

# Καρδιογράφημα στα παιδιά

**Άννα Κωστοπούλου**  
**Επιμελήτρια Α**

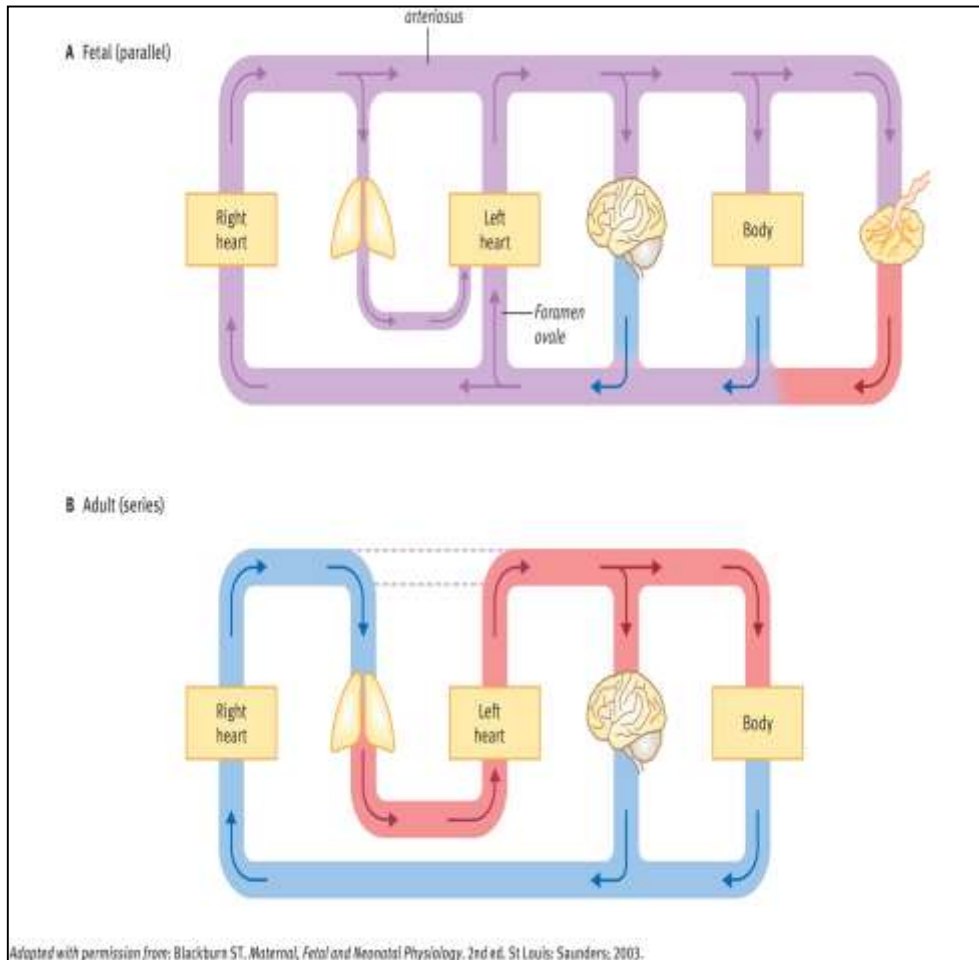
**Ωνάσειο Καρδιοχειρουργικό Κέντρο**  
**Τμήμα Ηλεκτροφυσιολογίας και Βηματοδότησης**



# Σύγκρουση συμφερόντων

Καμία

# Circulation changes after birth



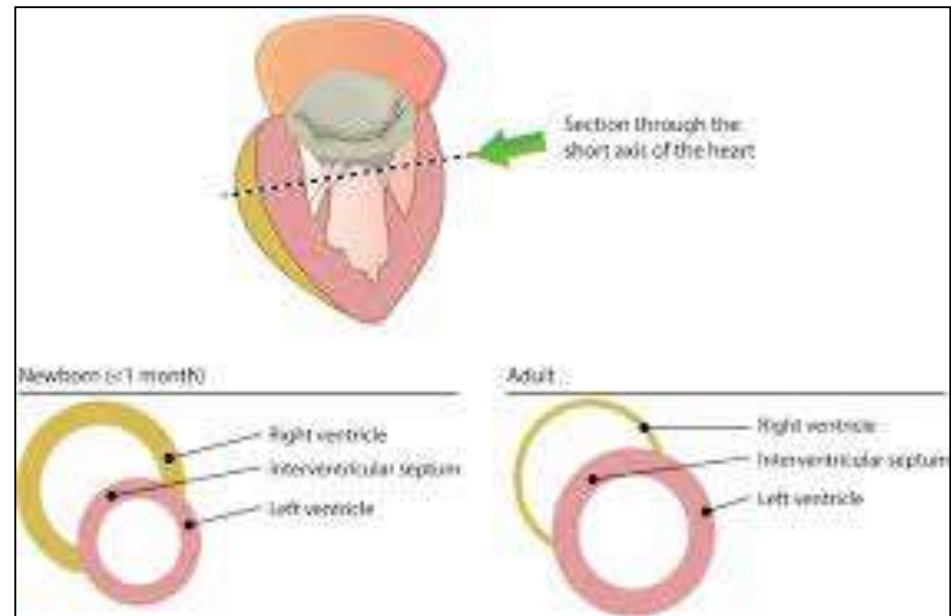
In utero, high pulmonary pressures exist and blood was shunted away from the pulmonary vasculature.

