Overview of pediatric arrhythmias

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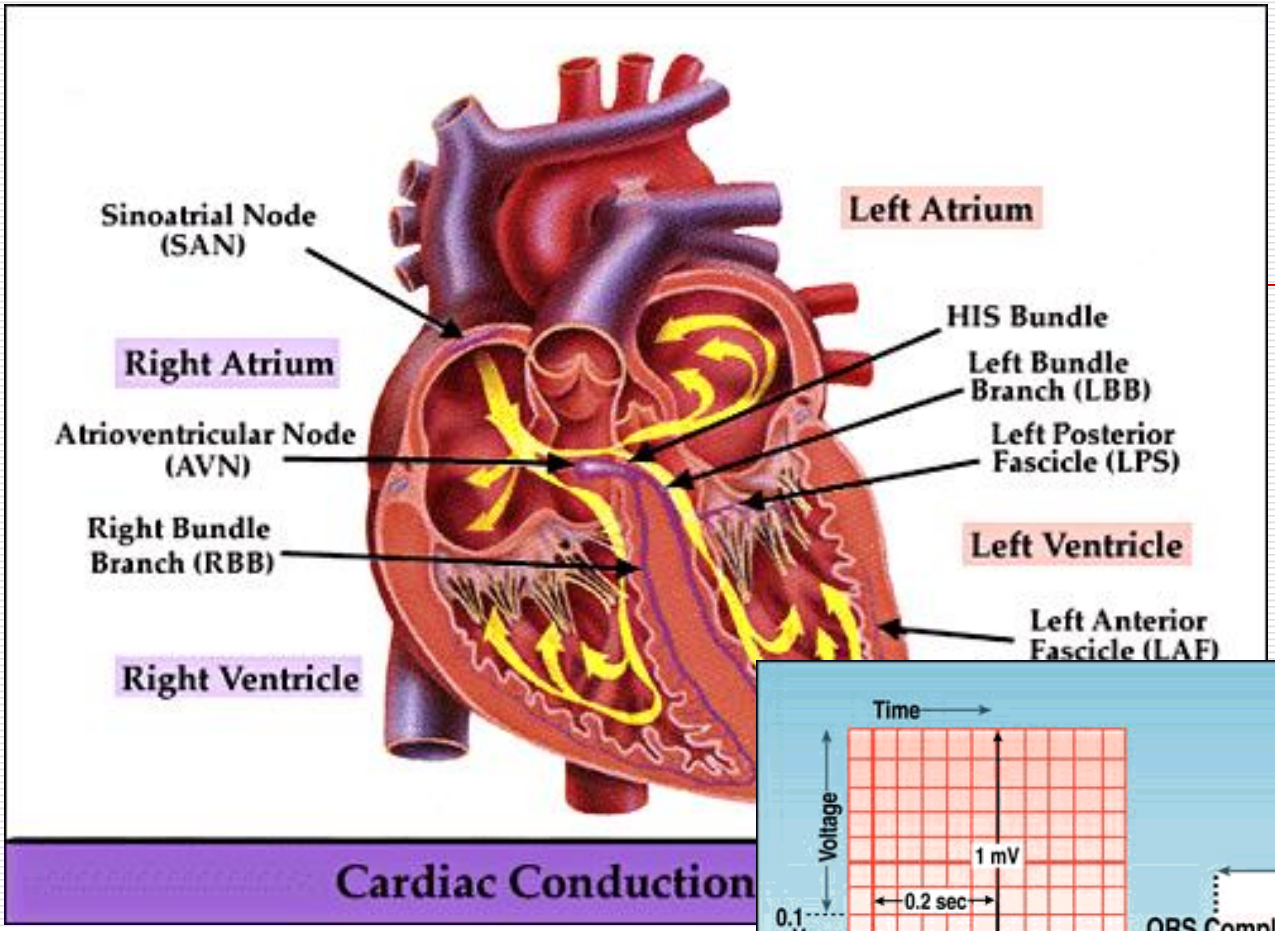
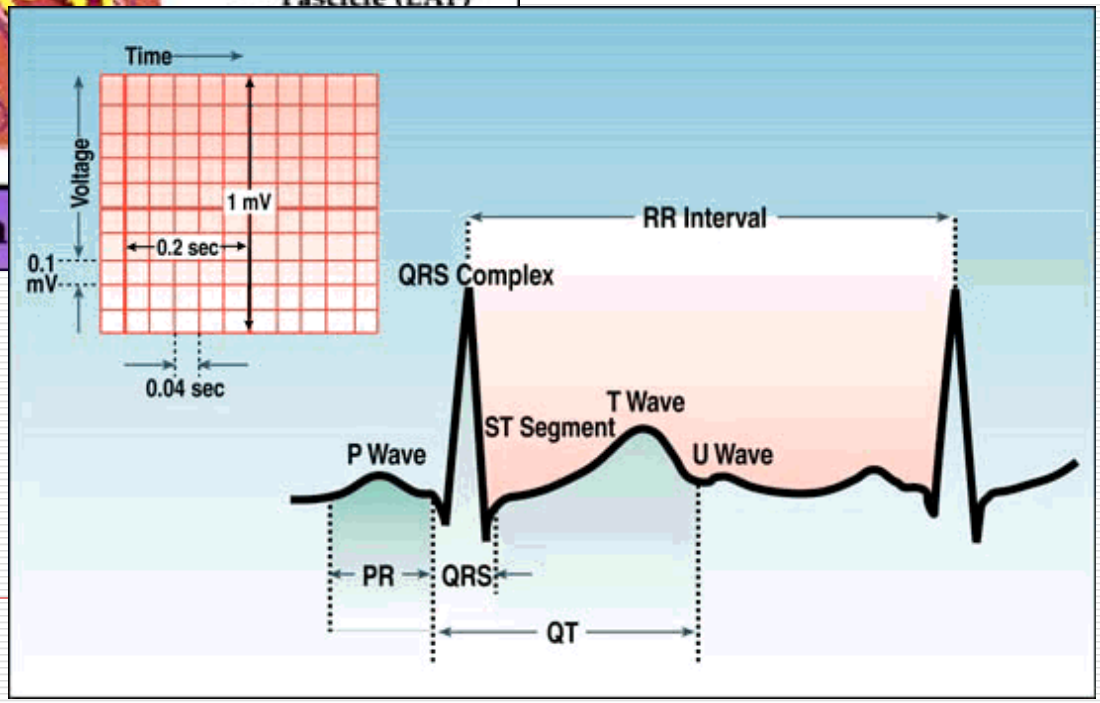
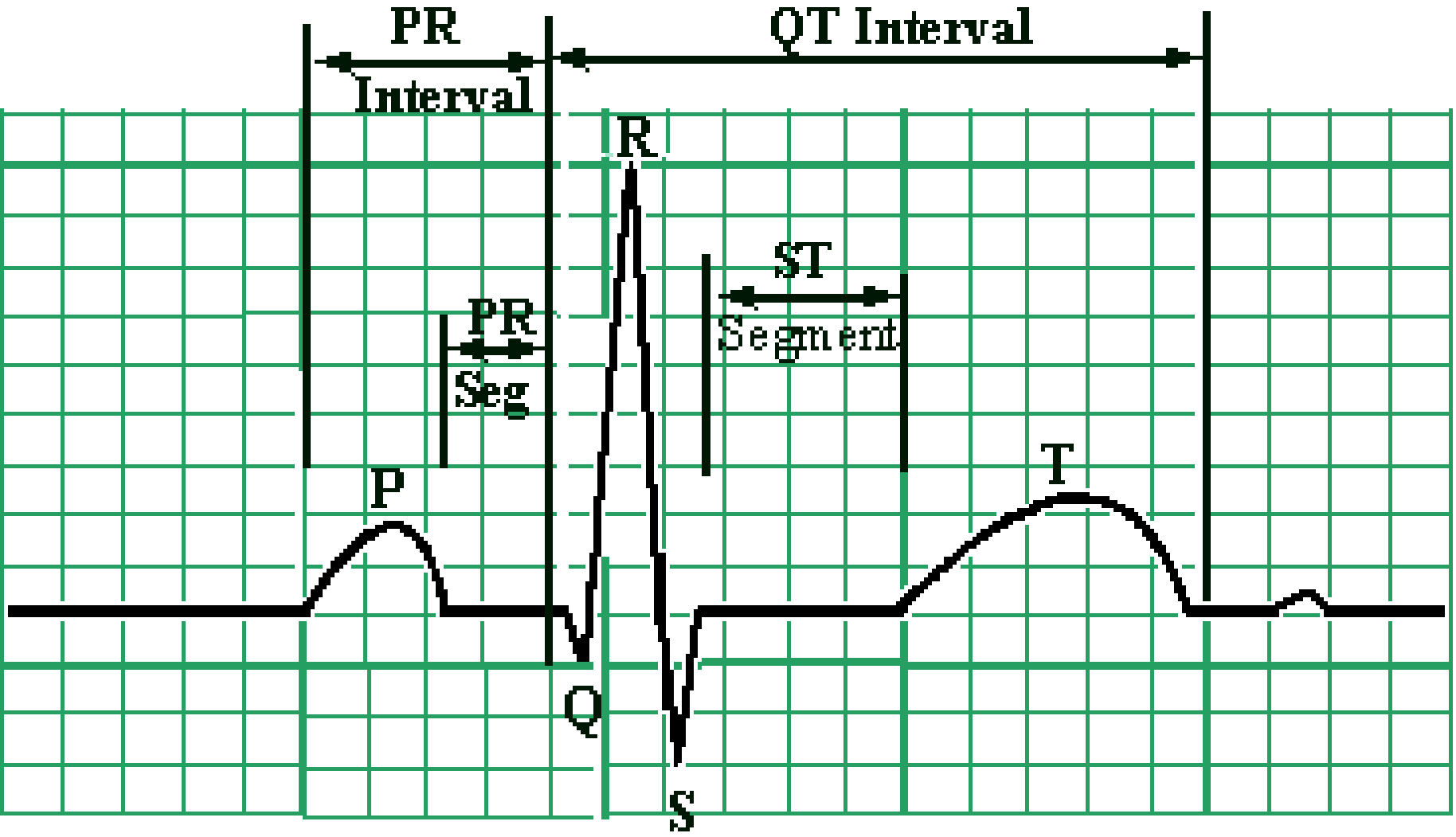
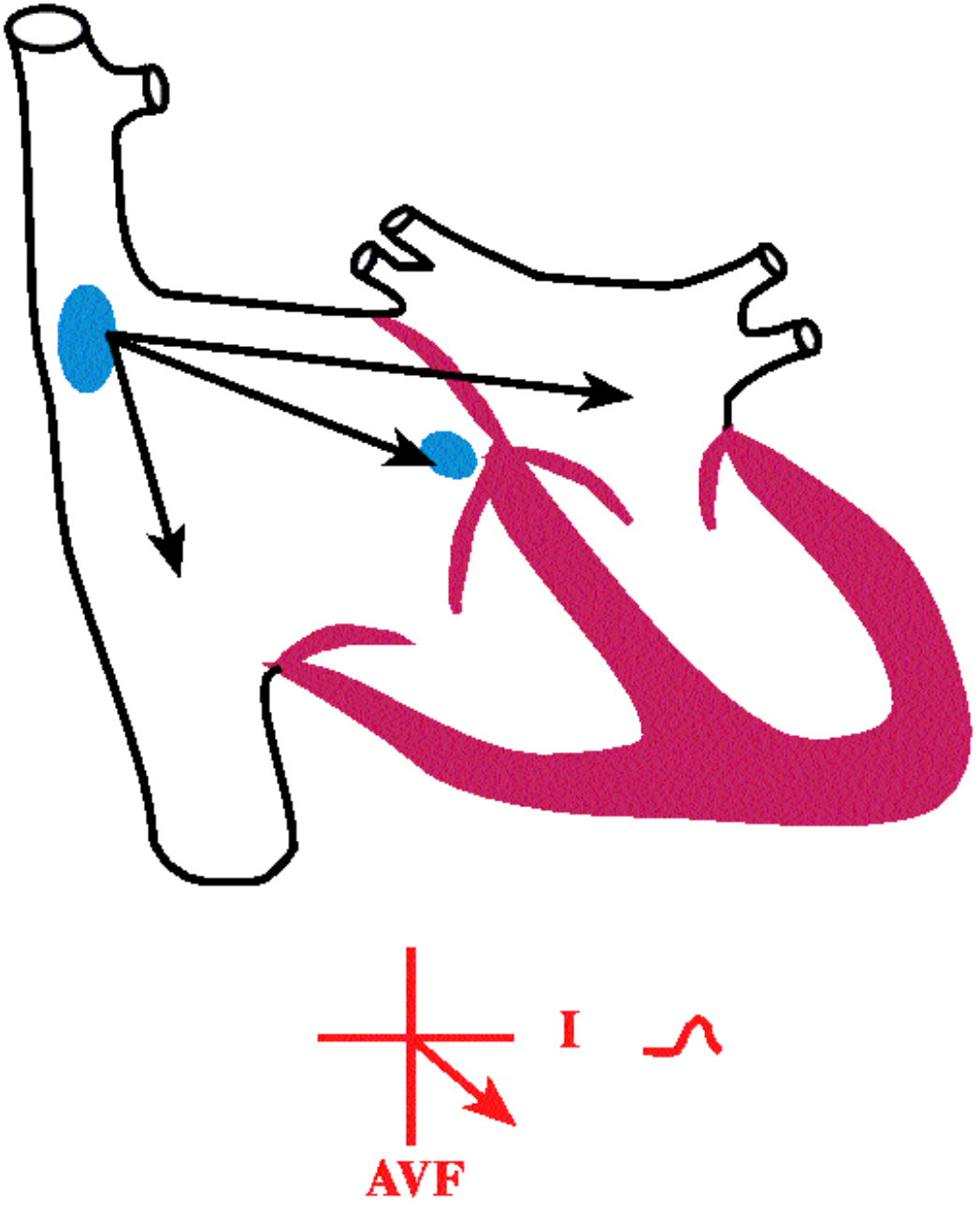
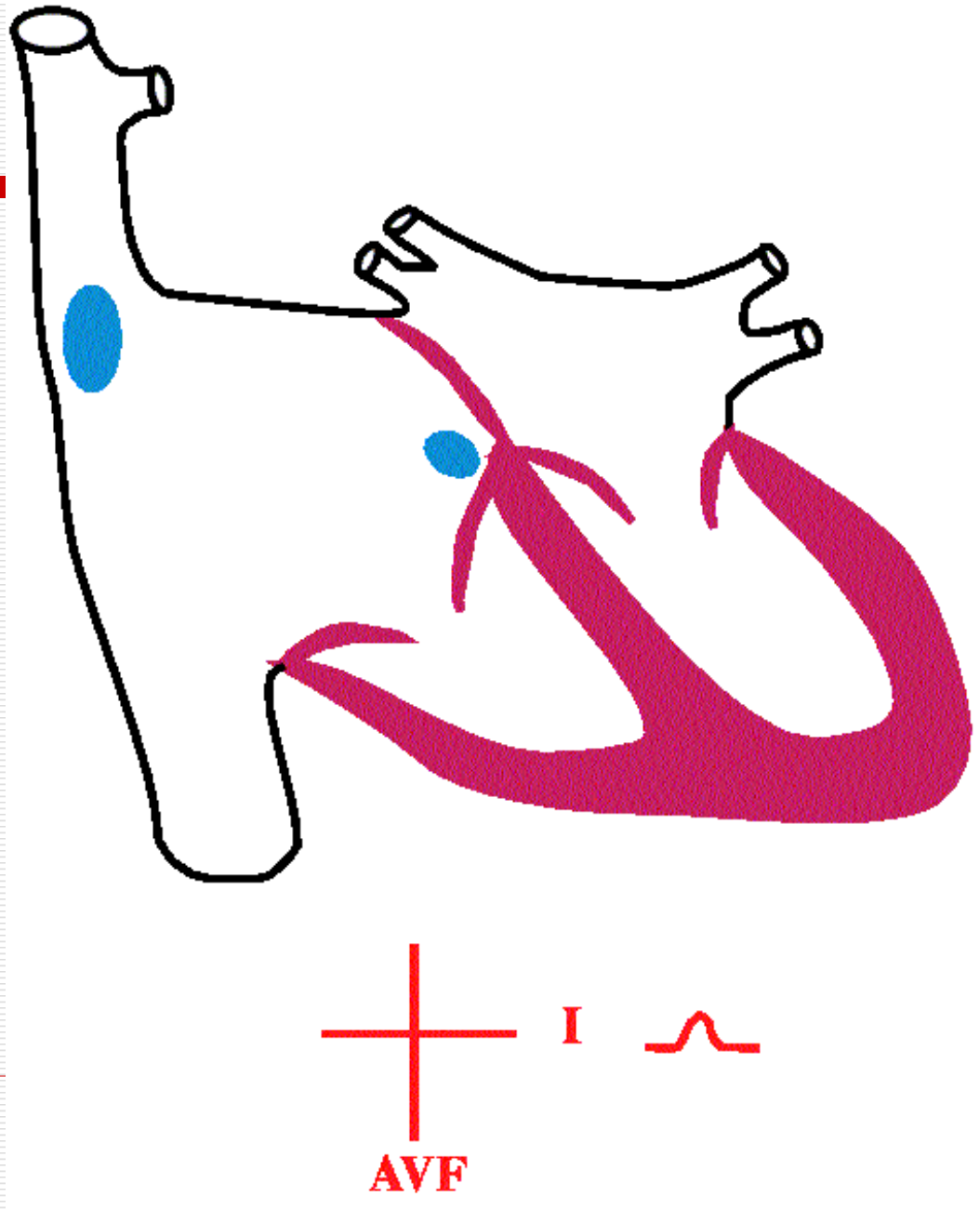
6th year 2023/2024


