EKG Approach

Intervals and Segments	**Q waves:** ventricular septal depolarization, which proceeds from left-to-right and inferior-to-superior • Small q waves should be seen in the inferior and left-facing leads (I,II,V5,V6 and III and aVF). • Duration should not exceed 0.04 sec and amplitude should not exceed 25% of QRS wave in height • Abnormally tall or long Q-waves may represent ischemia • Q waves in V1 and V2 are always abnormal **U Wave:** small deflection often seen closely following the T wave, which may represent repolarization of the Purkinje fibers or after depolarizations w/i the ventricle • A U wave is a normal finding if it is small (<25% the amplitude of the T wave), there is an isoelectric segment between the T wave and U wave, and if the U wave is upright. • If any of these features are not met, the U wave may be pathologic • Prominent U waves are seen most often seen in hypokalemia, but can also be seen in other electrolyte derangements, ventricular hypertrophy, LQTS and w/ antiarrhythmic therapy. • Inverted U waves are concerning for ischemia, ventricular hypertrophy or cardiomyopathy. • U waves are often more prominent at slow heart rates (<65 bpm). • If U waves are large (>25% of the T wave amplitude) and there is no isoelectric segment between the T wave and U wave, they should be included in the QTc calculation (which becomes the QTUc) **ST segment:** represents ventricular repolarization • Elevation or depression >1mm in limb leads or >2mm in precordial leads is abnormal and is concerning for ischemia if seen in a territorial distribution (especially w/ reciprocal changes in other territories) or pericarditis if diffuse • Concave "smiling" ST-elevation is often normal, as seen in benign early reoplarization, however convex "frowning" ST-elevation is ominous **R/S progression:** R/S ratio represents the ratio of left to right ventricular forces • R waves in the right precordial leads represent depolarization of the right ventricle and S waves in these leads represent depolarization of the left ventricle. Pattern reversed in left precordial leads • In newborn period of a FT infant, the RV is dominant and as such the R wave in lead V1 should be greater than the S wave • As a child ages, the LV becomes progressively more dominant until late adolescence when an adult-type R/S progression is seen w/ small R waves and large S waves in V1 w/ large R waves and small S waves in V6 **T wave:** normal T wave pattern varies w/ age • At birth, all T waves should be upright • Over the first days of life, leads V1-V3 invert (V1first, V3last) and after 7-10 days of life it is pathologic for there to be upright T waves in lead V1and represent RV strain if present • It is normal for the T waves in leads V1-V3to be inverted in children and between the ages of ~8 and 20 y/o, these T waves start to become upright (V3 first, V1 last), although it is not abnormal for T wave inversion to persist into an individual's 20s and this is called a persistent juvenile T wave • It is always abnormal to see an inverted T waves in leads V5+ V6. (ischemia or ventricular strain) Peaked T-waves are seen in hyperkalemia and elevated ICP and abnormally flat in hypokalemia
Chamber Size	**RAE:** P wave height >2.5 mm (2.5 small boxes) **LAE:** P-wave duration >2.5 small boxes (100 msec) • Notched in leads I or II or biphasic in lead V1 • Terminal neg. portion > 1 small box deep/wide. **LVH:** R-wave > 98th% in I, II, aVL, aVF, V5, V6. • S-wave > 98th% in V1, V2 • Inverted T in V5 or V6 • Left axis deviation **RVH**: R wave >98th% in aVR, III, V1, V2, V4R • S wave >98th% in I, V5, V6 • qR pattern in V1 • Upright T in V1 (pre-adol.) suggests RV strain • Right axis deviation **Strain**: QRS-T angle > 90° (diff. btw QRS / T axes)