Blood goes left through the patent ductus arteriosus and the foramen ovale

After birth pulmonary pressures fall and circulation goes through the lungs

At birth, the right ventricle is thick due to high pulmonary artery pressure in utero **RV dominance**

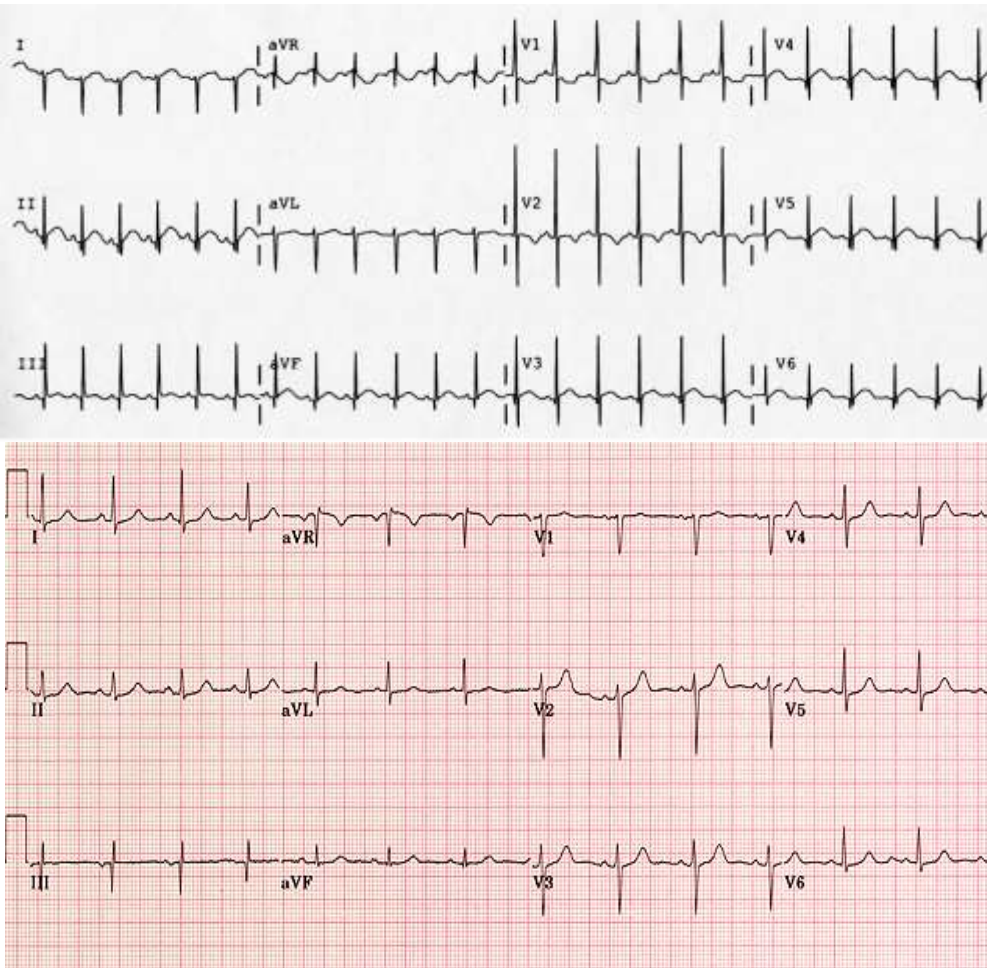
With the fall in pulmonary artery pressure during infancy RV wall stress and thickness decrease until right ventricular pressure approximates that of the adult **LV dominance**



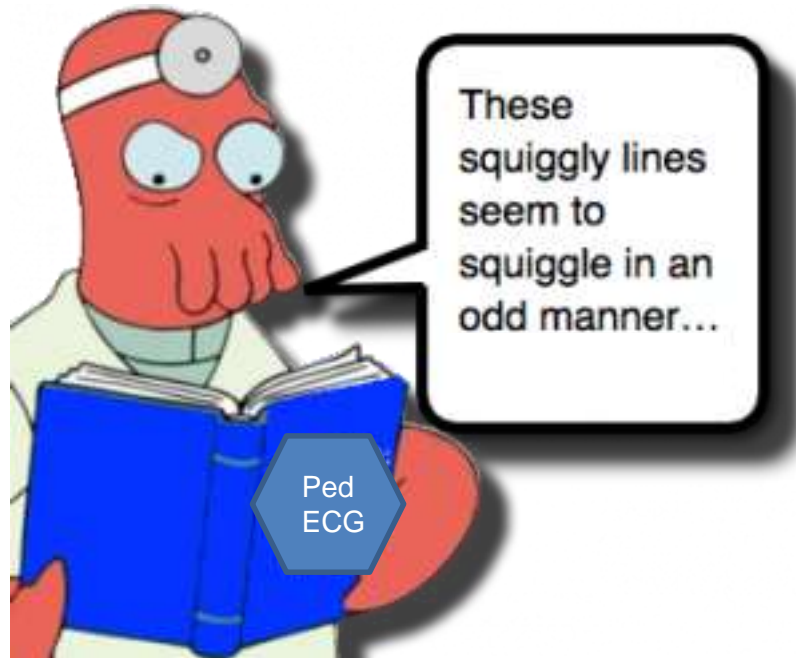
**Ped ECG.**  
Just like  
Small Adults,  
right?



# Normal Ped ECG



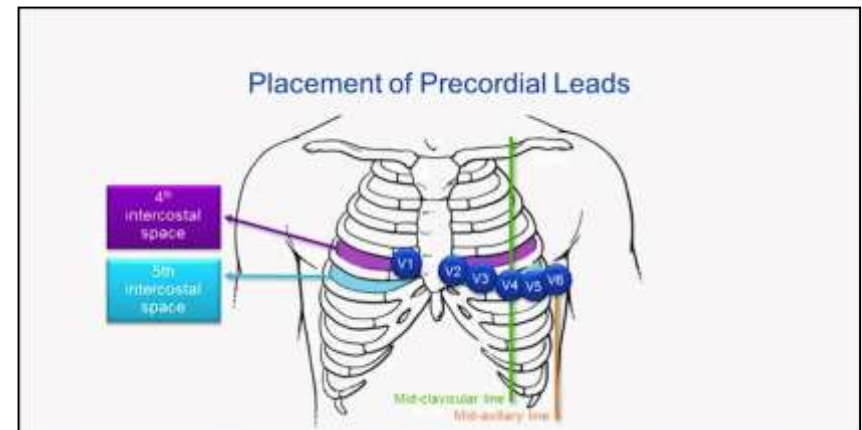
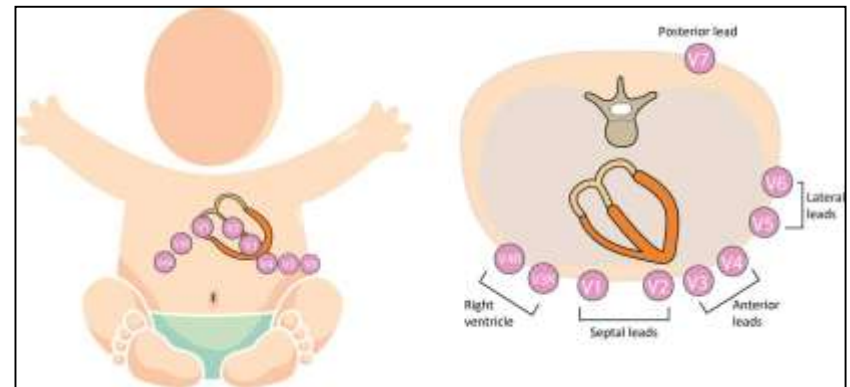
The pediatric ECG changes quite dramatically during childhood, particularly during infancy due to the pathophysiological and anatomical changes in the heart