Sinoatrial Node
(SAN)
Left Atrium
HIS Bundle
Right Atrium
Left Bundle
Branch (LBB)
Atrioventricular Node
(AVN)
Left Posterior
Fascicle (LPS)
Right Bundle
Branch (RBB)
Left Ventricle
Left Anterior
Fascicle (LAF)
Right Ventricle
Cardiac Conduction


Time
Voltage
1 mV
0.2 sec
0.1
mV
0.04 sec
RR Interval
QRS Complex
T Wave
ST Segment
P Wave
U Wave
PR
QRS
QT


PR
Interval
QT Interval
R
ST
Segment
PR
Seg
P
T
Q
S
0.20 sec
0.04 sec


I
AVF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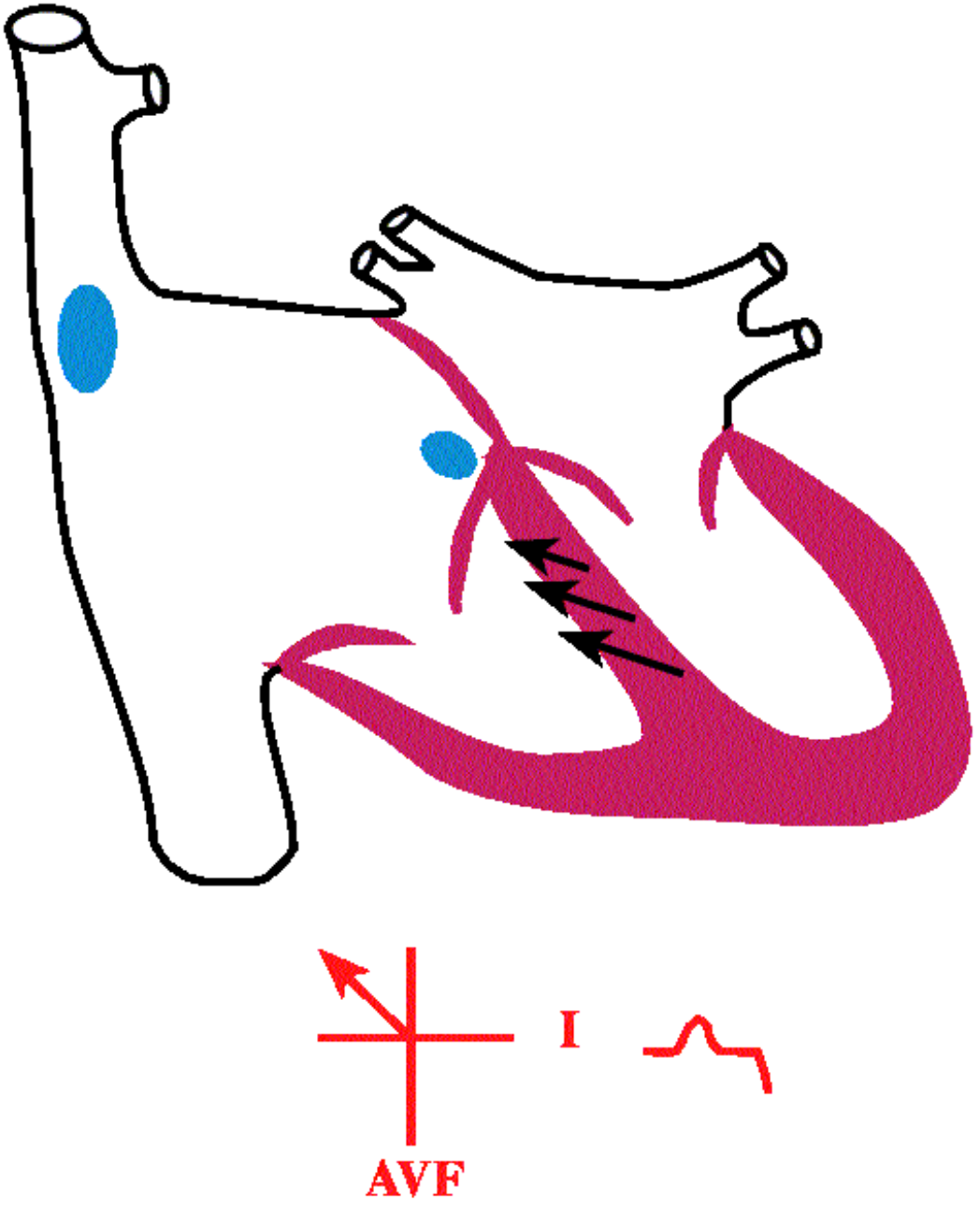
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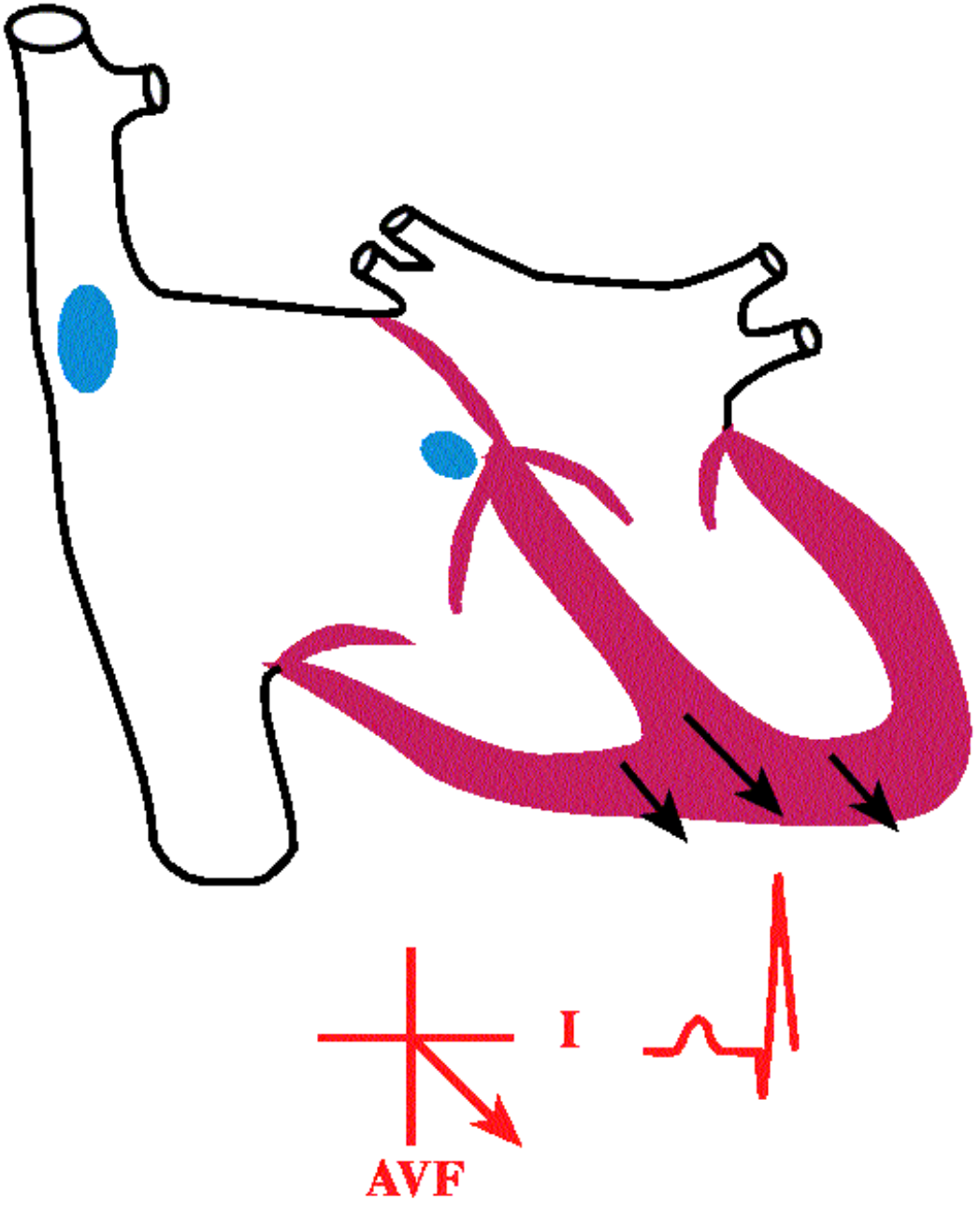
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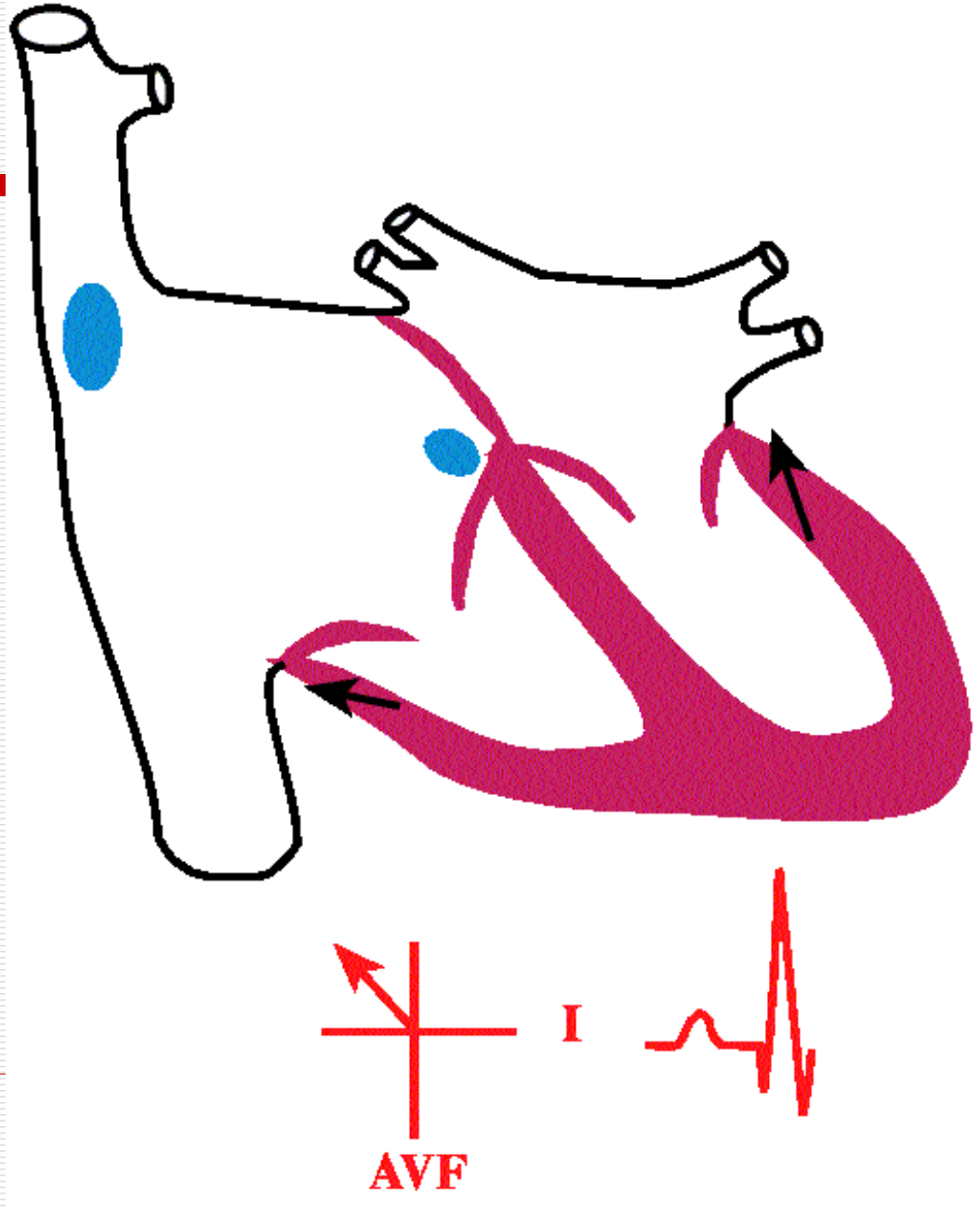
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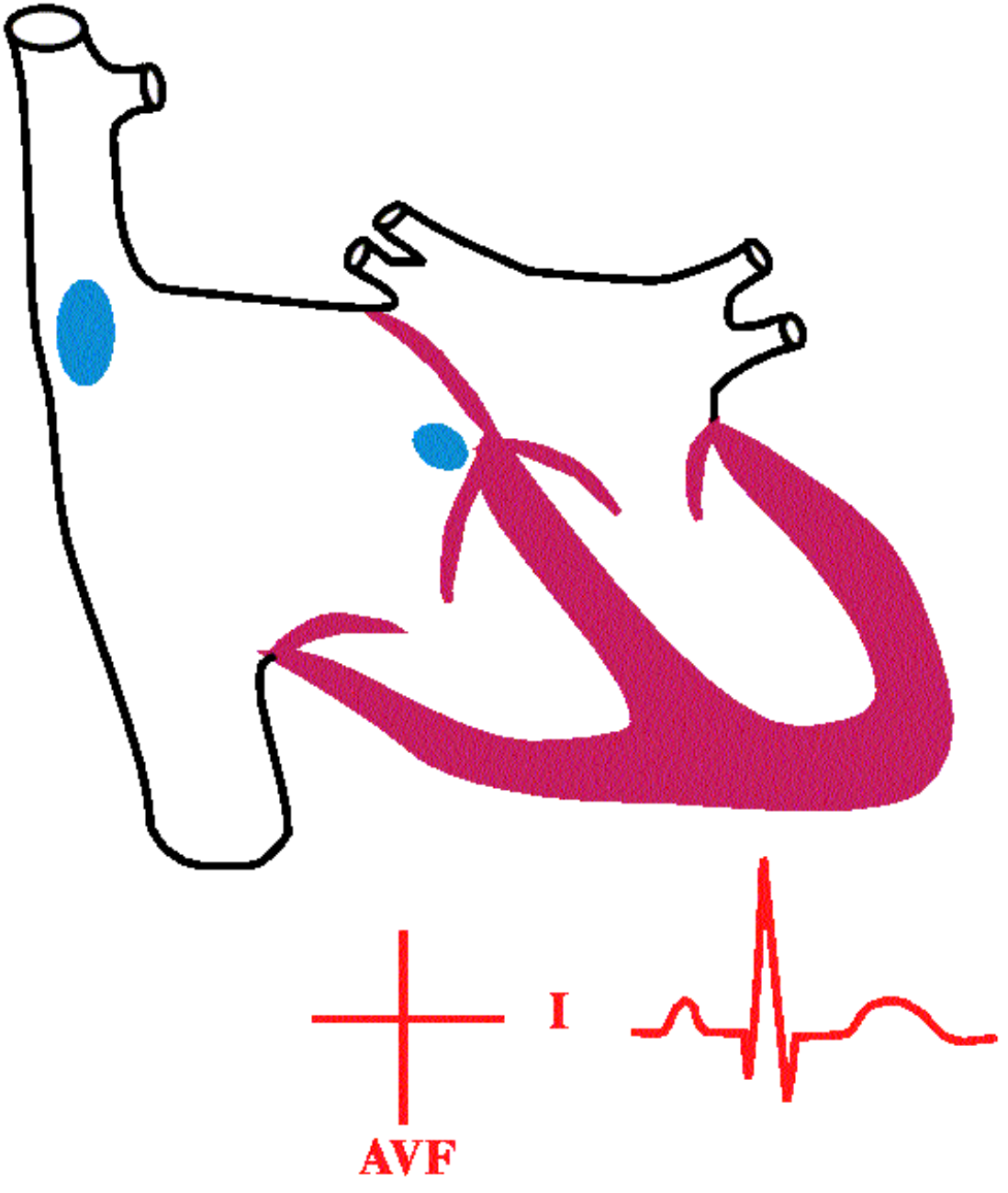

