Topic: Electrocardiogram and the Heart Conduction System

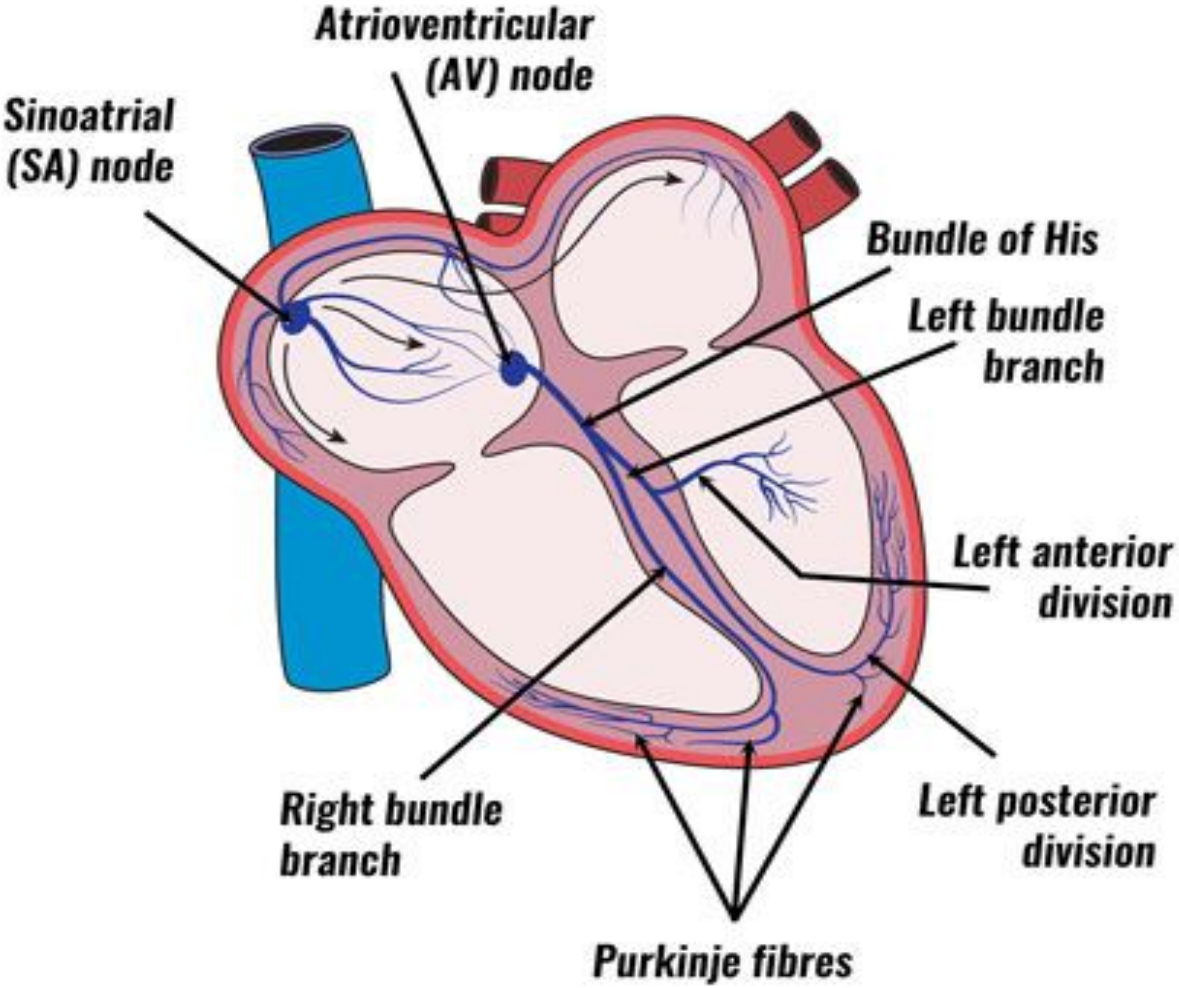
March 6, 2021

The Heart Conduction System

- Sinoatrial/sinus (SA) Node: Known as the heart's pacemaker. It is located at the upper part of the right atrium wall. The electrical pulses are generated from there.
- Atrioventricular (AV) Node: Located on the other side of the right atrium (near the tricuspid valve). Delays the electrical signal to the ventricles which makes the ventricles open and contract.

- AV Bundle (Bundle of His): Located between the atria and ventricles. It serves as a "road" to transmit the electric signals from the AV node to the Purkinje fibres. Furthermore, as the electrical signal travels through the bundle of his, it divides into two branches (right and left bundle branches). Then, the signals will reach the apex of the heart.

