PAEDIATRIC ACUTE CARE GUIDELINE	
ECG Interpretation	
Scope (Staff):	All Emergency Department Clinicians
Scope (Area):	Emergency Department

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ECG Interpretation

Background

Common Indications for paediatric electrocardiography

- Syncope, seizures and "funny turns"
- Cyanotic episodes
- Chest pain or other symptoms related to exertion
- Drug ingestion
- Diagnosis and management of rheumatic fever, Kawasaki's disease, pericarditis, myocarditis
- Diagnosis and management of arrhythmia
- Diagnosis and management of congenital heart disease
- Family history of sudden death or life threatening event
- Electrolyte abnormalities

Assessment

Age Variants

Normal Heart Rates	
Newborn	110-150
2 years	85-125
4 years	75-115

6+ years	60-100

Full Term Newborn Infant
- Right axis deviation (up to +180)
- RV dominance in praecordial leads:
  - all R in V1 (>10mm suggests RVH)
  - deep S in V6
  - R/S ratio > 1 in right chest leads, relatively small in left
- QRS voltages in limb leads relatively small
- T waves – low voltage
- T waves in V1 may be upright for <72 hours (>72 hours suggests RVH)

1 week – 1 month
- Right axis retained
- R waves remain dominant across to V6, although dominant S may be normal
- T wave negative V1
- T wave voltage higher in limb leads

1 – 6 months
- QRS axis rotates to leftward (less than +120)
- R wave remains dominant in V1
- R/S ratio in V2 close to 1 but may be >1 in V1
- T waves negative across right chest leads

ECG – 2 month old

6 months – 3 years
- QRS axis usually > +90
- R wave dominant in V6
- R/S ratio in V1 close to or less than 1
- Large voltages in praecordial leads persist

ECG – 2 year old

3 – 8 years
- Adult QRS progression in praecordial leads: dominant S in V1, dominant R in V6
- Large praecordial voltages persist
- q waves in left chest leads may be large (<5mm)
- T waves remain negative in right praecordial leads

8 – 16 years
- QRS axis mean +60, range 0 to +90
- Adult QRS progression
- Large praecordial lead voltages, R in left lead larger than adult
- T waves variable. Maybe upright in V1 but negative V1-V4 not abnormal

ECG – 8 year old

ECG – 15 year old

Adult
- QRS axis mean +50, range 0 to +100
- Dominant LV
- T waves upright across praecordial leads

Examination

P Wave

- P wave amplitude does not change significantly during childhood
- P waves are normally upright in I and aVF
- Amplitude < 3mm, if taller consider right atrial hypertrophy (RAH)
- Duration < 0.09 seconds, if wider consider left atrial hypertrophy (LAH)

Q Wave

- In most leads where a significant Q waves appears (I, III, aVF, V5, V6), there is a trend for amplitude to double over the first few months of life, reaching a maximum at about 3-5 years of age and declining thereafter back towards the newborn period.
- Abnormal if present in V1 or absent in V5 or V6
- Normal duration 0.02-0.03
- Normal amplitude < 5mm
- Amplitude > 5mm consider:
  - Hypertrophy
  - Volume overload

QRS Axis

- The relative right ventricular hypertrophy (RVH) of the neonate regresses over the first few months of life.

Normal QRS axis varies with age:		
Age	**Mean**	**Range**

1 week – 1 month	+ 100º	+30º – +180º
1 month – 3 months	+70º	+10º – +125º
3 months – 3 years	+60º	+10º – +110º
3 years +	+60º	+20º – +120º
Adult	+50º	-30º – +105º

- The amplitude of R waves in the right pericardial leads of normal children decreases with age while the amplitude increases in the left precordial leads.
- Similar but inverse changes occur in respect of the S wave amplitude.
- Further information: Cardiac Axis

T Wave

- In the first 2-3 days of life upright T waves in the right precordial leads (V1 and V3R) are normal.
- It is usual for the T waves in these leads to invert in the majority of infants during the first week of life.
- Persistence of a positive T wave in V1 or V3R beyond the first week of life should therefore raise the suspicion of abnormality, usually RVH.
- In the intermediate leads, V2 and V3, the T wave is often inverted in early childhood and there is progression to the T wave becoming upright in sequence V3, V2, V1.
- The T wave in V5 and V6 should be upright at all ages, but in a very small number of newborn babies the T wave in these leads may be flat or inverted for 1-3 days. Inversion after this suggests left ventricular hypertrophy (LVH).
- Tall T waves
  - Hyper K+
  - LVH
- Flat T waves
  - HypoK+
  - Pericarditis
  - Myocarditis
  - Newborns
  - Hypothyroidism

Variation in P-P interval

- The diagnosis of sinus arrhythmia is easily confirmed in most cases by observing the relation of the change to respiration (slowing in expiration, accelerating in inspiration).

