

A Review Paper: Design of ABIOCOR Artificial Heart

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ABSTRACT:

Heart is a vital organ of everyone, which works as a engine inside our body keeping everything inside body running. And if not taken well care of it like an ordinary engine it can break down and pump less effectively called heart failure. Today many people are suffering from the heart problems. To those many heart problem heart transplantation is a way, but patient may not realize that the amount of donor heart in relation to the patient in need of the donor heart is minuscule. Due to lack of reliable option the most recent success is Abiocor artificial heart. In this paper the design and component and importance of each component along with their function of the total artificial heart is presented. Abiocor works and acts as a real natural biological heart and allows the patient to be mobile and free from many restrictions. To increase the life expectancy of heart patient by at least two times the Abiocor artificial heart is designed.

INTRODUCTION:

Even though the artificial hearts design came in 1969, the first permanent heart is a jarvik 7 in 1982. there are many people suffering from heart problems & wants a donor heart to live a long life. But to transplant their heart with a donor heart may not possible with every patient because the number of patient waiting in a need of donor heart is more than that donor heart available. The artificial heart which were invented first in the past were lacking in many aspects such as the material of which it made, The battery and also not allowing patient to move. Due to those lacking aspect on artificial heart, the new method came up by researching for those heart patient i.e. the recent success the Abiocor total artificial heart. The Abiocor system plays same role as that of the natural biological heart & don't make patient to live in many restriction; allow being mobile & also going to the work he taken before having any heart problem. Also the design of the Abiocor heart increases the lifecycle of patient by two times.

The first internal artificial organ is the replacement Abiocor implantable heart which is also the world's first completely self contained. After research of three decades & development & testing, the product comes is an Abiocor artificial heart. The Abiocor maintain the circulatory system & protect

the function of the human biological heart. The Abiocor extends the life of patient who would die due to heart failure as well as gives an adequate life to patient, if any patient not having alternatives for treatments as if any severe damage to natural heart in those cases completely the Abiocor can replace the biological heart.

LITERATURE REVIEW:

Before 200 years ago the artificial circulatory support concept came. Total artificial heart proposed in 1920s. Cardio pulmonary's era bypass dates to 1951, successfully in 1953 by Gibbon. On congenital and acquired defects, the use of heart lungs machine at many hospital allowed an expanding surgical assault. The first artificial heart was implanted into an animal in 1957 at the same time research in artificial internal organ progressed and for human artificial heart research was going on. The National Institute of Health established the artificial heart program to faster both development of artificial heart and other circulatory devices such as VAD, in 1964. The first VAD implanted in patient in 1963 in Houston. It supported the patient post but unfortunately, the patient died, after 4 days of therapy. Again after 4 year, VAD support a patient for aortic valve replacement, after 10 days of support he discharged from hospital. On 4 April 1969 at Baylor, Cooley implanted an artificial heart into a patient which was designed by Domingo Liotta. The external console power was provided to device and which was duel chamber. Until the donor heart secured, it was used for 64 hours. The first use permitting the total artificial heart as a bridge of transplantation, unfortunately patient died due to pneumonia suddenly after one and half day. Again in 1981 a design by Akutsu is implanted in 26 year patient who supported for 55 hours as a bridge for transplantation but due to respiratory and renal infection he died in ten days.

The author T.A. Heimlich and et.al[1] discussed about how the electrical energy transmitted from outside body to the internal component of artificial heart without using any wire connection or without penetrating the skin with the wire, by using electromagnetic waves. The control of the whole artificial heart by using adaptive method of the autonomic nervous signals is described by the author

Suzuki.T and et.al[3] and Wenyu Shi and et. al [4]. The artificial heart uses bidirectional data communication system to communicate between the internal components and the external components. The bidirectional communication between those components is done by using a system which uses ultra high frequency radio wave for an artificial heart is reported by the author Tsujimura.S and et.al[5]. Kustosz. R and et.al[6] provides the concept of the charging and discharging of the backup battery which is situated inside the body below the human skin. The backup battery provides the battery to an Abioor Artificial heart with 1 hour charging providing human to do theirs chores.how the wave energy generated in an artificial heart to do communication is discussed by the author Bohang and et.al[8] in his reaserch paper while how the blood in artificial heart pump and circulate throughout the body of human is given by Min.ByoungG and et.al[8].

