# ECG Disease detection & Feature Extraction By Wavelet Transformation

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A THESIS

Submitted in fulfillment of the requirement for the degree


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# Certificate of Approval

The Thesis titled “ECG Disease detection & Feature Extraction by Wavelet Transformation” is completed under my supervision meet acceptable presentation standard and can be submitted for fulfillment of the requirement of the degree BSc in CSE from the department of Computer Science & Engineering, BRAC University.

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# Declaration

We hereby certify that this material, which we now submit for the assessment on the program BSc in CSE does not to the best of my knowledge breach any law of copyright. Any open source material or information that has been used are properly referenced and acknowledged within the text of our work.

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# Abstract

ECG is the most common and basic test to run on patients to check any kind of anomalies in the heart. In the ECG result 10 to 20 minutes long continuous data of a patient's heart is down sampled and printed as a 1D graph. We have develop a program which will take the continuous dataset from the ECG machine and analyses the data and extracts various features of the ECG wave. At first we decompose the data using Wavelet decomposition. Then the data is reconstructed in 4 levels which removes the noise from the signal. In the same time we detect major components of the ECG wave which is P wave, QRS complex and T wave. Then we calculate ST deviation, heart rate and extract other features such as location and amplitude of each waves in order to detect anomalies. Finally our output provides the heart status (healthy, if any disease found, if any major or minor risk) in a language that the patient can understand and also some detailed wave properties in medical term for the doctors.

# Contents

# Chapter 1: Introduction

## 1.1 Motivation

Bio-Medical Engineering is an emerging research magnet that has been attracting researchers.

An ECG/EKG is one such project.

Most of the doctors and medical staffs believe ECG/EKG is not 100% accurate and sometimes more tests are run to confirm any disease. It is also very difficult for the doctors to manually analyze each wave with bare eye. As the 10 to 20 minutes of continuous data of ECG is down sampled in the result printed in paper, it affects the accuracy. But the researchers believe that ECG/EKG is capable for detecting many anomalies in the heart if properly analyzed and if the noises are filtered. This is one of the main challenges of our thesis. Our program works on the continuous dataset from the ECG machine not on the printed result of ECG which ensures more accuracy. And wavelet Transformation also removes the noise that ensures high accuracy. And for the doctors, they don't need to analyses the graph rather they can view our wave properties which reduces a lot of their efforts and reduces human error.

Most of the stuffs that perform tests are not doctors. Thus they cannot detect any problems instantly. They forward the averaged printed result to the doctors and then the doctors provide medical explanation and recommendation which wastes a lot of time for a patient. Our program can detect diseases based on the properties of the ECG wave. So the patient gets to know the heart status as soon as the ECG is done without visiting a doctor which saves a lot of time for the patient and he/she can still visit the doctor for expert opinions and our program output will also provide wave properties which is helpful for the doctors. Our program may be integrated with the ECG machine in the diagnostic center to provide accurate output, heart status (if any disease detected, if any future risks, heart rate) and wave properties.

## 1.2 Features of the Program

### 1.2.1 Input Flexibility

Our Input which is continuous dataset of ECG/EKG test result, is taken from MIT-BIH Database (physionet.org) which is available is various formats (*.mat, *.csv, *.dat, etc.). At this moment we prefer using the *.mat file because *.csv and *.dat files require additional algorithm to remove the header. Our program can also be modified to take live feed from ECG/EKG machine.

### 1.2.2 Informative Medical Database

Our Program contains useful medical terms and data that the doctors use and need to treat a patient. All the waves in the ECG/EKG result are described in terms of shape and amplitude. Medical information corresponding with wave properties are included. The normal and abnormal range of each wave, segment and duration is displayed in our output taken from medical books.

### 1.2.3 Disease Detection

Our program detect diseases based on the wave properties and amplitude and duration of certain wave(s). Some properties gives hints or probability for a certain diseases but those are not 100% certain and require other medical test results. For this kind of probable disease our program output is given by Risk or Probability.

### 1.2.4 Statistical Information

Our program also calculates each wave amplitude, mean and deviation. They are compared with normal range to provide medical information and probable cause.

# Chapter 2: ECG/EKG Analysis

## 2.1 ECG/EKG

Electrocardiography (ECG or EKG*) is the process of recording the electrical activity of the heart over a period of time using electrodes placed on a patient's body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle depolarizing during each heartbeat. **

## 2.2 Medical Uses of ECG

Reasons for performing electrocardiography include:

- ♥ Suspected heart attack
- ♥ Suspected pulmonary embolism
- ♥ A third heart sound, fourth heart sound, a cardiac murmur or other findings to suggest structural heart disease
- ♥ Cardiac arrhythmia **/** dysrhythmias
- ♥ Fainting or collapse
- ♥ Seizures
- ♥ Monitoring the effects of a heart medication
- ♥ Assessing severity of electrolyte abnormalities, such as hyperkalemia

** More detailed information about ECG is in the Appendix Section

## 2.3 Types of ECG Wave

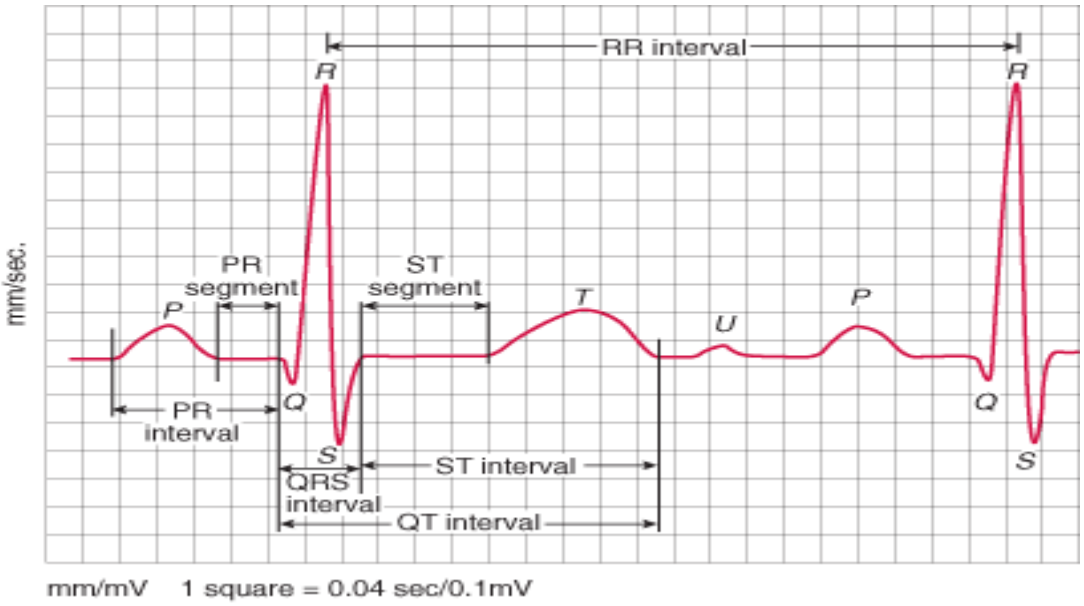



**Figure 2.3: All types of Wave in ECG**

### 2.3.1 P Wave

The P wave represents atrial depolarization. In a normal ECG, the P-wave precedes the QRS complex. It looks like a small bump upwards from the baseline. The amplitude is normally 0.05 to 0.25mV. Normal duration is 0.06-0.11 seconds. The shape of a P-wave is usually smooth and rounded.

### 2.3.2 QRS Complex

The QRS complex indicates ventricular depolarization. Depolarization triggers contraction of the ventricles.Because of the larger tissue mass, the QRS complex is larger than the P wave. While the prototypical QRS complex consists of three wave components, one or two of these components may be missing.QRS interval is measured from the end of the PR interval to the end of the S wave.

### 2.3.3 T Wave

The T wave indicates the repolarization of the ventricles. It is a slightly asymmetrical waveform that follows (after a pause), the QRS complex. Take note of T waves that have a downward (negative) deflection or of T waves with tall, pointed peaks. The U-wave is a small upright, rounded bump. When observed, it follows the T-wave.

## 2.4 Intervals and Segments

### 2.4.1 PR Interval

The PR Interval indicates AV conduction time. It is the interval from where the P wave begins until the beginning of the QRS complex. Normally this interval is 0.12 to 0.20 seconds in adults, longer in elderly people. This interval shortens with increased heart rate.Also evaluate if PR Intervals are constant or varying across the ECG signal. If they vary, determine if the variations are a steady lengthening until the point where an expected QRS does not appear.

### 2.4.2 QT Interval

The QT interval represents the time of ventricular activity including both depolarization and repolarization. It is measured from the beginning of the QRS complex to the end of the T wave. Normally, the QT interval is 0.36 to 0.44 seconds. The QT interval will vary with patient gender, age and heart rate. Another guideline is that normal QT Intervals is less than half of the R-R Interval for heart rates below 100 bpm.

### 2.4.3 ST Segment

The ST segment represents the early part of ventricular repolarization.The ST segment is the line that from the end of the QRS complex to beginning of the T wave. Normally the ST segment is flat relative to the baseline.

# Chapter 3: System Implementation

We are using MATLAB R2016a for our program.

## 3.1 ECG Dataset as an Input

We have collected a lot of continuous ECG dataset of patients which is a *.mat file from MIT-BIH Database (physionet.org). It is a matrix data. We have collected the real time continuous data of the patient for high accuracy disease detection.

Append 100 zeros before and after the signal to remove the possibility of window crossing the signal boundaries while looking for peak locations.

Plotting the matrix using the algorithm gives us the following diagram.