So lets try....to do a  
Systematic basic approach of a  
pediatric ECG

# Pediatric Lead position

- Precordial leads: same bony landmarks as for adults.
- Limb electrodes: near the shoulders and hips, for less muscle artifact
- Additional VR3 VR4 can be done



# Step I

## Rate and rhythm

### Normal HR

Infants: 145 (90-180)

6 m: 145 (105-185)

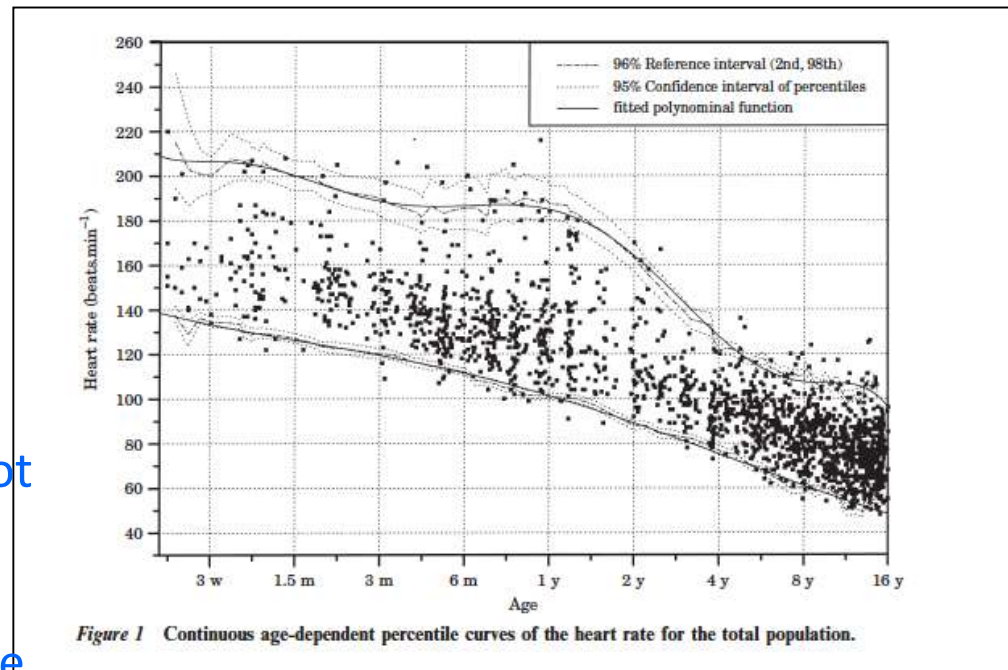
1 y: 132 (105-170)

**4 y: 108 (72-135)**

14 y: 85 (60-120)

Rate of 80 bpm in adults typically not achieved until mid adolescence

Changes due to the gradual increase in vagal tone with aging

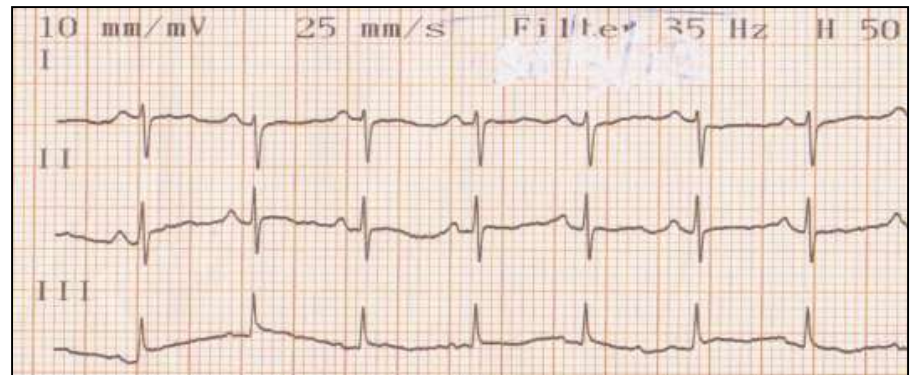


*European Heart Journal* (2001) **22**, 702–711



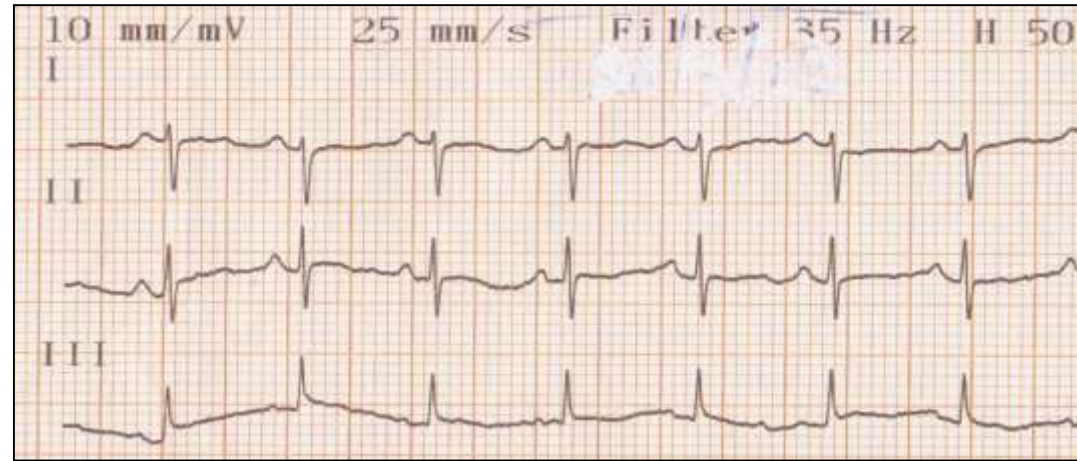
# Rhythm

- **Normal sinus rhythm**
- Same criteria w adults
- (+)P II &(-) aVR same  
Normally P axis positive
- **Use aVF** if negative  
lower rhythm