I
AVF

Pediatric and Adult ECG

- Pediatric ECG changes dramatically with age
  - A normal ECG may be abnormal if the age was not correct
  - There is need for tables of normal values to interpret pediatric ECG
- Indications to obtain ECG in a child is different from adults, ischemic heart disease is extremely rare in children
- As in adults ECG, consideration of clinical picture is very important, and it improves the accuracy and consistency of ECG interpretation

Reading ECG's

- Rate
- Rhythm
- Look for the "p"
  - Present or not
  - Followed by QRS or not
  - P wave axis
  - P wave morphology
- PR interval
  - Normal, short, or long

Reading ECG's

- QRS
  - QRS axis
  - QRS duration
  - Preceded by p or not
  - Analyze QRS components (Morphology)
- ST segment
  - Elevation and depression
- T wave
  - Morphology (Amplitude, direction in chest leads)
- U wave (present or not, amplitude)
- QT interval
  - Measure corrected QT

Rate

- Determine the rate of ventricular depolarization (QRS rate)
- Measure R-R duration in sec
- Devide 60 sec by the R-R interval
  - Rate = 60/ R-R (in sec)
- Rhythm must be regular for this formula to work
- If rhythm is not regular → you can't determine the rate from one page ECG

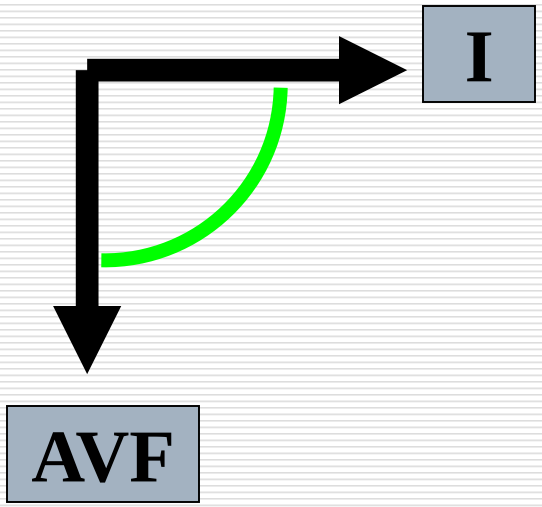
Rhythm

- Determine if regular or irregular
- Proceed with ECG reading

P

- Look for p waves
- If present, determine the rate if different from QRS rate
- Determine the axis

  ➔Is it sinus or ectopic?
- Morphology (II, V1)
  - Right atrial enlargement
  - Left atrial enlargement



PR interval

- Determine duration (beginning of p to beginning of QRS)
- PR interval increases with age
  - Generally less than 0.16 sec in children
  - Up to 0.2 sec in adults
- Common pathologies:
  - **Long**

    First degree AV block
  - **Elongating till AV block**

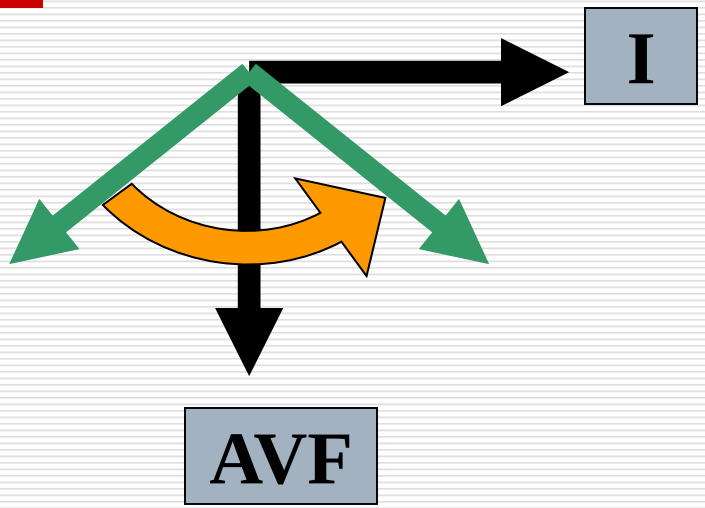
    Second degree Mobitz 1
  - **Variable**

    Be careful of AV dissociation
  - **Short**

    WPW syndrome

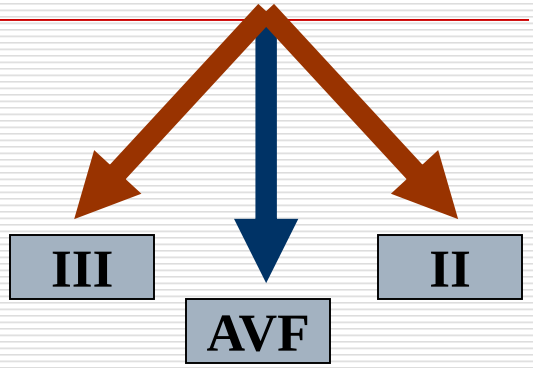
QRS

- Axis
  - Changes with age
- Duration
  - Changes with age
- Morphology
  - Changes with age

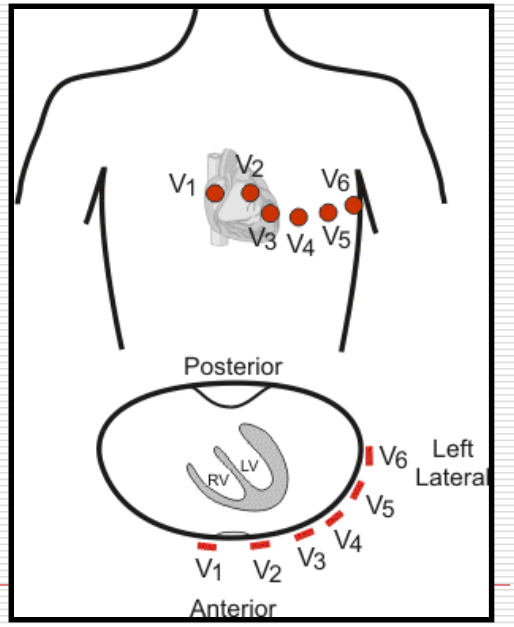


Common lead definitions

- **Inferior leads:**
  - aVF, II, III



- **Left precordial leads:**
  - V6, V5
- **Right precordial leads:**
  - V1, V3R
- **Septal leads:**
  - V3, V4



Q waves

- Normal in inferior leads, occasionally > 3 mm
- Deep Q in I, aVL
  - ➔ Anomalous left coronary artery from pulmonary artery
- Deep Q in left precordial leads
  - ➔ LVH, particularly septal hypertrophy

Right ventricular hypertrophy (RVH)

- Tall R in V1
- Deep S in V6
- T wave opposite of normal in V1
- Pure R (or QR) in V1

Left ventricular hypertrophy (LVH)

- Tall R in V6
- Deep S in V1
- If T wave in V6 is inverted ➔ Strain pattern
- Deep Q wave in V6 ➔ Septal hypertrophy

ST segment

- Elevated:

Pericarditis (diffuse elevation)

Ischemia

Other specific diagnoses

- Depressed:

Ischemia

- Early repolarization:

May look like ST elevation, but continuous with T wave (early T waves) ➔ not significant

T wave

- **Direction** of T in V1 changes with age

Newborns (days) ➔ *upright*

Few days – adolescents ➔ *inverted*

Adults ➔ *upright*

- **Amplitude**

High amplitude ➔ *when T wave is > 2/3rd of QRS amplitude*

- Most other changes ➔ Nonspecific if not associated with other ECG findings

U waves

- Repolarization of the purkinje system
- Significant U waves can be found in hypokalemia
- If amplitude > ½ of T wave amplitude ➔ counted in calculation of QT interval

QT interval

- Corrected QT should be calculated in all ECG's
- QTc= QT / √R-R
- Normal QTc (up to 450 m sec)
- If there is BBB, or in ventricular rhythm ➔ QTc is irrelevant (except if changing)

Why ECG a child?