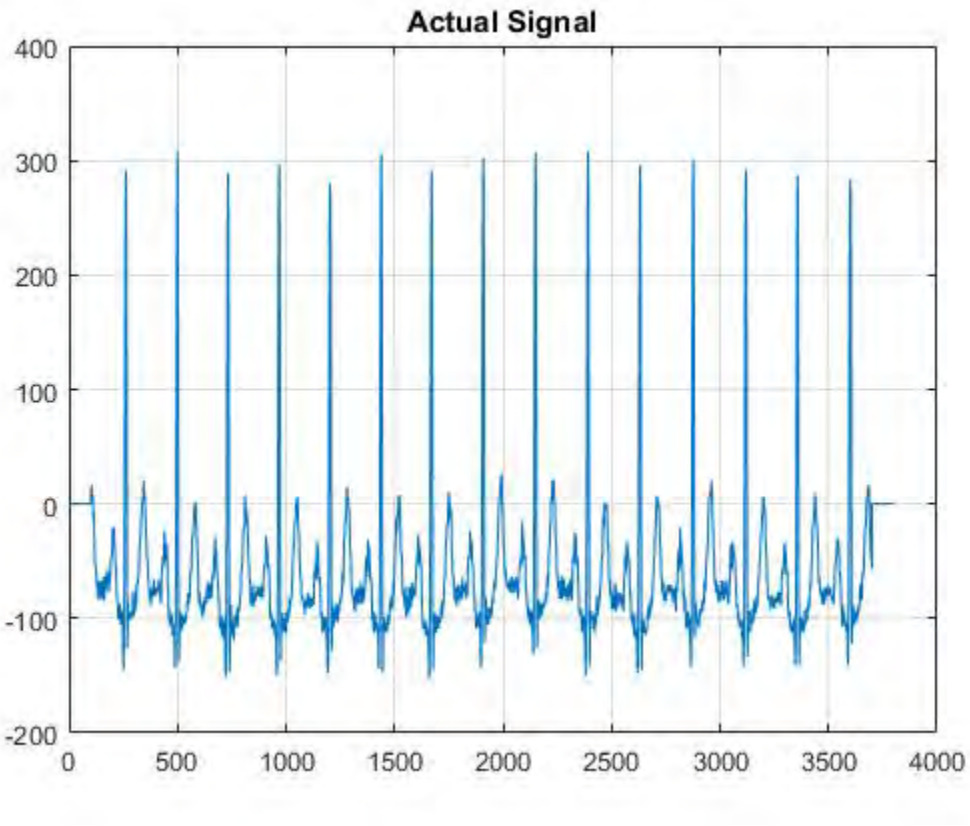



**Figure 3.1: Original ECG Signal**

## 3.2 Wavelet Decomposition

Perform wavelet decomposition. The process of wavelet decomposition down samples the signal. Which essentially means taking the samples at a much lower frequency than the original signal. Therefore details are reduced and QRS complex is preserved.

```
[c,l]=wavedec(s,4,'db4');
```

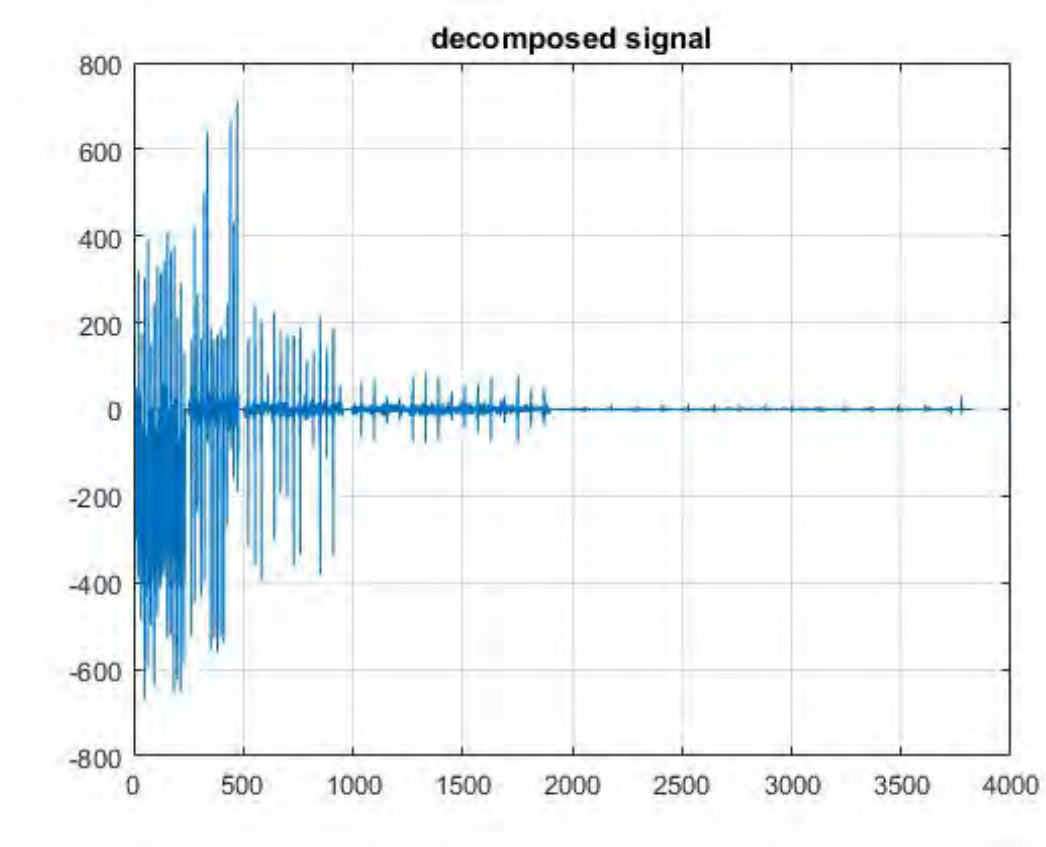



**Figure 3.2: Decomposed Signal**

## 3.3 Reconstruct Signal

Extract the Coefficients after the transform

```
ca1=appcoef(c,l,'db4',1);

ca2=appcoef(c,l,'db4',2);

ca3=appcoef(c,l,'db4',3);

ca4=appcoef(c,l,'db4',4);
```

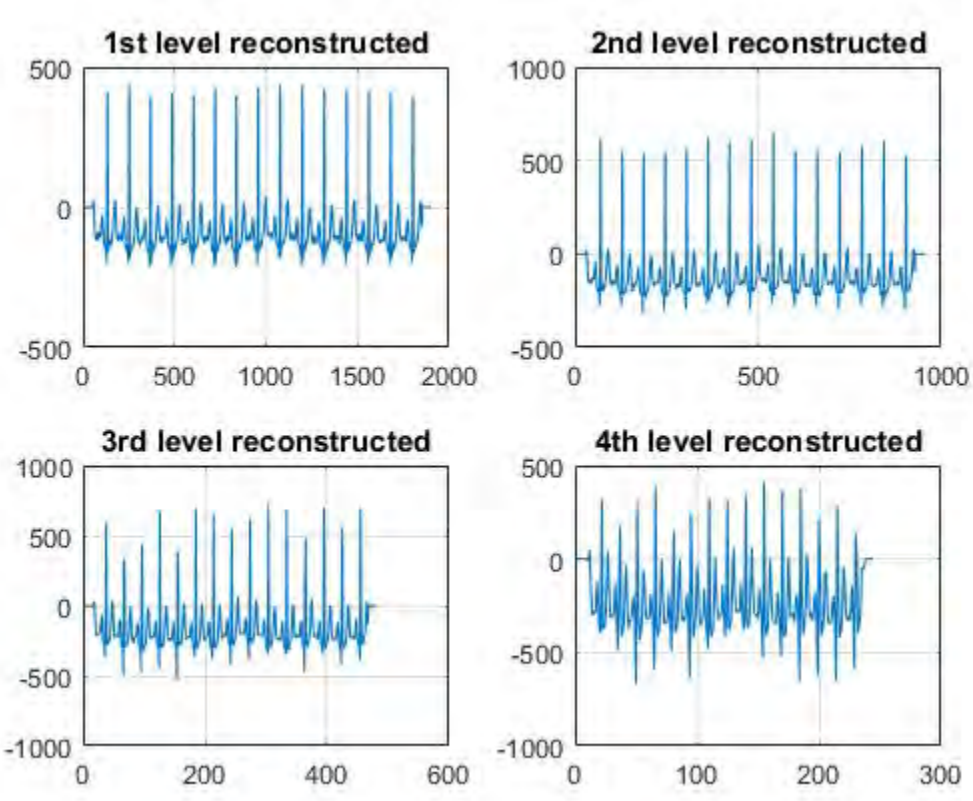



**Figure 3.3.1: Reconstructed Signal**

While plotting the coefficients we observed that the frequency bands are separated and ca1, ca2, ca3 and ca4 are cleaner signal. But they will have less number of samples than the actual

signal due to down sampling. We can see that first signal resembles to the actual signal but has exactly one forth number of samples because the signal was decomposed in 4 levels. 2nd level has exactly half number of samples that of 1st level, 3rd level has exactly half number of samples than the 2nd level. Because the number of samples is reduced, such signals are also called down-sampled signal.

It is clear that 2nd level decomposed data is noise free. Therefore we consider this signal as ideal ECG signal from which QRS must be detected. But the first R is located in 3rd level decomposition signal at approximately 40th sample whereas the same is located in the original signal at 260th location. Therefore once R peak is detected in 3rd level reconstructed signal, it must be cross validated in the actual signal.