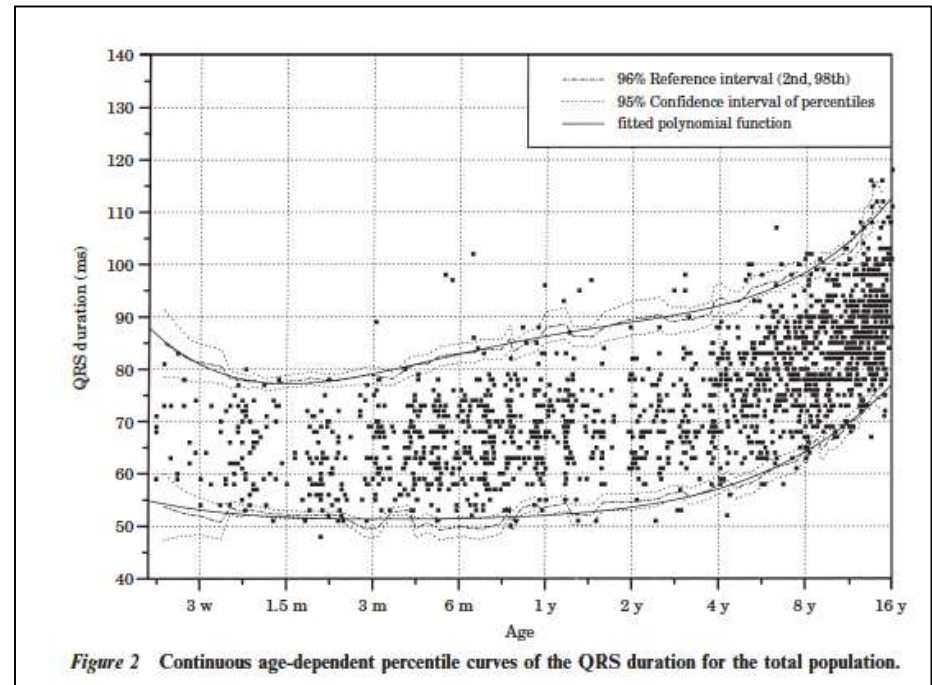


# Step II

## PR QRS QT



- Shorter due to smaller cardiac size
- PR depends on age and heart rate
- Normal < 0,12 infants  
< 0,16 children  
< 0,20 sec older
- QRS narrower increases w age  
0,04-0,08 sec



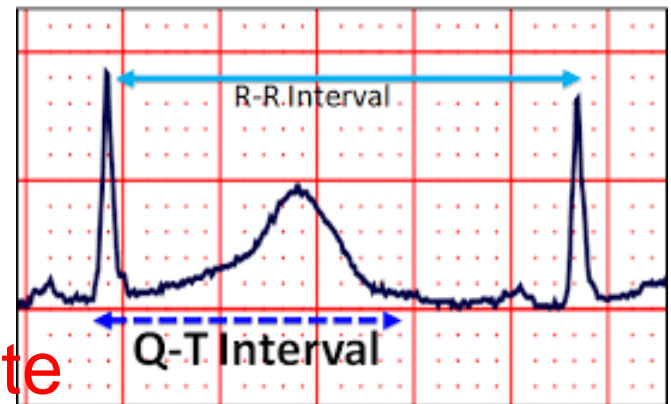
# QT interval and corrected QTc

QTc is longer in the young.

Infants < 6months QTc of < 490 msec  
>6 months similar to adult <440ms

Error in correction due to high rate  
Use ambulatory recordings

$$QTc = \frac{QT}{\sqrt{RR}}$$



# Slight differences between boys & girls

**Boys (adolescence)**  
Higher amplitudes  
slightly wider

**Girls longer QTc 460**

*Table 2 Lead-independent ECG measurements for boys (upper row) and girls (lower row): median (2nd percentile, 98th percentile)*

Lead	0-1 months	1-3 months	3-6 months	6-12 months	1-3 years	3-5 years	5-8 years	8-12 years	12-16 years
Heart rate (beats · min <sup>-1</sup> )	160 (129, 192) 155 (136, 216)	152 (126, 187) 154 (126, 200)	134 (112, 165) <b>139 (122, 191)</b>	128 (106, 194) 134 (106, 187)	<b>119 (97, 155)</b> <b>128 (95, 178)</b>	98 (73, 123) 101 (78, 124)	88 (62, 113) 89 (68, 115)	78 (55, 101) 80 (58, 110)	75 (48, 99) 76 (54, 107)
P axis (°)	56 (13, 99) 52 (24, 80)	52 (10, 73) 48 (20, 77)	49 (-5, 70) 51 (16, 80)	49 (9, 87) 50 (14, 69)	48 (-12, 78) 47 (1, 90)	45 (-13, 69) 44 (-6, 90)	41 (-54, 72) 42 (-13, 77)	39 (-17, 76) 42 (-15, 82)	40 (-24, 76) 45 (-18, 77)
P duration (ms)	78 (64, 85) 79 (69, 106)	79 (65, 98) 78 (62, 105)	81 (64, 103) 78 (63, 106)	80 (66, 96) 80 (64, 07)	80 (63, 113) 83 (62, 104)	87 (67, 102) 84 (66, 101)	89 (71, 107) 89 (71, 107)	92 (73, 108) 94 (75, 114)	98 (78, 117) 98 (78, 122)
PR interval (ms)	99 (77, 120) 101 (91, 121)	98 (85, 120) 99 (78, 133)	106 (87, 134) 106 (84, 127)	114 (82, 141) 109 (88, 133)	118 (86, 151) 113 (78, 147)	121 (98, 152) 123 (99, 153)	129 (99, 160) 124 (92, 156)	134 (105, 174) 129 (103, 163)	139 (107, 178) 135 (106, 176)
QRS axis (°)	97 (75, 140) 110 (63, 155)	87 (37, 138) 80 (39, 121)	66 (-6, 107) 70 (17, 108)	68 (14, 122) 67 (1, 102)	64 (-4, 118) 69 (2, 121)	70 (7, 112) 69 (3, 106)	70 (-10, 112) 74 (27, 117)	70 (-21, 114) 66 (5, 117)	65 (-9, 112) 66 (5, 101)
QRS duration (ms)	67 (50, 85) 67 (54, 79)	64 (52, 77) 63 (48, 77)	66 (54, 85) 64 (50, 78)	69 (52, 86) 64 (52, 80)	71 (54, 88) 68 (54, 85)	75 (58, 92) 71 (58, 88)	80 (63, 98) 77 (59, 95)	85 (67, 103) 82 (66, 99)	91 (78, 111) 87 (72, 106)
QTc interval (ms)*	413 (378, 448) 420 (379, 462)	419 (396, 458) 424 (381, 454)	422 (391, 453) 418 (386, 448)	411 (379, 449) 414 (381, 446)	412 (383, 455) 417 (381, 447)	412 (377, 448) 415 (388, 442)	411 (371, 443) 409 (375, 449)	411 (373, 440) 410 (365, 447)	407 (362, 449) 414 (370, 457)

