2. D-CCB (-dipines)

→ CAG-R (if not already done)

OTHERS

1. Long Acting NITRATES (ISDN/ISMN)
   - → PROBLEM : TOLERANCE → 12-14 Hr / day Nitrate free interval Kept
2. IVABRADINE (I_f ⊖) → [HR > 70 bpm + Sinus Rhythm] (pre-requisite)
   - * MOST © S|E → BRADYCARDIA
   - * VISUAL CHANGES → Luminous Phenomenon
3. NICORANDIL
   - Nitrate like
   - CO = KO → Kt opener
   - → Oral & Anal Mucosal ulcers
4. TRIMETAZIDINE → PFOX⊖ → makes ♡ to use Glucose as fuel ...
   - → movement disorders
5. RANOLAZINE → Late I_{Na^+} ⊖ / PFOX ⊖
   - ↓ Diastolic Tension → Coronary Blood Flow ↑

Date

II. ↑ SURVIVAL
- ASA ↔ Alternative → CLOPIDOGREL → can be used in all patients
- STATINS (High Intensity)
- ACE ⊖ / ARB → Indications
  - * DM
  - * HTN
  - * EF ≤ 40%

III. REVASCULARISATION
- PCI (↔ Survival)
  - {REFRACTORY ANGINA + No Indication for CABG}
  - FFR ≤ 0.8
    - fractional flow reserve
    - BMS
      - * ↑ Restenosis
      - * DAPT ≥ 1 month
    - DES
      - * Preferred ↓ Restenosis
      - * DAPT ≥ 6 months
      - mTOR ⊖
        - ~~*~~ SIROLIMUS
        - * EVEROLIMUS
        - * ZOTAROLIMUS
- CABG
  - * LMS Disease (regardless of Angina)
  - * REFRACTORY ANGINA + {* 3 Vessel Disease; * 2 Vessel Disease + Proximal LAD}
  - + DM
    - GRAFTS
      - LIMA → in-situ → ↑↑ patency
      - SVG (GSV) → free → ↓ patency
      - OTHERS : Radial Artery / RIMA

Date

HEART FAILURE

Suspicion of HF → Clinical → S_3

↑ Congestion

* JVD
* Edema
* Ascites
* Effusions
* Hepatomegally
* Crepitations

↓ Perfusion

* Cold & Clammy extremities
* Fatigue | exercise intolerance
* Oliguria
* ↑ CRT (Ⓝ <2sec)
* AMS
* ↓ BP → Shock

WORK-UP

BNP or NT pro BNP

↑↑ NPV

if Ⓝ → r/o HF

if ↑↑ → ECHO → Gold Standard

ECHO → Δ HF (CONFIRMED)

ECHO → r/o HF

Δ HF (CONFIRMED) → CLASSIFY (EF)

<40%	41-49%	≥ 50%
HFrEF	HFmrEF	HFpEF
reduced	mildly reduced	preserved

OVERALL MORTALITY IS SAME

Date

Management of Chronic HFrEF → GOALS → ↑ QOL, ↑ Survival, ↓ HF Hospitalisation

STEP-1 : Quadruple Rx ↔ CLASS I

① ARNi [SACUBITRIL – VALSARTAN] >> ACEI / ARB

- MOST © S|E
- ↓ BP
- S|E
  - * ↑ K^+ [C|I if S.K^+ > 5; Withold if S.K^+ > 5.5]
  - * ↓ GFR → ↑ S.Cr (Withold if ↑ by ≥ 30%.)

② BB
- METOPROLOL (succinate)
- BISOPROLOL → selective
- CARVEDILOL → non-selective

③ MRA
- SPIRONOLACTONE
- EPLERENONE
→ equal efficacy; ↓ S|E

④ SGLT-2 ⊖ → EMPA / DAPA
- AVOIDED if eGFR < 20
- AVOIDED if eGFR < 30

HF → ↓ Perfusion → SNS
- ↑ Renin → ↑ AT II → VC (aA, Venules) → ↑ afterload, ↑ preload → ADVERSE REMODELLING → Progressive HF → ESHF
- ACE ⊖
- ARB
- ↑ Aldosterone → ↑ Na^+ Reabsorption
- MRA
- BB (β_1, β_2) → ↑ HR, ↑ SV → ↑ CO → ↑ Workload (↑ O_2 cons.) → TO