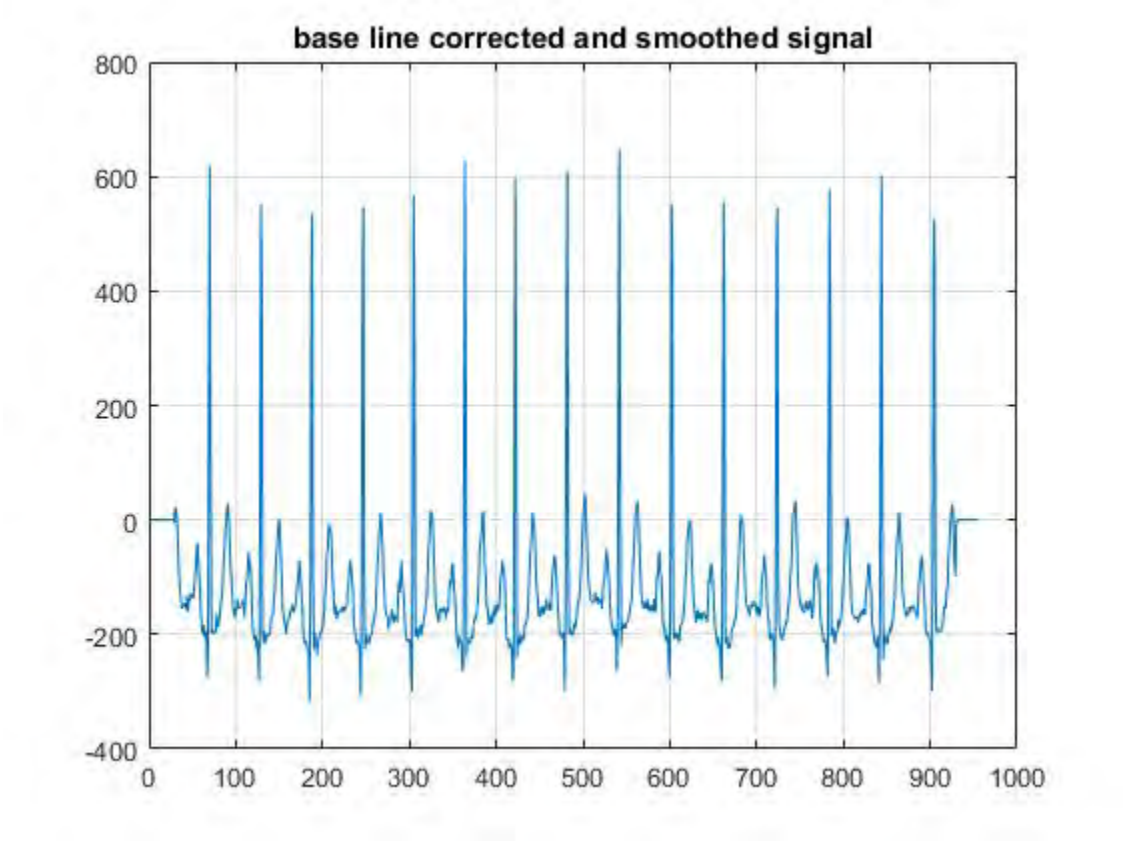



**Figure 3.3.2: Base line Corrected Signal**

## 3.4 Detecting R-peak

First we find the values which are greater than 60% of the max value of the actual signal. Invariably these are R peaks. As the decomposed signals are noise free signals, First R peak needs to be detected in the Noise free signal. But the ultimate goal is to detect the Peak in the

original Signal. The sample values in Original Signal will be different than the decomposed signal. So our strategy here will be to first detect the R peaks in the down sampled signal and then cross verify those points the actual signal.

Let y1 be the decomposed signal.

```
m1=max(y1)*.60;

P=find(y1>=m1);
```

So P is now set of points which satisfies the above criteria. If we observe the signal very closely, R-Peak is not a single impulse peak, therefore there are chances of multiple points in the same peak satisfying the criteria. One thing to remember is in 500Hz sampled signal number to R-Location will be found below 350 samples. In 4th Level decomposition order this value is around 20. So first we will remove the R locations that are too close.

Variable P2 represents the position of R-Peaks in the down sampled signal.

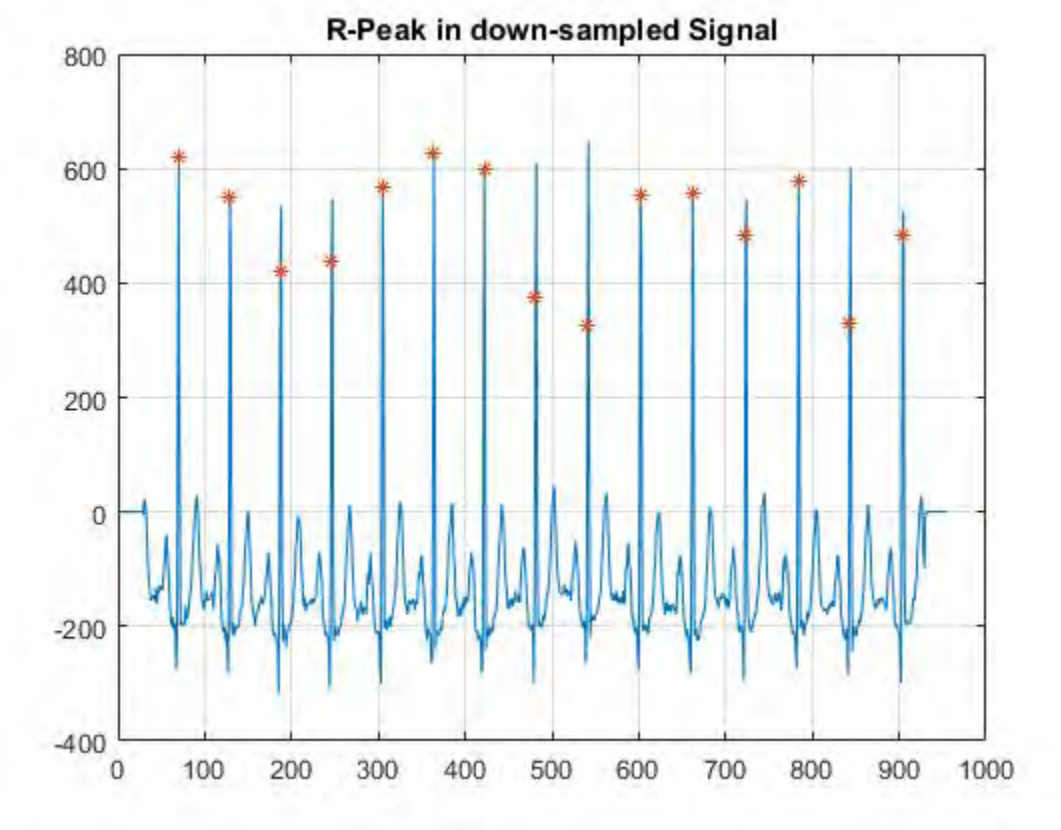



**Figure 3.4: R-peak detected in Down-sampled Signal**

## 3.5 Detecting R-peakin the Original Signal

Search for the position of all the location in signal y1 which are greater than this value m1. They are R locations. We know that a R Location in Rt is at least 1/4th of the actual R location of the same point. Hence we will first map the detected positions to original signal by first multiplying with 4.

```
P3=P2*4;

%Multiply the current location with 4 to get the actual scale.
```

R location in down sampled signal will never be on the original signal at a scale of 4. Down sampling process always deviate the signal positions. Hence we need to search for the maximum value in the Original Signal in a window of +-20 samples from the reference R point obtained as P3.

Now Ramp and Rloc represents the R peak amplitude and location at the original scale.

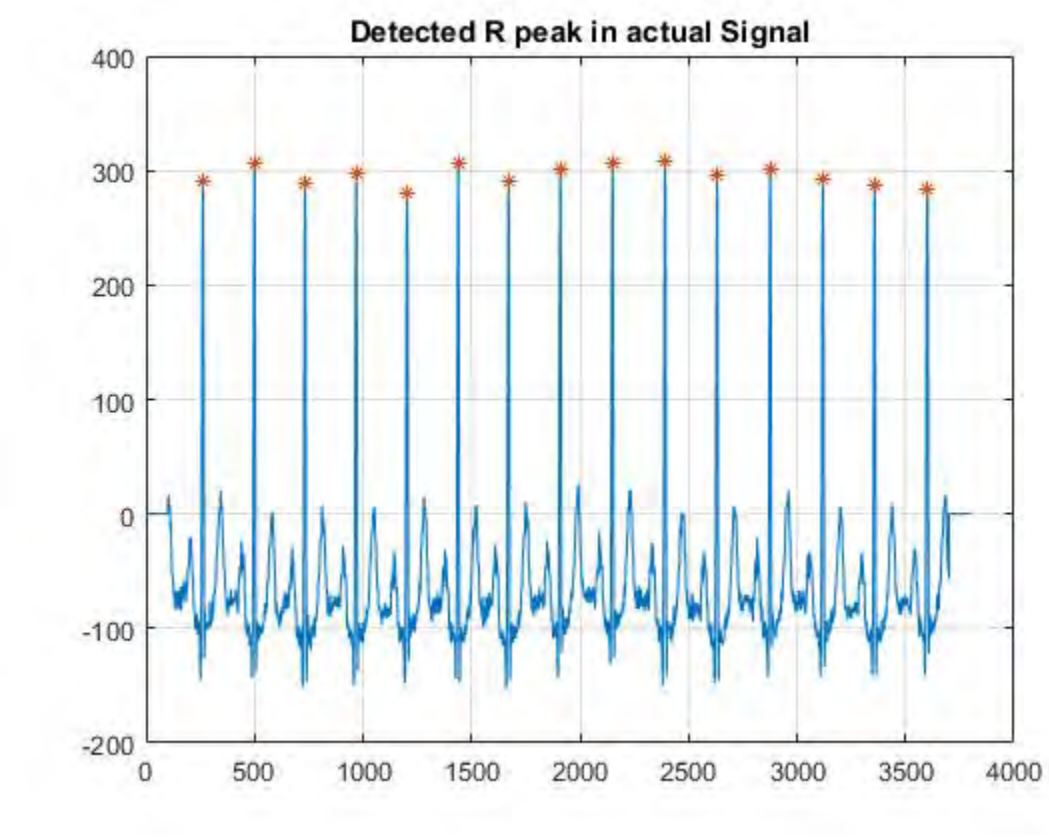



**Figure 3.5: R-peak in the Original Signal**

## 3.6 Detecting Other with reference to R-peaks

From R-Peak Traverse Forth and Back and Search for Minima and Maxima, these are P, Q, T, S peaks respectively. So loop in Rloc and search for the other peaks.

Firstly, if we observe the waveform, it will be very clear that from R location if we select a window of Rloc-100 to Rloc-50 and find the maximum, than that maxima is P peak.

