

Causal attributions, perceived benefits and morbidity after a heart attack: Modification of a new medicine and detection communicational smart system

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The beat was stifled in a state of trauma; the flow was snarled in a narrow tube; and the heart was completely dysfunctional. Until that moment, 1.6 million people in Egypt were suffering from heart diseases. Trying to raise our level of consciousness and visualize that problem from various perspectives, we came up with the solution. Firstly, leave the room to explain the problem itself. Clearly, we tried to perceive communication by considering the molecular interactions in the vital biological activities. Indeed, heart disorders have become an exacerbating grand challenge for Egypt. Heart disorders represents 51.75% of the notable disorders in Egypt. One of the predominant heart diseases is heart attack. The danger of the disorder underlies in the ensuing strokes and the total dysfunction of lungs. As enacted by the GMC, the death toll emanated from heart attack has reached 25% and the odds are increasingly hiking. Furthermore, 40% of the total deaths by the disease took place due to the considerable delay time till an effective treatment. All these facts triggered our minds to establish their own solution that will destroy such tragedies. Goring through the project, you will find how we could implement our test plan to prove our scientific hypothesis, and test the design requirements associated with it in order to obtain a reasonable bunch of findings. By setting the tests, we proved the rightness of the hypothesis, measured the accuracy and the different factors affecting it. As a result, we managed to exploit ECG readings to detect heart attack before erupting by error percent of 7.1%, provide a reasonable heart status for the patient, and even maintain their heart function in 67 seconds using intravenous oxygen. In addition, we have utilized the drugs verapamil and nifedipine to vasodilate the coronary artery as a treatment. Simply, we have emancipated the previous choked flow to fix its stifled state!

The paper consists of two sections. The first discusses systems for detection of heart attacks using Electrocardiogram monitoring system.

The other discusses the long-term treatment of heart attacks using calcium channel blockers to vasodilation the walls of the coronary artery.

Indexing Terms / Key words

Electrocardiograph – Intravenous Oxygen - Calcium Channel Blockers – Blood Clotting

Academic discipline and sub academic disciplines

Biology; Medical science; pathology; Heart-related disorders

Subject Classification

Natural science; library of medicine

Type (method/approach)

Biology Inquiry; Quasi-Experimental; medical-based hypothesis

1. Introduction

Setting up a strongly-founded communicative system is an interdisciplinary scientific task. That's due to the need to envisage the grand challenge associated with the mechanism enclosed in it. Really, scrutinizing the disorder of heart attack required us to surf for the previous solutions conducted for the sake of combating it beside the design requirements that weren't attained at the past. The National Health Service claims that 33% of the disorder victims comes from the delay time till detecting the onsets of the clot formation. Considerably, we've designed a medical bracelet to be associated with an ECG sensor programmed by a microcontroller to compare the heart function of the patient and predict whether a clotting is about to form. To maintain the efficiency of the bracelet, we've tested its energy consumption beside how flexible and wearable it is. The previous treatment for heart attack had ranged from drugs or even a surgical intervention done by general practitioners. However, the therapy using these kinds of drugs (ex. morphins or anticoagulants) increase the delay time until a considerable clot dissolving can be obtained beside keep the patient susceptible to fatal disorders

like angina or kidney failure. Pertaining to the surgical intervention, some operations like heart bypass surgery takes place. Nevertheless, this operation needs an expert, and requires much time.

Taking the indicated points into consideration, we've defined our solution in terms of the design requirement for it to be effective: cost, efficiency, and time. All of those factors trimmed with a directed biological learning transfer in neurology, a well-tested plan, easily obtained materials and smoothly identified methods have hiked our interpretation for the project and gave others an aid to conduct it.

1.1 Communicational System to detect Heart Attack

Outdated detection systems: - The previous epigram associated with the disorder had collaborated to a great deal of the disappointing death toll. This delay time typically affects the medical status for the patient due to the exacerbating growing of cholesterol and bloody clotting in the **coronary artery** which prevents a proper volume of blood to reach the **pulmonary artery**.

Lilypad based ECG: - This electronical approach will feed the patient with complete medical map regarding their heart status, whereby this will alert the patient while any abnormal function of the heart.

1.2 Methodological approach for the therapy obtained

Calcium channel blockers slow your heart rate and lower your blood pressure. Calcium channel blockers slow your heart rate by blocking the number of electrical impulses that cause the heart muscle to contract and pump blood. Calcium channel blockers help lower your blood pressure by relaxing the muscle tissue in your blood vessels. This makes it easier for blood to flow through the vessels. The table below shows **some notable Drugs**.