BRADYKININ ↑, AT-II
Degraded by NEPRILYSIN
↑ BNP → VD, Natriuresis
SACUBITRIL – VALSARTAN
S|E : Cough & Angioedema
d/t SACUBITRIL

---

if patients are CONGESTED → DIURETICS
- LOOP
- THIAZIDE

* ↓ HF Hospitalisation
* ↔ mortality

Date

STEP-1 : Quadruple Rx

↓

3-6 months

↓

STEP-2 : ECHO → < 40% → PERSISTENT HFrEF → NYHA II-IV → **STEP-3**

ECHO → >40% → HFimp EF → CONTINUE SAME QUADRUPLE Rx

HFrEF → NYHA-I → CONTINUE SAME QUADRUPLE Rx

STEP-3

① Hydralazine - ISDN (Blacks)

② INTERVENTIONS

- **ICD**
  - for 1° Prevention
    - a) EF < 35%
    - b) NYHA II | III
- **CRT** (Cardiac Resynchronization Therapy)
  - Biventricular Pacing
    - a) EF < 35%
    - b) NYHA → II-IV
    - c) c/o conduction delay...
      - **ECG**
        - QRS ≥ 120 ms
        - if QRS ≥ 150ms = LBBB
          - BEST !

CRT-D → Hybrid Device

Date

STILL SYMPTOMATIC
NYHA II – IV

STEP-4

* ↔ MORTALITY
* ↓ SYMPTOMS

① DIGOXIN (↓Sx / ↓HFH)
② IVABRADINE (if HR > 70 + Sinus Rhythm)
③ VERICIGUAT (Soluble Guanylate Cylase ⊕)
④ PUFA
⑤ IV IRON
  * if Ferritin < 100
  * if Ferritin 100–300 + T_{sat} < 20%

Sx → STEP-5

ADVANCED HF

① Heart Transplant
② LVAD (LV assisted device)
  * BTT (MC)
  * BTR
  * DT

BTT : Bridge To Transplant
BTR : Bridge To Recovery
DT : Destination Therapy

NYHA — based on Symptoms !

I → No Limit. / No SOB ē Ordinary Activity
II → Mild Limitation / SOB ē Ordinary Activity
III → Moderate Limitation / SOB ē < Ordinary Activities
IV → Severe Limitation / SOB @ Rest or Any Activity → results in SOB

ACC / AHA Staging

A : R/F Only
B : Structural ♡ Disease / Asymptomatic
C : Symptomatic
D : Refractory HF

Date

ACUTE HF

ETIOLOGY

Forget Medications

Arrhythmia / Anemia

Ischemia (eg. MI) / infections

Lifestyle (eg. ↑↑ Na^+ intake)

Upregulation of CO [Hyperdynamic States] → Pregnancy, ↑T_3, Beri-Beri

Renal Failure

Embolism (PTE)

GOALS OF Rx

↓ CONGESTION

LASIX (LOOP DIURETICS) → ↑ DOSE (iV Bolus = continuous iV infusio

± THIAZIDE

± SGLT-2⊖

± CRRT

MORPHINE → ↓ Preload

NITRATES

O_2 → if SpO_2 < 90-92% / SOB

POSITION → FOWLER's ± PPV (CPAP) } → ↓ Preload

Date

↑ PERFUSION → INOTROPES ± MCS (Mechanical Circulatory Support)

eg. V-A ECMO

LVAD | Impella | Tandem ♡ | IABP

BP

(N) → VD inotropes

↓↓ → Non VD inotropes

* DOBUTAMINE
* MILRINONE
* LEVOSIMENDEN

* NA
* DOPA

IABP Indications

* Acute MI + ♡ Shock + PCI Delayed
* Acute MI + Mechanical complications

* Congestion → PCWP ≥ 15 mm Hg
* ↓ Perfusion → C.I ⇒ < 2.1 L/m² (Cardiac Index)

APPROACH TO CMP

~~iCMP~~ / niCMP → NON-INVASIVE GOLD STANDARD → CMR

Date

* HCM / DCM / RCM
* Unclassified : ARVC

I. HCM (MOST ©)

* PREVALENCE : 0.2 - 0.5 % (1 in 200 - 500) / MCC of Sudden Death in Young Ad
* DEFINITION : unexplained LV (± RV) Hypertrophy (≥ 15 mm) [Ⓝ LV Thickness 9-10 mm]
* GENETICS : Sarcomeric # (AD) → [MYH 7 / CMy BPC] → ≃ 70 % cases
  - rarely → Non-Sarcomeric forms → FABRY's DISEASE (XLR) ♂
    - HCM
    - α - Galactosidase deficiency
    - PN ± (NS)
    - Skin Δ → AngioKeratoma
    - Rx : ERT (FABRAZYME)

