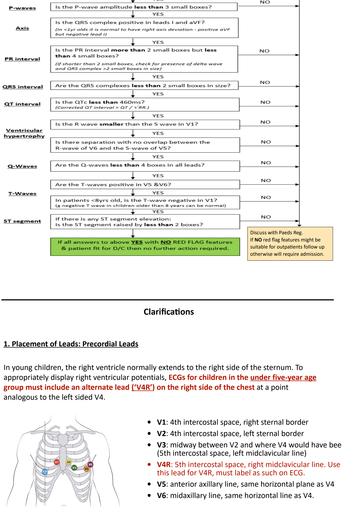
Paediatric ECG

Use the following chart as a quick checklist to review what's normal and what's not in a paediatric ECG. Further clarifications below if needed.

Remember:
- Lead V4R in under 5's
- Manually calculate QTc
- WPW needs referral for ablation - increase risk of sudden death

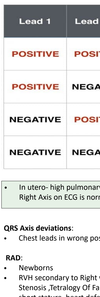
If in any doubt discuss with paediatric registrar/senior. If in need of urgent intervention then contact the paediatric cardiology team in LGI.



Clarifications

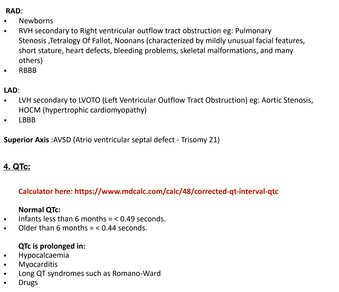
1. Placement of Leads: Precordial Leads

In young children, the right ventricle normally extends to the right side of the sternum. To appropriately display right ventricular potentials, **ECGs for children in the under five-year age group must include an alternate lead ('V4R') on the right side of the chest** at a point analogous to the left sided V4.



- **V1**: 4th intercostal space, right sternal border
- **V2**: 4th intercostal space, left sternal border
- **V3**: midway between V2 and where V4 would have been (5th intercostal space, left midclavicular line)
- **V4R**: 5th intercostal space, right midclavicular line. Use this lead for V4R, must label as such on ECG.
- **V5**: anterior axillary line, same horizontal plane as V4
- **V6**: midaxillary line, same horizontal line as V4.

2. P Waves:



3. Axis:

Lead 1	Lead aVF	Quadrant	Axis
POSITIVE	POSITIVE		Normal Axis (0 to +90°)
POSITIVE	NEGATIVE		**Possible LAD (0 to -90°)
NEGATIVE	POSITIVE		RAD (+90° to 180°)
NEGATIVE	NEGATIVE		Extreme Axis (-90° to 180°)

- In utero- high pulmonary pressures and a relatively thick Right Ventricle (RV) -> Initial Right Axis on ECG is normal and r**esolves after the first 6 months of life**

QRS Axis deviations:
- Chest leads in wrong position

RAD:
- Newborns
- RVH secondary to Right ventricular outflow tract obstruction eg: Pulmonary Stenosis ,Tetralogy Of Fallot, Noonans (characterised by mildly unusual facial features, short stature, heart defects, bleeding problems, skeletal malformations, and many others)
- RBBB

LAD:
- LVH secondary to LVOTO (Left Ventricular Outflow Tract Obstruction) eg: Aortic Stenosis, HOCM (hypertrophic cardiomyopathy)
- LBBB

Superior Axis :AVSD (Atrio ventricular septal defect - Trisomy 21)

4. QTc:

Calculator here: https://www.mdcalc.com/calc/48/corrected-qt-interval-qtc

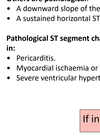
Normal QTc:
- Infants less than 6 months = < 0.49 seconds.
- Older than 6 months = < 0.44 seconds.

QTc is prolonged in:
- Hypocalcaemia
- Myocarditis
- Long QT syndromes such as Romano-Ward
- Drugs

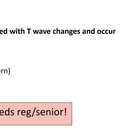
QTc is short in:
- Hypercalcaemia
- Congenital short QT syndrome

5. Ventricular Hypertrophy

Right Ventricular Hypertrophy



Left Ventricular Hypertrophy



- **Axis**: RAD for the patients age
- **Voltages**: Tall R waves in right-sided leads V4R and V1. Deep S waves in left-sided leads V5 and V6.
- **Abnormal T waves:** Upright T waves in V1 and V4R in children 7 days to 8 years . This is evidence alone of significant RVH.
- **Abnormal Q waves**: qR pattern in V1 (small Q wave, tall R wave) = highly specific for RVH.

Evans Rules:
Abnormal Right Ventricular Large Voltage ("RVH"):
- Use only V1 (the *right* most precordial lead)
- *Upright T wave in V1:* In first week of life is NORMAL. Between week 1 and adolescence this is ABNORMAL
- *Pure R wave in V1*: If child > 6 months old – this is ABNORMAL

- ***Axis***: LAD for the patients age
- ***Voltages:***
  - Tall R waves in the left-sided leads V5 and V6
  - Deep S waves in the right-sided leads V4R and V1
- ***Abnormal Deep Q waves*** in V5 and V6
- ***Inverted T waves*** in V5 and V6 (LV strain pattern)

Evans Rules:
Abnormal Left Ventricular Large Voltage ("LVH")
- Use only V6 (the *left* most precordial lead)
- If R wave of V6 intersects with baseline of V5, this is ABNORMAL

Voltage Criteria for RVH & LVH by Age

	Age				
	0-7 days	7 days - 1 yr	1-3 yrs	3-5 yrs	>5 yrs
LVH					
RV_5	>12 mm	> 23 mm	> 21-23 mm	> 24-25 mm	> 25-27 mm
SV_1	> 23 mm	> 15-18 mm	> 21 mm	> 22 mm	> 26mm
$SV_1 + RV_5$	> 28 mm	> 35 mm	> 38 mm	> 42 mm	> 47 mm
RVH					
RV_1	> 26 mm	> 20-22 mm	> 18 mm	> 14-18 mm	> 13 mm
SV_5	> 10 mm	> 7-10 mm	> 7 mm	> 6 mm	> 4 mm
$RV_1 + SV_5$	> 37 mm	> 43 mm	> 30 mm	> 24 mm	> 17 mm

6. T waves:

- The precordial T-wave configuration changes over time
- For the first week of life, T waves are upright throughout the precordial leads.
- After the first week, the T waves become inverted in V1-3 (= the "juvenile T-wave pattern")
- This T-wave inversion usually remains until ~ age 8; thereafter the T waves become upright in V1-3.
- However, the juvenile T-wave pattern can persist into adolescence and early adulthood (= "persistent juvenile T waves").

Tall, peaked T waves are seen in:
Hyperkalaemia, Dilated LV (volume overload), Benign early reporlarisation

Flat T waves are seen in:
Normal newborns, Hypothyroidism, Hypokalaemia, Pericarditis, Myocarditis

7. ST Segment:

Some ST changes may be normal:
- Limb lead ST depression or elevation of up to 1mm (up to 2mm in the left precordial leads).
- J-point depression: the J point is depressed without sustained ST depression, i.e. upsloping ST depression
- Benign early repolarisation in adolescents: the ST segment is elevated and concave in leads with an upright T wave.

Others are pathological:
- A downward slope of the ST followed by a inverted T.
- A sustained horizontal ST segment depression

Pathological ST segment changes are commonly associated with T wave changes and occur in:
- Pericarditis.
- Myocardial ischaemia or infarction.
- Severe ventricular hypertrophy (ventricular strain pattern)

If in doubt discuss with paeds reg/senior!