Generic Name	Brand Name
amlodipine	Norvasc
diltiazem	Cardizem, Dilacor, Taztia, Tiazac
felodipine	
nifedipine	Procardia
nisoldipine	Sular
verapamil	Calan, Verelan

2. Displayed Test Plans

2.1 Determining ECG sensors accuracy and Oxygen delivery rate

Steps:

1. Collect the medical returns (heart rate status) and the numerical values associated with a patient's heart.
2. Compare those values to the heart profile of the patient conducted in the hospital as long as the co-factors are nearly the same.
3. Stimulate the oxygen system after applying the intravenous oxygen
4. Monitor the change in the color of the Blue Bottle Solution.

Pass Criteria:

- ✓ Results garnered in both cases reproach one another.
- ✓ The color changes to blue, indicating the increase of dissolved oxygen.

The change in color can be traced back to the reducing effect of glucose on the Methylene Blue in the alkaline solution.

2.2 Investigate effect of: The patient's size and the age of the patient

Steps:

1. Apply the ECG sensor to two patients with different mass in nearly the same factors that affect the heart function
2. Demonstrate the two reading according to the varied masses
3. Apply the previous points on two patients: one with a normal hemoglobin level, and another with Anemia (low hemoglobin level)
4. Repeat step 1. But, instead, use the ECG sensor to feed the heart readings for a child, an adult and a man
5. For all of the steps, inject the patient with a medical-oriented amount of intravenous oxygen injection.

Pass Criteria:

- ✓ The readings exhibit a uniform trend from which we can infer the relationship of each factor on the ECG.
- ✓ The unit gram of the patient with the lower mass is worth more energy. Thus, the body will need more amount of oxygen to reach the organs: the thing that will increase the heart function.

- ✓ The body accommodate with low-hemoglobin sufferers by increasing the blood flow detected by the sensor.

The normal child exhibits a high heart rate than adults. Moreover, the readings of heart rate of adults will be more than healthy men. In all cases, the ECG sensor should be oriented with the medical status of the patients. Accuracy can be maintained if the ECG readings tolerate with the predicted results.

2.3 Investigate the effect of artery diameter on the blood flow and dissolving the blood clot

Steps:

1. Prepare solution with nearly same viscosity as blood.
2. Pump the solution into a tube blocked with a lump, (simulating a blood clot in coronary artery)
3. Compare the blood initial velocity with the flow velocity.
4. Calculate the time required to dissolve the lump.
5. Repeat the steps with different tube diameters.

Pass Criteria:

- ✓ The speed decreases with the increasing diameter.
- ✓ The clot dissolves in short time.

2.4 Power Efficiency of the system Pass Criteria:

Steps:

1. Connect the Arduino power source to a battery, with Ammeter connected in series.
2. Power on the system.
3. Collect data about consumed current intensity during the different phases of the process.

3. Results and Analysis

After constructing the prototype and designing the test plan, we conducted our experiments. The test plan was carried out as specified in the Methods section. To be brief, the results can be summarized in:

•The prototype worked with:-

- A percentage error of $\pm 7.1\%$
- Experimental oxygen recovery time of about 67 seconds

•Optimal settings would be:

- Age from 15 to 50 (adults and middle-aged men or women)
- The BMI of the patient ranging from 20 to 25 Kg/m^2

3.1 The accuracy of the ECG sensor

To guarantee the accuracy of the ECG sensor, we have identified the parameters associated with the heart maps fed by our sensor compared to others conducted by more accurate hospital devices. Indeed, the ECG electrodes are more accurate for the customer usage than photoplethysmography PPG. ECG is both non-invasive and widely available. However, PPG constitutes another means of determining the timing of cardiac cycles via continuous monitoring of changes in blood volume in a portion of the peripheral microvasculature. Being a little bit complex in usage (which violates our flexibility design requirements) kept it a non-preferable method for monitoring the heart function.

First Feedback: The readings were nearly reproaching similar numerical values. Additionally, We measured the rate at which the intravenous oxygen will flow in a concentration akin to that of the blood. To test this, we have made a solution with an indicator that changes its color according to the oxygen concentration. The next figure illustrates the color change.

Parameters	ECG sensor applying (seconds)	Hospital Electrocardiogram (seconds)
PR interval	0.13	0.14
PR segment	0.1	0.09
QT interval	0.43	0.40
ST segment	0.07	0.08
QRS complex	0.13	0.12

Second Feedback: changing of the color to blue indicates a surge in oxygen concentration in the solution. In the experiment, the change in color was traced back to the reducing effect glucose on the Methylene Blue in the alkaline solution.

3.2 Optimal medical settings

Identifying an optimal reading for the ECG sensor is related how its value comparable to a value conducted by a more effective medical device. We have indicated our optimal settings depending on the BMI and the age of the patient. This test is a business step for us to convince any customer with our project and determine the kinds of patients who are advised not to utilize the medical bracelet and other negative performance results.