IMPLANTED ARTIFICIAL HEART IN HUMAN:

Name of an artificial heart	Year implantanted	Duration	Size
Liotta	1969	64 hours	
Akutsu	1981	55hours	80 ml
Jarvik7-100	1982-92	6 days	100 ml
Phoenix	1985	11 hours	100 ml
Penn st	1985-89	1 day	100 ml
Jarvik7-70	1985-92	11 days	70 ml
Berlin	1986-90	60 days	120L/100R ml
Unger	1986-90	50 days	100 ml
Vienna	1989	18 days	87L/75R ml
BRNO	1998-90	50 days	80 ml
Poisk	1987-90	100 days	100 ml
CardioWest	1993-02	31 days	70 ml
Phoenix7	1998	15 days	100 ml
SynCardia	2002-06	1 year	70 ml
Carmat	2013-14	105 days	70 ml
ABIOCOR	2001	5 year	60 ml

1. DESIGN:

The necessary component of the Abiocor is not complicated, they are simple not decorated & not provided with coating where not necessary with materials. The Abiocor is made of external and

internal component. The internal component placed inside the human body and they are

1.1:Thoracic unit: The thoracic unit is nothing but an artificial heart & its physical appearance is same as that of the natural hearts physical appearance and of same size and shape of the biological heart. It consists of inflow and outflow is made from polyurethane plastic called Angioflex and of titanium. Its weight is about 0.9kg i.e. slightly more than 2 pound. On the position of natural heart the thoracic unit is placed inside the body. It consists of two hydraulic motors. From each ventricle, one keeps the blood pumping while the motion of the four heart valves is operated by other.

1.2:Implanted TET :(transcutaneous energy transmission) is the electrical energy provider to all the internal Abiocor system and is nothing but an electrical coil. The thoracic unit, implanted controller and the implanted battery are connected to it is placed opposite of the artificial heart in upper left part of the chest. It is provided with the ability to adjust to fit inside properly in patient's body. It provides wirelessly energy to the Abiocor system. External TET sends radio waves to it and it converts that wave in electrical energy and provides it to inside system without use of external power connection.

1.3:Implanted controller: It is small sized automatic controller placed in abdomen of patients body .the internal component are connected to it and is placed in titanium case, receiving energy from internal TET. The work of the implanted controller is to look after the Abiocor system and to communicate with PCE and console and to monitor communication of internal component with external component .patient is immediately notified if any problem is detected.

1.4:Implanted Battery: it is placed opposite to the implanted controller in abdomen, which is placed in a titanium case. External TET sends energy to it. Battery pack is being constantly charged by external and internal TET. It provides internal system with energy of 30 to 40 minutes to do works like having shower. It is needed to replace after every one year and for that patient need to go through a minor surgery.

The external component of artificial heart is;

1.5:External TET: It is placed on the internal TET above the skin. It is in the form of a silicon ring connected to the console or the PCE (patient carried electronics).it provides energy to the internal TET either from PCE or from console. If patient is stationary, the power source will be the console and if the patient is mobile the power source will be the PCE. The external TET transmits radio wave which

is enough to penetrate skin and is receive by the internal TET.

1.6: Console: It is a keyboard and a screen containing small computer used to provide power to external and the internal TET. It is plugged into electrical outlet; it uses wireless technology to communicate with controller consisting of antenna sending and receiving command and information respectively regarding internal Abiocor system. By setting off alarm or alarm light, it immediately notified the patient of something goes wrong.

1.7:PCE: (patient carried electronics):if the patients want to be mobile he need to use PCE which plugs the external TET with the PCE control module serving a portable power supply placed inside shoulder bag, The PCE battery bag contains two pairs of batteries.

1.9: PCE battery bag: nearly weighted of 10 pounds and can be carried by shoulder strap. It contain four compartment holding four batteries .outside of bag contains pocket in which patient can placed extra objects.

1.9: Batteries: about 1 hour of power is provided by each pair of battery. These batteries are different from common store batteries. Patient can also take extra batteries if he needed.

1.10: PCE control module: In the packet of PCE battery bag contains a PCE control module, where it is connected to external TET and by cable to battery by battery. It can use power by AC adapter. After getting power it converts the electrical energy to the electromagnetic energy in the form of the radio waves. Thus it provides energy from the external TET to the internal TET.Also checks the status of internal Abiocor system and if any problem occurs notifies to the patient.

CONCLUSION:

Thus the Abiocor consist of internal and the external component. The internal components are those which are located inside the patient's body while the external components are placed outside the patient's body. The external and internal component together work and convert the electrical energy into electromagnetic energy and transform the energy into the human body. All this keeps the Abiocor to pump blood and keep sending that blood throughout the patient's body. Thus the Abiocor is design to bridge the time for transplantation when patient is waiting for donor heart or can permanently replace original biological natural heart with Abiocor if any injury to natural heart occur .

FUTURE SCOPE:

Even though the artificial heart we have today is having the life span 5 years only. May be for future work the heart which can permanently replace heart and will stay longer without having a lifespan for few year. Also along with the large life of artificial heart in future their may come batteries which can stay for whole one days or more than two hour which is now provided by todays Abiocor artificial heart.

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