EKG Approach

Normal EKG Values By Age

AGE	0-7 days	1 wk–1 mo	1 mo-6 mo	6 mo-1 yr	1 yr-5 yr	5-10 yr	10-15 yr	>15 yr
Rate (beats/min)	90-160 (125)	100-175 (140)	110-180 (145)	100-180 (130)	70-160 (110)	65-140 (100)	60-130 (90)	60-100 (80)
QRS axis (degrees)	70-180 (120)	45-160 (100)	10-120 (80)	5-110 (60)	5-110 (60)	5-110 (60)	5-110 (60)	5-110 (60)
PR lead II (msec)	80-150 (100)	80-150 (100)	80-150 (100)	80-150 (100)	80-150 (120)	80-150 (120)	90-180 (140)	100-200 (160)
QRS duration (msec)	40-70 (50)	40-70 (50)	40-70 (50)	40-70 (50)	45-80 (65)	45-80 (65)	50-90 (70)	60-90 (80)
Maximum QTc[1] (msec)	450 max	450 max	450 max	450 max	440 max	440 max	440 max	430 max
QRS V_1 Q (mm)	0	0	0	0	0	0	0	0
R (mm)	5-25 (15)	3-22 (10)	3-20 (10)	2-20 (9)	2-18 (8)	1-15 (5)	1-12 (5)	1-6 (2)
S (mm)	0-22 (7)	0-16 (5)	0-15 (5)	1-20 (6)	1-20 (10)	3-21 (12)	3-22 (11)	3-13 (8)
QRS V_5 Q (mm)	0-1 (0.5)	0-3 (0.5)	0-3 (0.5)	0-3 (0.5)	0-5 (1)	0-5 (1)	0-3 (0.5)	0-2 (0.5)
R (mm)	2-20 (10)	3-25 (12)	5-30 (17)	10-30 (20)	10-35 (23)	13-38 (25)	10-35 (20)	7-21 (13)
S (mm)	2-19 (10)	2-16 (8)	1-16 (8)	1-14 (6)	1-13 (5)	1-11 (4)	1-10 (3)	0-5 (2)
QRS V_6 Q (mm)	0-2 (0.5)	0-2 (0.5)	0-2 (0.5)	0-3 (0.5)	0-4 (1)	0-4 (1)	0-3 (1)	0-2 (0.5)
R (mm)	1-12 (5)	1-17 (7)	3-20 (10)	5-22 (12)	6-22 (14)	8-25 (16)	8-24 (15)	5-18 (10)
S (mm)	0-9 (3)	0-9 (3)	0-9 (3)	0-7 (3)	0-6 (2)	0-4 (2)	0-4 (1)	0-2 (1)
T-wave V_1 (mm)	*0-4 days* = −3 to +4 (0) *4-7 days* = −4 to +2 (−1)	−6 to −1 (−3)	−6 to −1 (−3)	−6 to −1 (−3)	−6 to −1 (−3)	−6 to +2 (−2)	−4 to +3 (−1)	−2 to +2 (+1)

Values are 2nd – 98th percentile (mean) From Keane et al. *NADAS' Pediatric Cardiology*. 2006.

CXR	• **Heart Size**: >50-60% of thorax is abnormal on PA film (confounded by: poor inspiration, AP technique, thymic shadow) • **Lung Fields**: increased pulmonary blood flow (increased pulm. vasc. markings, engorged vessels) = sign of overcirc. • Decreased vascular markings indicate decreased pulmonary blood flow. • Pulmonary edema and effusions may indicate CHF. • **Thymic Shadow**: lack of a thymic shadow in neonates should raise suspicion for 22q11 del. and assoc. cardiac defects • **Aortic Arch**: sidedness (left-sided aortic arch is normal) • **Heart Border**: Left or right atrial enlargement • **Rib Notching**: suggests the presence of collateral vessels, as can be seen in coarctation.
What To Do Next	• 4-extremity BP: Upper > Lower (or less commonly R arm > Lt arm) suggests obstruction of the aorta (e.g. interrupted arch, coarctation). Exception to the rule: L arm > R suggests aortic obstruction w/ aberrant right subclavian. • Pre- and post-Ductal O2 sats (measure on right arm and either foot) • Hyperoxia Test: PaO2 < 100 mm Hg on 100% RA suggests cyanotic congenital heart disease. >200 suggests pulmonary etiology. Pulse oximetry can be used as approximation if unable to obtain ABG. • Consult cardiologist
When To Start Prostaglandins	• After workup, if high suspicion for cyanotic heart disease start PGE1 0.05 mcg/kg/min as soon as possible • Monitor for apnea and hypotension • Consider securing airway if patient requires transport

Arrhythmias and Pacemakers

Premature Ventricular Contractions (PVCs)

Presentation	Range: asymptomatic → **palpitations, lightheadedness**. Irregular pulse on exam
Pathophys	Re-entry, enhanced automaticity, triggered activity
Workup	**EKG, 24-48 Holter, chem10, thyroid panel**. May require echo or exercise testing. (dependent
Treatment	Usually none. **Trx underlying cause** (if one exists, e.g. a drug). Beta blockers or CCBs if symptomatic. If refractory, radiofrequency catheter ablation.

Arrhythmias and Pacemakers continued on next page →