3.2.1 Displayed Quantitative medical approach

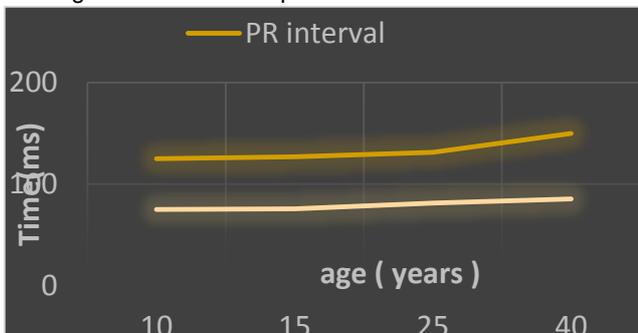
The readings exhibit a uniform trend from which we can infer the relationship of each factor on the ECG.

The unit gram of the patient with the lower mass is worth more energy. Thus, the body will need more amount of oxygen to reach the organs: the thing that will increase the heart function. The Table below illustrates this relation.

BMI (Kg/m^2)	PR interval (milliseconds)	QRS duration (milliseconds)
21.52	135.4	78.0
27.2	148.3	77.3
28.6	152.0	76.4

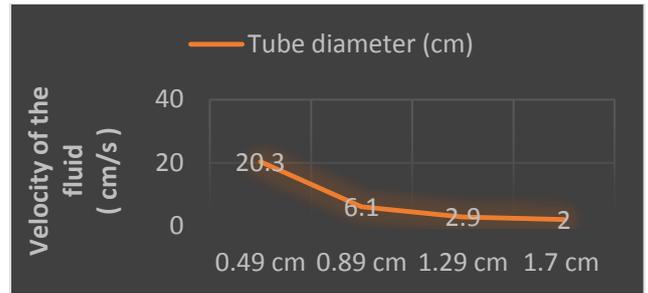
3.2.2 Aging and the observed cardiovascular function

The normal child exhibits a high heart rate than adults. Moreover, the readings of heart rate of adults will be higher than healthy men. In all cases, the ECG sensor should be oriented with the medical status of the patients. Accuracy can be maintained if the ECG readings tolerate with the predicted results.

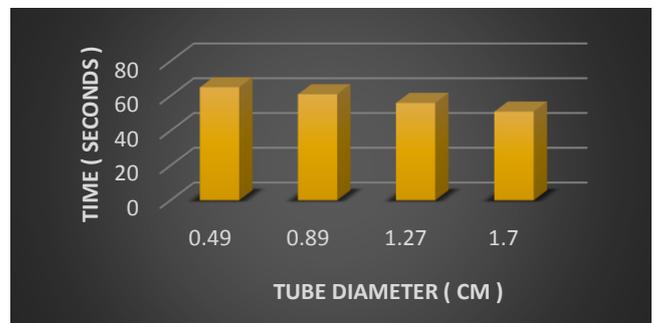


3.3 Mechanism of vasodilating the coronary artery

First Feedback: It seems that the diameter is associated with the velocity of the liquid inside the tube. Physically, Bernoulli equation governs this relation. The chart below had been extracted after setting a cholesterol clotting in 4 tubes with various diameters. A blood mimicking fluid BMF was applied to the tube with a velocity equals to 20.3 cm/s (the normal blood velocity in the coronary artery) The clot was roughly blocking half of the diameter of the tube, and the time taken to dissolve the clotting for the 4 cases has been indicated.



Second Feedback: Using Ca⁺ channels blockers will dilate the blood vessels of the artery. Although this vasodilation will decrease the normal velocity of the blood in the artery, it will increase the rate at which the clotting is dissolved as the volume per unit area will increase. Moreover, decreasing blood velocity will maintain the normal blood pressure (as the clotting typically causes hypertension).



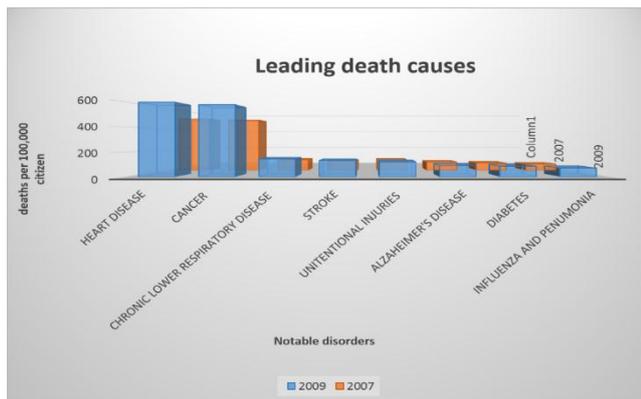
3.4 Power consumption

By connecting an ammeter in series to the Arduino circuit, we managed to get accurate readings illustrating the system's power consumption. By calculating the power consumption from the data of previous figure using the power Equation, we find that the overall power consumption reflects a well-designed circuit and suitable choice of electronic components. Also, by comparing the power consumption at each voltage, we find that using 12V is more power conservative than other power sources.



