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Study of Some Factors That Affect ECG Device

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Abstract Changes are studied that appear on the electrocardiogram due to the effect of electromagnetic waves emitting by mobile devices. The research was carried out at Fallujah Teaching Hospital by using a MAC1600-Morta ECG device. The work included a study on the effect of the presence of mobile devices during the measurement of electrocardiograms and the discussion of all cases, as well as the impact of the ordinary watch near the electrodes. The results showed a disturbance in the electric waves and return wave will return to its normal shape after the demise of the effect.

1. Introduction:

The process of producing an electrocardiogram (ECG or EKG) is Electrocardiography, and it is recording a graph from voltage versus time of the electrical activity of the heart by using electrodes placed on the skin. Reveal these electrodes a small electrical changes that are a effect of cardiac muscle depolarization followed up via repolarization during each cardiac cycle (heartbeat) [1].

The first attempts to record the electrical activity of the muscle by a number of the scientists began in 1666 by (Franciscuride), and in 1773 he managed (Walsh) to recognize the formation of some fish muscles for electricity, and in 1792 was completed published a report to the Italian world (Luigi Giuliani), which applied a preliminary registration process of the muscle. It followed six decades and until 1849, when the world showed that (Doubenez, Raymond) also recorded the activity of the involuntary muscle. In addition, he managed (MORI) recording the electrical activity of the working muscle. Use the worlds (Jasser, 1922) to display the electrical signals caused by constriction muscular.

The methods of recording such electrical signals quickly and extensively evolved 1930 research then used advanced electrodes to capture signals broad when studying muscles.

The history of ECG returns to 1903 when Einthoven invented the electrocardiogram, which was very complex, and need five people to operate it [2]. Fig.1 shows the old machine of the EGC in 1901 [3].



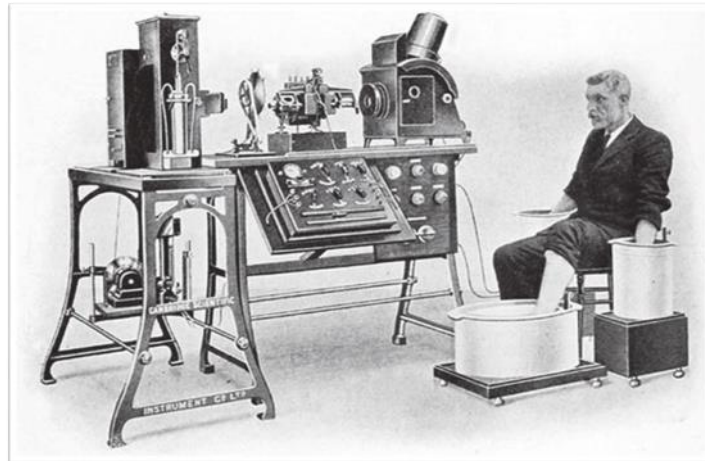


Figure 1. Old ECG machine [3].

2. Components of Cardiac Planning:

The devices of Heart-shaping share in the same principle but only differ slightly in the terms of ingredient. Generally this device consists from the following parts[4]:

1. Calibration: This part of device effectively adjusts a device and calibrates it correctly prior beginning to the process of cardiac planning, if a square wave is made one millivolt, exhibit that the device is in the state perfect.[4]
2. Sensitivity point: This part is extremely important in maintaining the sensitivity of this device, as in its normal state (1mV) via utilizing the sensitivity point, the wave can be amplified or reduced according to the patient's case during which we relate body of human and the device.
3. Ground: As usually, excessive charge deposition, and the electrical shock protection
4. Poles: The device Consisting of five electrodes put in specified places in the body of human used.
5. Speed limitation: The ECG has two of speeds (25-50 mm/s) employ each speed according to the existent case and specified via the doctor back to the heart if the patient is old age has a slightly weak pulse, so a low (25 mm/s). If the young is a fast pulse, utilize the high speed unto we get keeping pace with the planning of the patient's case.
6. The Screen: When the doctor is absent of the paper or not necessary for reading continuous to the heart.
7. The division: Of the protection circuits in the device, utilizing a circuit of protection from high currents and voltages it is indeed a succeeded method in all the organs.
8. The candidate: A currency is limited in the winding up of exterior effectes that can effect on the cardiac planning, because side effects such as neurons and other devices in the same room testing has a big role in acquiring to the wrong planning [4].

