APPROACH TO PEDIATRIC ECG

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1. First thing's first

a) Check the name on the top of the ECG – is this your patient?

b) Check the date – is this the one you ordered?

c) Check for old ECGs – just like a chest xray, it's always a good idea to compare with an old one

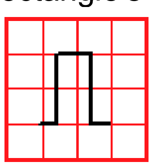
d) Check for the age of the patient – the heart physiology and the normal values differ in different age groups in the pediatric population

Note: You may want to cover the top part of the ECG sheet now. Do not rely on the computer calculated numbers; it may be wrong. Trust yourself!

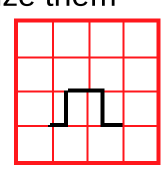
2. Technical Aspects

a) Is the ECG full standard?

- Full standard means that the ECG was not reduced in size so that it can fit on the paper
- Look at the left hand side of each line
- If it is full standard, the rectangle's height should be 2 big squares



- If it is half standard, the rectangle's height is only 1 big square. You will need to double all the waves to normalize them



b) What is the paper speed?

- The standard speed is 25mm/sec

- That means each little box is **0.04 seconds**, each big box is **0.2 seconds**, the whole strip is **6 seconds**
- Now look at the top of the ECG, there should be a print out of what speed the ECG was ran at
- For tachyarrhythmias, the speed of the ECG may have been increased to 50 mm/sec in order to visualize the p waves; in this case, the speed and duration of the ECG components will need to be doubled

3. **Rate**

a) Normal, Fast or Regular Rates

- Find 2 adjacent R waves, count the number of big squares between the R's
- Divide **300** by the number of big squares → this is your rate

Or . . . .

- Find a QRS complex that starts on a thick line, then count the thick lines using these numbers **"300-150-100-75-60-50"** to the next QRS

b) Slow or Irregular Rates

- The easiest way to calculate the rate is to count the total number of QRS complex along the length of the entire strip and multiply it by 10 → this is your rate (bpm)

Note: The normal value for heart rate ranges dramatically depending on your patient's age. Please compare your patient's age and heart rate with Table 1.

4. **Rhythm**

a) <u>Analysis</u>

- Is the rhythm sinus?

Sinus rhythm:

  - Is there a P wave before each QRS complex?
  - Is there a QRS complex after every P wave?
  - Are the P waves upright in leads I, II, III?
  - Do all P waves should look the same?
  - Are all P wave axis normal (0° to +90°)?
  - Are the PR intervals constant?

- Is the rhythm fast or slow? (refer to Table 1 values)
- Is the rhythm regular or irregular? Do the P waves and QRS follow a regular pattern?
- If it is irregular, is it consistently irregular or consistently irregular?

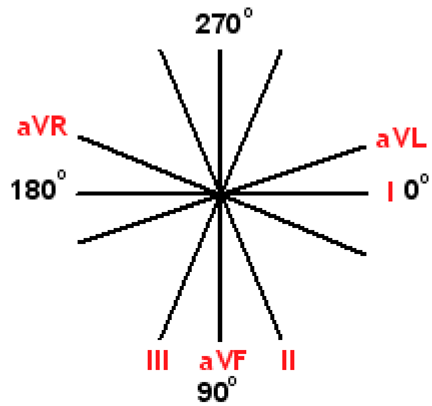
Consistently irregular = some form to the pattern of irregular complex i.e. predictable
Inconsistently irregular = no pattern at all i.e. unpredictable

b) <u>Abnormal Rhythms</u>

Premature Atrial Contraction (PAC)	➢ Length of two cycles (R-R) usually shorter ➢ Preceded by P wave, followed by normal QRS ➢ No hemodynamic significance
Premature Ventricular Contraction (PVC)	➢ Premature, wide QRS, no P waves, T wave opposite to

	QRS ➢ I.e. multifocal, bigeminy, trigeminy, couplets ➢ Maybe normal if uniform and decrease with exercise
Atrial Flutter	➢ Rapid atrial rate (~300 bpm) with varying ventricular rate ➢ Sawtooth pattern ➢ Suggests significant pathology
Atrial Fibrillation	➢ Very fast atrial rate (350-600 bpm) ➢ Irregularly irregular ➢ No P waves, normal QRS ➢ Suggests significant pathology
Ventricular Tachycardia	➢ Wide, unusually shaped QRS ➢ T waves opposite direction of QRS ➢ HR 120-200 bpm ➢ Suggests significant pathology
Ventricular Fibrillation	➢ Very irregular QRS ➢ Rate is rapid and irregular ➢ "terminal arrhythmia"

5. **Axis**
   - Axis is the "conduction flow" of the heart
   - Normal axis varies with age – i.e. newborns have a right axis deviation because the left and right ventricles are the same size due to fetal circulation



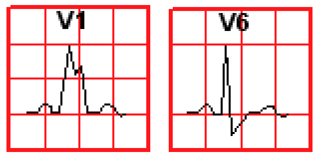
   - Look at the QRS complex of Lead I and Lead aVF
   - Is the QRS complex of Lead I more negative (downgoing or conduction away from the lead) or positive (upgoing or conduction towards the lead)?
   - Is the QRS complex of Lead aVF more negative or positive?

