شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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Mechanical Assist Devices and Artificial Organs in Critically Ill Patients

Essay

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In Intensive Care

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ABSTRACT

Background: Millions of patients worldwide have benefited from technological innovation from biomaterials. Yet, while future keeps on expanding, organ damage keep on filling clinics and lessen the personal satisfaction. Advances in getting illness and tissue recovery joined with expanded availability of current innovation have made new open doors for the utilization of biomaterials in extraordinary manners. There are three general settings in which mechanical circulatory support devices are used: resuscitation, bridge-to- transplant, and postcardiotomy. Resuscitation for cardiac arrest can be handled promptly by mechanical circulatory support in the catheterization laboratory, intensive care unit, or emergency room. Prompt stabilization with assist devices can allow enough time to evaluate the problem fully and proceed to therapy in an informed fashion.

Aim of the Work: The aim of this essay is to discuss the role of mechanical assist devices and artificial organs in improving the outcome of critically ill patients.

Summary: The use of mechanical circulatory support has increased over the past decade for both extracorporeal membrane oxygenation and ventricular assist devices owing to a growing number of devices .

One of the mechanical circulatory support devices is the Intra-aortic balloon counterpulsation which is a temporary method that attempts to create more favorable balance of myocardial oxygen supply.

The intraaortic balloon pump is one of the most frequently placed mechanical circulatory support devices which is used in managing cardiogenic shock, intractable angina and myocardial ischemia.

Recently, the application of extracorporeal membrane oxygenation (ECMO) technology to provide mechanical circulatory support is increasing in an incremental fashion because Maximal medical therapy can no longer be seen as a justifiable end-point treatment.

Keywords: extracorporeal membrane oxygenation, left ventricular assist devices, Renal replacement therapies.

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INTRODUCTION

Millions of patients worldwide have benefited from technological innovation from biomaterials. Yet, while future keeps on expanding, organ damage keep on filling clinics and lessen the personal satisfaction. Advances in getting illness and tissue recovery joined with expanded availability of current innovation have made new open doors for the utilization of biomaterials in extraordinary manners **(Bonventre et al., 2019)**.

There are three general settings in which mechanical circulatory support devices are used: resuscitation, bridge-to-transplant, and postcardiotomy. Resuscitation for cardiac arrest can be handled promptly by mechanical circulatory support in the catheterization laboratory, intensive care unit, or emergency room. Prompt stabilization with assist devices can allow enough time to evaluate the problem fully and proceed to therapy in an informed fashion **(den Uil et al., 2017).**

ECMO (extra corporeal membrane oxygenation) is founded for the administration of dangerous pneumonic or heart disappointment (or both), when no other type of treatment has been or is probably going to be effective. ECMO can be sent in a veno-arterial setup for the treatment of

cardiogenic shock. Veno-venous ECMO is used for respiratory failure. ECMO is also used for neonatal and paediatric respiratory support. Its use in premature neonates is the mainstay of treatment for immature lungs **(Makdisi and Wang, 2015)**.

Trials to build up an artificial liver begun in the 1950. The main purpose of the early artificial liver-support devices is to restore the homeostasis of patients with acute liver failure like hemodialysis in patients with renal failure **(Shen et al., 2016)**.

Renal replacement therapies (RRTs) represent a cornerstone in the management of severe acute kidney injury. In recent years there is great improvemebt in this area of intensive care and nephrology **(Ronco et al., 2015)**.

AIM OF THE WORK

The aim of this essay is to discuss the role of mechanical assist devices and artificial organs in improving the outcome of critically ill patients.

Classification of MECHANICAL ASSIST DEVICES

Introduction:

Technology has no boundary. During the last four decades, a huge revolution has occurred for the electronics industries including biomedical engineering. The most important aspect in biomedical devices is safety and reliability. Around the world there are inclusive regulations, rules and standards which apply to the planning, designing, manufacturing, testing and installation of medical devices **(Tavakoli Golpaygani, 2019)**.

Medical devices are made of electrical, mechanical, or electromechanical parts, such as sensors. There are two sensing systems for biomedical purposes: regular transducers and biosensors. Sensors, transducers and biosensors have a major role in the diagnosis of diseases and in its treatment, from the simple stethoscope or otoscope to advanced image processing or monitoring system **(Ostadfar, 2016)**.

Currently new materials like gold, silica and carbon nanotubes which have unique physical, electrical and chemical properties are used in the development of biosensors with the use of biomolecules derived from cell, bacteria and viruses **(Ince, 2019)**.

Mechanical circulatory assist devices:

There is a great increase in the number of patients with decompensated heart despite of the major advances in treatment methods for heart failure with left ventricular pump dysfunction. Because of a limited number of organ donors available worldwide per year, alternative approaches have been the subject of major research over recent decades like mechanical circulatory support **(Combes, 2017)**.