The heart Anatomy:

The heart's wall is consist of three layers [4]:

The epicardium, the myocardium, and the endocardium

- The Epicardium is the external layer
- The myocardium, is the midst layer, that consists the largest part from wall of the heart. This layer of muscle tissue contracts with each heartbeat.
- The endocardium, the deepest layer in heart.

2.1. Champers of the heart:

The heart consist of four chambers two atria and two ventricles. The right and left atria serve as large tank for the blood being send to the ventricles.

- The right atrium receiving deoxygenated blood return from the human body.
- The left atrium receives the oxygenated blood from the two lungs during the four pulmonary veins [4].

right and left ventricles serve as the pumping chambers for the heart.

- The right ventricle receives blood from right atrium and pumping it during the pulmonary arteries to lungs, where it picks the oxygen and drops off the carbon dioxide.
- left ventricle receives the oxygenated blood from left atrium and pumping it during the aorta and thereafter out to the rest of the body [4].

2.2. The electricity of the heart:

: [2] The conductive system of the human heart consists from five specialized tissue

- 1- Sinoatrial node "SA" node .
- 2 - Atrioventricular node "AV" node
- 3- His bundle is a group of the human heart muscle cells specializing
- 4- Left bundle branch "LBB" and right bundle branch "RBB"
- 5- Purkinje fibers.

As impulses arise in SA node and traverse through atria, they cause depolarization of the atria, From the atria impulses reach AV node, where there is some delay, this delay will allow the atria to contract and pumping blood for the ventricles.

This impulse is later spread along branch of His, left and right branch branch and lastly, during Purkinje fibers causing ventricular depolarization. The predominant pacemaker is "SA node". Atrial cells, "AV node", bundle of His, bundle branch, Purkinje fibers and myocardial cells are the other pacemaker sites. When SA node fails, they can initiate impulse at a slow rate [2]. This entire process take a less than 200 parts from one second to form one beat.

2.3. How ECG Works:

In a classic ECG that component of 12 lead , ten electrodes are placed on the patient's limbs and on the surface of the chest for the patient. The total volume for the heart's electrical potential is then measured from the twelve various angles "leads" and is registered along a interval of the time (commonly ten seconds). In this way, the total volume and direction of heart's electrical depolarization is captivated at each moment during the cardiac cycle [5].

In ECG the lead registration the heart's electrical activity utilizing a chain of electrodes tacked on the patient's extremities and chest wall. The 12 leads contain to three dipolar limb leads "I, II, and III" up, down, and across scanning up, down, and across the heart, every lead transferred data about a various region. The waveforms acquired from every lead change counting on the place of the lead link to the wave of depolarization, or electrical stimulus, by passing throughout myocardium [4].

recording electrical activity for the six-limb leads in the heart's frontal plane. This plane is a view during the midst of the heart from the top to the bottom. Electrical activity is registered from the frontal to the rear axis [3]. The six precordial leads supply information about electrical activity in heart's horizontal plane, a transversal view during the midst of the heart, dividing it into upper and lower parts. Electrical activity is on record from either a top or an inferior approach [4]. Every lead consist of metal strip that connect the electricity from heart.

2.4. The 12 leads:

To recording the bipolar limb leads (I, II, III) the unipolar limb leads (aVR, aVL, and aVF) placed electrodes on both of the patient's arms and on his left leg. The leg right also receives an electrode, however that electrode acts as a ground and does not participate into the wave form. Three limb leads (aVR, aVL, and aVF), and six unipolar precordial, or chest, leads (V1, V2, V3, V4, V5, and V6). These leads providing 12 various views of the heart's electrical activity [4].

The placed of electrodes (leads) [4]:

Placement of limb leads:

“RA” on the right arm

“LA” on the left arm

“RL” on the right leg

“LL” on the left leg

Placement of Chest Leads:

“V1” fourth intercostal space at right sternal boundary

“V2” fourth intercostal space at left sternal boundary

“V4” fifth intercostal space at left midst clavicular line

“V3” midway between V2 and V4

“V5” at the itself horizontal level as V4 in the anterior axillary line

“V6” at the same horizontal level as V4 in the midst axillary line.