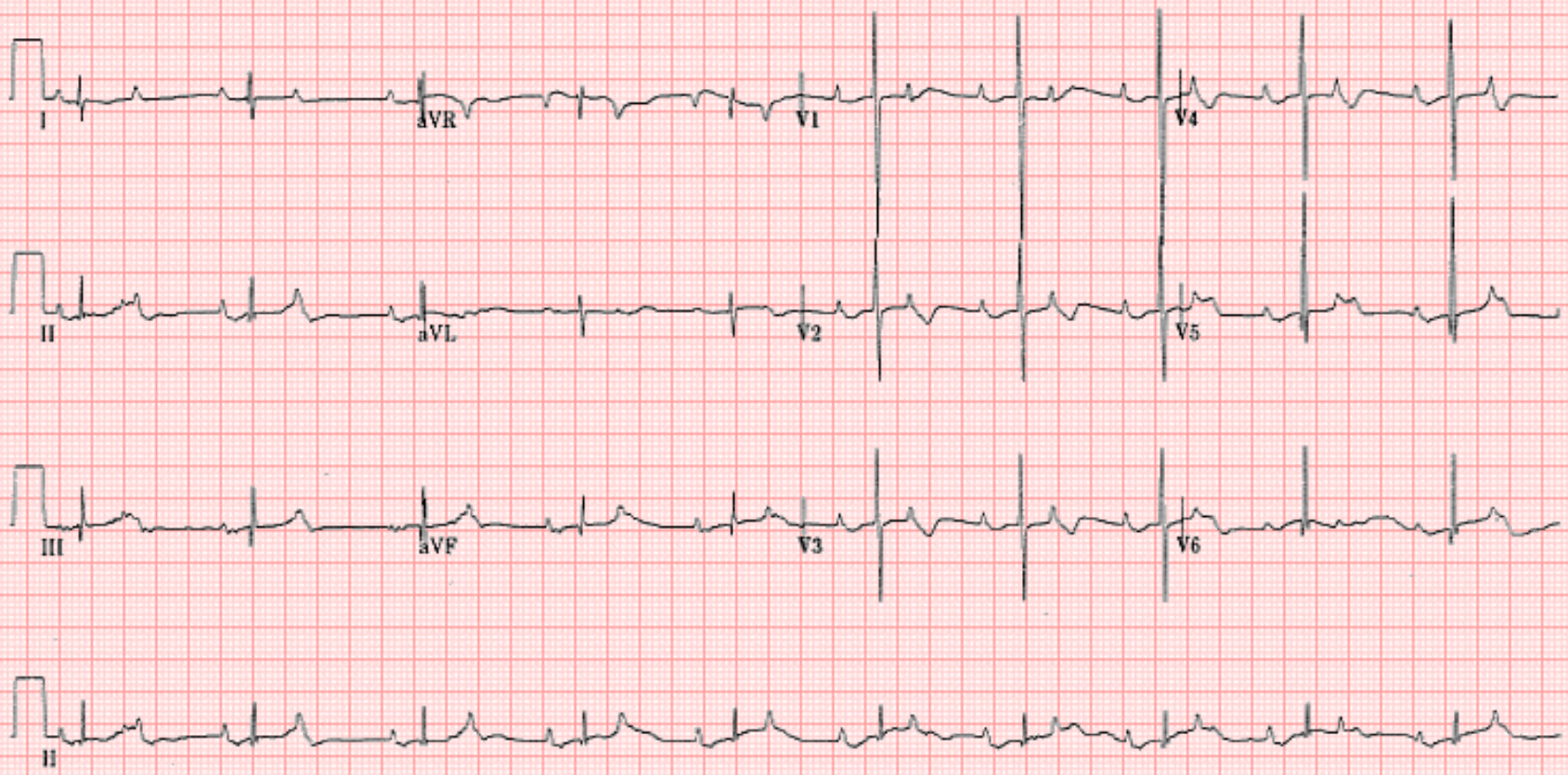
- Child with episodes of loss of consciousness
- Child with palpitation
- Child with suspected congenital or structural heart disease
- Child with incidental finding of abnormal heart rhythm (slow, fast, or irregular)
- Child with chest pain

Rhythm disturbances

- Bradycardia:
  - Sinus bradycardia
    - Usually non-cardiac causes
  - Sinus node dysfunction
    - Leading to slow atrial rhythm, junctional escape rhythm or ventricular escape rhythm
    - In children, most common cause is following congenital heart surgery
      - SV ASD surgery
      - S/P Fontan surgery (single ventricle)
  - Heart block
    - Advanced second degree block
    - Complet heart block

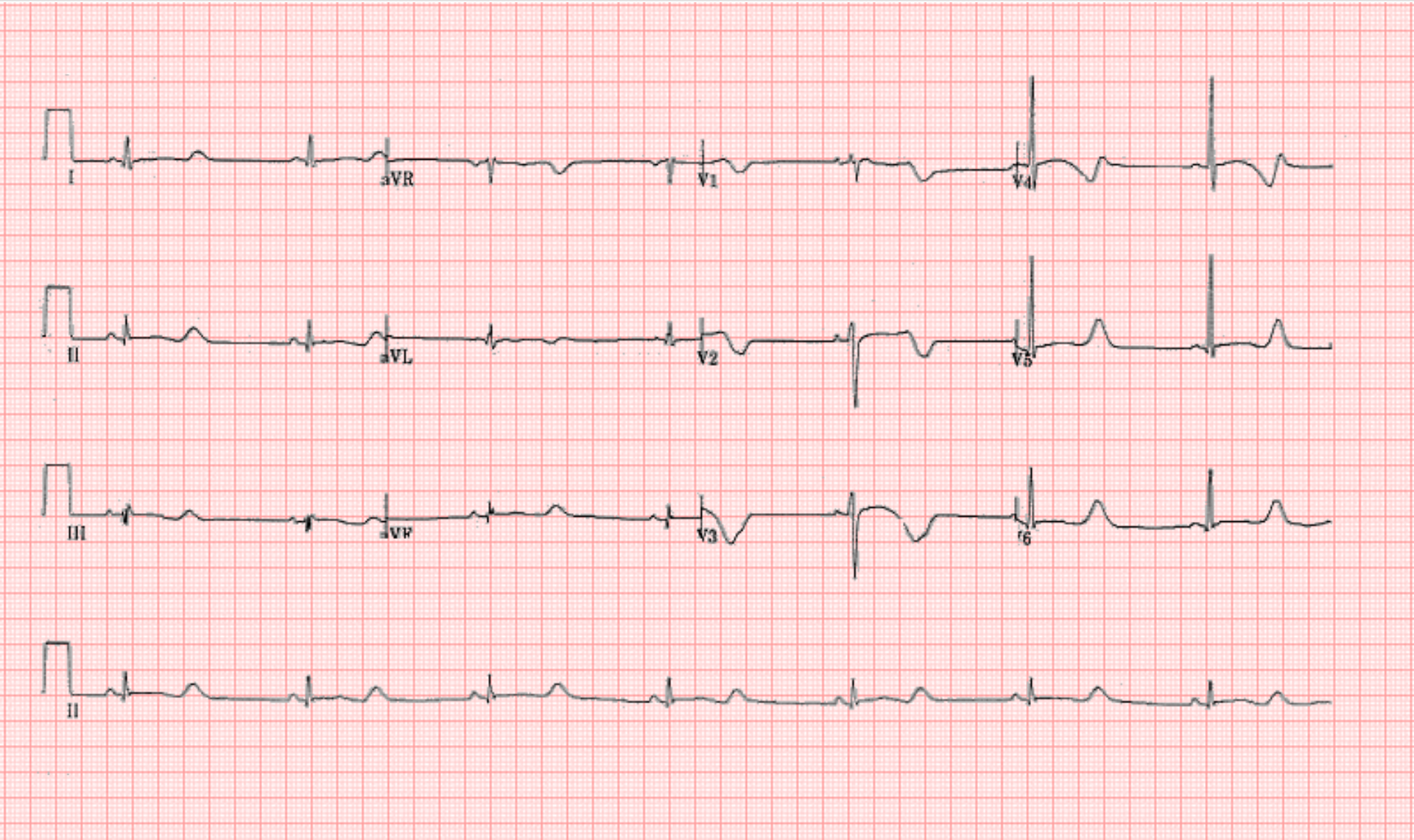
3 year old with episodes of LOC, and slow heart rate