- Purkinje Fibres: It is located in the inner ventricular walls of the heart. The main function of the purkinje fibres are to send nerve impulses to the ventricles of the heart so it can pump blood to supply the body.


Atrioventricular
(AV) node
Sinoatrial
(SA) node
Bundle of His
Left bundle
branch
Left anterior
division
Right bundle
branch
Left posterior
division
Purkinje fibres

Vocabs To Know

Depolarization: The contraction of your heart muscle (when it's not resting).
Repolarization: Relaxation of the heart muscle.
Cardiac Cycle: One complete heartbeat.

What is an electrocardiogram?

First, we can break down the word “electrocardiogram” into “electro”, “cardio”, and “gram”.

Electro = Electricity
Cardio = Heart
Gram = Visualize

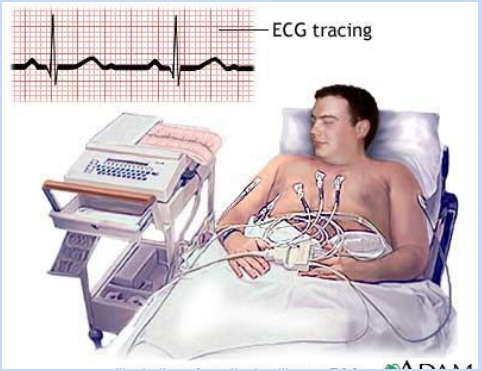
Hence, electrocardiogram is “to use electricity to visualize the activity of the heart”

An **electrocardiogram** is a simple, painless test that measures your heart's electrical activity. It's also known as an ECG or EKG. Every heartbeat is triggered by an electrical signal that starts at the top of your heart and travels to the bottom. Heart problems often affect the electrical activity of your heart.

Facts To Know

1. Cardiac cells at rest are considered polarized, meaning no electrical activity takes place
2. The cell membrane of the cardiac muscle cell separates different concentrations of ions, such as sodium, potassium, and calcium. This is called the resting potential
3. Electrical impulses are generated by automaticity of specialized cardiac cells
4. Once an electrical cell generates an electrical impulse, this electrical impulse causes the ions to cross the cell membrane and causes the action potential, also called *depolarization*
5. The movement of ions across the cell membrane through sodium, potassium and calcium channels, is the drive that causes contraction of the cardiac cells/muscle
6. Depolarization with corresponding contraction of myocardial muscle moves as a wave through the heart
7. *Repolarization* is the return of the ions to their previous resting state, which corresponds with relaxation of the myocardial muscle
8. Depolarization and repolarization are electrical activities which cause muscular activity
9. The action potential curve shows the electrical changes in the myocardial cell during the depolarization – repolarization cycle
10. This electrical activity is what is detected on ECG, not the muscular activity

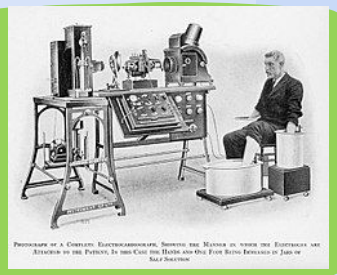
Electrocardiogram



Bonus facts about ECG

- It cost about $50 to take the ECG test (without insurance).
- It is a diagnostic test.
- Modern ECG is capable of showing the part of your heart that triggers heart beat, heart's electrical pathway, and the heart rate and rhythm.
- It is often used in the ER, routine checkups, and during surgery. Doctors uses ECG to evaluate patients when they have symptoms like angina, trouble in breathing, and arrhythmia.
- Unlike some other medical tests (MRI, CT, and coronary angiogram) there are no side effects and risks after conducting an ECG test.
- It is painless to do the ECG test.
- ECG machine can vary from $1,000 to $7,000. Depending on the quality and utilities.
- An ECG test takes about 5-10 mins to complete.
- ECG Technicians make about $49,000 per year.
- Willem Einthoven (a Dutch physician and physiologist) was known as the founder/father of modern ECG because he invented the "string galvanometer" which is capable of directly record the electrical activities of the heart. Due to his contribution, he won the Nobel Prize of Medicine/Physiology at the year of 1924.