2.5. Monitoring limb leads:

Lead “aVR”: This lead links right arm (positive magnate) with the heart (negative magnate).

Lead “aVL”: This lead links left arm (positive magnate) with the heart (negative magnate).

Lead “aVF”: This links left leg (positive magnate) with the heart (negative magnate).

Lead I: This lead links right arm (negative magnate) with the left arm (positive magnate).

Lead “II”: This lead links right arm (negative magnate) with the left leg (positive magnate).

Lead “III”: This lead links left arm (negative magnate) with the left leg (positive magnate)

[4].

Criterion limb leads (dipolar)

(I): Side wall

(II): Inferior wall

(III): Inferior wall

Augmented limb leads (unipolar)

“aVR”: No specified view

“aVL”: Side wall

“aVF”: Inferior wall

Precordial, or chest, leads (unipolar)

(V1): Septal wall

(V2): Septal wall

(V3): Frontal wall

V4: Frontal wall

(V5): Side wall

(V6): Side wall

2.6. The heart rate

The number of times the heart beats per minute (bpm) is the heart rate, and it varies according to physical necessity such as the need for absorb oxygen and remove carbon dioxide, usually the heart rate is equal or closer to the measuring pulse in any endpoint.

- Activities that can affect the heart rate are exercises, sleeping, worry, stress, disease, and ingestion of drugs like B-blockers and atropine [4].

The tracing on an ECG, bpm is usually calculated as the number of QRS(wave) complexes.

The rate is measured of the R-R entr'acte, the distance between one R wave and the next. The atrial rate (the number of P waves) and the ventricular rate the number of QRS complexes wave the analysis may show them as different rates, one atrial and one ventricular. The way selection to calculate HR(the heart rate) varies according to rate and regularity on ECG

Where the normal rate of heart rate into an adult at the rest time is 60-90 bpm tracing[4].

and recognized the tachycardia when heart rate override 100 bpm at the rest time, and heart rate goes down the 60 bpm also known bradycardia at the rest time.

2.6.1. Heart rate calculation:

The Heart rate has many features as a clinical parameter: It's quick and inexpensive to measurement and is easy understand. In spite of the passable boundaries from the heart rate this convenience was based on the scale of a squares on are among 60 and 100 beats per min, the electrocar diagram paper; The better definition of natural sinus heart rate may become among 50 and 90 beats per min[6].

The standard textbooks of physiology and the medicine mention that the heart rate "HR" is easily calculated of ECG as following:

($HR = 1,500/RR$) period in mm, ($HR = 60/RR$) period in seconds, or ($HR = 300/\text{number of large squares between consecutive R waves}$). At every case, the writer are really indicate to the instantaneous (HR), which is the number of times the heart would beat if consecutive (RR) periods were constant. However, because of the top formula refer is nearly always aforementioned, students limitations (HR) this method without looking at ECG any further.

2.6.2. Paper of ECG graph:

Waveforms generated via the heart's electrical current are registered on graphed the ECG paper via a stylus. The paper of ECG consists of horizontal and vertical lines formation a grid. An ECG strip or tracing is a piece of ECG paper [2]. A horizontal axis of the ECG strip is represents the time, every little bulk equals (0.04 sec), and five little bulks form a big bulk, which equal to (0.2 sec). This time increase is specific via multiply (0.04 sec) (for one small bulk) via 5, the number of little bulks that form a large bulk. Five number of large bulks equal to (1 sec) (5×0.2). At measure or calculate a heart rate of patient's[4].

The strip of ECG cephalic axis measures the amplitude in millimetres or electrical voltage in millivolts. Every little bulk representing (1 mm) or (0.1 mV); Any large bulk (5 mm) or (0.5 mV). For determine the amplitude of the wave, segment, or interval, counting the number of little bulks from the base line to a high or low point of the wave, segment, or interval [4].