Common variations in rhythm which may be normal

- Pronounced sinus arrhythmia

- Short sinus pauses <1.8 seconds
- First degree atrioventricular block (Prolonged PR)
- Mobitz type 1 second degree atrioventricular block
- Junctional rhythm

PR Interval

- In infants PR interval would be in the range 80-110ms
- In children up to 150ms
- In teenagers with slower heart rates the upper limit of normal is 180ms
- Prolonged PR
    - Congenital Heart Disease (CHD), Myocarditis, Hyperkalemia
- Shortened PR
    - Wolff-Parkinson-White (WPW)
    - Glycogen Storage Disease (GSD)

ECG – Wolff-Parkinson-White

Extrasystoles

- Isolated ventricular premature beats may be identified on a routine resting ECG in 0.2-2.2% of normal children
- Extrasystoles which conform to this pattern and suppress on exercise are almost certainly benign

QRS Duration

There is a progressive increase in QRS duration with age, with a normal range from about:

- 50-70ms in neonates
- 60-90ms in children
- 90-100ms in adolescents
- Prolonged QRS duration
    - Bundle branch blocks (BBB)
    - Wolff-Parkinson-White (WPW)
    - Ventricular arrhythmias
- Decreased amplitude
    - Myocarditis
    - Pericarditis

QT interval

- Detecting prolongation of the QT interval is important in the identification of

individuals at risk of life threatening arrhythmia associated with syncope and sudden death
- QTc<0.49 under 6 months
- QTc<0.44 over 6 months
- For practical purposes Bazett's formula (QTc = QT ∕ √R-R interval) remains the most commonly used method for determining the rate corrected

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- Prolonged QTc is seen in:
  - Head injury
  - Hypo Mg, K+, Ca++
  - Hypothermia
  - Myocarditis
  - Commonly used drugs such as azithromycin, erythromycin, clarithromycin and terfenadine

Differential diagnoses

ECG Signs of Pericarditis
- ↑ ST in left ventricular leads returns to normal within 2-3 days
- Flat T waves initally then inverts after 2-4 weeks
- ↓ QRS amplitude

ECG Signs of Myocarditis
- ↑ PR interval
- ↓ T wave amplitude
- ↑ QT interval
- ↓ QRS amplitude

ECG Abnormalities in Patients with Syncope
- Long QT
- Wide complex tachycardia
- Hypertrophic Obstructive Cardiomyopathy (LVH)

Tags

ECG, EKG, electrocardiogram, electrocardiograph, interpret, P wave, PR interval, Q wave, qrs, QT, QT interval, QTc, ST, T wave, U wave, understand

References

• Mehta C, Dhillon R, Understanding Paediatric ECGs. Current Paediatrics Volume 14, Issue 3, Pages 229-236, June 2004
• Davignon A, Rautaharju P, Boiselle E, Soumis F, Megelas M, Choquette A. Normal ECG standards for infants and children. Paediatric Cardiology. 1979;1:23-131
• Emmanouilides GC, Moss AJ, Adams FH. The electrocardiogram in normal newborn infants: correlation with hemodynamic observation. J podiatry. 1965;67:578-87. [PubMed]
• Sreenivasan VV, Fisher BJ, Liebman J, Downs TD. Longitudinal study of the standard electrocardiogram in the healthy premature infant during the first year of life. Am J Cardiol. 1973;31:57-63[PubMed]
• Garson A. Electocardiography. In: Anderson RH, Macartney FJ, Shinebourne EA, Tynan M, editors. Paediatric Cardiology. Edinburgh: Churchill Livingstone; 1987. pp. 235-317.
• Garson A. The Electrocardiogram in Infants and Children: A symptomatic approach. Lea Feibiger. 1983
• Myung K, Park MK, Guntheroth WG. St Louis: Mosby Year Book; 1992. How To Read Pediatric ECGs.

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