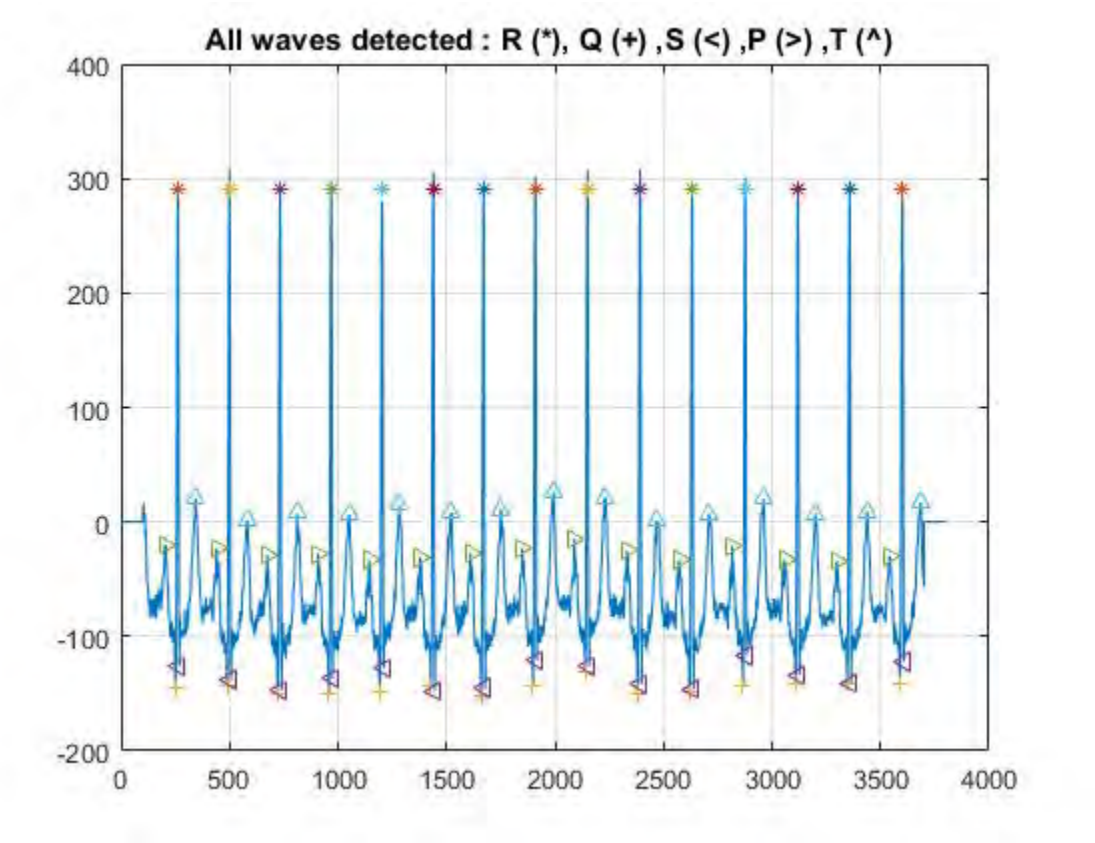



**Figure 3.6: All waves detected in Original Signal**

# Chapter 4: Results

## 4.1 Feature Extraction & Disease detection

### 4.1.1 ST Deviation:

ST Deviation calculation is necessary to detect Myocardial Infarction (MI) which causes Cardiac arrhythmia in common language Heart Attack.

- **Normal Range:** ST Deviation/100 < 1
- **Heart Attack :**ST Deviation/100 > 1

### 4.1.2 PR Interval

Measured from beginning of P to beginning of QRS in the frontal plane

- **Normal Range:** 0.12 - 0.20s
- **Short PR:** < 0.12s

Syndromes:

- **WPW (Wolff-Parkinson-White) Syndrome:** An accessory pathway (called the "Kent" bundle) connects the right atrium to the right ventricle *or* the left atrium to the left ventricle, and this permits early activation of the ventricles (delta wave).
- **LGL (Lown-Ganong-Levine):** An AV nodal bypass track into the His bundle exists, and this permits early activation of the ventricles without a *delta-wave* because the ventricular activation sequence is normal.
- AV Junctional Rhythms with retrograde atrial activation (inverted P waves in II, III, aVF): Retrograde P waves may occur *before* the QRS complex (usually

with a short PR interval), *in* the QRS complex or *after* the QRS complex.

- Ectopic atrial rhythms originating near the AV node (the PR interval is short because atrial activation originates close to the AV node; the P wave morphology is different from the sinus P)

- **Prolonged PR:**> 0.20s

Syndromes:

- First degree AV block (PR interval usually constant)
- Intra-atrial conduction delay (uncommon)
- Slowed conduction in AV node (most common site)
- Slowed conduction in His bundle (rare)
- Slowed conduction in bundle branch (when contralateral bundle is blocked)
- Second degree AV block (PR interval may be normal or prolonged; some P waves do not conduct)
- Type I (Wenckebach): Increasing PR until nonconducted P wave occurs
- Type II (Mobitz): Fixed PR intervals plus nonconducted P waves
- AV dissociation: Some PR's may appear prolonged, but the P waves and QRS complexes are dissociated.

### 4.1.3 QRS Duration

Duration of QRS complex in frontal plane

- **Normal:** 0.06 - 0.10s
- **Prolonged QRS Duration:**

**QRS duration > 0.10s:**

- QRS duration 0.10 - 0.12s
- Incomplete *right* or *left* bundle branch block
- Nonspecific intraventricular conduction delay (IVCD)
- Some cases of left *anterior* or *posterior* fascicular block

**QRS duration ≥ 0.12s:**

- Complete RBBB or LBBB
- Nonspecific IVCD
- Ectopic rhythms originating in the ventricles (e.g., ventricular tachycardia, pacemaker rhythm)

### 4.1.4 QT Interval

Measured from beginning of QRS to end of T wave in the frontal plane

- **Normal:** heart rate dependent (corrected QT = $QT_C$ = measured QT, sq-root RR in seconds; upper limit for $QT_C$ = 0.44 sec)
- **Long QT Syndrome:** "LQTS" (based on upper limits for heart rate; $QT_C \geq 0.47$ sec for males and ≥ 0.48 sec in females is diagnostic for *hereditary* LQTS in absence of other causes of increased QT)

This abnormality may have important clinical implications since it usually indicates a state of increased vulnerability to malignant ventricular arrhythmias, syncope, and sudden death. The prototype arrhythmia of the Long QT Interval Syndromes (LQTS) is Torsade-de-pointes, a polymorphic ventricular tachycardia characterized by varying QRS morphology and amplitude around the isoelectric baseline. Causes of LQTS include the following:

- Drugs (many antiarrhythmics, tricyclics, phenothiazines, and others)
- Electrolyte abnormalities ($\downarrow K^{+}$, $\downarrow Ca^{++}$, $\downarrow Mg^{++}$)
- NS disease (especially subarrachnoid hemorrhage, stroke, trauma)
- Hereditary LQTS (e.g., Romano-Ward Syndrome)
- Coronary Heart Disease (some post-MI patients)

### 4.1.5 No disease/ Healthy Heart

For a healthy heart the primary condition is:

- ST Deviation/100 < 1

And for a perfect heart condition which is very rare includes these conditions:

- PR Interval: 0.12 - 0.20s
- QRS Duration: 0.06 - 0.10s
- Heart Rate: 60 - 90 bpm

## 4.2 Result Validation& Accuracy Check:

## 4.3

### 4.3.1 Case Study 1:

We have collected a lot of ECG data from MIT-BIH Arrhythmia Database, the largest Bio-Engineering Research Organization. These Arrhythmia Database contains ECG data along with the disease analysis from doctors and they have also developed their own method for detecting wave properties. Now we will take only the ECG data from the database and cross-verify with our program output with MIT-BIH report analysis.

These are the Information found with the data 300m_C.mat file from MIT-BIH:

```
Record ecgiddb/Person_03/300m_C

Notes

=====

 Age: 25

 Sex: male

 ECG date: 07.12.2004

 Findings: Myocardial Infarction (MI)

=====



Starting time: not specified

Length:     0:20.000 (10000 sample intervals)

Sampling frequency: 500 Hz

2 signals

Group 0, Signal 0:

 File: rec_2.dat

 Description: ECG I

 Gain: 200 adu/mV

 Initial value: -20

 Storage format: 16
```

```
I/O: can be unbuffered

ADC resolution: 12 bits

ADC zero: 0

Baseline: 0

Checksum: -32042

Group 0, Signal 1:

File: rec_2.dat

Description: ECG I filtered

Gain: 200 adu/mV

Initial value: -12

Storage format: 16

I/O: can be unbuffered

ADC resolution: 12 bits

ADC zero: 0

Baseline: 0

Checksum: 556
```

Analyzing the same data by our program gives us the following output:

```
Heart Condition: Myocardial Infarction (Heart Attack) detected

PR Interval Report

PR interval >.20sec (Prolonged PR)

First degree AV block (PR interval usually constant)

Second degree AV block (PR interval may be normal or prolonged; some P
waves do not conduct)

AV dissociation: Some PR may appear prolonged, but the P waves and QRS
complexes are dissociated

QRS Duration Report

QRS Duration >.20sec (Prolonged QRS Duration)

Incomplete right or left bundle branch block

Nonspecific intraventricular conduction delay

Intra-atrial conduction delay (uncommon)

Slowed conduction in bundle branch (when contralateral bundle is
blocked)QRS Duration normal (.06sec ~.10 sec)
```

## Validation:

Although MIT-BIH does not provide PR interval and QRS duration, but our program successfully detected the disease Myocardial Infarction (Heart Attack) validated by MIT-BIH database patient description.

### 4.3.2 Case Study 2:

'ECG Q R S wave online detector' Program is found from Matlabworks.com. The program detects only Q, R, S wave and thus heart rate. We will run this program and also our program on the same input to cross-validate our result.