4. Analytical approach

The communicative system we have developed copes with a powerful method of grasping one of the most significant challenges facing Egypt, Health. You can figure out how cardiovascular diseases are significant issue from the by-side chart. So, we've applied chemical, biological and even electronic learning outcomes to come up with such a definition for communication beside the methodology for implementing it in a reasonable, strongly-back grounded criteria for attaining Egypt grand challenges.



Based on the previous test plans regarding both the detection and the viable treatment for the disorder, we can scrutinize the preceding data as follows:

Pertaining to the detection angle:

Adults and mid-aged people are advised to use the bracelet. Those settings get a strongly accurate map for their heart rate, and the sensor will alarm them if any clotting is about to erupt. The scientific interpretations for the slight discrepancies between the values of the sensor and other accurate devices of some kinds of patients are handled in the coming points according to our test plan:

A) Children and Newborns are at a relatively significant stage in stabilizing their whole body function. Thus, the respiratory and heart rates are increasing changing. This keep them not advised to use the bracelet due to their changing medical state (negative performance result).

B) The BMI of the patient has a vital role in guaranteeing the efficiency of the sensor. This is because too much fats can change the heart rate, and confuse the sensor whether the change is due to a clot formation. Indeed, the highest portion of heart attack sufferers (as enacted by GMC) settles in patients bearing the optimal medical circumstances identified above. The clot in the coronary artery blocks a proper

blood level to the lungs, the thing that will combat the function of the lungs. Thus, we've applied the Intravenous oxygen.

Intravenous oxygen (short-time oxygen substitute)

This will bolster the heart status of the patient as a proper volume of oxygen will reach the brain. The test plan established data regarding the needed time for the oxygen to dissolve in the fluid (which was about 67 seconds). The infusion time can be calculated with the depicted formula:

$$\text{Hours to infuse} = \frac{\text{Volume} \times \text{drop factor} \left(\frac{\text{gtts}}{\text{ml}} \right)}{\text{flow rate} \left(\frac{\text{gtts}}{\text{min.}} \right) \times 60}$$

Pertaining to the long-term treatment:

1- One of our biological learning outcomes is the physiology of smooth muscles. The smooth muscles of the coronary artery experience contraction mechanisms as the Ca⁺ ions in the sarcoplasmic reticulum binds to the protein calmodulin. By inhibiting the flow of the ions, a relaxation reaction would take place.

2- To initiate the relaxed muscle fibres, we have used some drugs to block the calcium channels. This relaxation will maintain a proper blood delivery for the heart. Moreover, this will decrease the delay time required to dissolve the clotting (as the volume per unit area had increase).

Test 3 of the test plan illustrates this principal.

The utilized Ca⁺ channel blockers are verapamil and nifedipine. Those kinds of drugs feature by the suitable cost beside the limited side effects that may erupt from having them.

1- Those drugs increase the diameters of the blood vessels by about 4.01 mm for every 30 micrograms used from the drugs.

2- The test plan using the tubes has been designed in a way that mimics the normal conditions of the heart. (The tube had the same diameter as the coronary artery and the fluid flew by the same velocity of the blood in the artery)

For every 0.5 cm increase in the diameter of the tube, the velocity of the BMF in it was decreasing by an amount roughly equals 10cm/s.

Moreover, the rate at which the clotting had dissolved was directly proportional to the increase in the diameter.

The concluded values can be extracted from the table below.

Dose quantity	30 microgram	60 microgram	80 microgram
Artery Diameter Increasing	4.01 Mm	7.1 Mm	11 Mm
Blood Velocity	6.1 Cm/S	4.5 Cm/S	2.45 Cm/S
Suspecting Hypotension	Not Susceptible	Hypotension May Erupt	Harmful
Time for the clotting to be dissolved	60 S	58 S	Not Advised To Be Used

5. Conclusion

Adding those together, we can grasp the following: We have designed a communicative system dealing with the human body by considering electronic, biological and even chemical aspects. The electronic part will assist in feeding the patient with a complete medical map regarding their heart function, and alert them before a considerable eruption of heart attack. Then, an injection of intravenous oxygen will be applied. This injection will compensate the dysfunction of the lungs. This powerful mechanism will save the patient from being a victim to a brain stroke. Furthermore, injection of Ca⁺ channels blockers will increase the diameter of the coronary artery (at which the clot had occurred), which will decrease the accumulated blood pressure, and maintain a proper blood level.

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