* PATHOLOGY ↔ Biopsy
  - MYOCYTES → fibrosis
    - DISARRAY (HELTER-SKELTER)
    - Hypertrophy

* PATHO-PHYSIOLOGY → LVH
  - FIBROSIS → ↑ risk of VA
  - HFpEF (diastolic dysfunction)
  - LVOTO → MOST © reason → Asymmetric LVH (Asymm. Septal Hypertrophy)
    - seen in ≃ 70 %
    - POOR PROGNOSIS (↑ risk of Death)

LVOTO → Dynamic

HOCM → opposite

	LOAD dependent	CONTRACTILITY dependent
Leg Raising / Squatting	↑ Preload → ↓ LVOTO	
Valsalva / Squat → Stand / Diuretics / NTG	↓ Preload → ↑ LVOTO	
isometric hand grip	↑ Afterload → ↓ LVOTO	
Amyl Nitrite / NTP, ACEI / ARB / ARNi	↓ Afterload → ↑ LVOTO	
iNOTROPES		↑ Cont. → ↑ LVOTO
		↓ Cont. → ↓ LVOTO
EXERCISE	↓ Afterload + ↑ Cont.	→ ↑↑↑ LVOTO

→ Early Gadolinium Enhancement → EDEMA

→ LGE = FIBROSIS / SCAR

Date

EXTENT → PROGNOSIS

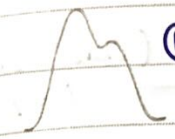
PATTERN → DIAGNOSIS

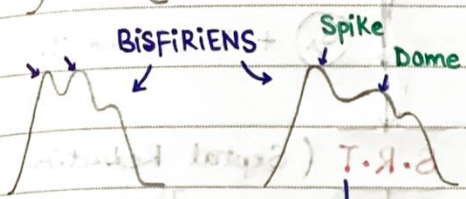
* C/F : Asymptomatic (90%) / Symptomatic

Symptomatic → HF

Symptomatic → Syncope / Sudden Death (exertion / athlete)

Sudden Death → VA





* Severe AR

* AS + AR

HOCM

Signs : BISFIRIENS PULSE (d/t dynamic LVOTO)

Double / Triple Apical Impulse

MURMUR → ESM (ejection systolic)

ESM → dynamic

LLSB / Erb's point

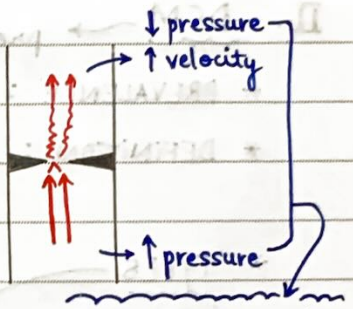
± S_4 / AFib / MR → Pan Systolic Murmur

WORK-UP

i) ECG → LVH / Septal Hypertrophy / Pseudoinfarction

ii) ECHO → LVH ± LVOTO (dynamic) → ∇↑↑ c VALSALVA / EXERCISE

∇ (gradient)



∇ ∝ Severity of Obstruction

± Asymmetrical Septal Hypertrophy (AS > PL)

± SAM of AML (Systolic Ant. Motion of Ant. Mitral Leaflet)

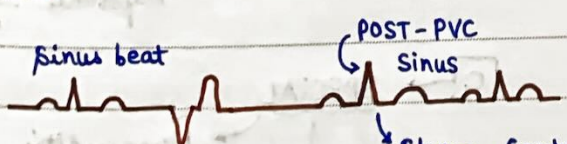
SAM of AML → worsen LVOTO

± MR

iii) CMR → LGE → non-ischemic pattern

LGE → Extent → prognosis

iv) ♡ CATH → BROKENBROUGH EFFECT



VPC (extrasystole) → weak contraction

Strong Contraction → SV↑ → ↑SBP → ↓PP → N

Strong Contraction → ↑ LVOTO → ↓↑∇ → ↓SV → ↓SBP → ↓↓PP

Date

Rx : SUDDEN DEATH → ICD

- 2° Prevention
- 1° Prevention
  - * LVH ≥ 3cm Q
  - * Unexplained Syncope Q
  - * Family H/O sudden death Q
  - * Apical Aneurysm
  - * Extensive LGE (≥20% of LV Mass)