'ECG Q R S wave online detector' output for the input

| Our Program | ECG Q R S wave online detector |
|---|---|

| Qamp | Ramp | Samp | Qamp | Ramp | Samp |
|---|---|---|---|---|---|
| -1.4500 | 29.1000 | -1.2600 | -1.5144 | 33.3722 | -1.2238 |
| -1.4300 | 30.7000 | -1.3800 | -1.4313 | 39.7646 | -3.5495 |
| -1.5100 | 28.9000 | -1.4700 | -1.8009 | 32.4060 | -3.5566 |
| -1.5000 | 29.7000 | -1.3700 | -4.9175 | 42.7260 | -3.4787 |
| -1.4800 | 28.0000 | -1.2800 | -4.2792 | 32.1911 | -2.7645 |
| -1.4400 | 30.6000 | -1.4800 | 2.4358 | 38.1961 | -2.6690 |
| -1.5200 | 29.1000 | -1.4500 | 3.5608 | 37.2970 | -2.3829 |
| -1.4300 | 30.2000 | -1.2100 | -1.8476 | 34.0001 | -2.3514 |
| -1.3100 | 30.7000 | -1.2600 | -1.1340 | 31.7916 | 5.0717 |
| -1.5000 | 30.8000 | -1.4200 | -1.4043 | 42.1343 | -8.4291 |
| -1.4800 | 29.6000 | -1.4600 | -0.1384 | 26.8916 | -6.6780 |
| -1.4300 | 30.1000 | -1.1700 | -1.8052 | 39.6187 | -1.3938 |

| | | | | | |
|---|---|---|---|---|---|
| -1.4500 | 29.2000 | -1.2600 | 1.5144 | 33.3722 | 0.2238 |
| -1.4300 | 29.1000 | -1.3800 | -1.4313 | 39.7646 | -3.5495 |
| -1.5100 | 30.7000 | -1.4700 | -1.8009 | 32.4060 | 3.5566 |

| | |
|---|---|
| Our Program | ECG Q R S wave online detector |

| Final Result | Final Result |
|---|---|
| Heart Condition: Myocardial Infarction (Heart Attack) detected<br><br>PR Interval Report<br><br>PR interval >.20sec (Prolonged PR)<br><br>QRS Duration Report<br><br>QRS Duration normal (.06sec ~.10 sec) | Heart-rate is =45<br><br>Irregular Rhythm: Arrythmia Detected |

## Validation:

As per Medical Books Q and S wave is negative. The comparison shows all our Q and S amplitudes are negative and consistent. On the other hand, 'ECG Q R S wave online detector' detects some false positive points which is not accurate. In our Program R-peak is also consistent and matches with actual signal. Both the programs detect Irregular Heart Rate but our program offers addition feature such as PR Interval and QRS duration. Thus with the above data we can conclude that our program is more accurate.

# Reference

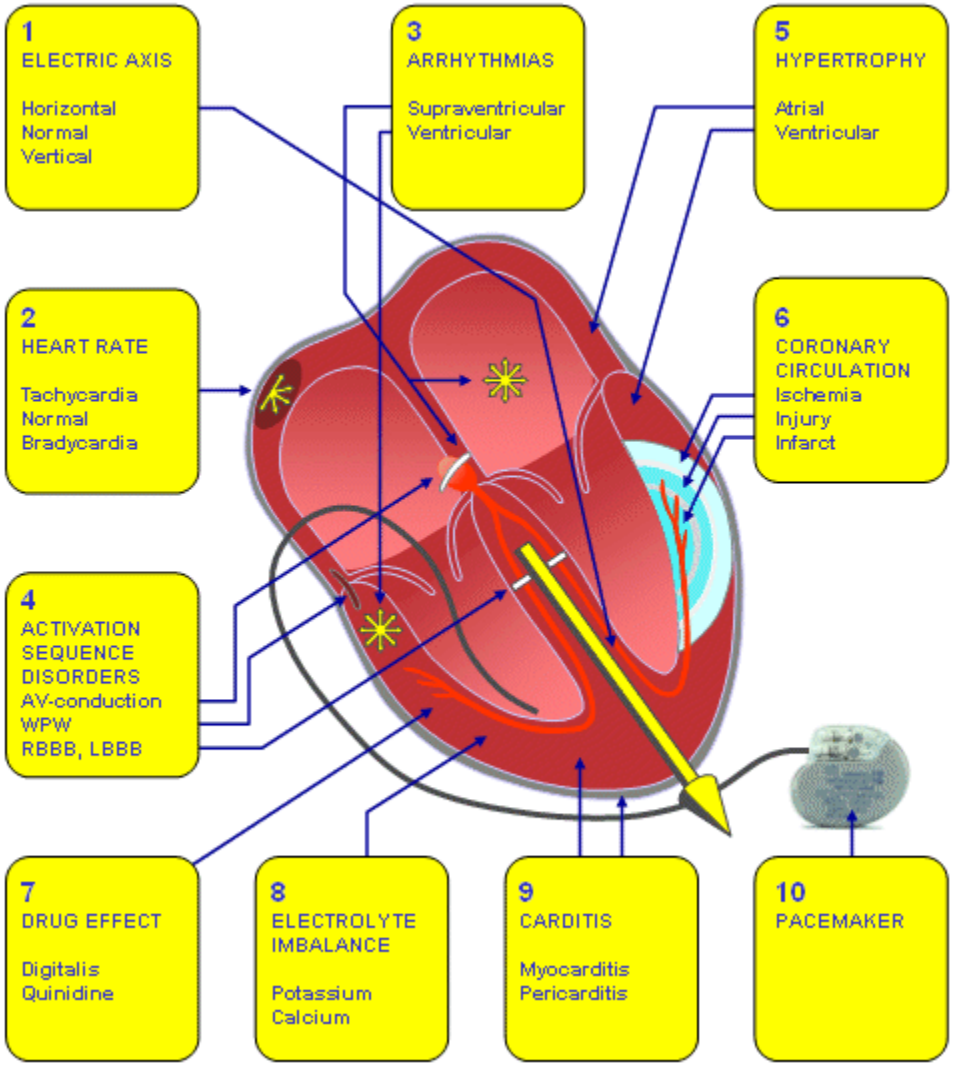
1. Uddin, J., Van, D. N., & Kim, J. (2015). Accelerating 2D Fault Diagnosis of an Induction Motor using a Graphics Processing Unit. International Journal of Multimedia and Ubiquitous Engineering IJMUE, 10(1), 341-352. doi:10.14257/ijmue.2015.10.1.32
2. R Wave Detection in the ECG. (n.d.). Retrieved April 15, 2016, from https://www.mathworks.com/examples/wavelet/mw/wavelet-ex77408607-r-wave-detection-in-the-ecg
3. PhysioNet. (n.d.). Retrieved April 15, 2016, from https://www.physionet.org/
4. Normal ECG. (n.d.). Retrieved April 15, 2016, from https://meds.queensu.ca/central/assets/modules/ECG/normal_ecg.html
5. Nixon, M. S., &Aguado, A. S. (2002). Feature extraction and image processing. Oxford: Newnes.
6. Medscape. (n.d.). Retrieved April 15, 2016, from http://www.medscape.com/viewarticle/545741_1
7. MATLAB Speaks SDR. (n.d.). Retrieved April 15, 2016, from http://www.mathworks.com/
8. Lesson 4. (n.d.). Retrieved April 15, 2016, from http://www.ieee-uffc.org/ultrasonics/software/matlab/lecture4/lecture4_6.htm
9. Grasshopper Network Discussion Forum. (n.d.). Retrieved April 15, 2016, from http://www.grasshoppernetwork.com/
10. EKG Nomenclature. (n.d.). Retrieved April 15, 2016, from http://www.practicalclinicalskills.com/ekg-lesson.aspx?CourseCaseOrder=2
11. ECG – A Pictorial Primer. (n.d.). Retrieved April 15, 2016, from http://www.medicine-on-line.com/html/ecg/e0001en_files/05.htm
12. ECG processing — R-peaks detection. (n.d.). Retrieved April 15, 2016, from http://www.librow.com/cases/case-2
13. ECG analysis using wavelet transform: Application to myocardial ischemia detection. (n.d.). Retrieved April 15, 2016, from http://www.sciencedirect.com/science/article/pii/S1297956203000032
14. ECG Basics. (n.d.). Retrieved April 15, 2016, from http://lifeinthefastlane.com/ecg-library/basics/
15. ECG. (n.d.). Retrieved April 15, 2016, from https://en.wikipedia.org/wiki/ECG

16. Detection of ECG characteristic points using Multiresolution Wavelet Analysis based Selective Coefficient Method. (n.d.). Retrieved April 15, 2016, from http://www.sciencedirect.com/science/article/pii/S0263224109002139
17. CodeProject - Forum Discussion. (n.d.). Retrieved April 15, 2016, from http://www.codeproject.com/
18. Characteristics of the Normal ECG. (n.d.). Retrieved April 15, 2016, from http://ecg.utah.edu/lesson/3
19. BioMedical Engineering OnLine. (n.d.). Retrieved April 15, 2016, from https://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-10-23
20. Annadurai, S., &Shanmugalakshmi, R. (2010). Fundamentals of digital image processing. Noida: Pearson.
21. Algorithm Links. (n.d.). Retrieved April 15, 2016, from http://www.mit.edu/~gari/algos.html
22. Acharya, T., & Ray, A. K. (2005). Image processing: Principles and applications. Hoboken, NJ: John Wiley.
23. Citation Machine automatically generates citations in MLA, APA, Chicago, Turabian, and thousands more! (n.d.). Retrieved April 15, 2016, from http://www.citationmachine.net/

# Appendix

## 1. ECG Applications & Limitations

### 1.1 The Application Areas of ECG Diagnosis



The main applications of the ECG to cardiological diagnosis include the following

1. The electric axis of the heart
2. Heart rate monitoring
3. Arrhythmias
    - ♥ Supraventricular arrhythmias
    - ♥ Ventricular arrhythmias
4. Disorders in the activation sequence
    - ♥ Atrioventricular conduction defects (blocks)
    - ♥ Bundle-branch block
    - ♥ Wolff-Parkinson-White syndrome
5. Increase in wall thickness or size of the atria and ventricles
    - ♥ Atrial enlargement (hypertrophy)
    - ♥ Ventricular enlargement (hypertrophy)
6. Myocardial ischemia and infarction
    - ♥ Ischemia
    - ♥ Infarction
7. Drug effect
    - ♥ Quinidine
    - ♥ Digitalis
8. Electrolyte imbalance
    - ♥ Calcium
    - ♥ Potassium
9. Carditis
    - ♥ Pericarditis
    - ♥ Myocarditis
10. Pacemaker monitoring

### 1.2 Limitations of ECG

An ECG is a simple and valuable test. Sometimes it can definitely diagnose a heart problem. However, a normal ECG does not rule out serious heart disease. For example, you may have an irregular heart rhythm that 'comes and goes' and the recording can be normal between episodes. Also, not all heart attacks can be detected by ECG. Angina, a common heart disorder, cannot usually be detected by a routine ECG.

