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Research Article

BATTERYLESS PACEMAKER TECHNOLOGY

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ABSTRACT

Implantable pacemaker is a battery operated real time embedded system which includes software and hardware strategy. As it is placed within the heart by surgery Battery life is an important constraint to extend device lifetime. This methodology seems to be an innovative concept in real time systems. The pacemaker is connected to your heart by one or more wires (fig 1).Tiny electric charges that you can't feel move through the wire to your heart. Pacemakers work only needed. They go on when your heart beat is too slow, too fast or irregular. This paper describes about the battery less technology which mainly depends upon the longevity of the battery.

INTRODUCTION

Pacemaker is just a device for stimulating heart muscle and regulating its contractions. The main aim of using a pacemaker is to cure arrhythmia (one of the major disesase in heart). Arrhythmia is a heart disorder where heart beats too fast, too slow or in irregular intervals. Pacemaker is mainly used to control abormal heart rhythms.

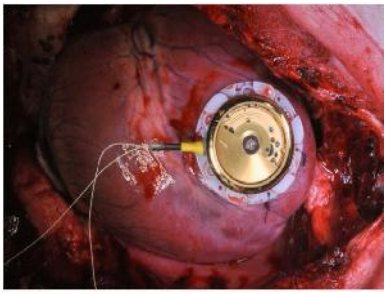

Figure 1

When Arrhythmia occurs, the heart cannot able to pump enough blood that is required for the funtioning of the system. Lack of blood can damage brain, heart and other organs. This mainly causes due to special nerve cells which does not transmit the electric signals properly. Arrhythmia results in heart attack, heart failure and increase in blood pressure. External factors are smoking heavy alcohol and sometimes it becomes unknown. It affects people older than 60. T. Wilson Great batch was the first to invent an cardiac pacemaker. (Fig 2)

Figure 2

The pacemaker's battery lasts seven years needs frequent replacement which results in potential risks. It is a semi-permanent flexible piezo electric nano generator.It is powerd bysmall movements of the body. The energy produced during bending and pushing operations were 8.2v and 0.22mA which was enough to stimulate the heart.

Level 1 Components of a pacemaker

Battery

It is a small, sealed lithium battery that will last for years. The energy from the battery is delivered as tiny electrical impulses that stimulates the heart. It provides power and the lead sends the elctric impulses from the pacemaker to the electrode, which senses each beat of the heart and delivers the electric impulses needed.

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Pulse generator

It contains battery and electronic circuitry. This stimulates the heart and causes it to beat at a normal rythm. Pulse generator is called the hub of pacemaker. It weighs nearly 20 to 30 grams.

Circuitry

It controls the timing and intensity of the impulses delivered to the heart. It is made up of silicon semicondutors.

Case

The battery and circuitry are sealed inside a

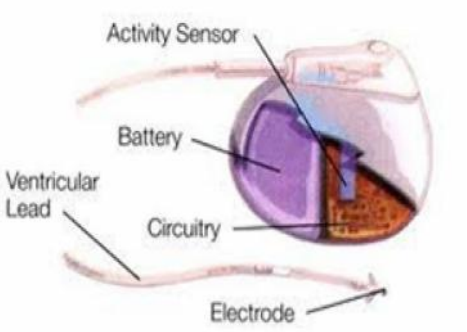

Figure 3 Metal case. Titanium and its alloy are used due its extreme resistance to corrosion.

Connector block: The plastic connector

Which lies on top of the pacemaker's metal case, provides the connection between pacemaker and the leads. (Fig 3)

Leads

Pacemaker leads are thin wires that are inserted through a vein connected to the heart. It is an insulated wire that carries electrical impulses to the heart and carries information about heart back to the pacemaker. One end is connected to the connector block and other end is inserted through a vein and placed in a right ventricle or the right atrium. For a heartbeat of 70 times, it bends 100,000 times a day. Leads are extremely flexible and strong, so that they can withstand the twisting and bending caused by movement of body and beating of the heart. Leads are made up of metal alloy. The ideal characteristics should be inert, non-toxic and sterilizable. Battery and casing are welded by high-powered laser beam. Generator It is powerd bysmall movements of the body. The energy produced during bending and pushing operations were 8.2v and 0.22mA which was enough to stimulate the heart

Level2: Funtioning of pacemaker

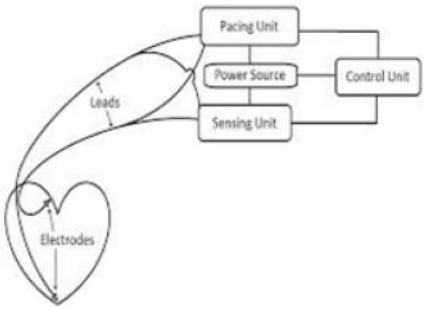

Figure 4

The two main important funtions of a pacemaker are

- Pacing
- Sensing

Pacing: which paces the heart's own rythm that it is interrupted irregular or too slow.