Bold values indicate that the 95% confidence intervals of the percentile estimates for boys and girls do not overlap.

\*Corrected QT interval, according to Bazett's formula:  $QTc = QT \cdot \sqrt{\frac{\text{heart rate}}{60}}$





# Step 3

## QRS axis frontal

### Use I & aVF

- 1 week-1 m:  $+110^\circ$  ( $+30^\circ$  -  $+180^\circ$ )
- 1-3 month:  $+70^\circ$  ( $+10^\circ$  -  $+125^\circ$ )
- 3 m-3 y:  $+60^\circ$  ( $+10^\circ$  -  $+110^\circ$ )
- $>3$  y:  $+60^\circ$  ( $+20^\circ$  -  $+120^\circ$ )
- adults:  $+50^\circ$  ( $-30^\circ$  -  $+105^\circ$ )

Birth RV dominance  
 $>3$  y LV dominance

Lead I	Lead aVF	Quadrant	Axis
POSITIVE	POSITIVE		<b>Normal Axis</b> ( $0$ to $+90^\circ$ )
POSITIVE	NEGATIVE		<b>**Possible LAD</b> ( $0$ to $-90^\circ$ )
NEGATIVE	POSITIVE		<b>RAD</b> ( $+90^\circ$ to $180^\circ$ )
NEGATIVE	NEGATIVE		<b>Extreme Axis</b> ( $-90^\circ$ to $180^\circ$ )

# Step 4

## transverse axis- precordial leads

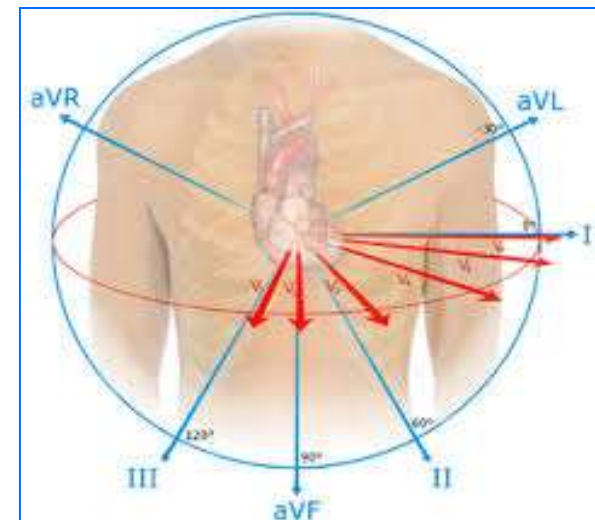
### A) R/S ratio in V1 -V6

**0-6months:** R dominant in right leads V1, V2, RV3 & deep S in left

**6m-3y:** R smaller in right leads larger in left & less deep S or RSR'

**>3y** R/S < 1 in V1 V2, tall R in left leads small S **LV dominance**

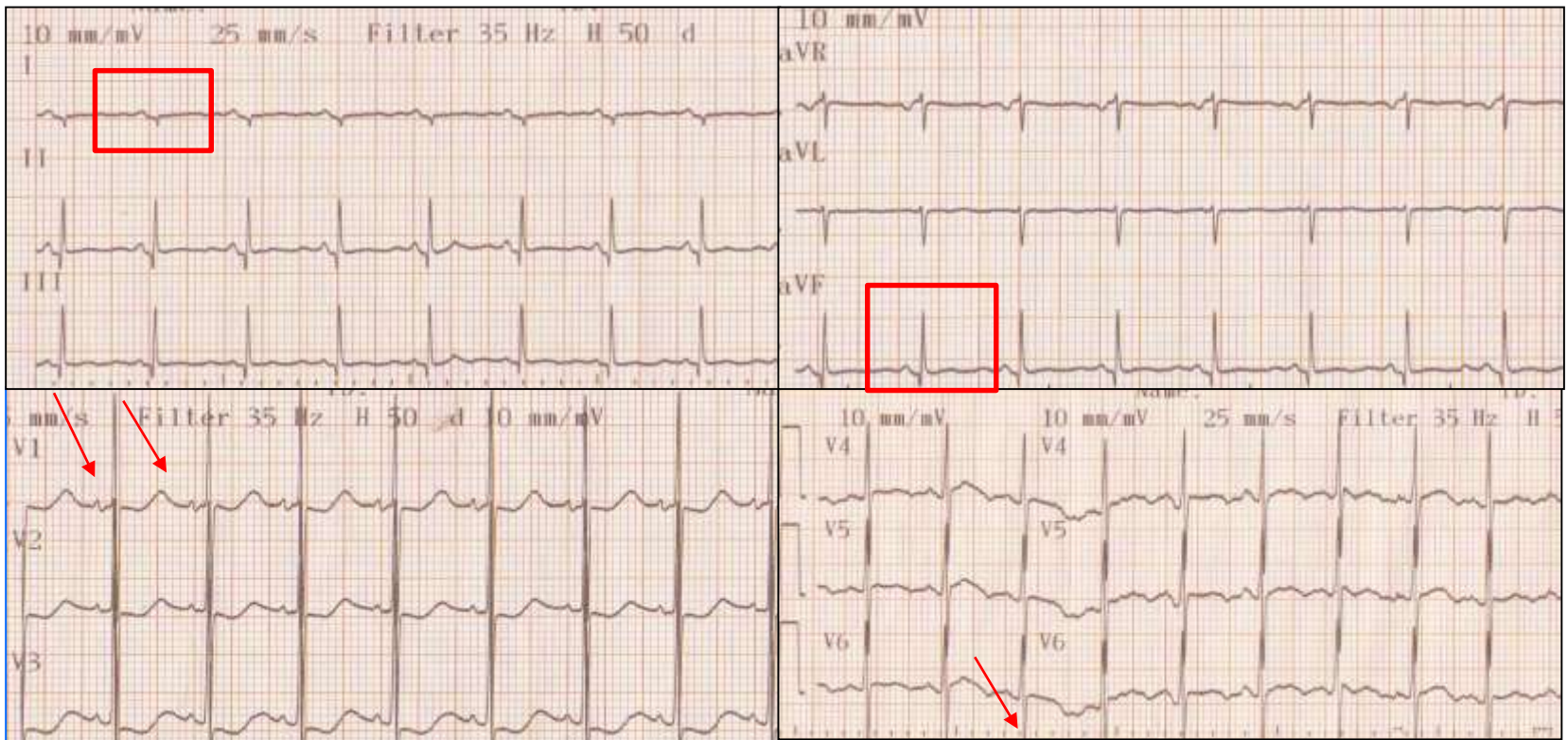
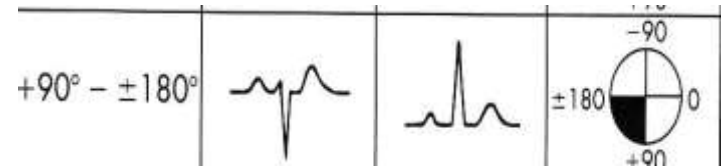
**B) T waves** negative in V1 V2 Rv3 after 7 days until adolescence 8y  
10-15% juvenile T after 8y