Complete heart block



11 year old with LOC after waking up from sleep

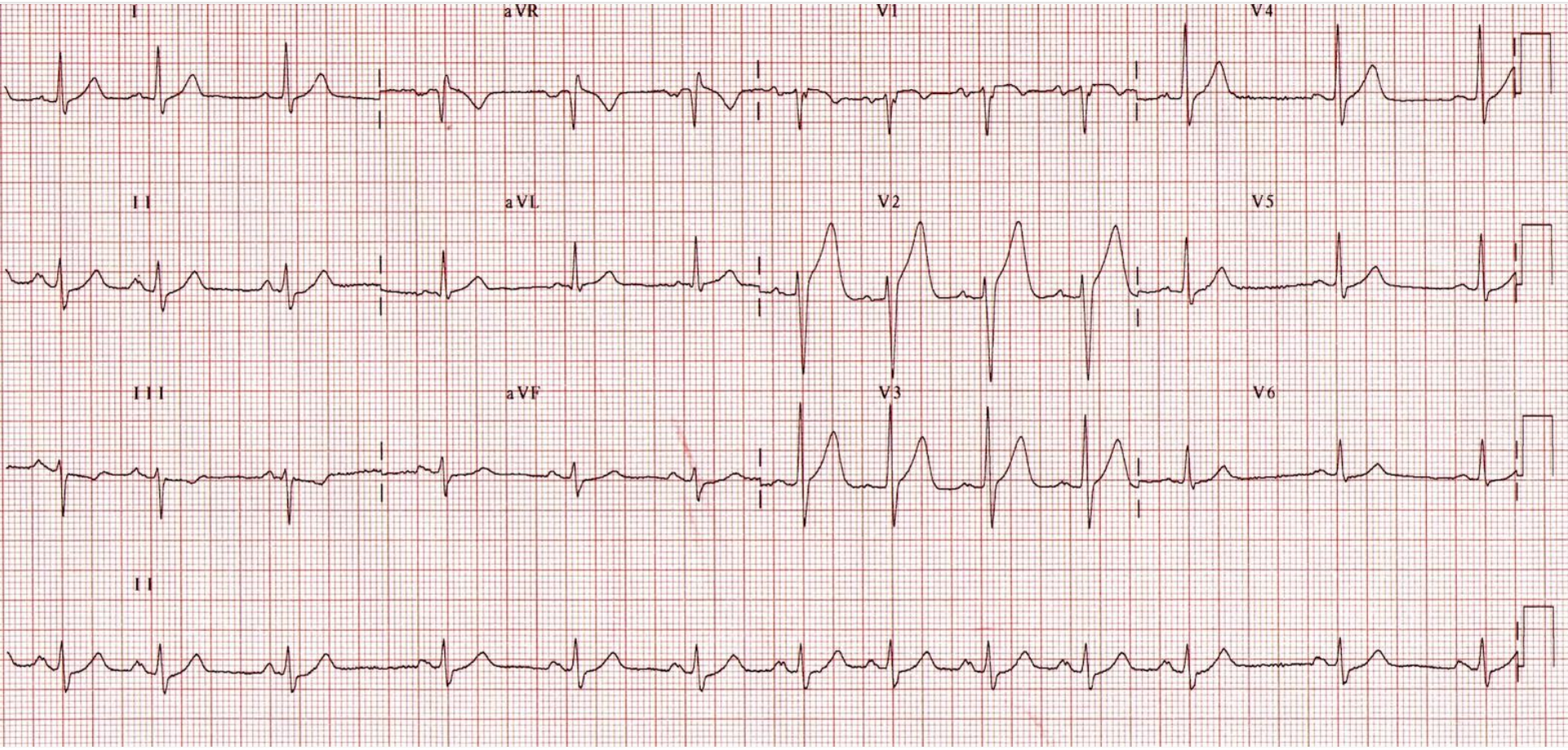
QTc= 580 msec, long QT syndrome



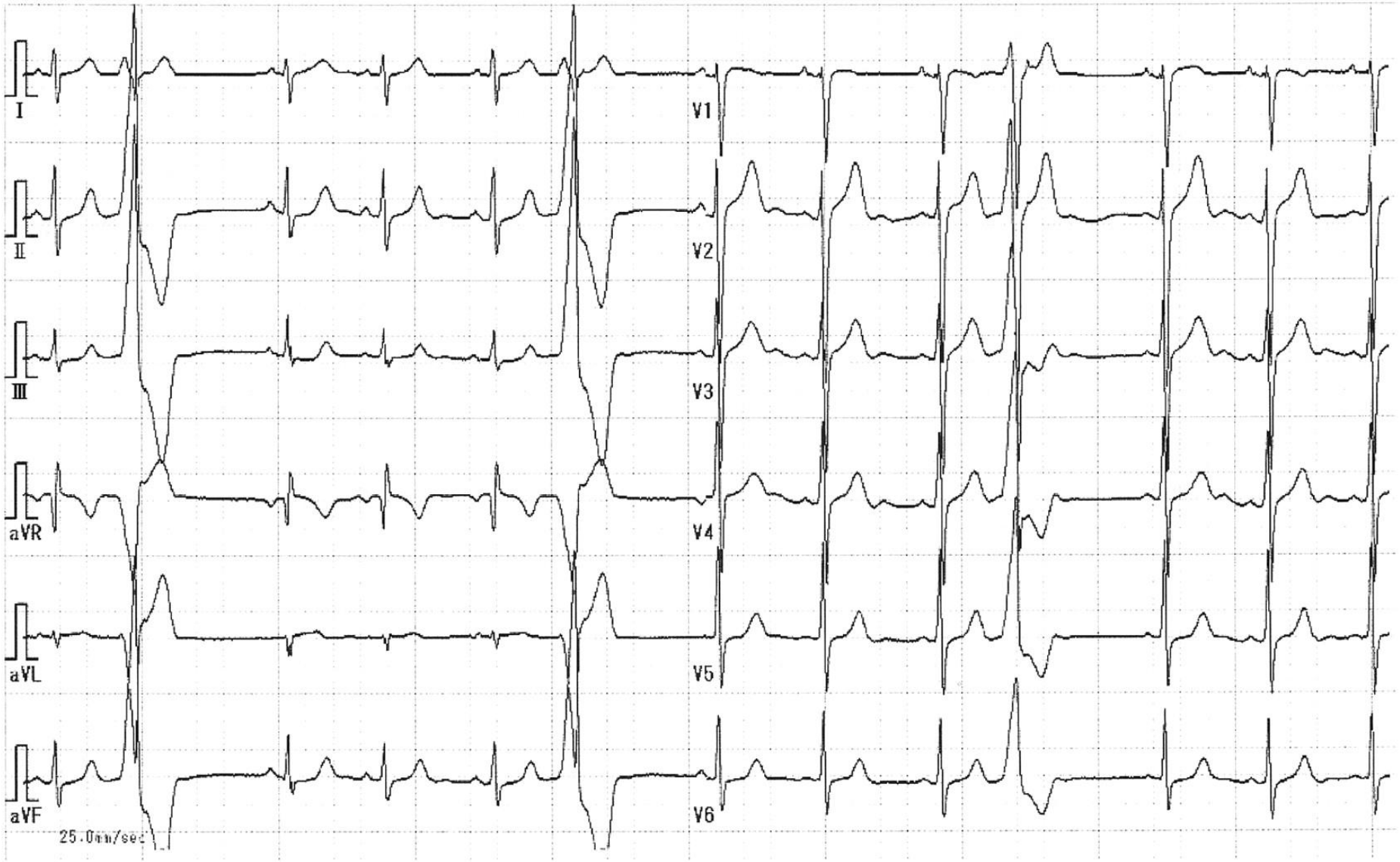
Irregular rhythm

- Sinus arrhythmia
  - Normal variation of heart rate between inspiration and expiration
- Heart block
  - Second degree heart block may present with regularly irregular rhythm
- Atrial fibrillation
  - Irregularly irregular rhythm, usually fast in children
- Premature contractions (PAC's, PVC's)
  - Usually present incidentally as "missed beats" on auscultation
  - Benign in most cases

Diagnosis?



Diagnosis?



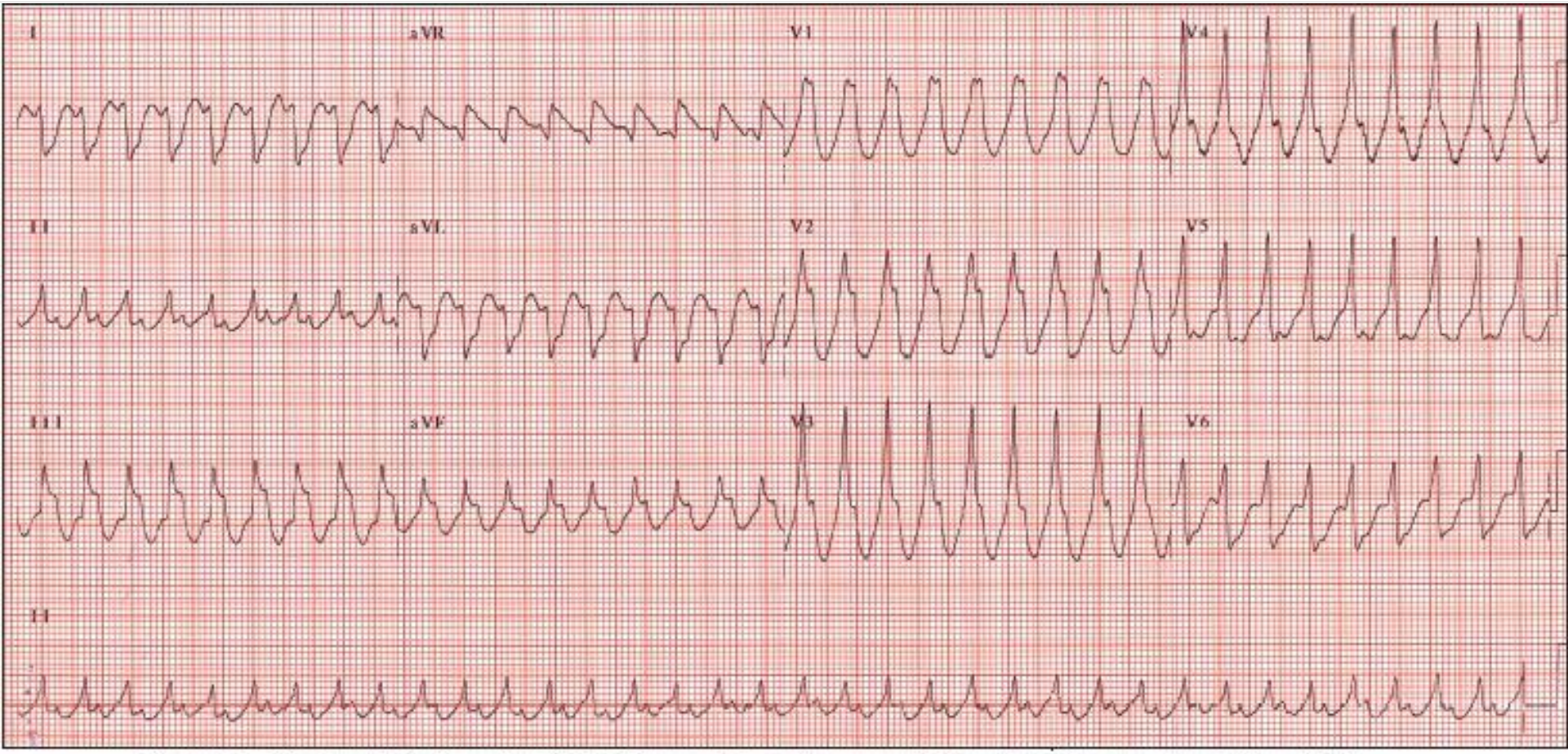
Tachyarrhythmias

- Sinus tachycardia:
  - Usually non-cardiac
  - May be a compensation for decreased cardiac output (heart failure, cardiomyopathy)
  - Normal p waves, Normal QRS duration
- Differential diagnosis:
  - Inappropriate sinus tachycardia
  - Sinus node re-entry tachycardia (very rare, difficult to diagnose)

Ventricular tachycardia

- Always wide complex QRS
- Rate in children is variable, usually faster than the normal sinus rhythm by 20%
- Occasional sinus beats between the wide complex QRS's ➔ diagnostic of VT
- Occasionally normal p waves may be seen representing (Ventriculo-Atrial dissociation) ➔ diagnostic of VT

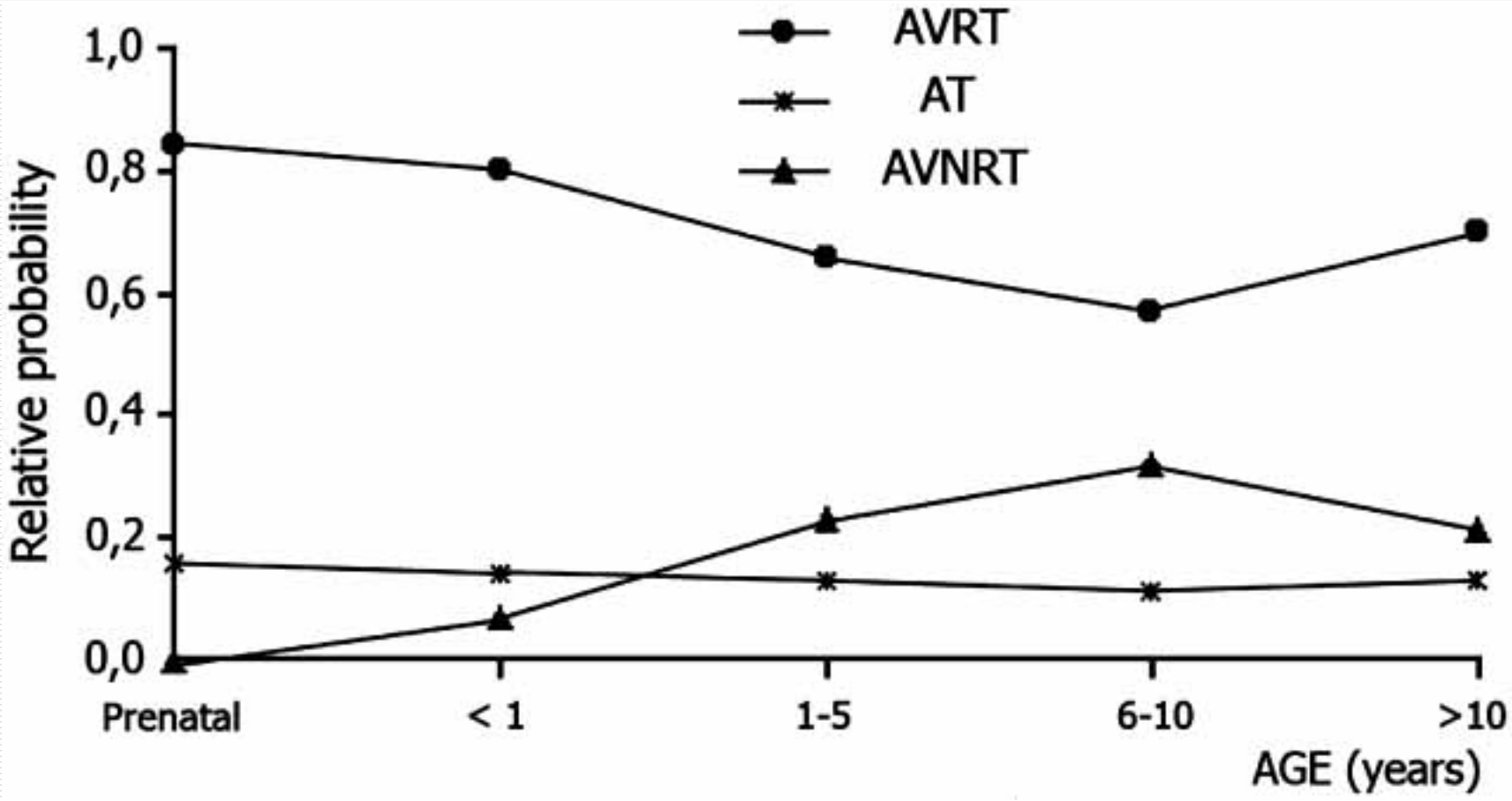
Diagnosis?



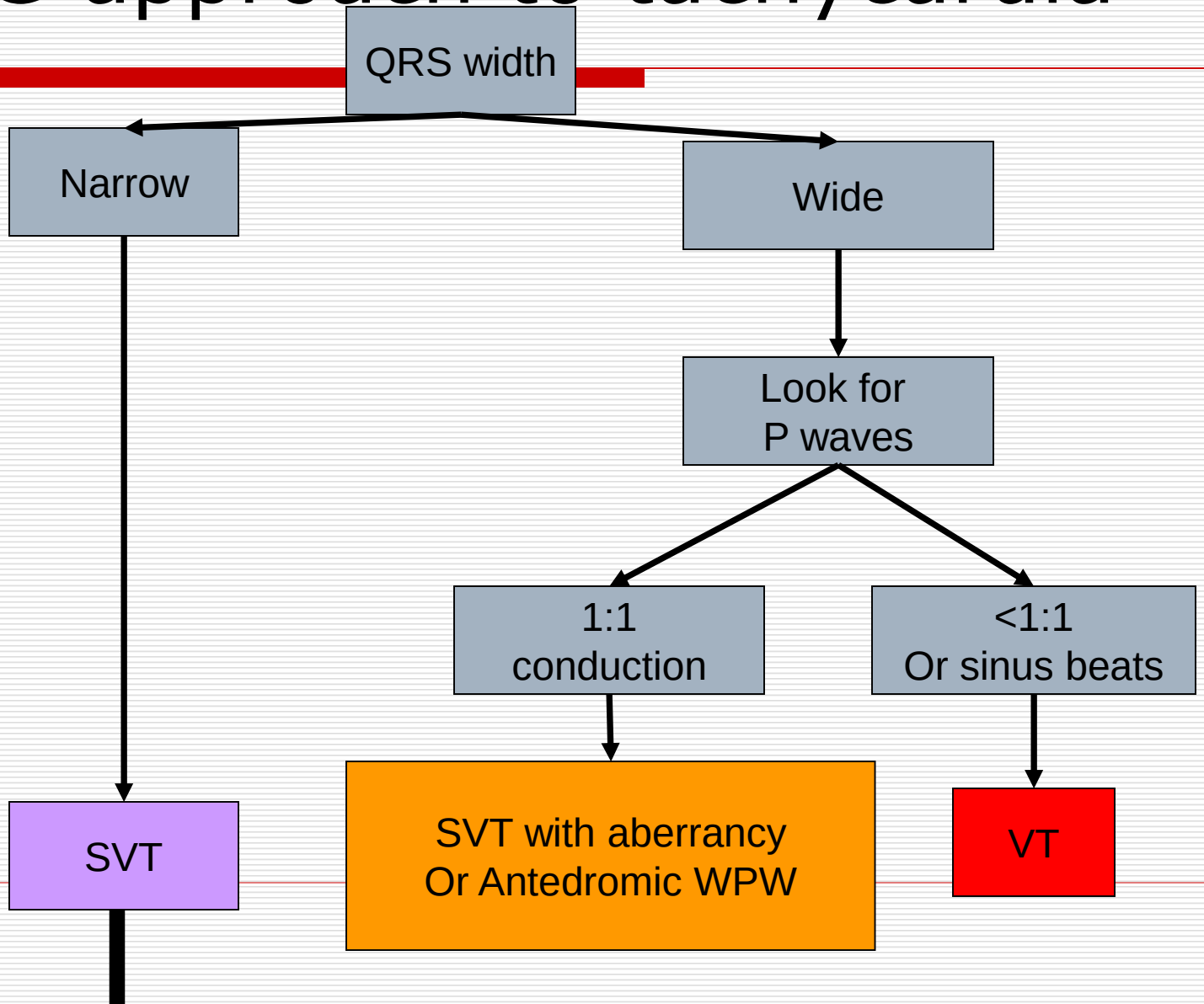
Supraventricular tachycardia

- Usually narrow complex, but can be wide complex QRS
- Rate is usually outside the limits of sinus tachycardia (except for permanent or incessant types)
- Presentation is variable from incidental in the newborn period, to palpitation in older child, to heart failure.
- There are many types of SVT's. Diagnosis is based on ECG features, and may require further electro-physiological testing