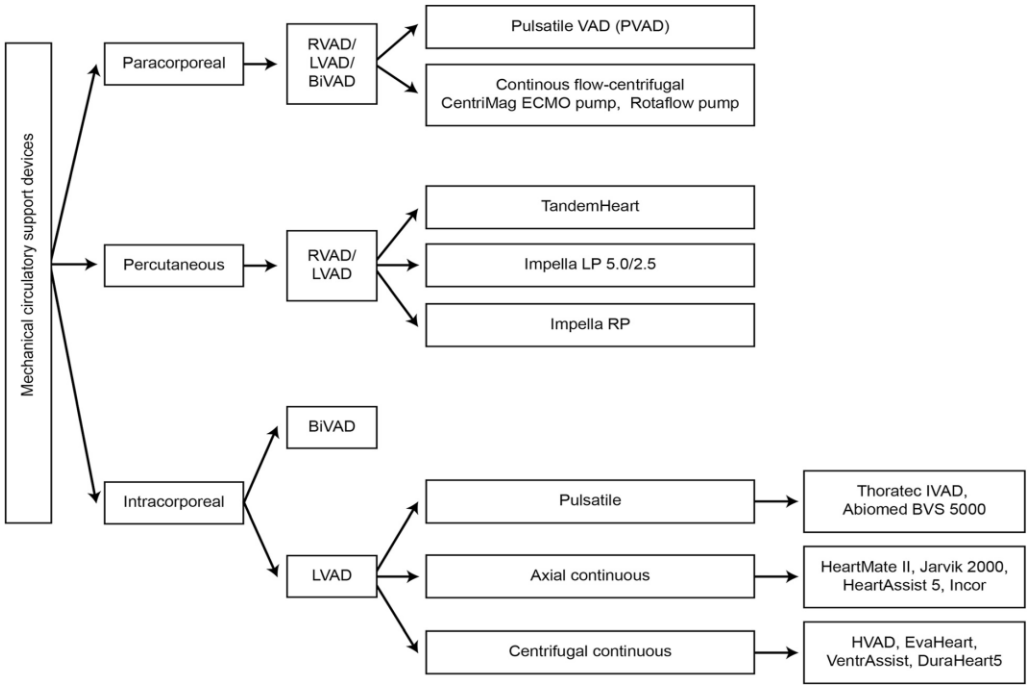

Figure1: Classification of mechanical circulatory assist devices **(Sen et al., 2016)**

The first clinical implantation of a pneumatically-driven ventricular assist-device (VAD) was done by De Bakey in 1966. Since then, collaborative efforts between scientists, engineers and clinicians have resulted in major improvements in the design, biocompatibility and

performance of these machines. There are three Traditional indications or strategies for mechanical circulatory support included bridge-to-bridge, bridge-to recovery of heart function, bridge-to-transplantation and destination therapy **(Combes, 2017)**.

The Total Artificial Heart:

There are many medical problems that may prevent many patients from being capable of using Left Ventricular Assist Devices (LVAD) therapy, including severe heart failure, restrictive cardiomyopathy, arrhythmia, rupture of myocardial wall, allograft rejection or presence of ventricular thrombus. This has created a need for the total artificial heart (TAH) invention due to the availability of limited number of cardiac transplant donors, which in the United States is currently indicated as proceed to transplantation **(Cook et al., 2015)**.

On December 18, 2014 The SynCardia Total Artificial Heart is already FDA-approved as a bridge to a donor heart transplant (the United States Food and Drug Administration). Helping those patients who are at the waiting list for long period **(Arabía, 2020)**.

Intra -Aortic Balloon Pump:

The intra-aortic balloon pump (IABP) is a mechanical device designed to support the ischaemic myocardial failure. It is usually inserted percutane-ously through the femoral arteries, with the tip locates distal to the left subclavian artery. Its function depends on diastolic counterpulsation (augmentation) that inflates at the start of diastole and deflates just before systole. This allows increased coronary perfusion during diastole and also reduces the resistance to forward flow during systole **(Bridgewater and Soon, 2015)**.

IABP leads to reduce cardiac workload and increase supply of oxygen resulting in increased cardiac output. Indications include mechanical complications of myocardial infarction, refractory unstable angina, high-risk cardiac surgery, and support of the failing myocardium before transplantation. Contraindications include aortic dissection, aortic regurgitation and severe peripheral vascular disease **(Bridgewater and Soon, 2015)**.

Extracorporeal Membrane Oxygenation

Extracorporeal membrane oxygenation (ECMO) has been available for decades as a supportive therapy for severe cardiopulmonary disease; however, its early use was distorted by high complication rates and poor outcomes. This problem has solved due to advances in technology which improve complication rates, and an increasing amount of evidence suggesting a potential benefit in select forms of cardiac and