Paper of ECG graph

For better understanding the ECG graph as shown Fig.2 [2]:

- 1 (mm) = 0.04 (sec)
- 2 (mm) = 0.08 (sec)
- 3 (mm) = 0.12 (sec)
- 4 (mm) = 0.16 (sec)
- 5 (mm) = 0.20 (sec)
- 10 (mm) = 0.40 (sec)
- 15 (mm) = 0.60 (sec)
- 20 (mm) = 0.80 (sec)
- 25 (mm) = 1.00 (sec)

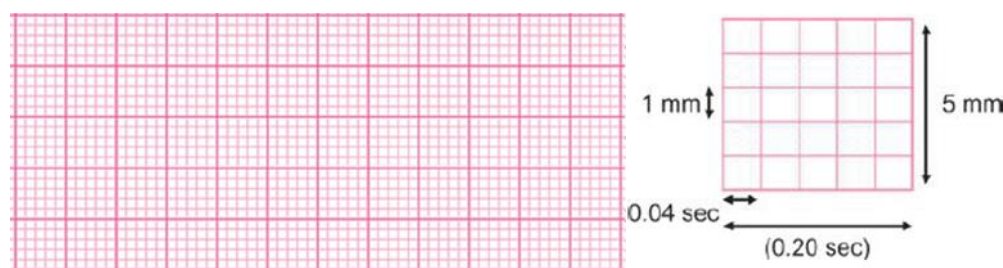


Figure 2. paper of ECG graph

2.7. A normal wave of ECG graph:

The wave of the ECG result consisting of five of waves ("P", "Q", "R", "S", and "T"). Each wave of these represents the electrical events as shown below:

- Wave P symbolize atrial de-polarization conduction of an electrical impulses during the atria, a first wave seen very small, up-right (positive wave indicating atrial constriction) and it's amplitude is (2 to 3 mm) high and its period (0.06-0.12 sec)[7].
- (PR interval): The distance among the first of (P wave) and first of (QRS complex) Measurments time through which a depolarization wave trips from atria to ventricles and it's period (0.12 -0.20 sec)[7].
- (QRS complex): Three of deviations after (P wave) mentions ventricular de-polarization and constriction (Q Wave): First negative deviations, (R Wave): First positive deviations, (S wave): First negative deviations following (R wave) and it's amplitude is (5 to 30 mm) high and it's period (0.06-0.10 sec).
- (ST-segment): The distance among (S wave) and the beginning of (T wave) measurment of time among ventricular de-polarization and the beginning of re-polarization and its period minimal than (0.10 sec).
- (T wave): Rounded up-right (the positive) wave following (ORS) represents ventricular re-polarization and it's amplitude (0.5 mm) in leads (I, II, III) and up to (10 mm) in the precordial leads.
- (QT interval):The distance inter beginnings of (QRS) to end of (T wave) representing overall ventricular activity and it's period varies; generally continues from (0.36 to 0.44 sec) as illustrate in Figure 3.
- (U waves): The small rounded, up-right wave that following (T wave) most readily seen with a slow heart rate represents re-polarization of Purkinje fibers [7].

Indicates the height of wave to the strength of voltage exerted and the width of wave indicates to the time wanted, the distance among the waves symbolizes to the time needed for transmission the electricity from one point to another point[4].

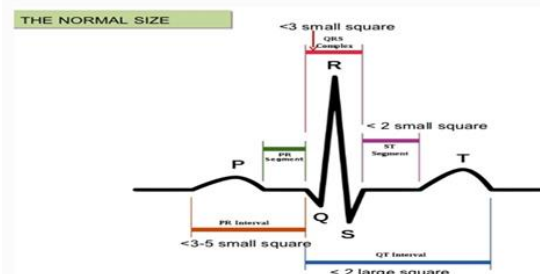


Figure 3. ECG of the heart in natural(Heart's wave) sinus rhythm [6].

2.7.1. Normal ECG pattern:

Fig.4 shows the normal waves in each lead

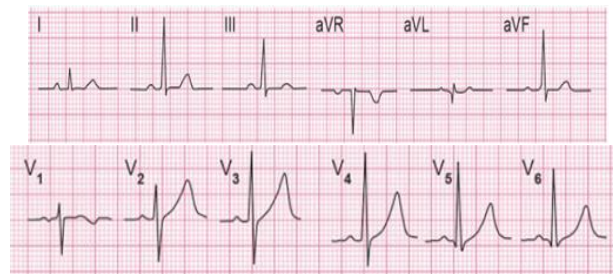


Fig.4. Normal waves of leads [2]

The heart of a normal human being was examined at Al Fallujah Teaching Hospital by using a MAC1600-Morta ECG device as shown in Fig. 5.