SVT and age


AVRT
AT
AVNRT
1,0
0,8
0,6
0,4
0,2
0,0
Relative probability
Prenatal
< 1
1-5
6-10
>10
AGE (years)

ECG approach to tachycardia



SVT → Look for p

Look for p → 1:1 conduction

Look for p → > 1:1 conduction

1:1 conduction → Measure RP interval

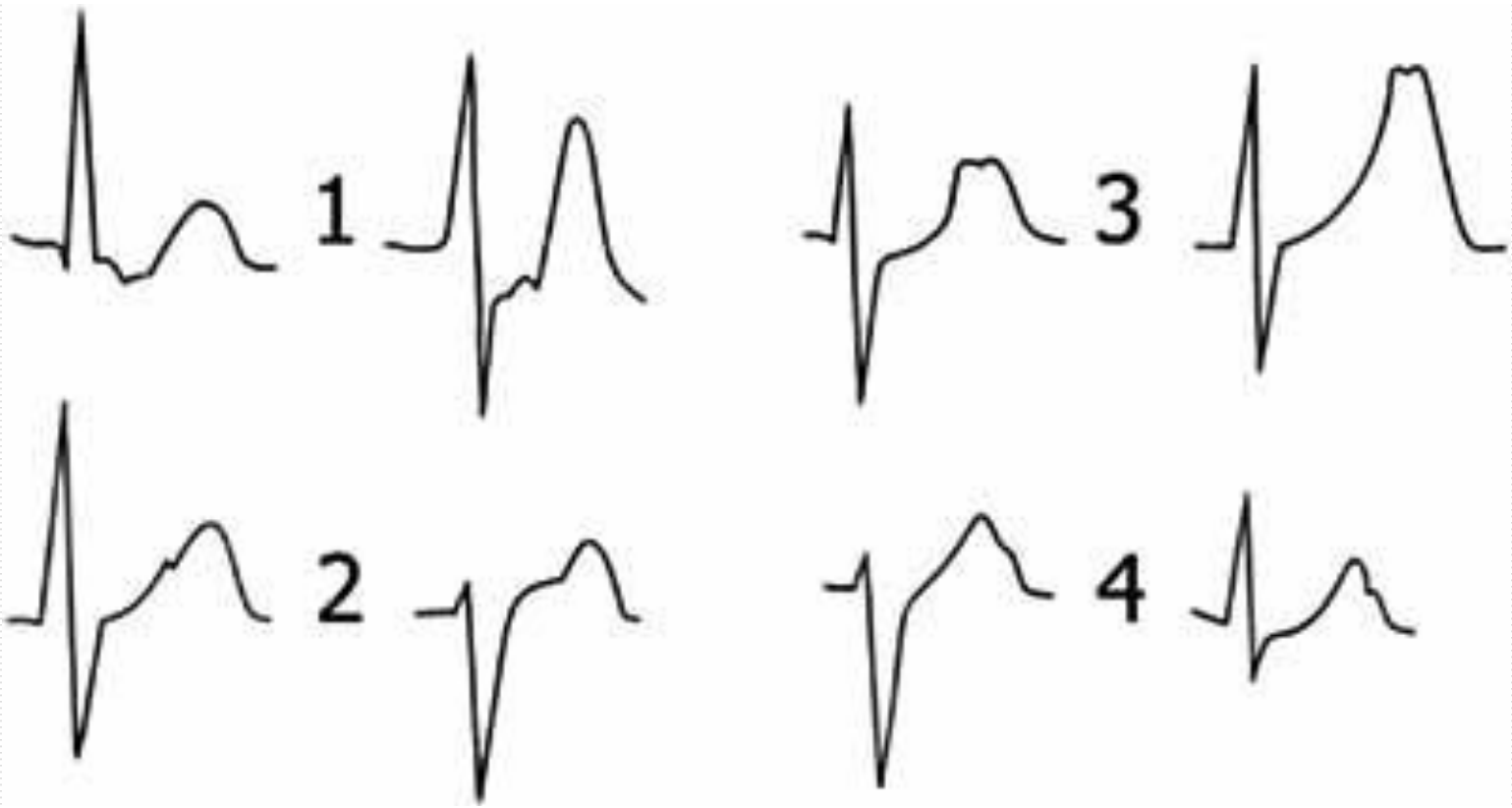
Measure RP interval → Short RP

Measure RP interval → Long RP

> 1:1 conduction → Mostly atrial Flutter

- Typical AVNRT (shortest RP)
- WPW
- Consealed accessory pathway
- Atrial Ectopic tachycardia
- PJRT (rare)
- Atypical AVNRT (extremely rare)

Where to look for p waves?



Mechanisms of SVT

Re-entry

Non-reentry (automatic)

Accessory Pathway Mediated Tachy.

Non-AP mediated Tachycardia

WPW

Consealed AP

PJRT

Others

AV node Reentry Tachycardia (AVNRT)

Atrial Flutter

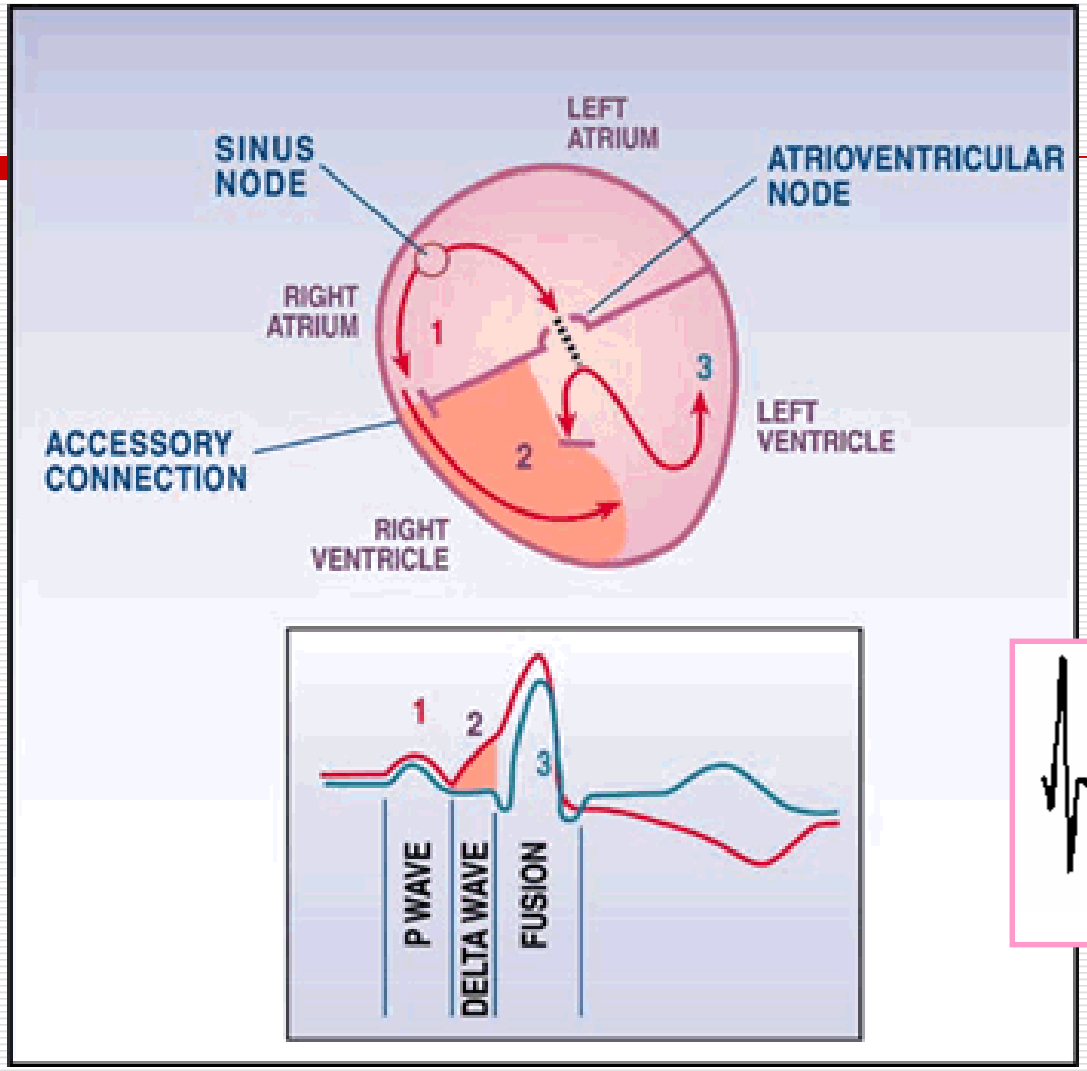
Atrial Fibrillation

IART (intra-atrial Reentry tachycardia)

Atrial Ectopic Tachycardia (AET)

Junctional Ectopic Tachycardia (JET)

Chaotic Atrial Tachycardia (multi-Focal)

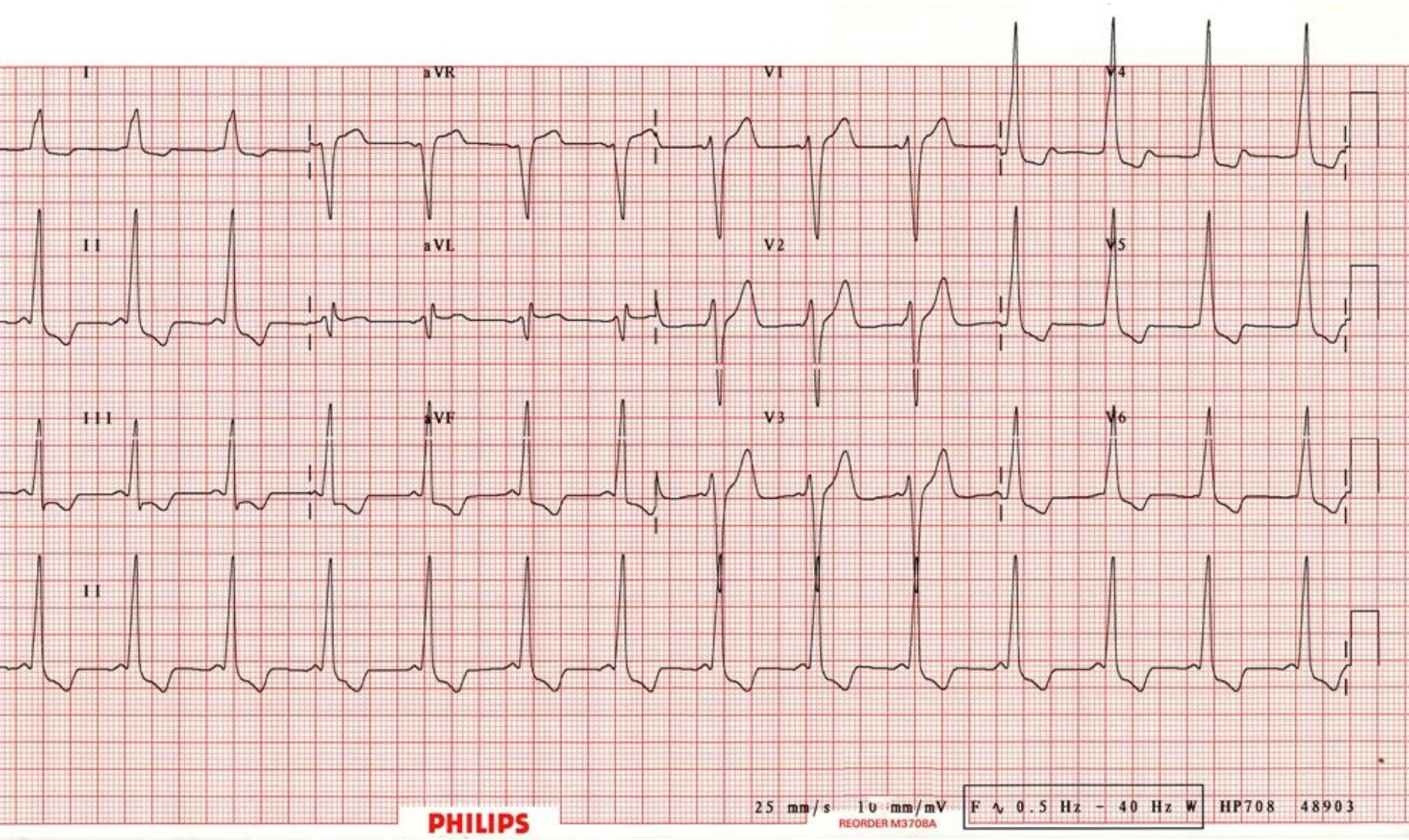

LEFT ATRIUM
SINUS NODE
ATRIOVENTRICULAR NODE
RIGHT ATRIUM
1
3
LEFT VENTRICLE
ACCESSORY CONNECTION
2
RIGHT VENTRICLE
1
2
3
P WAVE
DELTA WAVE
FUSION