Specialized ECG recordings sometimes help to overcome some limitations. For example:

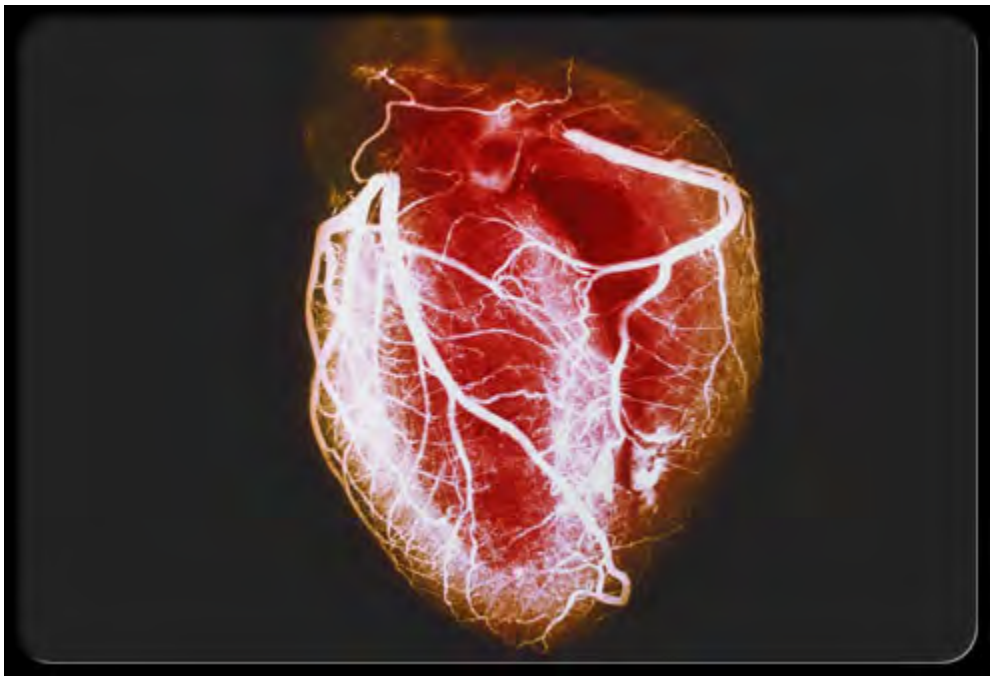
- Exercise ECG. In this test, a tracing is done when you exercise (on a treadmill or exercise bike). This helps to assess the severity of the narrowing of the coronary arteries which causes angina.
- Ambulatory ECG. In this test you wear a small monitor which constantly records your heart rhythm. This test records the electrical activity of your heart when you are walking about (ambulatory) and doing your normal activities. It aims to detect abnormal heart rhythms that may 'come and go'. The electrical activity is usually recorded for 24-48 hours.

## 2. ECG detected Diseases Information

### 2.1 Heart Attack

A heart attack (also known as a myocardial infarction or MI) is the damage and death of heart muscle from the sudden blockage of a coronary artery by a blood clot. Coronary arteries are blood vessels that supply the heart muscle with blood and oxygen.

An electrocardiogram (ECG) is a recording of the electrical activity of the heart. Abnormalities in the electrical activity usually occur with heart attacks and can identify the areas of heart muscle that are deprived of oxygen and/or areas of muscle that have died. In a patient with typical symptoms of heart attack (such as crushing chest pain) and characteristic changes of heart attack on the ECG, a secure diagnosis of heart attack can be made quickly in the emergency room and treatment can be started.



If a patient's symptoms are vague or atypical and if there are pre-existing ECG abnormalities, for example, from old heart attacks or abnormal electrical patterns that make interpretation of the ECG difficult, the diagnosis of a heart attack may be less secure. In these patients, the diagnosis can be made only hours later through blood tests.

## 2.2Atrial fibrillation

Atrial fibrillation (also referred to as AFib) is the most common type of abnormal heart rhythm. AFib is caused by abnormal electrical discharges (signals) that generate chaotically throughout the upper chambers of the heart (atria). AFib reduces the ability of the atria to pump blood into the ventricles, and usually causes the heart to beat too rapidly.

### 2.2.1 Symptoms:

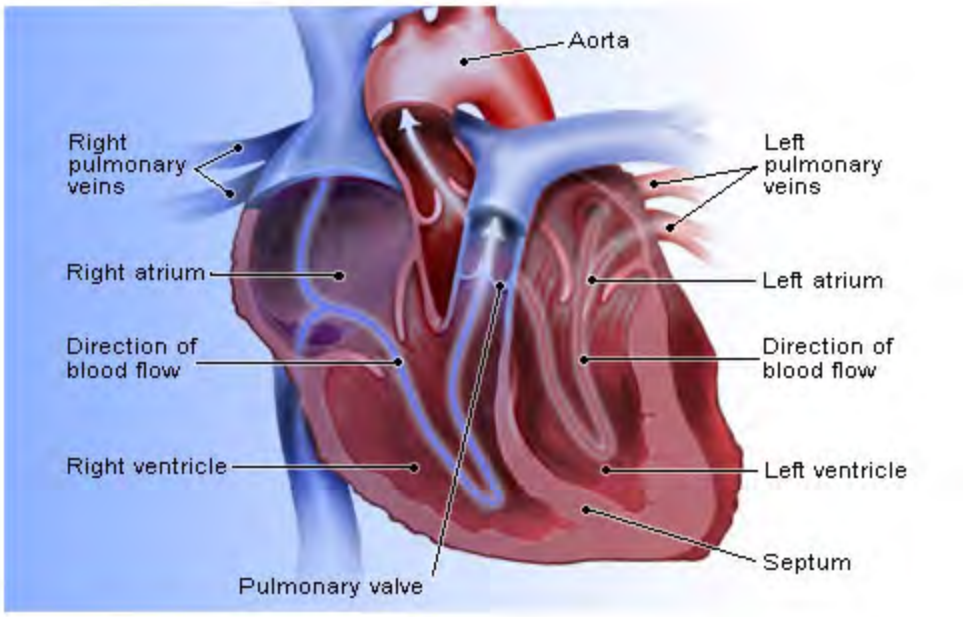
- Palpitations, dizziness, fainting, weakness, fatigue, shortness of breath, and chest pain.
- Complications of atrial fibrillation include heart failure and stroke.

## 2.3 Angina

Angina pectoris describes the pain, discomfort, ache, or other associated symptoms that occur when blood flow to heart muscle cells is not enough to meet its energy needs.

The classic description of angina is a crushing pain, heaviness or pressure that radiates across the chest, sometimes down the arm, into the neck, jaw or teeth, or into the back. It may be associated with shortness of breath, nausea, vomiting, sweating, and weakness.

Angina is often brought on by exercise and other strenuous activities and gets better with rest. When the body requires the heart to pump more blood, the heart muscle is asked to do more work and that can cause it to outstrip its energy supply. When the body rests, angina should start to subside.




Angina tends to progress slowly over time and patients may not recognize that their symptoms are due to heart disease. It may be fatigue and exercise intolerance, the gradually inability to perform work or other activities that had once been easier to do. It may be shortness of breath with activity like walking up steps or uphill. It is worrisome when the pain comes on at rest or at sleep, since it means that little activity is causing enough stress to cause angina symptoms.

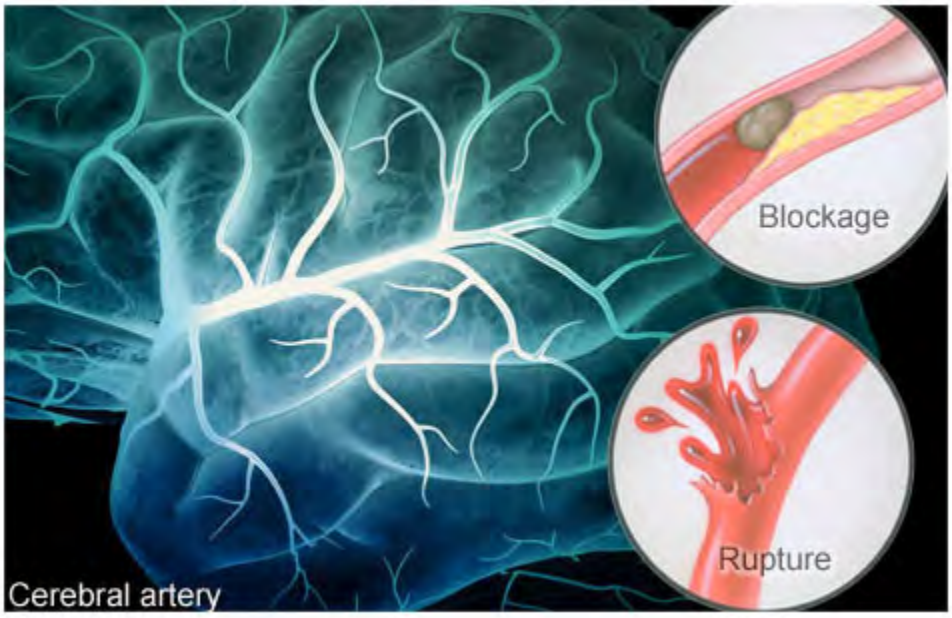
This is the same situation that occurs when muscles in the leg or arm fatigue because of overuse and they begin to ache. The difference is that one can stop lifting or running but the heart cannot stop beating to rest. The other difference is that the symptoms of angina are felt in different ways by different patients and may not be recognized as coming from the heart.

Unfortunately for some patients, they may have no symptoms at all, even with significant narrowing of their coronary arteries, and they may first present for care in the midst of a myocardial infarction or heart attack, when a coronary artery is completely blocked. This is especially true for women who may have atypical angina symptoms including fatigue, malaise, weakness, and dizziness.

Angina is a warning sign that the heart muscle is not getting adequate blood supply and oxygen. If unheeded it may lead to a heart attack or myocardial infarction.