Lead I	**Lead aVF**	**Axis**
+	+	Normal
+	-	Left Axis Deviation
-	+	Right Axis Deviation
-	-	Extreme Right Axis Deviation

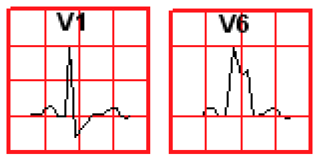
6. **P Wave and PR Interval**
   - PR = beginning of P to beginning of QRS
   - P wave normal is 2-3 little squares (0.08-0.12); if wide P wave = **left atrial enlargement**

- If P wave is taller than 2-3 little squares = **right atrial enlargement**
- PR interval is dependent on age (Table 1); if PR is wide = **first degree AV block**

7. **QRS Complex**
   - If beginning of Q to end of S is longer than 2-3 small squares → **bundle branch block**
   - Look for the "M" sign in either V1 or V6
   - If the "M" is on V1 → **Right bundle branch block (RBBB)**



   - If the "M" is on V6 → **Left bundle branch block (LBBB)**



8. **QTc Interval**
   - Beginning of Q to end of T
   - QT corrected interval for heart rate because as HR decrease, QT lengthens and vice versa
   - Normal: <0.45 (<6 months), <0.44 (>6 months)
   - QTc = QT / square root of RR interval
   - DDx prolonged QT: long QT syndrome, hypokalemia, hypomagnesemia, hypocalcemia, neurologic injury
   - Prolonged QT predisposes to ventricular tachycardia and associated with sudden death

9. **T wave**
   1. DDx of peaked, pointed T = hyperkalemia, LVH
   2. DDx of flattened T waves = hypokalemia, hypothyroidism

10. **Ventricular Hypertrophy**

   a) <u>Right ventricular hypertrophy</u>

   if any of the following:
   - R wave >98% in V1 or S wave >98% in I or V6
   - Increased R/S ratio in V1 or decreased R/S in V6
   - RSR' in V1 or V3R in the absence of complete RBBB
   - Upright T wave in V1 (>3 days)
   - Presence of Q wave in V1, V3R, V4R
   - DDx of RVH: ASD, TAPVR, pulmonary stenosis, TOF, large VSD with pulmonary HTN

   b) <u>Left ventricular hypertrophy</u>

   if any of the following:
   - R >98% in V6, S >98% in V1
   - Increased R/S ratio in V6 or decreased R/S in V1
   - Q >5mm in V6 with peaked T
   - DDx: VSD, PDA, anemia, complete AV block, aortic stenosis, systemic HTN

Appendix

a) Table 1: Normal Values

Age	HR bpm	QRS axis degrees	PR interval seconds	QRS interval seconds	R in V1 mm	S in V1 mm	R in V6 mm	S in V6 mm
1st week	90-160	60-180	0.08-0.15	0.03-0.08	5-26	0-23	0-12	0-10
1-3wks	100-180	45-160	0.08-0.15	0.03-0.08	3-21	0-16	2-16	0-10
1-2 mo	120-180	30-135	0.08-0.15	0.03-0.08	3-18	0-15	5-21	0-10
3-5 mo	105-185	0-135	0.08-0.15	0.03-0.08	3-20	0-15	6-22	0-10
6-11 mo	110-170	0-135	0.07-0.16	0.03-0.08	2-20	0.5-20	6-23	0-7
1-2 yr	90-165	0-110	0.08-0.16	0.03-0.08	2-18	0.5-21	6-23	0-7
3-4 yr	70-140	0-110	0.09-0.17	0.04-0.08	1-18	0.5-21	4-24	0-5
5-7 yr	65-140	0-110	0.09-0.17	0.04-0.08	0.5-14	0.5-24	4-26	0-4
8-11 yr	60-130	-15-110	0.09-0.17	0.04-0.09	0-14	0.5-25	4-25	0-4
12-15 yr	65-130	-15-110	0.09-0.18	0.04-0.09	0-14	0.5-21	4-25	0-4
> 16 yr	50-120	-15-110	0.12-0.20	0.05-0.10	0-14	0.5-23	4-21	0-4

References

1. Garcia, Tomas and Neil Holtz. **12-Lead ECG: The Art of Interpretation.** Jones and Bartlett Publishers Canada. 2001
2. **Interpreting Pediatric ECG**. Pediatric Cardiology at the University of Chicago. http://pediatriccardiology.uchicago.edu/MP/ECG/ECG-submenue.htm

Acknowledgements

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