WPW

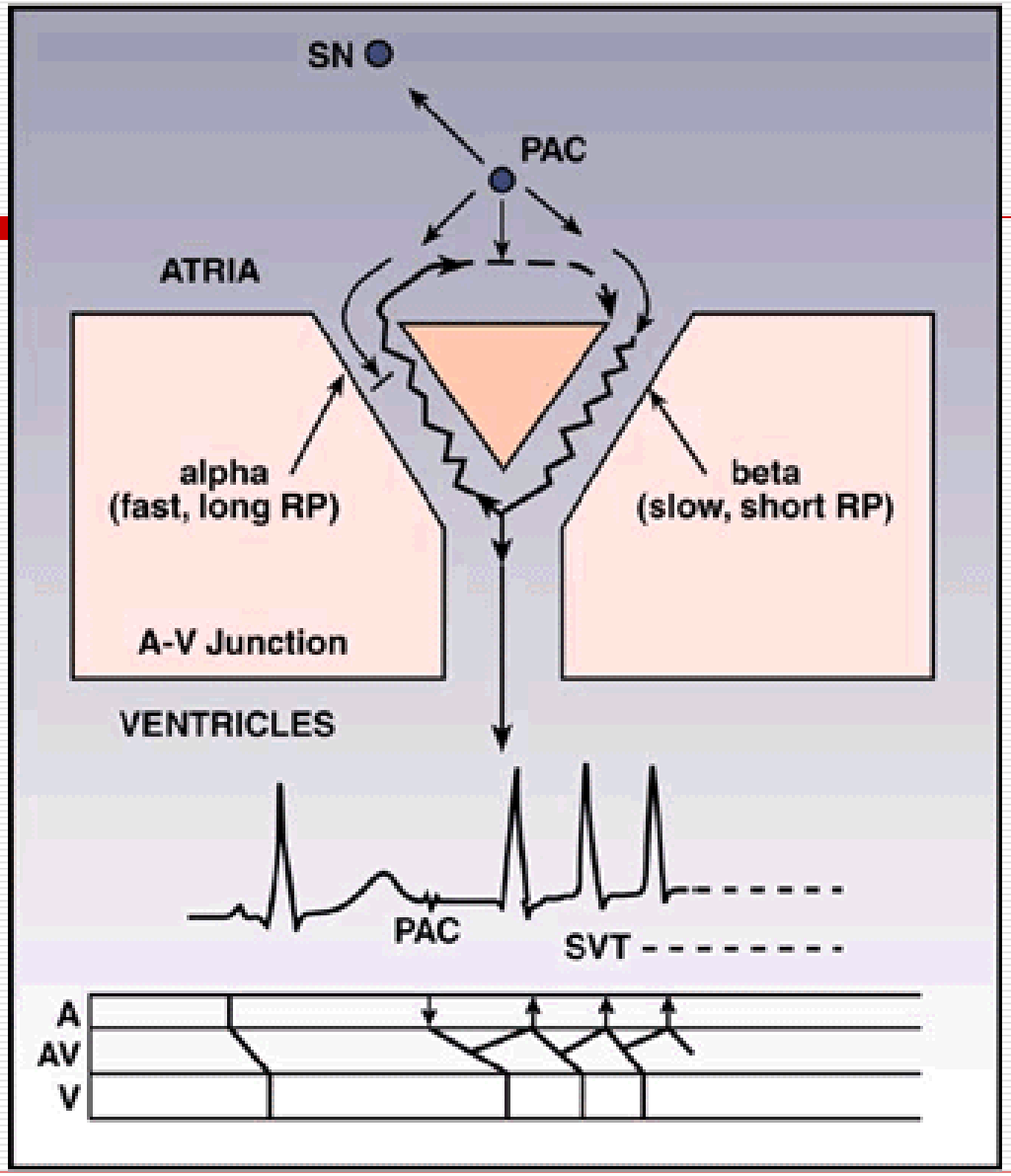

SVT

14 year old with short episodes of palpitation

WPW syndrome



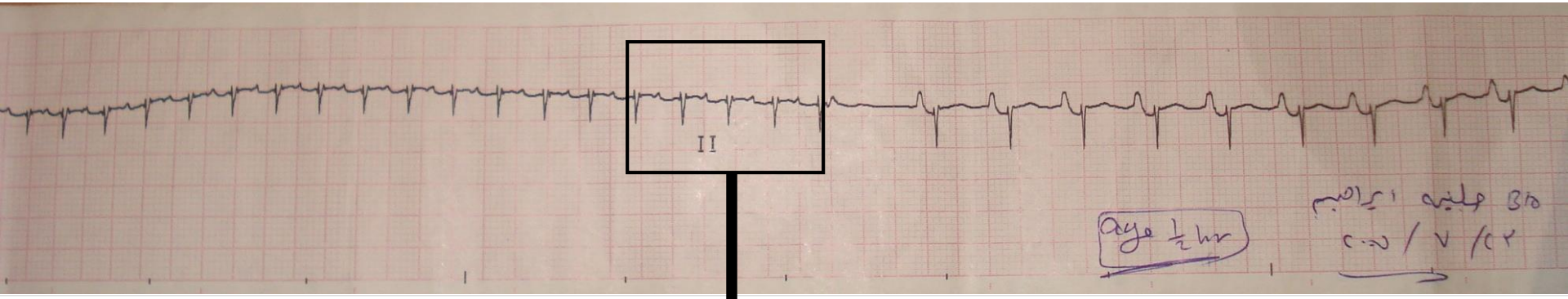
AVNRT

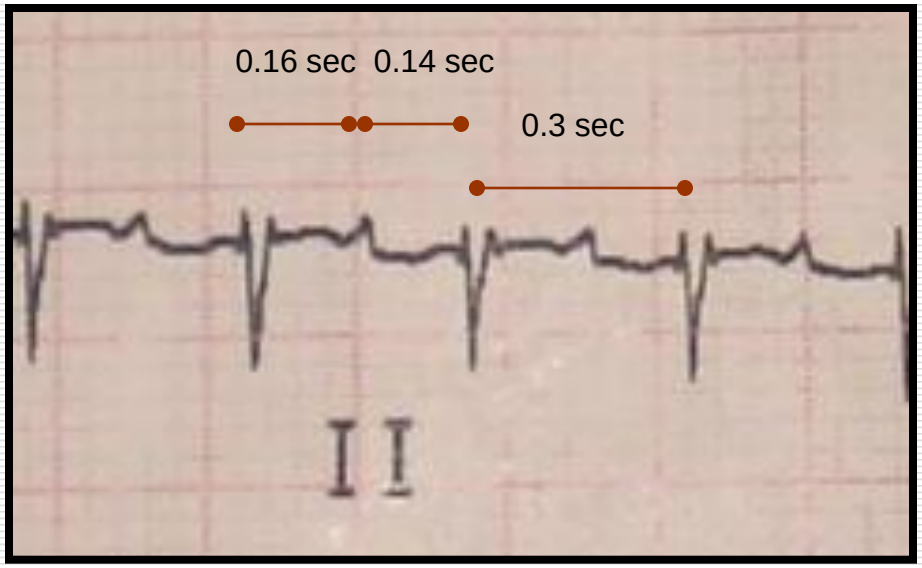


Fast-slow (atypical AVNRT) long RP

Slow-fast (typical AVNRT) Short RP

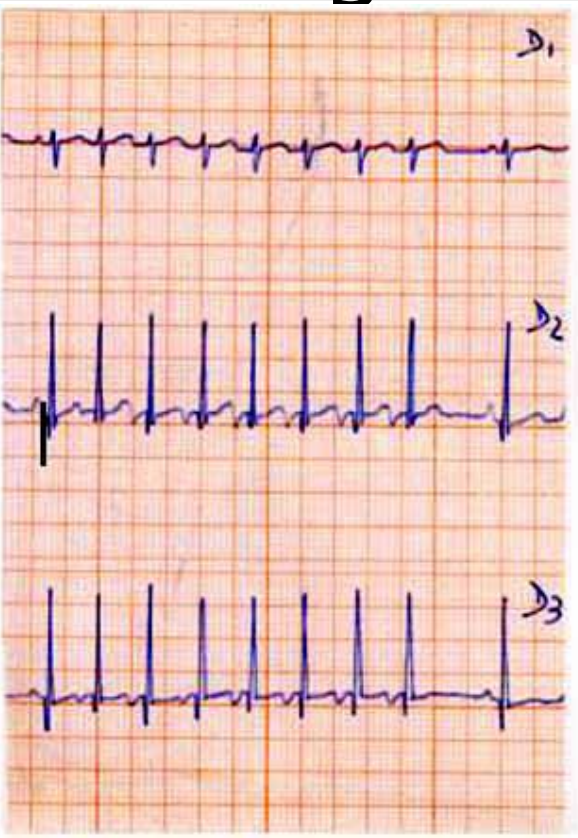
Long RP ..AET

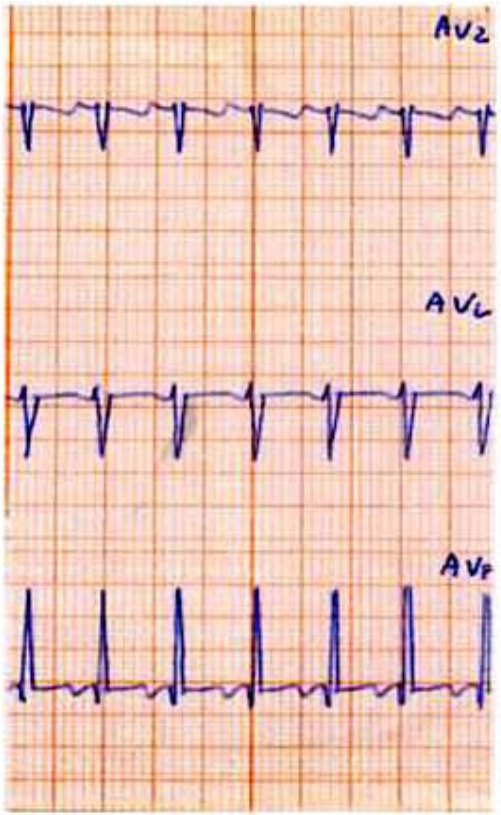


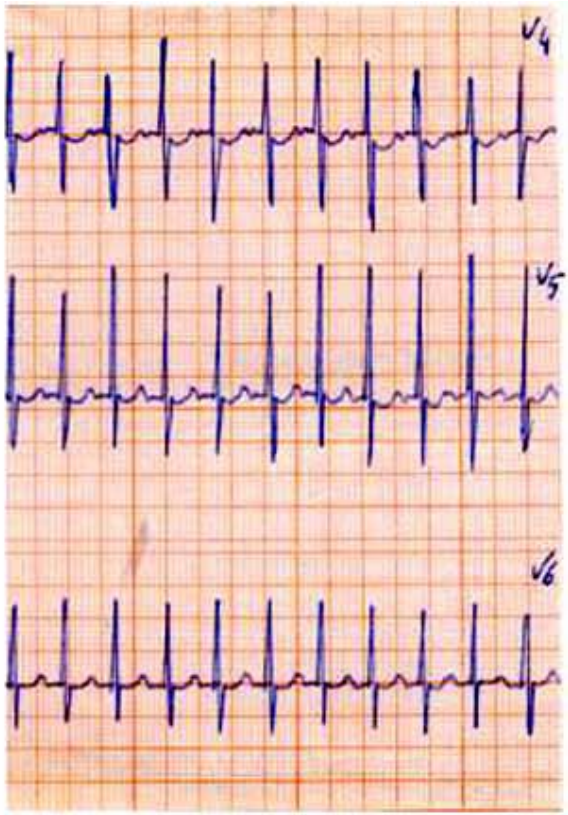


Long RP tachycardia

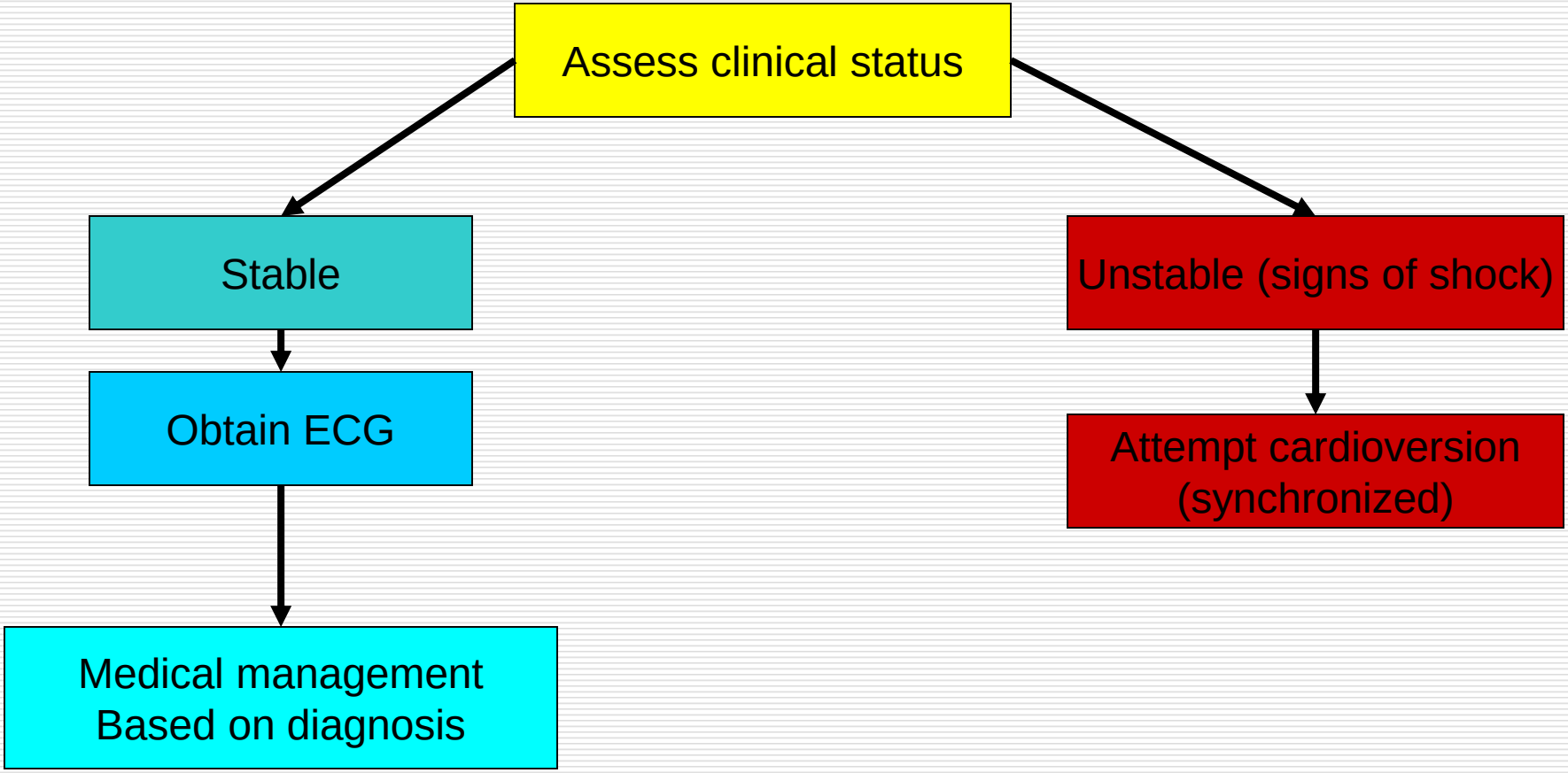
Long RP- PJRT