HF

* 1st Line : BB ↔ Alternative : ND-CCB
* 2nd Line : + DISOPYRAMIDE (Class-Ia AAD)

Sx + ∇ ≥ 50 mm Hg → S.R.T (Septal Reduction Therapy)

- ★ MYOMECTOMY (young / fit)
- ★ ALC. ABLATION (old / unfit)

Δ of Exclusion

II. DCM → presentation similar to HFrEF

* PREVALENCE : 1 in 2500
* DEFINITION : unexplained LV (± RV) Dilatation
* TYPES
  - 1° DCM (Idiopathic) — MOST ©
    - GENETICS
      - * MC : TITIN (20-30%)
      - * Dangerous : FLNC / LMNA / PLN / SCN5a
        - Early VA
          - ∴ Consider Early ICD
  - 2° DCM
    - A. DRUGS / TOXINS
      - * ANTHRACYCLINES [DOXORUBICIN, DONORUBICIN]
      - * TRASTUZUMAB
      - >550 mg / m²
      - ALCOHOL — Δ of exclusion
        - >80 gm/d x >5yrs
        - ↑ risk
    - B. NM Disorders
      - Friedrich Ataxia
      - Myotonic Dystrophy
    - C. SPECIAL
      - Myocarditis
      - Peripartum
      - Stress

Rx : similar to chronic HFrEF

Date

* Peripartum DCM : [-1 month to +5 month] / PRL ? fragments
  - NO LGE
  - Rx : BROAD → Oral HF Drugs (A/C, DIURETICS) ; BROMOCRIPTINE
  - / Risk of Recurrence → 30-35 %.

** STRESS DCM → MYOCARDIAL STUNNING
  - ♀ >50y (95%)
  - = BROKEN ♡ SYNDROME
  - H/O Stress (Physical / Emotional)
  - NO LGE
  - C/F : MINOCA
    - * CP ± HF
    - * ECG : new ST Δ (ST ↑)
    - * Tn : mild ↑
    - * ECHO : RWMA (non-coronary)
      - APEX → APICAL BALLOONING (Q) → TAKOTSUBO
      - BASAL → Reverse Takotsubo
  - TAKOTSUBO
    - some → LVOTO (dynamic) → AVOID DOBUTAMINE (Q)
  - Rx : Supportive

*** MYOCARDITIS
  - LGE ⊕ → LAKE-LOUISE CRITERIA
  - Infectious (MOST ©)
    - * VIRAL : PARVO-B19 / HIV
      - PARVO-B19 → MC
      - HIV → MOST SEVERE
    - * BACTERIAL : ARF / Diphtheria
      - ARF → Lyme's
    - * PARASITIC : Chagas Disease (Travel H/O)
  - Non-Infectious
    - AUTOIMMUNE
      - * C.T.D
      - * Idiopathic GCM → Poor Prognosis (Q)
    - DRUGS / TOXINS
      - Eosinophilic Myocarditis
      - * Snake Bite
      - * Bee Sting
      - * Scorpion bite
  - Rx : Supportive + Rx the cause
  - GOLD STANDARD → Endo-Myocardial Biopsy (DALLA'S CRITERIA)

Date

III. RCM : EF ⓝ/↓ ← 2° Diastolic Dysfunction → RHF features are prominent

Myocardial

INFILTRATIONS
- THICK VENTRICLES
- LOW VOLTAGE

* Amyloidosis (AL/AA/ATTR)
* Sarcoid Granulomas
* Storage Disorders (GAUCHER's)
* Hemochromatosis

Endomyocardial

FIBROSIS → Carcinoid | Toxins | RT → CP + RCM

Chronic Eosinophilic → Mural Thrombi → TE

* Loeffler's Endomyocarditis → ? idiopathic temperate
* EM fibrosis → Tropical

PB: ↑ Eos

AMYLOID → Concenteric LGE / Black Blood after giving contrast

℞: ATTR → TAFAMIDIS (stabilise TTR tetramers)

