The Easy R’s of EKG Interpretation

I. Let us start at the beginning:

The EKG /Rhythm strip is a graphic tracing of the electrical activity of the myocardial cells. It measures the length of time it takes for the initial impulse to fire at the Sino Atria Node (Sinus Node) and then ends in the contracting of the Ventricles. Normally, the impulse starts at the SA Node, and then travels down the internodal pathways stimulating the atria. The impulse then pauses briefly at the AV node to allow complete contraction of the atria to dump more preload into the ventricles. From the AV node, the impulse travels to the Bundle of His, Right and Left Bundle Branches, throughout the Purkinje Fibers and results in stimulation and depolarization/contraction of the Ventricles.

The contraction/depolarization of the atria causes a “P” wave on the EKG. The contraction/depolarization of the ventricles causes a “QRS” waveform on the EKG indicating ventricular systole. As the myocardium relaxes during diastole and repolarizes, a “T” wave is results on the EKG. We will not address “U” wave here as its origin is still in question.

Certain disease states, medications and/or electrolyte imbalances can cause alterations in the normal electrical activity of the heart. This can result in delays, slow rhythms, fast rhythms and/or ectopic beats (these are beats originating outside the normal cardiac electrical pathway). If there is a delay in the length of time it takes the impulse to travel from the SA Node to the AV node (>0.20 seconds) initiating atrial contraction, this is called a “First Degree AV Block”. If the QRS measures > 0.12 seconds or 3 small boxes this is called a Bundle Branch Block indicating a delay in the time it takes the impulse to travel from the AV Node, down the Bundle of His, through
the right and left bundle branches and distally throughout the tiny \textit{purkinje fibers} initiating ventricular contraction. If there is a problem in the relationship of the “P” to the “QRS”, meaning more P’s then QRS’s then there is a 2\textsuperscript{nd} or 3\textsuperscript{rd} Degree Heart Block.

\textbf{II. The first R is Rate} – This is the first step in EKG interpretation.

\begin{itemize}
  \item[A.] We need to know that each small line/box represents 0.04 seconds. Therefore, it takes 5 small lines/boxes to make one big box which represents 0.20 seconds. It takes 5 large boxes to = one second. It takes 30 large boxes to equal 6 seconds. With regular or irregular rhythms, you can always count the \# of QRS complexes (Ventricular contractions) in a 6-second strip and multiply by 10 to determine your heart rate/min.

  \item[B.] A more accurate method to determine heart rate in regular rhythms is to count the \# of small boxes between two R waves and divide that number into 1500. (60 seconds divided by 0.04 = 1500- that is why we use this #). Example: from one R to the next R there were 17 small boxes therefore that would be 1500/17 = 88.23 or 88 beats/min. This is the most accurate way to determine heart rate, \textit{BUT} the rhythm \textbf{MUST} be \textit{REGULAR!!!!!!!!!!}

  You can also count the \# of big boxes between two R waves and divide it into 300, but again the rhythm \textbf{MUST} be \textit{REGULAR}.
III. The second R is for Rhythm: is the rhythm regular or irregular?

A. Compare $R$ wave to $R$ wave interval and determine if they are occurring at regular intervals. If so, this indicates a regular rhythm. One method to determine regularity is to make a small mark on a piece of paper over two consecutive $R$ waves, then move the paper to the next $R$ wave and see if the dots line up/march out. You can also use calipers to accomplish this step.

B. Next we need to determine the length of time it takes the impulse to travel from the SA Node to the AV Node and accomplish Atrial contraction/depolarization. This is the PR interval and should be $< 0.20$ seconds or one big box. Make a mark on paper at the upstroke of the P wave and another mark over the $R$ wave (at the top) then move the paper to the top of the EKG paper and measure. If measurement is longer than 0.20 seconds (or one big box) it is defined as a 1st Degree AV Block.

C. The next measurement is the QRS interval to determine the length of time it takes for Ventricular depolarization/contraction. Place a mark over the first negative deflection after the P wave (this is the Q wave) and make the second mark at the end of the second negative deflection after the P wave (this is the S wave). Move the paper to the top of the EKG paper and measure. This measurement should be $< 0.12$ seconds or 3 small boxes. If it is $>$ than this, it is termed a Bundle Branch Block.
D. The point where the $S$ and the $T$ wave join is the $J$ point and is important in diagnosing cardiac ischemia or injury.