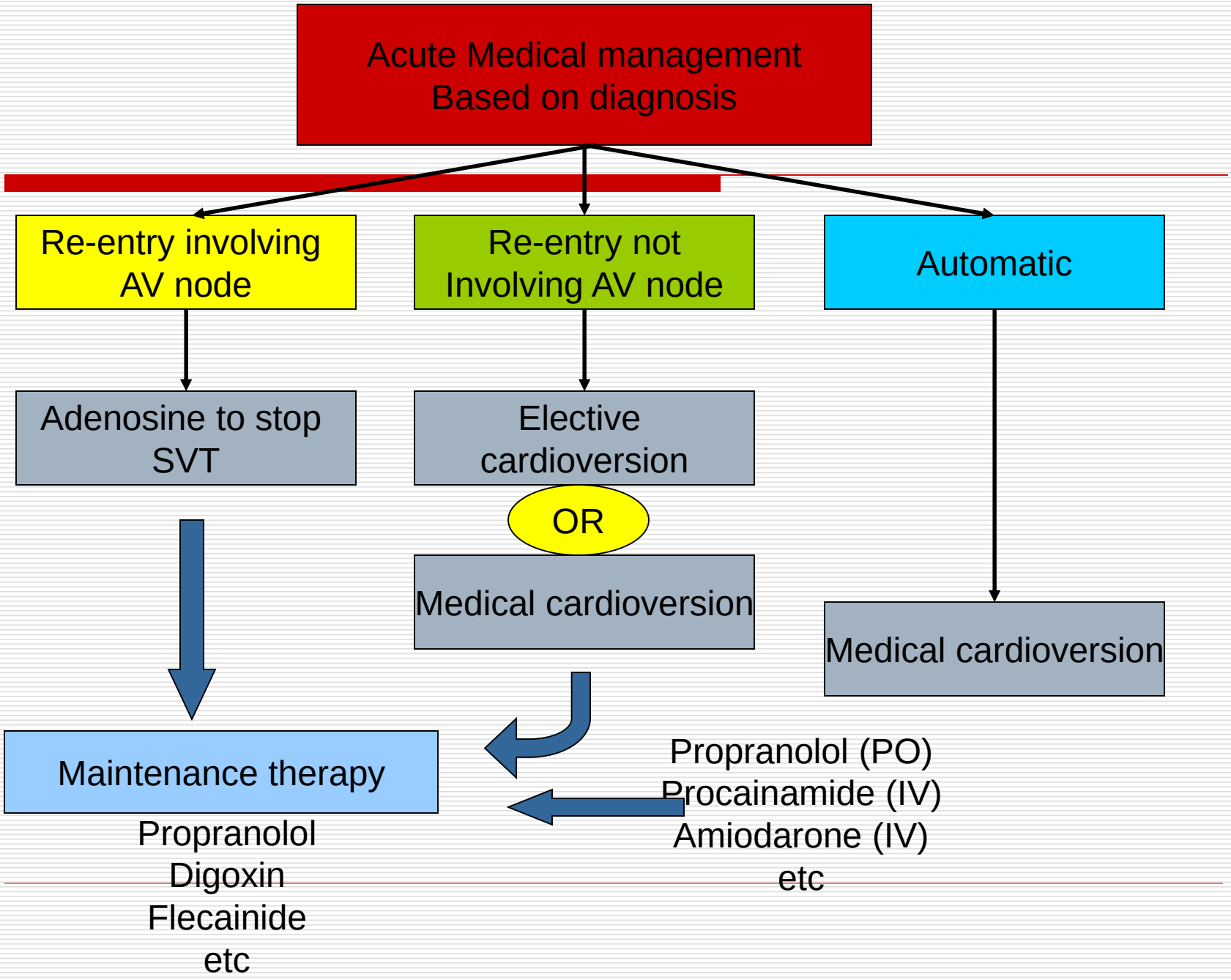




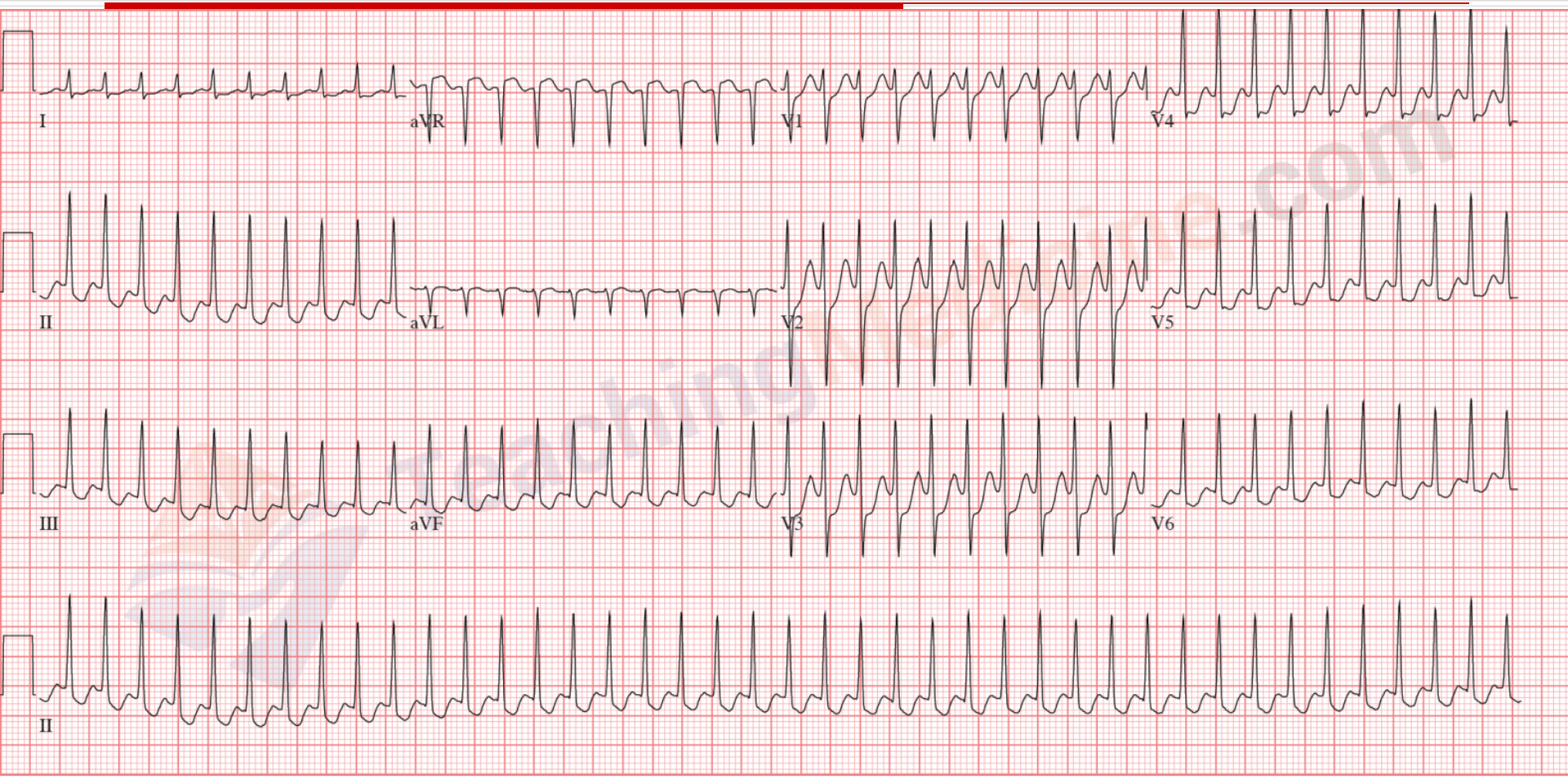


Management approach

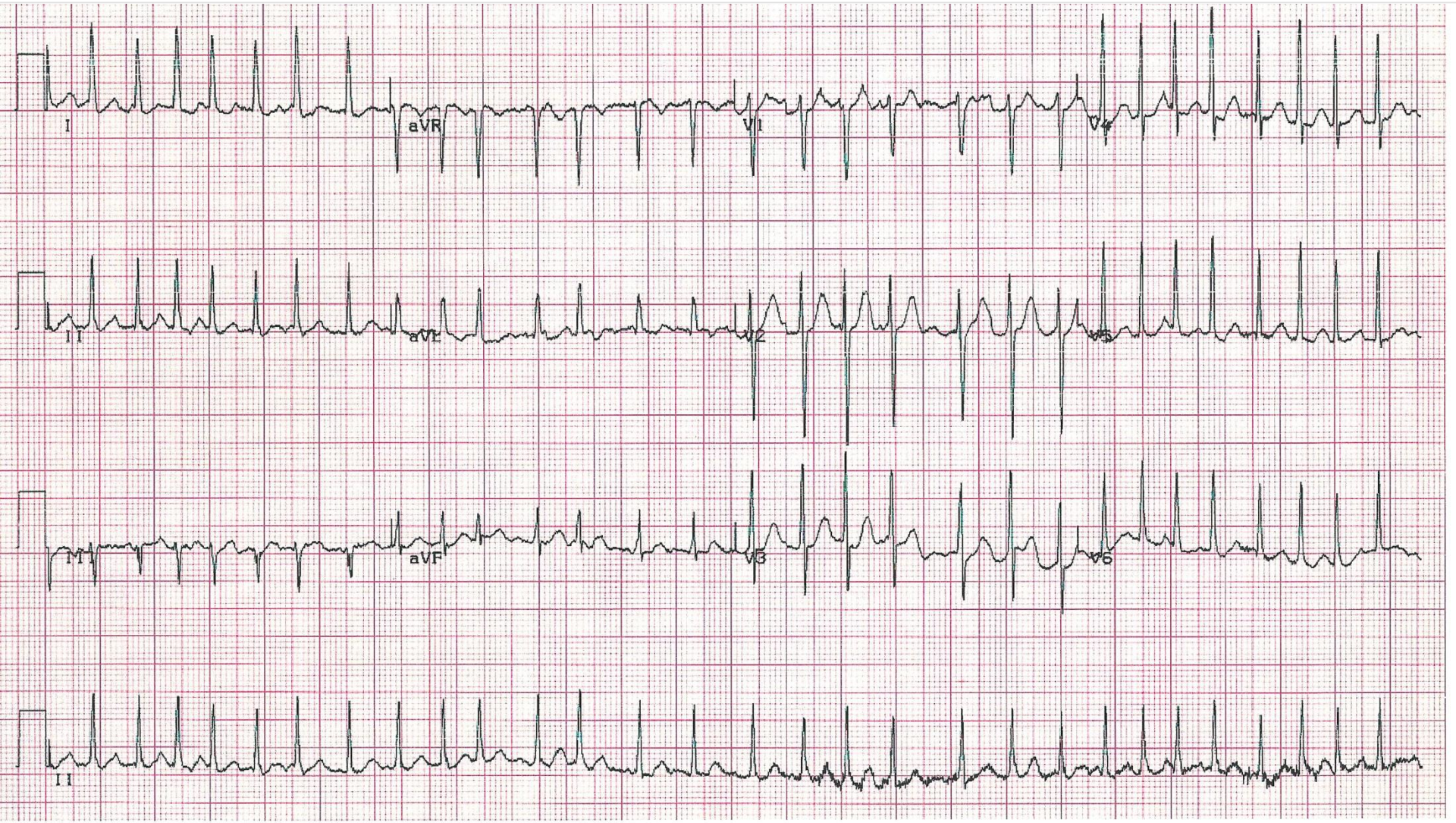



Acute Medical management
Based on diagnosis
Re-entry involving AV node
Re-entry not Involving AV node
Automatic
Adenosine to stop SVT
Elective cardioversion
OR
Medical cardioversion
Medical cardioversion
Maintenance therapy
Propranolol
Digoxin
Flecainide
etc
Propranolol (PO)
Procainamide (IV)
Amiodarone (IV)
etc

Diagnosis?



Diagnosis?



Thank you