Addition Equipment



String Galvanometer

Computer Tomography (CT)

Magnetic resonance Imaging (MRI)

A brief video to wrap up what we learned so far

https://www.youtube.com/watch?v=924uGXR6ReE

The ECG Waves

P Wave: It represents the atrial contraction/atrial depolarization of the heart.
PR Interval/PQ Segment: It represents the time for the electricity to pass from the SA node to the AV node.
QRS Complex: It represents the ventricular depolarization.
ST segment: It represents the interval between ventricular depolarization and repolarization (when the ventricles contract and pup blood).
T Wave: It represents ventricular repolarization.

Basic Terminology to the ECG

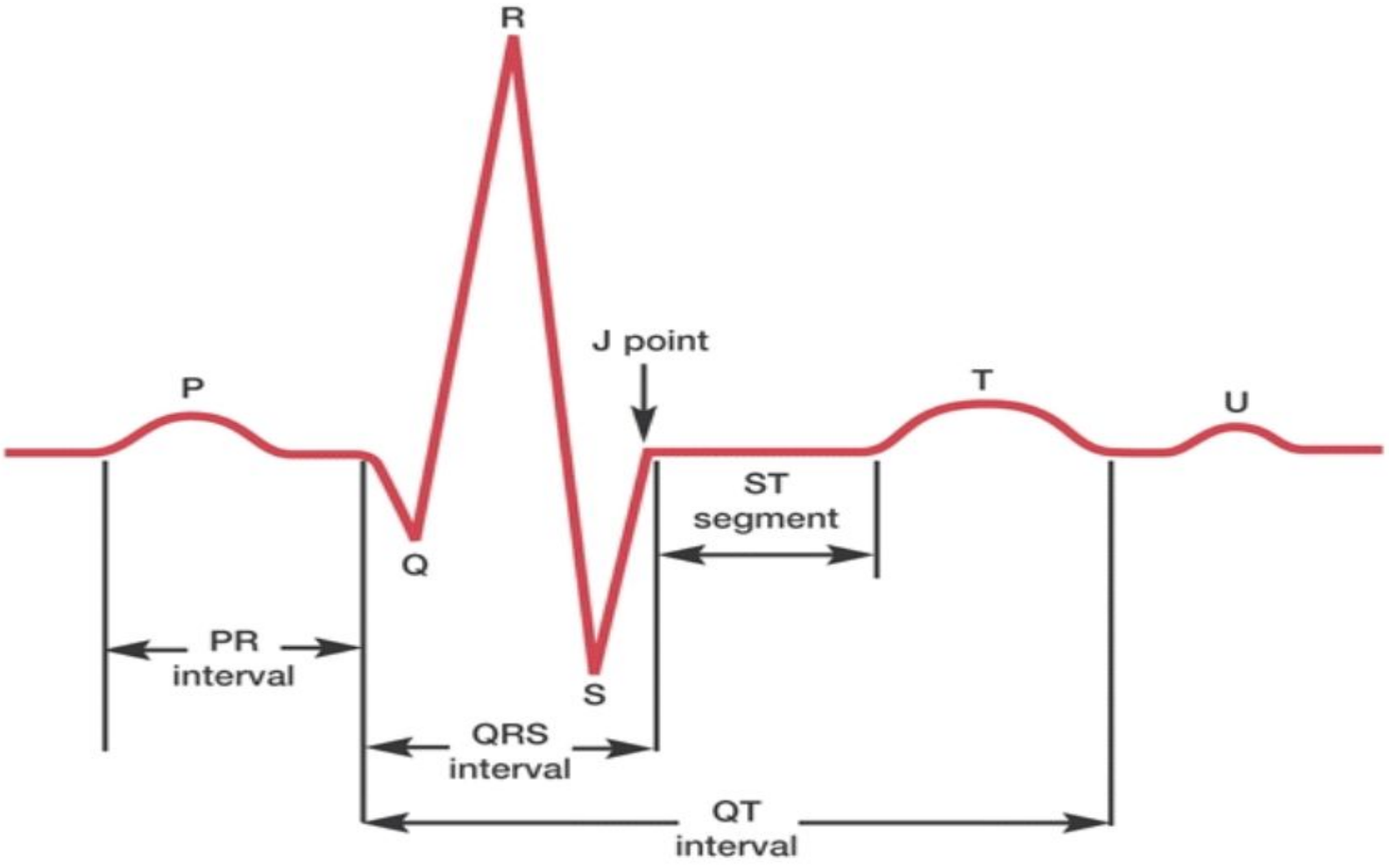
Wave: A positive or negative deflection from baseline that indicates a specific electrical event. The waves on an ECG include the P wave, Q wave, R wave, S wave, T wave and U wave.