- chamber pacing
- dual chamber pacing

Sensing: It monitor's the heart's natural activity. If it senses a natural heartbeat, it will not stimulate the heart. The electrical impulses are produced by diffusion of calcium, sodium and potassium ions across the membrane of cells in the pacemaker region. The impulse created by the motion of ions is transferred to atria causing them to contract and push blood into ventricles. As impulse move away from each chamber that section relaxes. It is able to do, since it is equipped with sensors that constantly monitor's the patient's heart. (fig 4).

It converts the energy from a beating heart which could provide enough electricity to power a pacemaker. The system worked out in three steps:

Step: 1 Acquiring energy from the heart
Step: 2 Storing energy into the buffer
Step: 3 Buffered energy was used by the pacemaker to apply minute stimuli to the heart.

Experimental setup of a pacemaker

To detect the normal working of a pacemaker they went through some procedures.

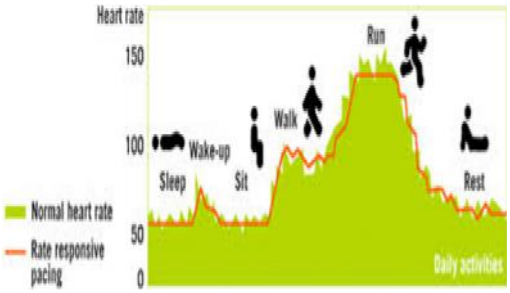

Figure 5

They used 'shaker' to reproduce vibrations which equalize tha rthyms of natural heart beat. The vibrations produced was connected to a prototype cardiac energy harvester. The performance of a prototype was measured based on providing 100 heart beats at various heart rate. It is proved that the energy produced is 10 times more than it is needed to power an pacemaker. It is found that while running, walking or exercises the rate response increases and the energy produced by the heart beat was more than enough to power a pacemaker. (Fig 5)

Level 3: Impact and needs of batteryless technology

The main impact is that they eliminated the need for surgeries for replacing batteries. Since lithium batteries should be replaced every seven to five years, when batteries run out. They become inconvenient and costly. More than 600000 pacemakers are used in day to day life. The use of titanium allowed patients to safely use appliances such as microwave ovens, it helps to shield and reduce external electromagnetic interference. The major impact is due to its longevity. The two

excellent power source for using lithium-iodine battery is that it has low self discharging rate and stable voltage. Since heart beats for 24 hours and 7 days was continous energy and non-interrupted.

Need for pacemaker

The pacemaker was designed to replace the natural pacemaker of the heart. The 'sinus node 'or 'sinuatrial node is the natural pacemaker of the heart.

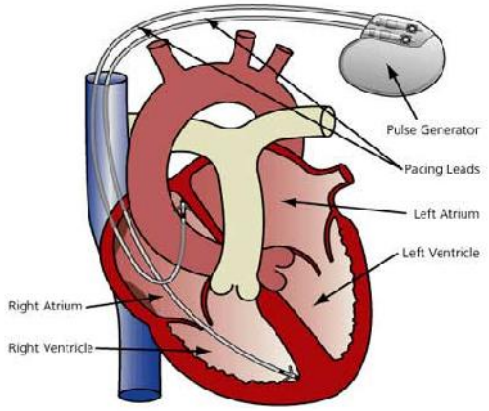

Figure 6

When it is not able to funtion properly, artificial pacemaker takes the role of it. It is able to do so since it always senses the heart beat regularly. If it is does not work properly, it sends electric signals to beat the heart as normal**.** Between 2003 and 2007, 1517 patients receive pacemaker implantation.

Benefits and de-tracts of an pacemaker

This helps the person to live a longer more productive and healthy life. Since the longevity of the battery is increased there is no need of surgeries, which is inconvenient and expensive. The potential benefits of a pacemaker include normalized heart rhythm and improved quality of life. pacemakers depend on varying degrees of cardiac distress which improves the quality of pacemaker.

De-tracts

There are potential side effects and complications associated with pacemaker implantation. If the dysfunction of the conduction system persists, the heart rate can drop to an unsafe range and electrical impulses from the top chambers of the heart may not make it to the bottom chambers, leading to complete heart block. While performing implantation, there is a risk of bleeding. Pacemaker implantation results in infection, where an antibiotic is given by vein to reduce the risk of infection.

CONCLUSION

Advances in technology have resulted in smaller devices with abundant programming options. Battery life will extend to ensure that the lifetime of pacemaker surpassess the life expectancy of patients, eliminating the need for replacement surgery. New rate adaptive sensors will improve the pacemaker's response to patient activity. This paper explains various concepts and step-wise methods for explaining importance

Acknowledgement

This paper explains various concepts and step-wise methods for explaining importance of pacemakers. I wish to express my profound thanks to all those who helped in making this paper a reality.

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