AVOID → DIGOXIN / NIFEDIPINE
- DIGOXIN → ↑ Toxicity
- NIFEDIPINE → ↓ BP

ARRHYTHMOGENESIS

AUTOMATICITY
- ↑ⓝ Automaticity → S. Tachy
- Abⓝ Automaticity → AT/VT

RE-ENTRY
MOST Ⓒ MECHANISM
- * MICRO (AFib)
- (VS)
- * MACRO (A. Flutter / Scar related VT)

TRIGGERED ACTIVITY
after depolarisation
- EAD → Phase 2/3 → * ↑QT → * PMVT's / TDP
- DAD → Phase 4 → Ca^{2+} Overload eg. DIGOXIN

★ STRUCTURAL
(VS)
★ FUNCTIONAL (ischemia)

APPROACH TO SUDDEN DEATH IN YOUNG

VA

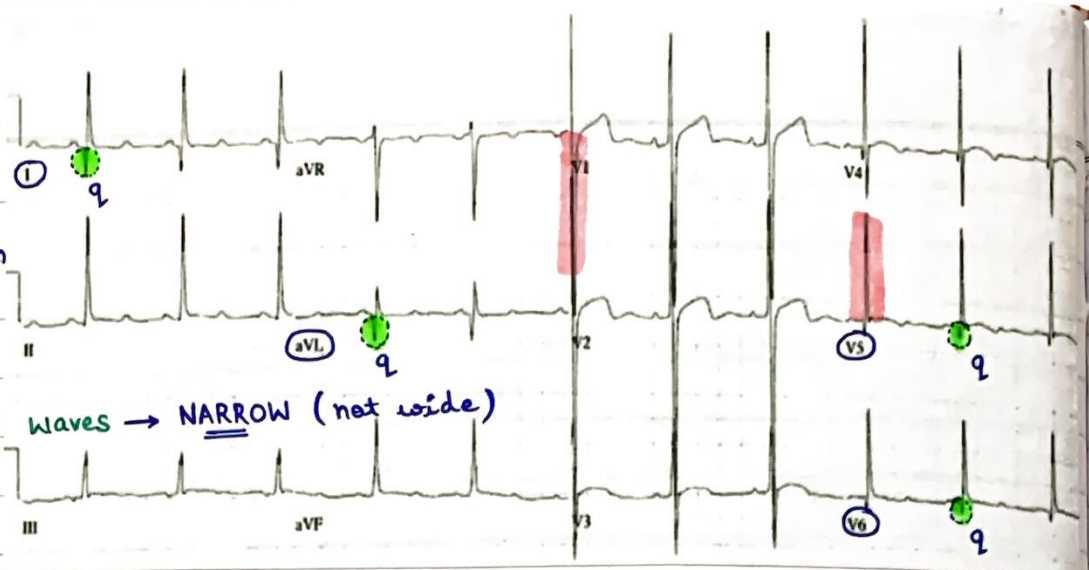
CONCUSSIO CORDIS → H/O Sudden Blow to CHEST → VF → DEATH

FEATURES	HCM (MC)	ARVC	LQTS (Congenital)	BRUGADA	CPVT
GENETICS	SARCOMERIC (MYH7/CMyBPC) → Structural Heart Disease	DESMOSOMAL → S.H.D	LONG QT SYNDROME → CHANNELOPATHY → Na^+ / K^+ / Ca^{2+}	CHANNELOPATHY → SCN5a (Na^+)	CATECHOLAMINERGIC POLYMORPHIC VT → CHANNELOPATHY → Ca^{2+} → MOST © : RyR-2
INHERITANCE	AD Rarely → NON-SARCOMERIC FORMS → eg. FABRY's (XLR) → Angiokeratoma	AD Rarely → SYNDROMIC FORMS → eg. NAXOS DISEASE (AR)	AD (No Deafness) Rarely : JERVELL LANGE NEILSEN SYNDROME (AR) → K^+ Clue : Long QT + Deafness	AD —	AD Rarely → CASQ # (calsequestrin) → (AR)
MECHANISM	RE-ENTRY	RE-ENTRY	EAD	PHASE-2 RE-ENTRY	DAD
RISK OF DEATH	EXERTION	EXERTION	K^+ *LQTS-1 → Swim *LQTS-2 → Loud Noise *LQTS-3 → REST / SLEEP → SCN5a #	REST / SLEEP	EXERTION
ECG ABNORMALITY	✓	✓	✓	✓	X
Imaging abⓝ	✓	✓	X	X	X
Rx	BB + ICD	BB + ICD	LQTS-1/2 : BB + ICD LQTS-3 : ICD ~~BB~~	ICD ~~BB~~ ± QUINIDINE Q	BB + ICD