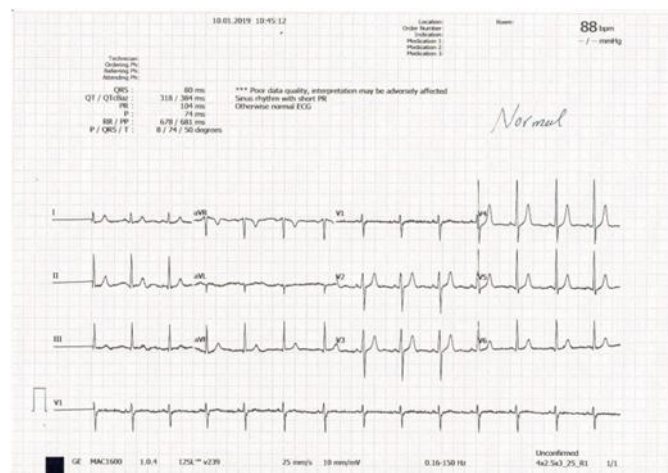


Figure 5. Normal record for the ECG of the patient in Fallujah Teaching Hospital.

3. Result and discussion

3.1. Effect of the phone:

In last years, there has been an increasing in the utilize of telecommunication devices, which has become an simple means of communication [8]. During the last decade, the utilize of mobiles has become more Pronounced. So, it has result to the structure of transmission turret in large numbers, both in urban, as well as in rural regions inclusively other sparsely populated regions. Many attempts are made to investigate the effect of the mobile phones (MP) on the health of human [8].

A form of energy appear wave like behaviour as it travels during space is electromagnetic radiation, the electromagnetic radiation has each electric and magnetic field components, which oscillate in phase vertical form to each other and vertical form to the direction of energy propagation. Though the amount of electromagnetic energy due to the cell phones is very small in compare to other radio frequency sources, the increased utilize of wireless mobile phones world wide (about 3.8 billion mobile users) has focused solicitude on it's probable side affects, and the health potential impacts [8]. Mobile phones can effect on the heart rate, TP segment and time of T wave. So, it appears that long time utilize can effect the heart of human. Based on several reports on the influence of these waves on biological processes, precautionary measures should be taken about employ mobile phones [9].

The cell phone is not a safety device, so, we must use it as little as possible, and in necessary situations. Keeping in mind, don't put it behind heart or ear for long receiving call time, since its effects on human body temperature, as a result, the temperature has been increased so the mobile effect on human rhythm, heart rate...etc. Mobile phone cells send electromagnetic waves and these waves interfere with the electricity wave of the human sent by the heart and therefore affected the signal received by the ECG device [10]. It has been illustrate that through ECG recordings should be turned off the mobile phone or must be (7.5cm) from every pole of the ECG electrodes [10].

It must be notice that even when mobile phone is not utilized for any voice or information communication it is periodical sending low-frequency bursts during the phone ring, the cell phone sent high electromagnetic waves that cause interference to the signal received by the ECG [10] therefore inaccurate planning when the ECG is recording and the mobile phone ringing. As shown in this Fig.6 and Fig.7.