# Infant- 1st day

- 1) HR rhythm
- 2) PR QRS
- 3) Axis up to +180
- 4) R/S- Twaves



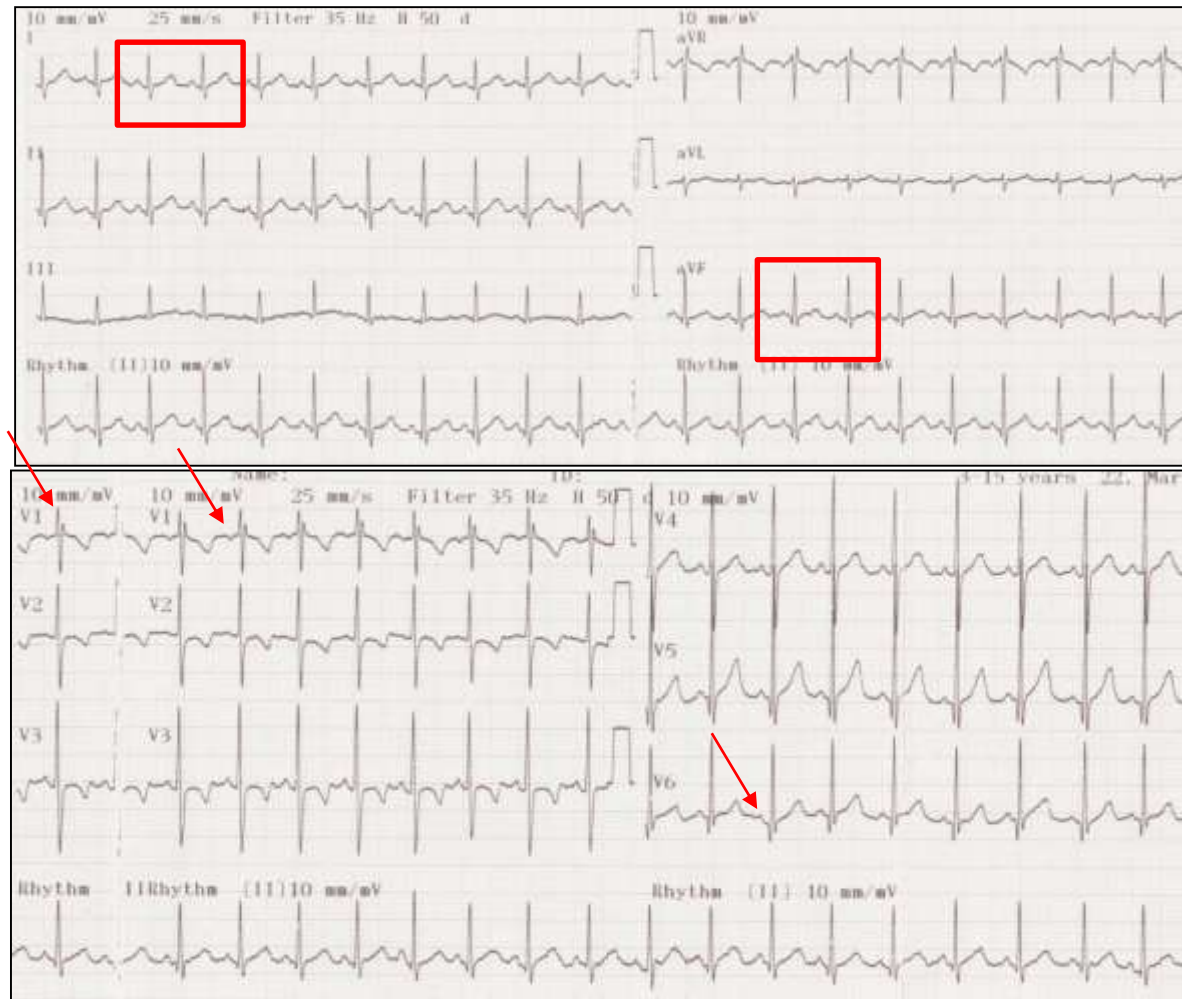
# Infancy early childhood >6m -3y



- 1) HR -rhythm
- 2) PR QRS
- 3) **Axis <+90**
- 4) R/S- T waves

Normal Q  
waves in  
left leads

>6m pure R or RSR'  
R;>R is abnormal





# ECG >3 years

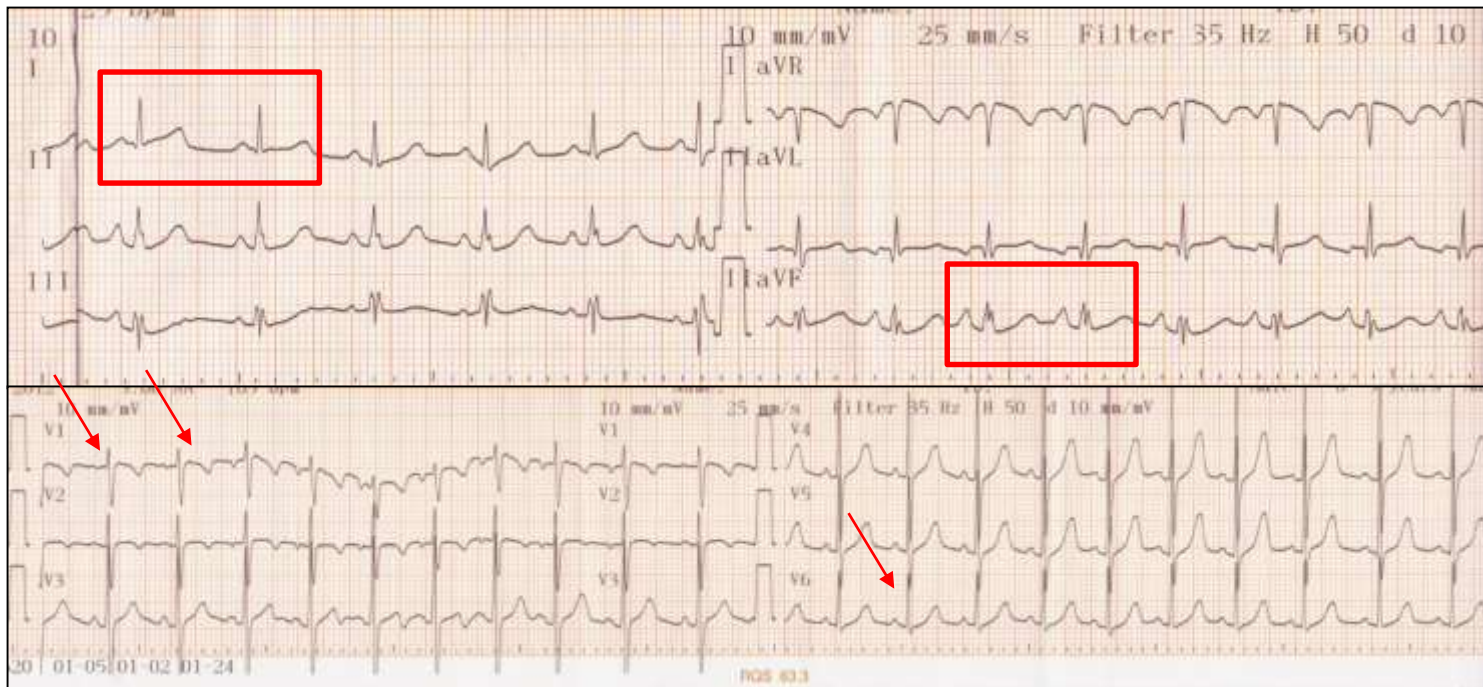