Date

HCM

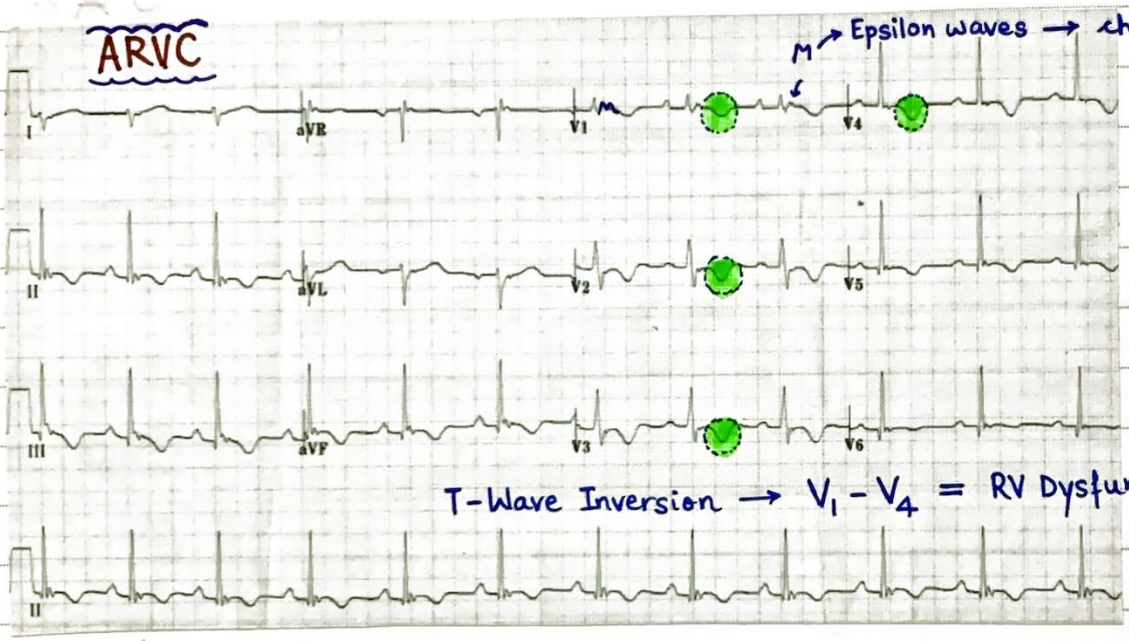
1. LVH : SOKOLOV LYON CRITERIA
   - $SV_1 + RV_5 | V_6 > 35$ mm
2. SEPTAL HYPERTROPHY
   - Dagger like Septal 'q' waves → NARROW (not wide)
     (I | aVL | V_5 | V_6)
3. PSEUDOINFARCTION