Interval: The time between two specific ECG events. The intervals commonly measured on an ECG include the PR interval, QRS interval (also called QRS duration), QT interval and RR interval.

Segment: The length between two specific points on an ECG that are supposed to be at the baseline amplitude (not negative or positive). The segments on an ECG include the PR segment, ST segment and TP segment.

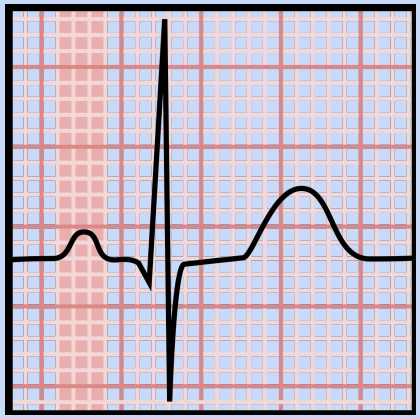
Complex: The combination of multiple waves grouped together. The only main complex on an ECG is the QRS complex.

Point: There is only one point on an ECG termed the J point, which is where the QRS complex ends and the ST segment begins.


R
J point
P
T
U
ST
segment
Q
PR
interval
S
QRS
interval
QT
interval

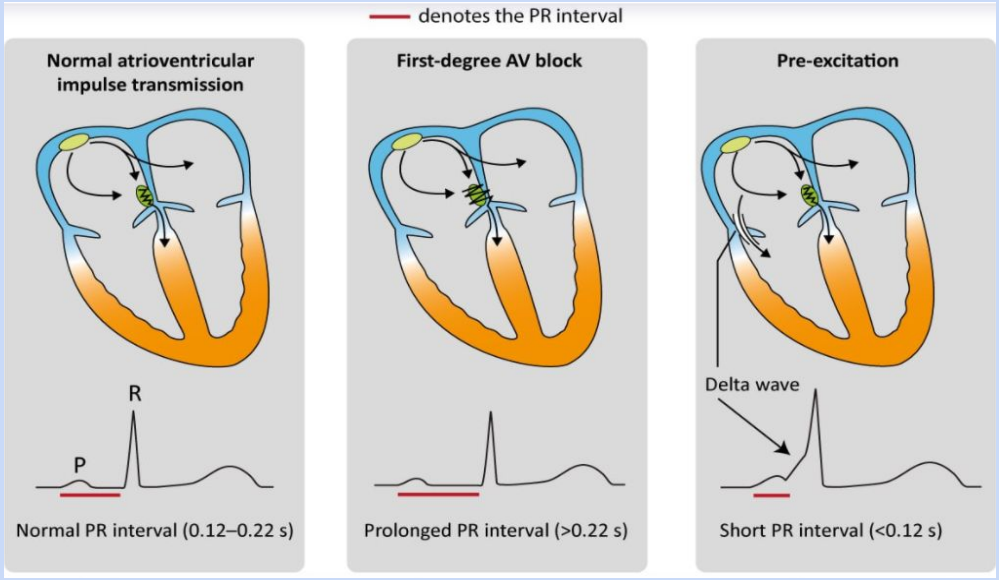
P Wave

- Small (in terms of size), positive, and smooth wave.
- The first wave in the ECG cycle.
- Normal P Wave should be smooth, and monophasic.
- P wave symbolizes the time between the SA node sending the electrical signal and when the electrical signal spread throughout the heart.
- The amplitude of the P Wave should not be higher than the QRS complex



PR Interval/PQ Segment

- Normal PR segment should be between 0.12 secs to 0.22 secs.

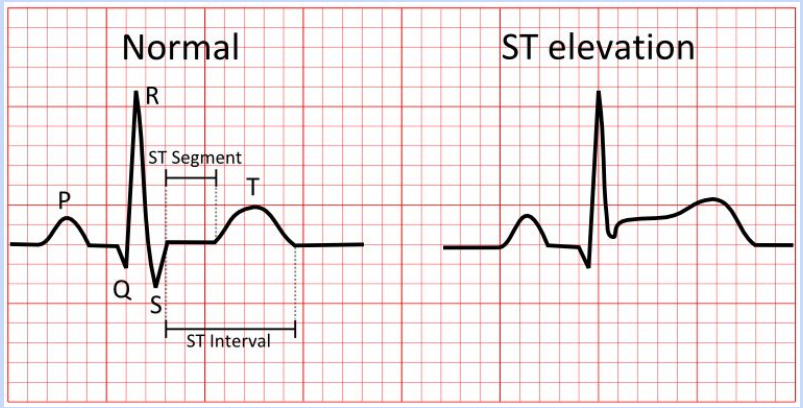


QRS Complex

- First the Q wave declines, then the R wave inclines. Lastly, the S wave declines.
- QRS Complex is composed of Q wave, R wave, and S wave.
- A healthy QRS Complex should last 80-100 ms (millisecond).
- The amplitude of the QRS complex should be higher than P and T waves.