1) HR rhythm

2) PR QRS

3) Axis +90-+125

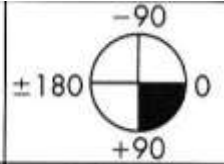
4) R/S-T waves



# ECG 8-16 years



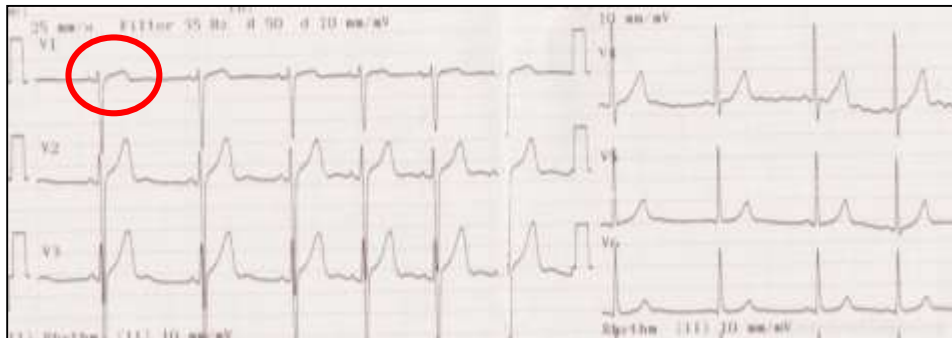
$0^\circ - +90$



- R/S < 1 adult type
- Taller R in left leads compared to adults

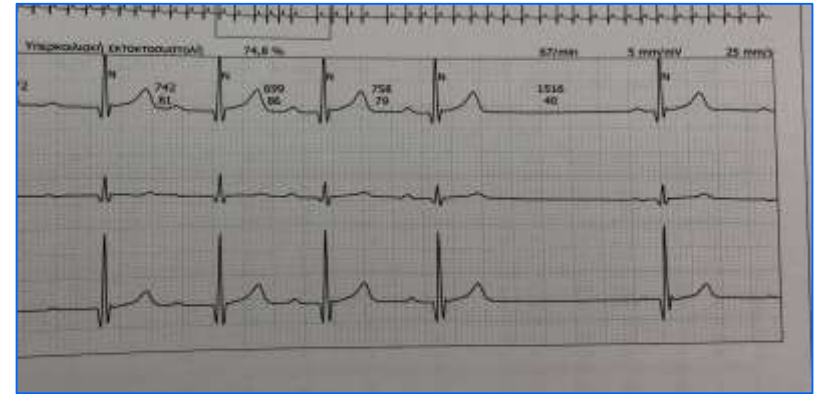
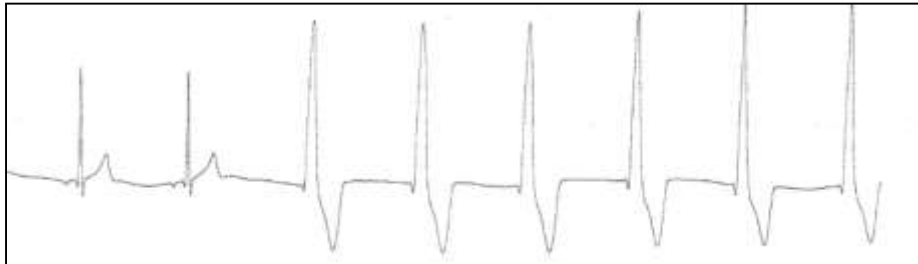