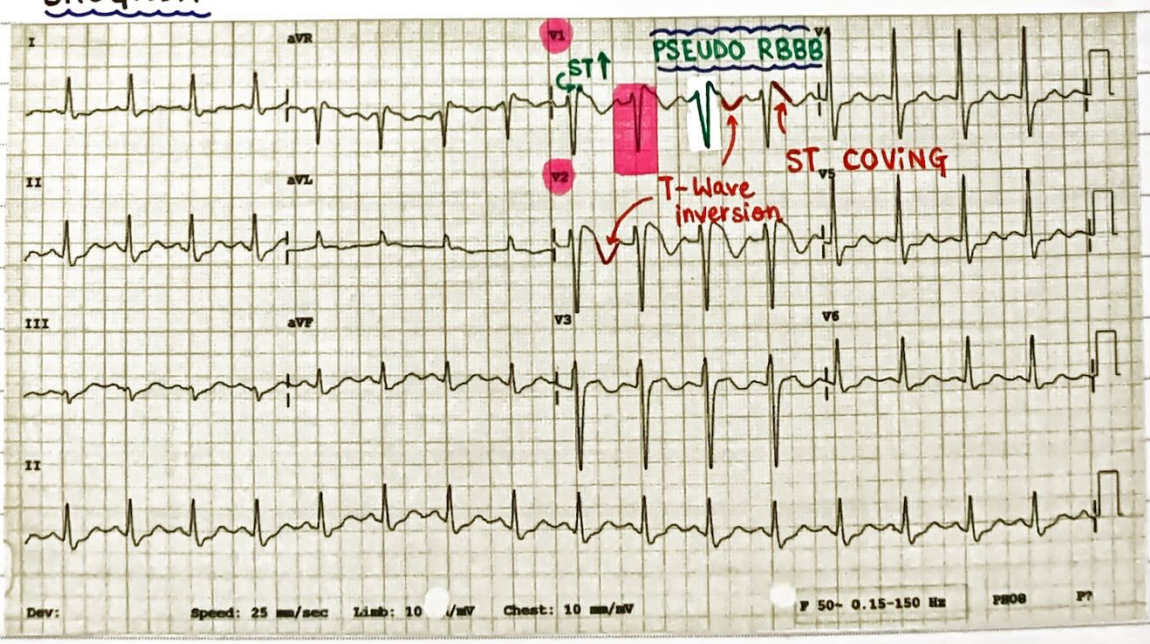
ARVC

M → Epsilon waves → characteristic for ARVC...

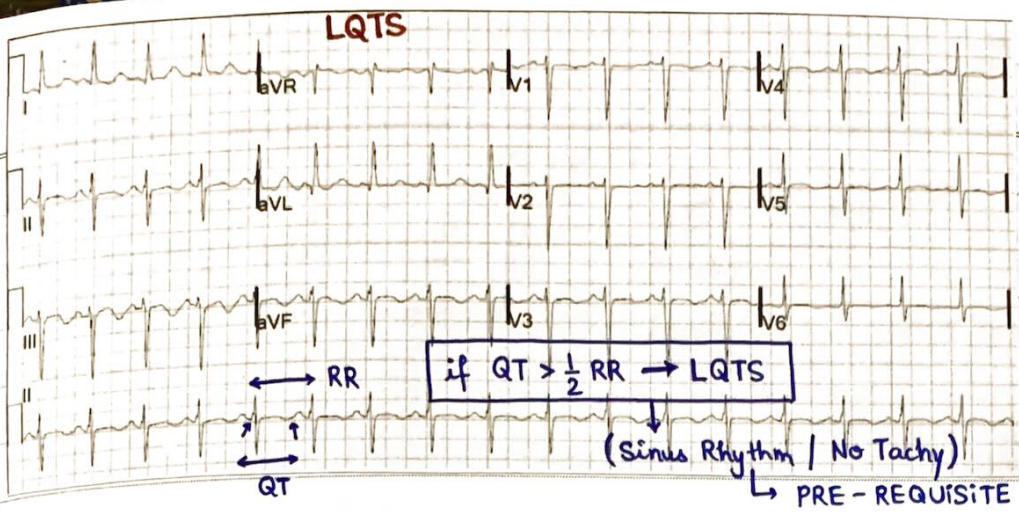
T-Wave Inversion → $V_1 - V_4$ = RV Dysfunction



BRUGADA



LQTS



Date

QT interval = AP duration

* Ventricular (D + R)
* Vary ↓ HR

if QT > ½ RR → LQTS

(Sinus Rhythm / No Tachy)
↳ PRE-REQUISITE

$$QT_c \text{ (corrected)} = \frac{QT}{\sqrt{RR}}$$ → BAZETT'S FORMULA

QT_c > 440 ms → PROLONGED QT (if QT_c > 500 ms → ↑ risk of TDP)

CAUSES

Congenital LQTS

* ROMANO-WARD SYNDROME (AD)
  (LQTS-1/2/3)
* JERVELL LANGE NEILSEN Sx
  (JLN Sx) → AR
  JLN-1/2 → Deafness

Family H/O ⊕

ACQUIRED

* DRUGS (MCC) [QUINOLONES | MAQROLIDES | BEDAQLINE | FLUQONAZOLE]
  → ANTIMICROBIALS
  → FLUQONAZOLE → Any AZOLE
  → AAD : Ia | III (Max.)
  → ANTI-PSYCHOTICS
  → ANTI-HISTAMINICS
* 4 HYPO's
  ↳ ↓K^+ / ↓Ca^{2+} / ↓Mg^{2+} / Hypothermia
* 2 I's → ISCHEMIA
  → ↑ICP (eg. SAH)