Worcestershire Acute Hospitals NHS Trust

ECG Interpretation

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The following guidance is taken from the Partners In Paediatrics (PIP)

ECG INTERPRETATION

- Examine all ECGs for:
- P wave size and axis
- axis of QRS complex
- R-S pattern in chest leads
- P-R, QRS and Q-T intervals
- P and T wave configuration
- size of QRS in chest leads

PAPER SPEED

ECG normally recorded at 25 cm/sec

- 1 mm (1 small square) = 0.04 sec
- 5 mm (1 large square) = 0.2 sec

P WAVE

Reflects atrial activity
Duration shorter than in adults

- infants: 0.04–0.07 sec
- adolescents: 0.06–0.1 sec

Height ≤2.5 mm
Varying P wave morphology may indicate wandering atrial pacemaker

Right atrial hypertrophy (RAH)
Increased P wave amplitude in leads II, V1, and V4R

Causes

- Pulmonary hypertension
- Pulmonary stenosis
- Pulmonary atresia
- Tricuspid atresia

Left atrial hypertrophy (LAH)
Biphasic P wave (later depolarization of LA)

Causes

- Mitral valve disease
- LV obstruction and disease

P-R INTERVAL

Atrial depolarization varies with age and rate

Normal range of P-R interval (time in sec)

HEART RATE	P-R INTERVAL (SEC)			
	0–1 month	0–12 months	1–12 yr	12–16 yr
<60	-	-	-	0.1–0.19
60–99	-	-	0.1–0.16	0.1–0.17
100–139	0.08–0.11	0.08–0.12	0.1–0.14	-
140–180	0.08–0.11	0.08–0.12	0.1–0.14	-
>180	0.08–0.09	0.08–0.11	-	-

Prolonged interval

- Normal
- Myocarditis
- Ischaemia
- Drugs
- Hyperkalaemia

Short interval
- Wolff-Parkinson-White syndrome
- Lown-Ganong-Levine syndrome
- Glycogen storage disease

Variable interval
- Wandering atrial pacemaker
- Wenckebach phenomenon

QRS COMPLEX

Ventricular activity
Duration: 0.06–0.08 sec

Prolonged
- Ventricular hypertrophy
- Bundle branch block
- Electrolyte disturbance
- Metabolic disease
- Drugs (e.g. digoxin)

Normal range of R and S waves (height in mm)

Age	R and S waves (height in mm)					
	V4-R	V1-R	V1-S	V5-R	V6-R	V6-S
Birth	4–12	5–20	0–20	2–20	1–13	0–15
6–12 months	2–7	3–17	1–25	10–28	5–25	0–10
1–10 yr	0–7	2–16	1–12	5–30	5–25	0–7
>10 yr	0–6	1–12	1–25	5–40	5–30	0–5

Q WAVE

Normal in II; III; aVF; V5-6
Depth 2–3 mm
- pathological if >4 mm (i.e. septal hypertrophy)

May be found in other leads in:
- anomalous coronary arteries
- hypertrophic obstructive cardiomyopathy
- transposition of great arteries (with opposite polarity)

Q-T INTERVAL

Inversely proportional to rate
Calculate ratio of Q-T interval to R-R interval
- QTc = $\frac{\text{Q-T}}{\sqrt{\text{R-R}^{\text{I}}}}$
- QTc is usually less than 0.44 s
- prolonged QTc is associated with sudden death: alert consultant immediately

Prolonged interval
- Hypocalcaemia
- Myocarditis
- Jervell-Lange-Nielsen syndrome
- Romano-Ward syndrome
- Head injuries or cerebrovascular episodes
- Diffuse myocardial disease
- Antiarrhythmics

Short interval
- Hypercalcaemia
- Digitalis effect

T WAVE

Ventricular repolarization

Normal

- T inversion V4R/V1 (from 3rd day of life until 10 yr)
- Amplitude is 25–30% of R-wave
- Aged <1 yr: V5 ≤11 mm; V6 ≤7 mm
- Aged >1 yr: V5 ≤14 mm; V6 ≤9 mm
- Adolescence reduces amplitude

Peaked T wave

- Hyperkalaemia
- LVH
- Cerebrovascular episode
- Post-MI

Flat T wave

- Normal newborn
- Hypothyroidism
- Hypokalaemia
- Hyper/hypoglycaemia
- Hypocalcaemia
- Peri/myocarditis
- Ischaemia
- Digoxin effect

MEAN QRS AXIS

Vertical plane (limb leads)

Normal axis in vertical plane

- Birth +60° to +180° (av +135°)
- Aged 1 yr +10° to +100° (av +60°)
- Aged 10 yr +30° to +90° (av +65°)

Right axis deviation

- Right ventricular hypertrophy (RVH)
- Left posterior hemiblock
- Ostium secundum atrial septal defect (ASD)/right bundle branch block (RBBB)

Left axis deviation

- Left ventricular hypertrophy (LVH)
- Ostium primum ASD (+ RBBB)
- Often in conduction defects

Horizontal plane (anterior chest leads)

Normal

- Transition at around V3

Clockwise rotation

- S>R in V4 = RA/RV hypertrophy

Anticlockwise rotation

- R>S in V2 = cardiac shift (e.g. pneumothorax)

LEFT VENTRICULAR HYPERTROPHY

Diagnosis

SV1 + RV5 ≥40 mm (30 mm aged <1 yr)
+/- prolonged QRS
Flat T wave
T wave inversion V5-V6 (LV strain)
Left bundle branch block

Causes include

- Aortic stenosis
- Aortic regurgitation
- Hypertension
- Moderate VSD
- Hypertrophic obstructive cardiomyopathy
- Patent ductus arteriosus
- Mitral regurgitation

RIGHT VENTRICULAR HYPERTROPHY

Diagnosis

RAD and RV1 > SV1 (aged >1 yr)
SV6 above maximum for age:

- 0–6 months 15 mm
- >6 months 10 mm
- >12 months 7 mm
- 10 yr 5 mm

R waves in V4R/V1 >normal
T wave changes

- upright in V1/V4R (aged from 3 days to 10 yr)

Causes include

- Pulmonary stenosis/atresia
- Transposition of great arteries
- Pulmonary regurgitation
- Total anomalous pulmonary drainage
- Tricuspid regurgitation
- Fallot's tetralogy
- Pulmonary hypertension

BIVENTRICULAR HYPERTROPHY

Diagnosis

R + S >50 mm in V3-V4
LVH + bifid R <8 mm in V1
RVH + LV strain
Q waves V3-V6 imply septal hypertrophy

TYPICAL ECG ABNORMALITIES

Heart lesion	ECG abnormalities
PDA	LVH > RVH; LAH
VSD	LVH > RVH; +/- RBBB; T inv LV leads
ASD	Secundum RAD; RBBB; +/- increased P-R; AF Primum LAD; RBBB; BVH; RAH
Eisenmenger's	RVH; P pulmonale
Aortic stenosis	LVH + strain
Aortic regurgitation	LVH
Coarctation	Newborn: RVH Older: Normal or LVH +/- strain; RBBB
Mitral regurgitation	LVH
Pulmonary stenosis	RVH; RAH
Ebstein's anomaly	Prolonged P-R interval; gross RAH; RBBB
Fallot's tetralogy	Newborn: Normal or T +ve V1 Older: RVH; RAH
Pulmonary atresia	RAH
Tricuspid atresia	LAD; RAH; LVH