- Pos or negative T in  $V_1 - V_4$



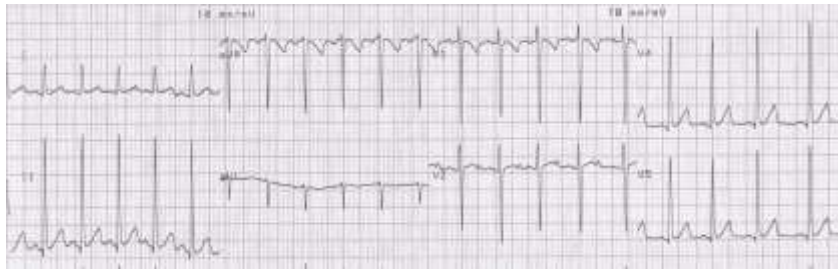
# Common “normal” variations in ECG

- 1) Sinus arrhythmias- pauses  $<1.8s$  & junctional rhythm (vagal, athletes)
- 2) AV block 1 & 2<sup>nd</sup> MI 10% of normal children

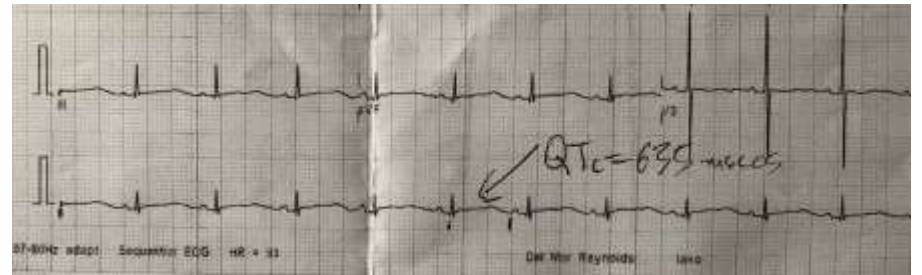


- 3) Ventricular or supraventricular extrasystole 20-30% of Holter recording
- 4) Early repolarization





# Pathological ECGs



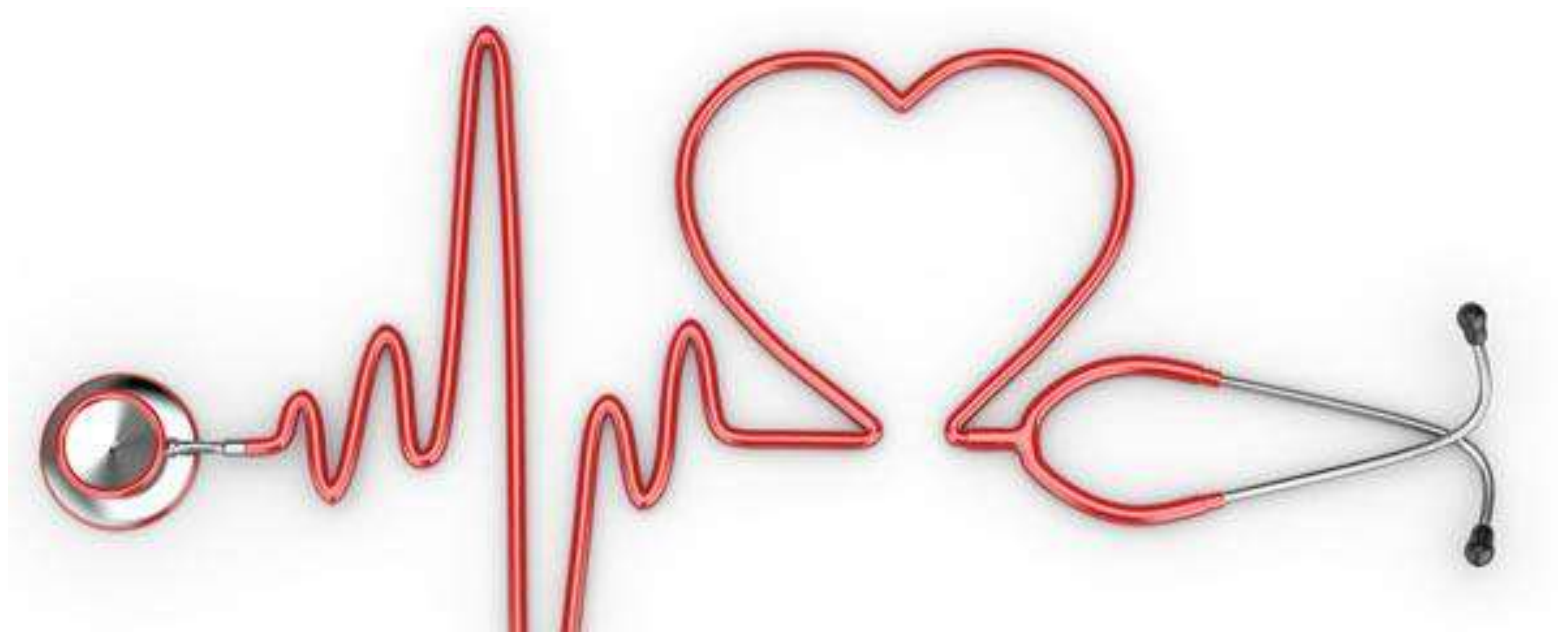
# Conclusions

## “Normal” ECG depends on age

Understanding the underlying pathophysiology and recognizing the normal pattern is important for all cardiologists emergency and acute care providers



Ευχαριστίες στην Υποδιευθύντρια Παιδοκαρδιολόγο  
ΩΚΚ κ Ρία Αποστολοπούλου για την πολύτιμη βοήθεια



Ευχαριστώ για την προσοχή σας