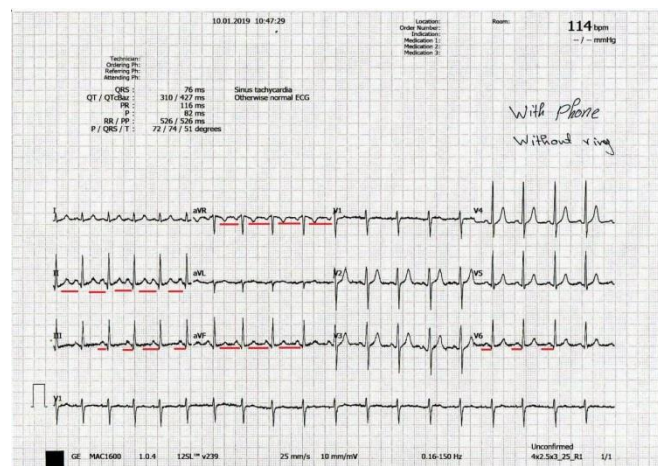


Figure 6. ECG record with effect of phone without ring

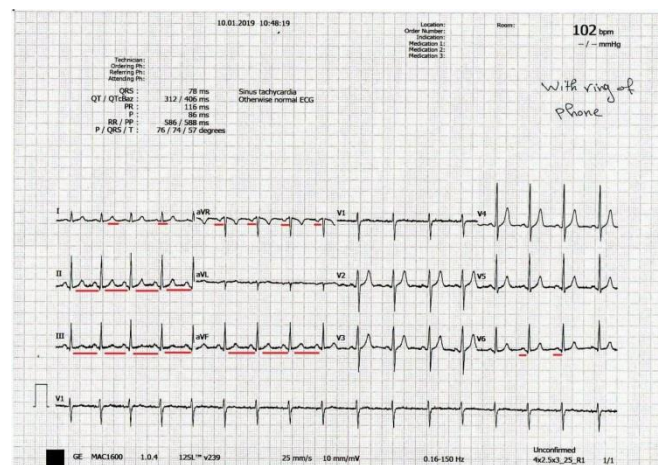


Figure 7. Effect of the ring of phone on ECG

3.2. Effect of the watch:

The ECG readable patient must get rid of all metals including the ordinary or digital clock because they effect there adding of the ECG due to the interference of the wave. In the present work not effect from the watch on ECG as shown in Fig.8.

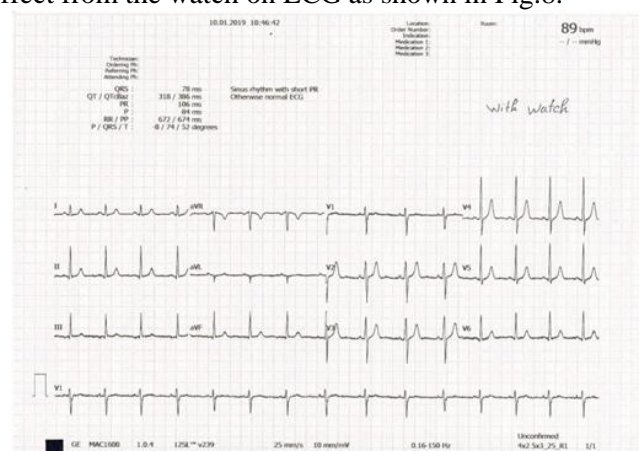


Figure 8. ECG record show little effect of ordinary watch

3.3. Effect of the hair:

Before beginning the ECG recording, the hair on the chest should be shaved off it. Because the presence of hair causes an improperly electric field, it results because the electrodes do not stick well on the skin. Hair causes a resistance between the skin and the leads so all of this referred above occur.

3.4. ECG Gel:

The gel of ECG is a water depending conduction (transport) gel with high conductivity characteristics. The ECG gel generation has been formulate with high viscosity and is specific destined to decrease resistance among the skin and electrodes in a most cardiac electrical operations. It is likewise destined to transfer weak electrical signs in a high precision method to improve the precision testing of ECG . Hight conductivity stay constant even through long procedures [11]. The gel of ECG includes non-toxic components and non-toxic preservatives tested in terms of toxicity by an independent third party[11].

The gel put on the skin to decrease the resistance among the skin and the electrodes.

3.5. Apple watch:

Recently Apple company detected watch measures the rhythm of the heart and heart rate that allow the patient to observe his/her heart [12].

Principle work of apple watch:

The sensor of optical used to measure the pulse of the heart in Apple watch utilizes what a recognized as scaling. This technicality is depended on an extremely easy fact: the blood is red because of reflect red and absorb green. Apple Watch utilizes green lights of LED as well as light sensitive light diodes to expose the amount of blood flowing during the wrist at any given moment. When the heartbeats, the blood streams in the wrist and the green absorption is maximal. While lower among each pulse and others. Apple Watch calculates number of heartbeat times per min. via flashing of the LED lights hundreds of times every sec., thus calculating the pulse rate of your heart. The light sensor for pulse measurement supports a range of 30 to 210 pulses per min. In addition, this light of sensor is designed to recompense for low sign levels via increasing the LED of light rate and the sampling rate [12].

4. Conclusions:

There are numerous interventions that influence the quality of the ECG recording process and will indicate to each other in summary the most important of them is the electrical interference. All mobile devices effect on the ECG recording process because overlapping the waves that are sent from the device that leads to addling on the ECG wave recorded so the patient should get rid of mobile devices. Also all metals including the ordinary or digital clock because they effect there adding wave on the ECG due to the interference of the waves.

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