## 2.4 Stroke

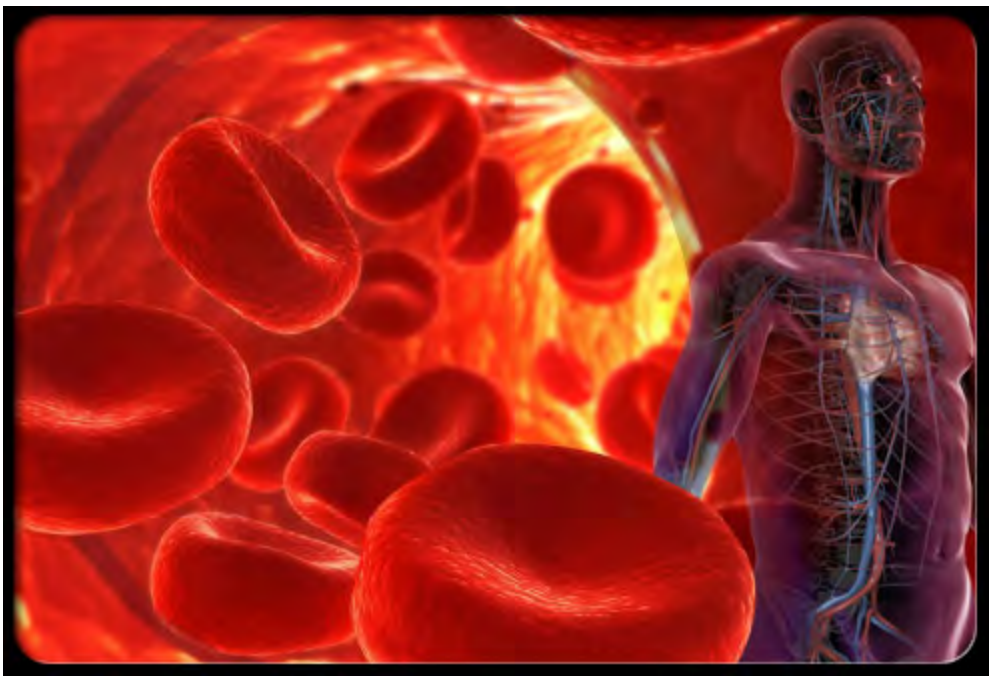
A stroke occurs when part of the brain loses its blood supply and stops working. This causes the part of the body that it controls to stop working as well.




Time is of the essence since the longer a stroke remains unrecognized and untreated, the longer brain cells are deprived of oxygen-rich blood and the greater number of brain cells that die and cannot be replaced.

## 2.5 Palpation

Palpations are sensations by a person that they are having hard, rapid, or irregular heartbeats or a combination of these sensations.



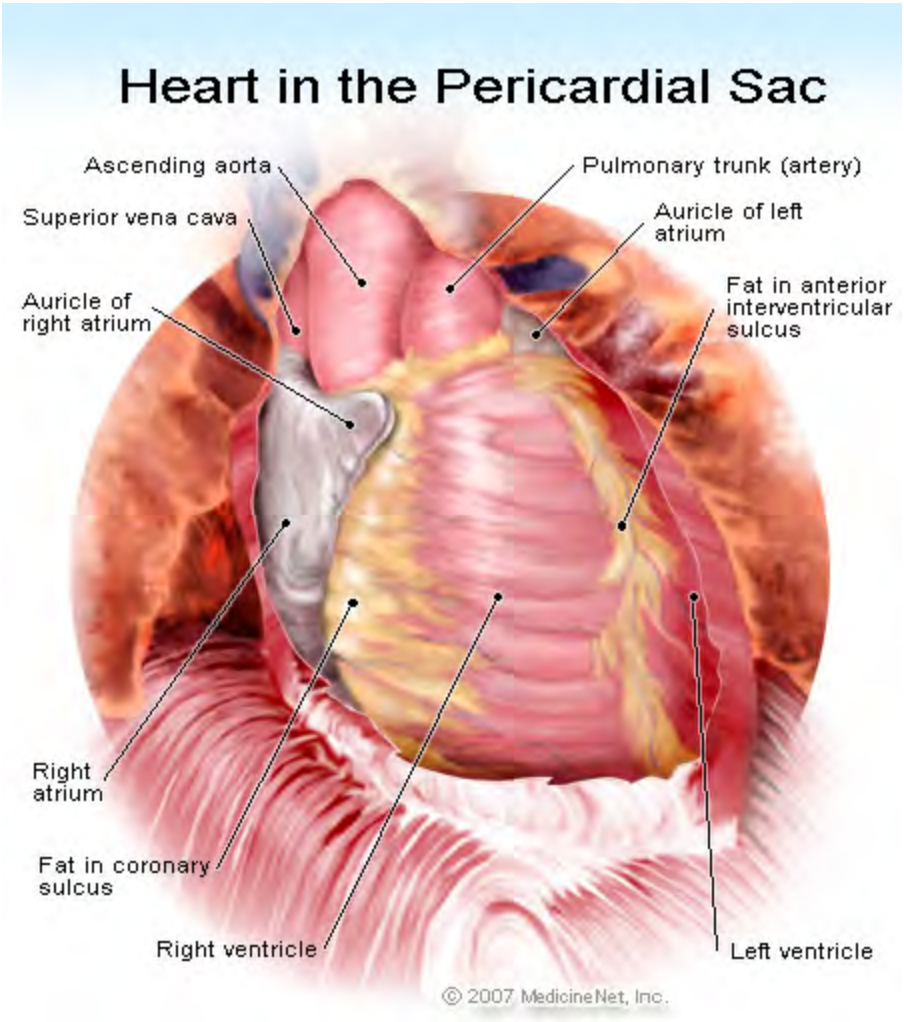
Treatment for palpitations depends upon the underlying situation and cause of the abnormal heart rhythm and is tailored to the specific patient's needs.

Many causes of palpitations are self-limiting and lifestyle changes may help decrease their occurrence. These include deceasing or avoiding the use of caffeine, alcohol, and over-the-counter cold medications. As well, many herbal medications contain stimulants that may affect the heart's electrical conducting system. Smoking cessation is always appropriate.

Pacemakers and defibrillators may be indicated if life-threatening conditions are the cause of palpitations.

## 2.6 Pericarditis

Pericarditis is an inflammation of the lining surrounding the heart




Most often, pericarditis is caused by a viral infection and the treatment is aimed at decreasing inflammation and controlling pain. Nonsteroidal anti-inflammatory drugs or NSAIDs (ibuprofen [Motrin and others], naproxen [Aleve, Naprosyn, and others]) are commonly used. A short course of narcotic pain medication may be helpful. For other causes of pericarditis, treatment of the underlying cause of pericarditis is essential.

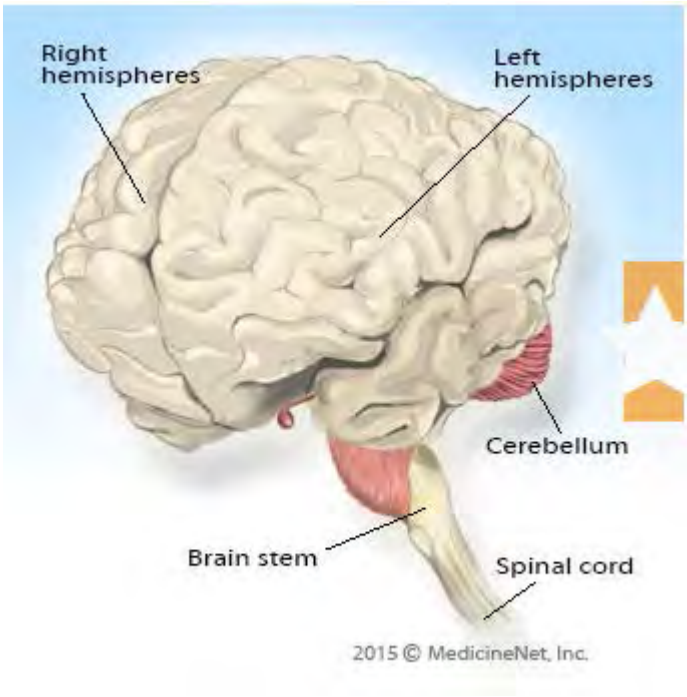
Pericardiocentesis, a procedure where a thin needle is inserted through the chest wall into the pericardial sac, may be considered if a large effusion is present that affects heart function (see cardiac tamponade below).

Pericardotomy (cutting a hole in the pericardial sac) or pericardectomy (removing the sac completely) may be needed for recurrent pericarditis that causes scarring within the pericardial sac and prevents the heart from beating properly.

## 2.7Fainting (Syncope)

Fainting, "blacking out," or syncope is the temporary loss of consciousness followed by the return to full wakefulness. This loss of consciousness may be accompanied by loss of muscle tone that can result in falling or slumping over. To better understand why fainting can occur; it is helpful to explain why somebody is awake.

The brain has multiple parts, including two hemispheres, the cerebellum, and the brain stem. The brain requires blood flow to provide oxygen and glucose (sugar) to its cells to sustain life. For the body to be awake, an area known as the reticular activating system located in the brain stem needs to be turned on, and at least one brain hemisphere needs to be functioning. For fainting or syncope to occur, either the reticular activating system loses its blood supply, or both hemispheres of the brain are deprived of blood, oxygen, or glucose. If blood sugar levels are normal blood flow must be briefly disrupted to the whole brain or to the reticular activating system for fainting to occur.




Fainting is not caused by head trauma, since loss of consciousness after a head injury is considered a concussion. However, fainting can cause injury if the person falls and hurts themselves, or if the faint occurs while participating in an activity like driving a car.

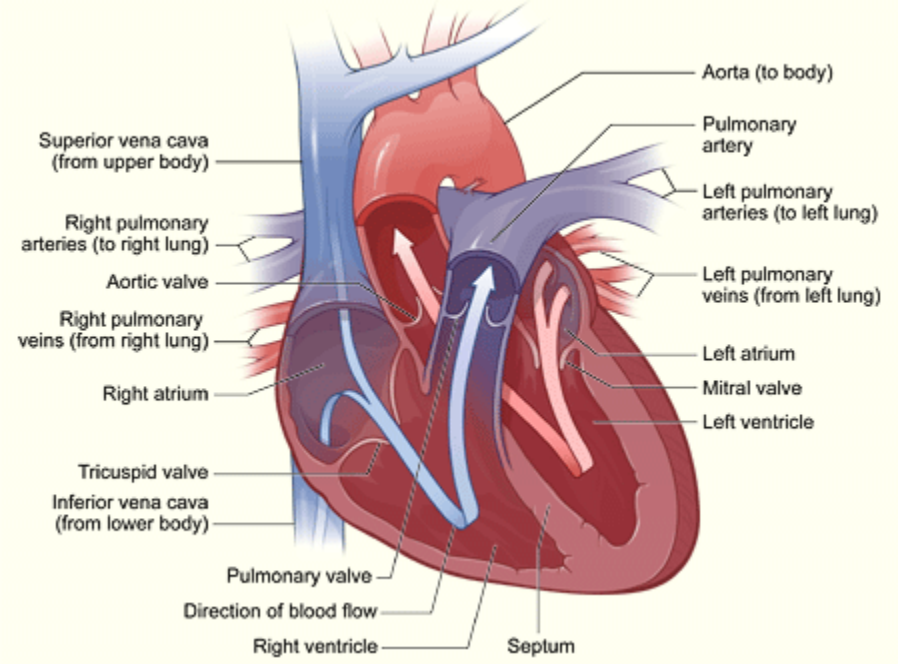
## 2.8Congenital heart defects

Congenital (kon-JEN-ih-tal) heart defects are problems with the heart's structure that are present at birth. These defects can involve:

- The interior walls of the heart
- The valves inside the heart
- The arteries and veins that carry blood to the heart or the body

Congenital heart defects change the normal flow of blood through the heart.