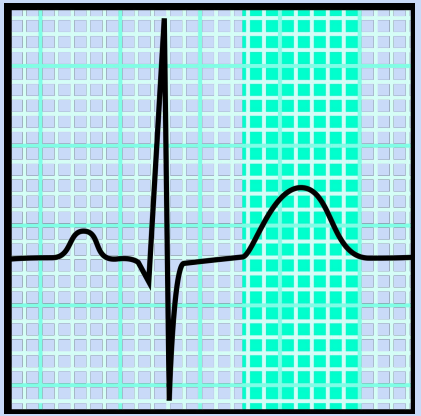
ST Segment

- The normal range of a typical ST segment should be around 0.08 sec (80 ms).
- A normal ST segment presenting on an ECG should be flat.



T Wave

- T wave comes after the ST interval.
- The wave amplitude should not be higher than the QRS complex.
- The average T Wave duration is about 0.1 to 0.25 secs (10 - 25 ms).
- The shape of the T Wave is sharply or bluntly rounded and slightly asymmetrical.



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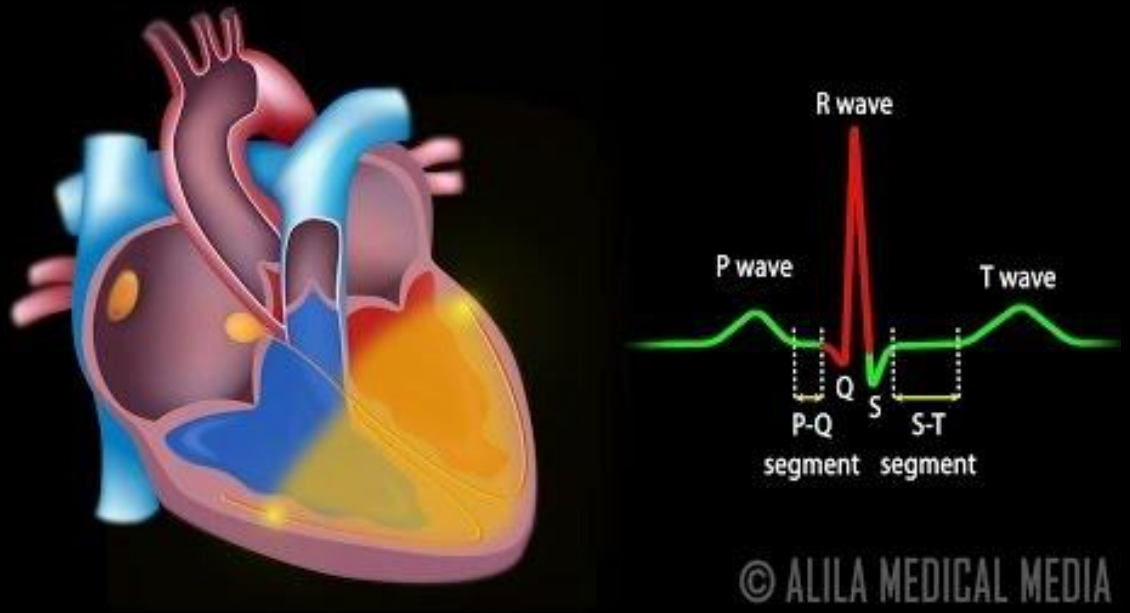
Additional Video



https://www.youtube.com/watch?v=RYZ4daFwMa8

Interview Questions

1. What other jobs can you work at the hospital other than as doctors, nurses, and pharmacists?
2. What are the education requirement for a cardiology nurse?
3. What qualities/characteristics do you need to acquire to exceed as a healthcare worker?
4. How do you deal with night shifts?
5. How do you deal with disrespectful patients?

Interview Questions Part 2: Common Myths in the Hospital

1. Are healthcare worker shortages a real issue?
2. Do doctors have the right to overrule nurses?
3. Is it true that technology significantly reduced the amount of work healthcare professionals have to do?
4. Is it true that nursing in US is easier?
5. Is it true that you might risk Covid infection if you come inside a hospital/medical center?

Meeting concluded!

Next meeting: Introduction to Public Health