Role of continuous flow Left ventricular assist device in the management of patients with heart failure

Essay

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Ahmed Ibrahim Mohamed Abd El-Aziz

Contents

List of Abbreviations

ACEIs	**:**	Angiotensin-converting enzyme inhibitors
ADH	**:**	Antidiuretic hormone
AF	**:**	Atrial fibrillation
AI	**:**	Aortic insufficiency
ANP	**:**	A-type natriuretic peptide
ARBs	**:**	Angiotensin receptor blockers
ARNI	**:**	Angiotensin receptor neprilysin inhibitor
ARVC	**:**	Arrhythmogenic right ventricular cardiomyopathy
AUS	**:**	Anaemia of undetermined source of bleeding
AVP	**:**	Arginine vasopressin
AvWS	**:**	Acquired von Willebrand syndrome
BNP	**:**	B-type natriuretic peptide
BTC	**:**	Bridge to candidacy
BTD	**:**	Bridge to decision
BTT	**:**	Bridge to heart transplant
CABG	**:**	Coronary artery bypass grafting
CAD	**:**	Coronary artery disease
CCS	**:**	Canadian Cardiovascular Society
CF-LVAD	**:**	Continuous flow left ventricular assist device
CKD	**:**	Chronic kidney disease
CMR	**:**	Cardiac magnetic resonance
CNS	**:**	Central Nervous System

CPAP	**:**	Continuous positive airway pressure
CRP	**:**	C-reactive protein
CRT	**:**	Cardiac resynchronization therapy
CTA	**:**	Computed tomography angiography
CTGF	**:**	Connective tissue growth factor
DCM	**:**	Dilated cardiomyopathy
DHA	**:**	Docosahexaenoic acid
DLI	**:**	Driveline infection
DT	**:**	Destination therapy
ECLS	**:**	Extracorporeal life support
ECM	**:**	Extracellular matrix
ECMO	**:**	Extracorporeal membrane oxygenation
EMA	**:**	European Medicines Agency
EPA	**:**	Eicosa-pentaenoic acid
EPPY	**:**	Event per patient year
GIB	**:**	Gastrointestinal bleeding
HCM	**:**	Hypertrophic cardiomyopathy
HDL	**:**	High-density lipoprotein
HF	**:**	Heart Failure
HFmrEF	**:**	Heart failure with mid range ejection fraction
HFpEF	**:**	Heart failure with preserved ejection fraction
HFrEF	**:**	Heart failure with reduced ejection fraction
HPA	**:**	Hypothalamic pituitary adrenal
HRV	**:**	Heart rate variability
HTx	**:**	Heart transplantations

IABP	**:**	Intra-aortic balloon pump
ICDs	**:**	Implantable cardioverter-defibrillator
ICER	**:**	Incremental cost effectiveness ratio
IHD	**:**	Ischemic heart disease
INR	**:**	International normalised ratio
INTERMACS	**:**	Interagency Registry for Mechanically Assisted Circulatory Support
LBBB	**:**	Left bundle branch block
LDH	**:**	Lactate dehydrogenase
LV	**:**	Left ventricular
LVAD	**:**	Left ventricular assist device
MCS	**:**	Mechanical circulatory suppor
MI	**:**	Myocardial infarction
MMP	**:**	Matrix metalloproteinase
MRAs	**:**	Mineralocorticoid-aldosterone receptor antagonists
n-3 PUFAs	**:**	n-3 polyunsaturated fatty acids
NOACs	**:**	Non-vitamin K antagonist oral anticoagulants
NPs	**:**	Natriuretic peptides
OMT	**:**	Optimal medical therapy
OSA	**:**	Obstructive sleep apnea
PDE3	**:**	Phosphodiesterase 3
PPV	**:**	Positive pressure ventilation
PS-PEEP	**:**	Pressure support positive end-expiratory pressure
PT	**:**	Pump thrombosis

QALYs	**:**	Quality-adjusted life-years
RAAS	**:**	Renin–angiotensin–aldosterone system
RCTs	**:**	Randomized controlled trial
ROS	**:**	Reactive oxygen species
RVF	**:**	Right ventricular failure
SAVE	**:**	Survival AfterVenoarterial ECMO
SDB	**:**	Sleep disordered breathing
SNS	**:**	Sympathetic nervous system
STEMI	**:**	ST-elevated MI
sTNFR	**:**	Soluble tumor necrosis factor receptor
SVR	**:**	Systemic vascular resistance
TAH	**:**	Total artificial heart
TET	**:**	Transcutaneous energy transfer
TGF-β_1	**:**	Tissue growth factor-beta1
TNFα	**:**	Tumor necrosis factor-α
VCE	**:**	Video capsule endoscopy
vWF	**:**	Von Willebrand factor