There are many types of congenital heart defects. They range from simple defects with no symptoms to complex defects with severe, life-threatening symptoms.




To understand congenital heart defects, it's helpful to know how a healthy heart works. Your child's heart is a muscle about the size of his or her fist. The heart works like a pump and beats 100,000 times a day.

The heart has two sides, separated by an inner wall called the septum. The right side of the heart pumps blood to the lungs to pick up oxygen. The left side of the heart receives the oxygen-rich blood from the lungs and pumps it to the body.

The heart has four chambers and four valves and is connected to various blood vessels. Veins are blood vessels that carry blood from the body to the heart. Arteries are blood vessels that carry blood away from the heart to the body.

The illustration shows a cross-section of a healthy heart and its inside structures. The blue arrow shows the direction in which oxygen-poor blood flows from the body to the lungs. The red arrow shows the direction in which oxygen-rich blood flows from the lungs to the rest of the body.

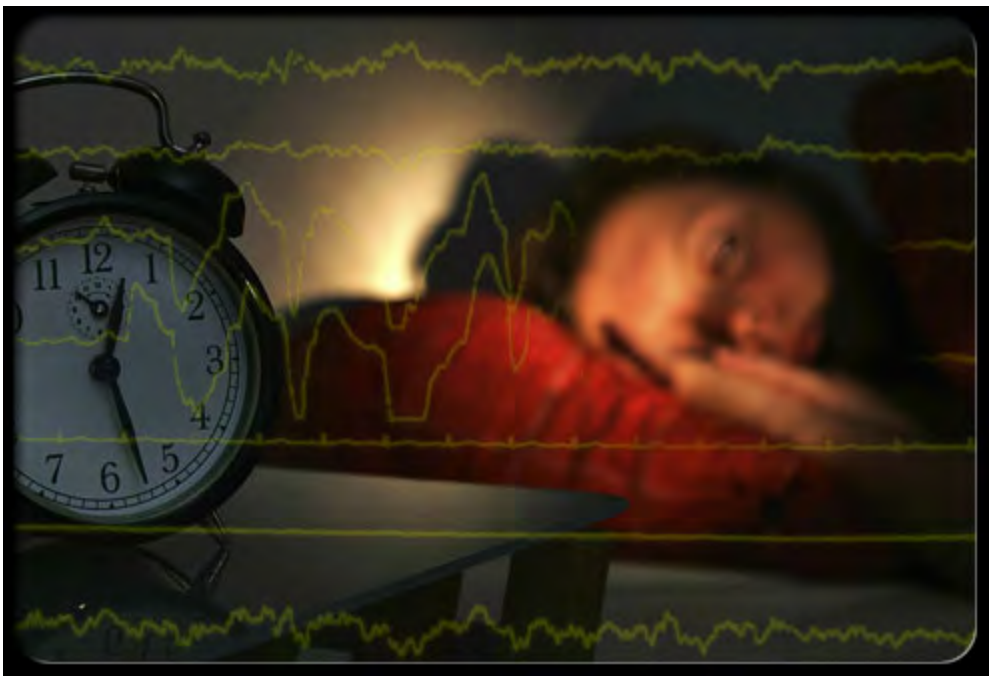
Heart Chambers

The heart has four chambers or "rooms."

- The atria (AY-tree-uh) are the two upper chambers that collect blood as it flows into the heart.
- The ventricles (VEN-trih-kuhls) are the two lower chambers that pump blood out of the heart to the lungs or other parts of the body.

## 2.9Sleep

Physiologically, sleep is a complex process of restoration and renewal for the body. Scientists still do not have a definitive explanation for why humans have a need for sleep. We do know that sleep is not a passive process or "switching off" of body functions; sleep is believed to be important in many physiologic processes including the processing of experiences and the consolidation of memories. It is also clear that sleep is essential, not only for humans but for all animals.



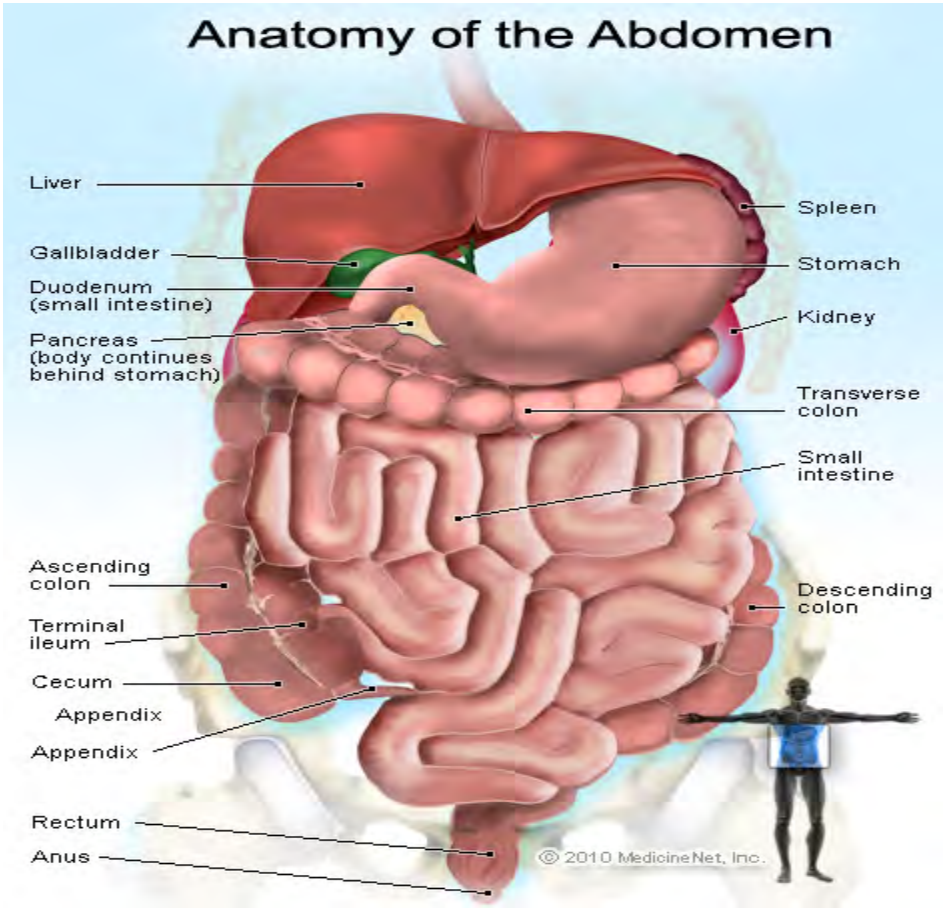
The importance of sleep is underscored by the symptoms experienced by those suffering from sleep problems. People suffering from sleep disorders do not get adequate or restorative sleep, and sleep deprivation is associated with a number of both physical and emotional disturbances.

Sleep is influenced by the circadian rhythms (regular body changes in mental and physical characteristics that occur in the course of about 24 hours). These are controlled by brain neurons that respond to light, temperature and hormones and other signals and comprise the body's biological clock. This clock helps regulate the "normal" awake and sleep cycles. Disruption of these cycles can make people sleepy, or somnolent, at times people want to be awake. For example, travelers experience "jet lag" when they cross time zones. When a New Yorker arrives in Paris at midnight Paris time, his or her body continues to operate (their biological clock) on New York time. It may take several days to reset a person's biologic clock, depending on how much it has been altered by the time change. Different organ systems in the body recover at different rates.

## 2.10 Indigestion (Dyspepsia, Upset Stomach)

Dyspepsia is one of the most common ailments of the bowel (intestines), affecting an estimated 20% of persons in the United States. Perhaps only 10% of those affected actually seek medical attention for their dyspepsia. Dyspepsia is not a particularly good term for the ailment since it implies that there is "dyspepsia" or abnormal digestion of food, and this most probably is not the case. In fact, another common name for dyspepsia is indigestion, which, for the same reason, is no better than the term dyspepsia! Doctors frequently refer to the condition as non-ulcer dyspepsia.

Dyspepsia (indigestion) is best described as a functional disease. (Sometimes, it is called functional dyspepsia.) The concept of functional disease is particularly useful when discussing diseases of the gastrointestinal tract. The concept applies to the muscular organs of the gastrointestinal tract, the esophagus, stomach, small intestine, gallbladder, and colon. What is meant by the term, functional, is that either the muscles of the organs or the nerves that control the organs are not working normally, and, as a result, the organs do not function normally, and the dysfunction causes the symptoms. The nerves that control the organs include not only the nerves that lie within the muscles of the organs but also the nerves of the spinal cord and brain.



Some gastrointestinal diseases can be seen and diagnosed with the naked eye, such as ulcers of the stomach and can be seen at surgery, on X-rays, and by endoscopy. Other diseases cannot be seen with the naked eye but can be seen and diagnosed under the microscope. For example, gastritis (inflammation of the stomach) can be diagnosed by microscopic examination of biopsies of the stomach. In contrast, gastrointestinal functional diseases cannot be seen with the naked eye or the microscope. In some instances, the abnormal function can be demonstrated by tests (for example, gastric emptying studies or antro-duodenal motility studies). However, the tests often are complex, are not widely available, and do not reliably detect the functional abnormalities. Accordingly, and by default, functional gastrointestinal diseases are those that involve abnormal function of gastrointestinal organs in which the abnormalities cannot be seen in the organs with either the naked eye or the microscope.

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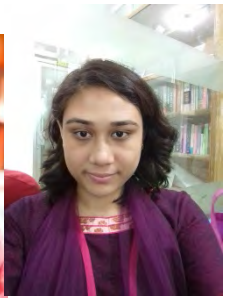


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