When the myocardium is deprived of oxygen, it becomes **ischemic** and ‘**depressed**’. This results in ST depression-below the isoelectric line—the horizontal line starting before the “P” wave that imaginarily travels across the waveforms.

If cardiac blood supply is not restored, the myocardium next becomes **injured** and gets angry and raises it’s hand to say, “pay attention, I’m injured”. This is evidenced by ST **elevation** on the EKG.
After twenty minutes without oxygen, myocardial tissue dies and quits leaving a large Q wave—greater than 1/3 the height of the R wave and at least 0.04 sec wide. Once myocardial tissue infarcts, it can no longer conduct electricity or contract.

**REMEMBER**….You must use at least 2 different leads (views of the electrical activity of the heart) in order to diagnose ST depression= *Ischemia*, ST elevation=*Injury* or pathological Q wave=*Infarct*

IV. **Third R is for Relationship**—are there *P* waves for every *QRS* and is there a *QRS* after every *P* wave. This is looking at the relationship of the Atrium to the Ventricles. Are they communicating to each other, or do we have the Atrium doing one thing (contracting at one rate) and the Ventricles contracting at another rate. When we have more P waves then QRS’s it is a second or third degree *Heart Block* indicating a block at the level of the AV node not allowing all or any P waves from getting through to the ventricles.. Putting all of the above measurements together we are analyzing the EKG rhythm.

V.   Lets do some practice strips …. REMEMBER the 3 R’s  
1. Rate  
2. Rhythm  
3. Relationship
Answer  Key to Practice Rhythm Strips

1. Rate = 38 small blocks or pulse 39 beats/min. PR = 0.20 QRS = 0.10 For every P wave there is a QRS
   **This is a Sinus Bradycardia**

2. Rate = 22 Blocks or pulse 68 beats/min. PR = Not able to measure QRS = 0.08 There are more Atrial waves (known as Flutter waves) for every one QRS
   **This is Atrial Flutter with 3:1 conduction**

3. Rate = 24 blocks or pulse 62 beats/min. PR = 0.16 QRS = 0.10 For every P wave there is a QRS
   **This is a Normal Sinus Rhythm**

4. Rate = 12 blocks or pulse of 125 beats/min. PR = 0.16 QRS = 0.06 For every P wave we have a QRS
   **This is a Sinus Tachycardia**

5. Rate = not able to use small box method NOT REGULAR must count # of QRS complexes in 6 second strip and X by 10. PR = Not measurable. PR = not able to measure
   There are no P waves just undulating /Fibrillating Atrial line &
   QRS interval is not regular from beat to beat QRS = 0.08
   **This is Atrial Fibrillation**

6. Rate = 9 blocks or pulse rate of 166 beats/min. * MAY NOT HAVE PALPABLE PULSE. There are no discernable P waves
   PR = Not able to measure
   QRS = WIDE or > 0.20
   **This is Ventricular Tachycardia**

7. Rate = not measurable as there are no discernable QRS complexes
   PR = not measurable There are no P waves. QRS not measurable
   **Ventricular Fibrillation**

8. Rate = 23 blocks or pulse of 66 beats/min.
   PR = 0.24 QRS = 0.10 There are P waves for every QRS and a QRS after each P wave.
   **Normal Sinus Rhythm with 1st degree AV Block**

9. Rate = 13 blocks or pulse of 115/min. PR = 0.16 QRS = 0.10 .
   There are P waves for every QRS and a QRS after every P waves
   ***** NOTICE ST segment**
   **Sinus Tachycardia with ST Depression**

10. Rate = 24 blocks or pulse 62 beats/min. PR = 0.20 QRS = 0.10
    There are P waves for every QRS and a QRS after every P
*** NOTE $ST$ elevation**
There is a length of time between 4th & 5th beat
   Normal Sinus Rhythm with ST elevation and possible
   Sinus pause (the SA node failed to fire) or non-conducted
   beat