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Introduction

Heart failure is a challenging disease that ranges from patients who do well for many years with oral therapy to patients who require cardiac transplantation. For patients with advanced heart failure, multiple options are now available, including inotrope support (both inpatient and outpatient), cardiac transplantation, and long-term mechanical circulatory support (MCS) (***Joseph et al., 2016).***

Heart transplantation remains the definitive therapy for patients with advanced heart failure; however, owing to limited donor organ availability and long wait times, continuous-flow left ventricular assist devices (CF-LVADs) have become standard therapy for the management of advanced heart failure both for patients who will eventually receive a transplant (bridge to transplantation) and as an option for those who may not qualify for transplant but qualify for long-term MCS (***Feldman et al., 2013).***

The concept of using MCS began approximately 85 years ago when Dr Michael DeBakey, then a student at Tulane University, developed the roller pump. This important breakthrough eventually allowed for the development of the first heart and lung bypass machine. The first pulsatile LVAD HeartMate XVE (Thoratec Corp.)

was approved in 1994 as a bridge to heart transplantation and in 2003 was approved for destination therapy ***(DeBakey, 2016).***

The mechanical assist devices were developed to provide patients with advanced heart failure an additional support option prior to transplantation. In the past several years, the indications have been expanded to include use as a bridge to transplantation, as a bridge to decision regarding transplantation, or as destination therapy for those who are not transplantation candidates ***(Starling et al., 2011).***

LVAD use is promising, and has become standard therapy for advanced heart failure as a bridge to recovery, as destination therapy, and as a bridge to transplantation. Questions regarding MCS are shifting from which patients are candidates to receive an LVAD to how to choose the proper LVAD for an individual patient and how to prevent the complications of thrombosis, stroke, and pump failure ***(Joseph et al., 2016).***

Aim of the Work

The aim of the work is to highlight benefits of Left ventricular assist device (LVAD) and its role in the management of left side heart failure.

Pathophysiology of Heart Failure

Definition of heart failure:

HF often occurs as the terminal common pathway of any combination of cardiac conditions that affect the myocardium's productivity. It can be described as the inability of the heart to adequately fill or contract in order to meet the body's metabolic demands (***Jivraj et al., 2014).***

HF is a clinical syndrome characterized by typical symptoms (e.g. breathlessness, ankle swelling and fatigue) that may be accompanied by signs (e.g. elevated jugular venous pressure, pulmonary crackles and peripheral edema) caused by a structural and/or functional cardiac abnormality, resulting in a reduced cardiac output and/ or elevated intracardiac pressures at rest or during stress ***(Filippatos et al., 2015).***

The current definition of HF restricts itself to stages at which clinical symptoms are apparent. Before clinical symptoms become apparent, patients can present with asymptomatic structural or functional cardiac abnormalities [systolic or diastolic left ventricular (LV) dysfunction], which are precursors of HF. Recognition of these precursors is important because they are related to poor outcomes, and starting treatment at the precursor stage may reduce mortality in patients with asymptomatic systolic LV dysfunction ***(Wang, 2003).***

Demonstration of an underlying cardiac cause is central to the diagnosis of HF. This is usually a myocardial abnormality causing systolic and/or diastolic ventricular dysfunction. However, abnormalities of the valves, pericardium, endocardium, heart rhythm and conduction can also cause HF (and more than one abnormality is often present). Identification of the underlying cardiac problem is crucial for therapeutic reasons, as the precise pathology determines the specific treatment used (e.g. valve repair or replacement for valvular disease, specific pharmacological therapy for HF with reduced ejection fraction (EF), reduction of heart rate in tachycardiomyopathy, etc) (***McMurray, 2015).***

Overview of HF Pathophysiology:

Myocardial damage regardless of etiology can cause a decrease in cardiac output, which stimulates a cascade of events dictated (mainly) by the sympathetic nervous system (SNS) and the renin–angiotensin–aldosterone system (RAAS) in order to restore cardiac output and supply enough oxygen to meet the increasing demands The main pathological alterations preventing the heart from functioning properly, thereby causing HF, are decreased preload, increased afterload, and reduced contractility/force of contraction that insufficiently pumps blood to the periphery. The most common cause of left ventricular systolic dysfunction is end-stage coronary artery disease,