Ain Shams University
Ain Shams Faculty of Medicine
Anaesthesia & Critical Care Department

Anaesthesia Management for Cardiac Transplantation

An Essay Submitted by

Ali Eissa Mohammad Al-Saffar
LRCP&SI., MB., BCh., BAO.(NUI), Msc (Healthcare Management-RCSI)
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Supervised By

Prof. Dr. / Fikry Fouad Ahmed El-Bokl

Prof. of Anaesthesia & Critical Care
Faculty of Medicine – Ain Shams University

Dr. / Waleed Abd El-Mageed Mohammed Al-Taher

Assisst. Prof. Anaesthesia & Critical Care
Faculty of Medicine – Ain Shams University

Dr. / Mohammed Sayed El-Shorbagy

Lecturer of Anaesthesia & Critical Care
Faculty of Medicine – Ain Shams University

Faculty of Medicine
Ain Shams University
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LIST OF ABBREVIATIONS

ACC	American College of Cardiology
ACE	Angiotensin Converting Enzyme
ACT	Activated Clotting Time
AHA	American Heart Association
AMR	Antibody-Mediated Rejection
APTT	Activated Partial Thromboplastin Time
ARDS	Acute Respiratory Distress Syndrome
ASA	American Society of Anesthesiologists
AV	Atrioventricular
BIVAD	Biventricular Assist Device
BP	Blood Pressure
BVAD	Biventricular Assist Device
CABG	Coronary Artery Bypass Graft
cAMP	cyclic Adenylate Monophosphate
CAV	Coronary Allograft Vasculopathy
CHF	Congestive Heart Failure
CI	Cardiac Index
CK	Creatine Kinase
CK-MB	Creatine Kinase-MB
CMV	Cytomegalovirus
CNI	Calcineurin Inhibitor
CNS	Central Nervous System
CO	Cardiac Output
CPB	Cardio Pulmonary Bypass
CPCAST	Clinical Practice Committee of the American Society of Transplantation
CRT	Cardiac Resynchronisation Therapy
CSA	Cyclosporine
CVL	Central Venous Line
CVP	Central Venous Pressure
CVVHF	Continuous Veno-Venous Haemofiltration
DDAVP	1-Desamino-8-D-Arginine Vasopressin
DDDR	Dual-mode, Dual-pacing, Dual-sensing (pacemaker)
EBV	Epstein–Barr Virus

ECG	Electrocardiogram
ECMO	Extra Corporeal Membrane Oxygenation
ED	Erectile Dysfunction
EMB	Endomyocardial Biopsy
ESC	European Society of Cardiology
ESHD	End-Stage Heart Disease
ETT	Endo Tracheal Tube
FEV1	Forced One-Second Expiratory Volume
FiO2	Fraction of Inspired Oxygen
FT3	Free Triiodothyronine
FT4	Free Thyroxine
GFR	Glomerular Filtration Rate
GGT	Gamma-glutamyl transferase or Gamma-glutamyl transpeptidase
HAART	Highly Active Antiretroviral Therapy
HF	Heart Failure
HFSA	Heart Failure Society of America
HFSS	Heart Failure Survival Score
HIV	Human Immunodeficiency Virus
HLA	Human Leukocyte Antigen
HVAD	HeartWare Ventricular Assist Device
i.v.	Intravenous
IABP	Intra-Aortic Balloon Pump
ICD	Implantable Cardioverter Defibrillator
ICU	Intensive Care Unit
IJ	Internal Jugular
INR	International Normalized Ratio
ISHLT	International Society for Heart and Lung Transplantation
ITP	Intrathoracic Pressure
IV	Intravenous
IVAD	Intracorporeal Ventricular Assist Device
IVUS	Intravascular Ultrasound
LA	Left Atrium
LAP	Left Atrial pressure
LVAD	Left ventricular Assist Device

LVEF	Left Ventricular Ejection Fraction
MAC	Minimum Alveolar Concentration
MAP	Mean Arterial Pressure
MCS	Mechanical Circulatory Support
MMF	Mycophenolate Mofetil
N_2O	Nitrous Oxide
NHS	National Health Service
NO	Nitric Oxide
NPO	Nil Per Os
NYHA	New York Heart Association
OT	Operating Theatre
PA	Pulmonary Artery
PAC	Pulmonary Artery Catheter
PaO2	Partial Pressure of Oxygen in Arterial blood
PAP	Pulmonary Arterial Pressure
PAVR	Pulmonary Artery Vascular Resistance
PCO2	Carbon Dioxide Partial Pressure
PCWP	Pulmonary-Capillary Wedge Pressure
PDE	Phosphodiesterase
PEEP	Positive End-Expiratory Pressure
PRA	Percentage (or Panel) of Reactive Antibody
PRES	Posterior Reversible Encephalopathy Syndrome
PTLD	Post-Transplant Lymphoproliferative Disorder
PTT	Prothrombin Time
PVAD	Paracorporeal Ventricular Assist Device
PVR	Pulmonary Vascular Resistance
RBC	Red Blood Cell
RV	Right Ventricle
RVAD	Right Ventricular Assist Device
SaO2	Oxygen Saturation
SVC	Superior Vena Cava
SvO2	Mixed-Venous Oxygen Saturation
SVR	Systemic Vascular Resistance
T3	Triiodothyronine
TAC	Tacrolimus
TEE	Transesophageal Echocardiogram

TOR	Target Of Rapamycin)
TPG	Transpulmonary Gradient
TPZ	Thromboplastin Time
TSH	Thyroid Stimulating Hormone
UK	United Kingdom
UNOS	United Network for Organ Sharing
VAD	Ventricular Assist Devices
VAS	Ventricular Assist System
VF	Ventricular Fibrillation
VO2	Volume of Oxygen utilization
VT	Ventricular Tachycardia
FDA	Food and Drug Administration in USA

CHAPTER 1
Introduction

Cardiac transplantation is the surgical placement of a healthy heart from a human donor into the body of a person whose own heart is badly diseased. The procedure is also referred to as orthotopic cardiac graft **(Columbia Surgery, 2012).**

Heart transplantation is a widely accepted therapy for most patients under 65 years of age with advanced heart failure who remain symptomatic with the expectation of high intermediate term mortality, despite optimal heart failure medications. Heart transplantation should be reserved for those patients most likely to benefit in terms of both life expectancy and quality of life. Over years of experience, heart transplantation has been the most scrutinized and intensively studied therapy for advanced heart failure **(Erbasan *et al*, 2008).**

The incidence of heart failure has dramatically increased. It is estimated that at least 400 000 new cases of heart failure are diagnosed each year. Despite the advances in management, heart failure is the principal cause of 40 000 deaths and a contributing factor to another 250 000 deaths each year **(Costanzo *et al*, 1995).**

The donor shortage, which limits heart transplants in the

world to 5000 procedures per year **(Taylor *et al*, 2009)**, underscores the alarming discrepancy between the number of patients with heart failure who might benefit from transplantation and those fortunate enough to receive a suitable donor organ. These facts make it imperative to restrict the option of transplantation to those patients with the greatest need and who are likely to derive the maximum benefit from transplantation. In the absence of contraindications to transplantation, the choice of recipients from a pool of critically ill patients who require frequent hospitalization for parenteral medical therapy or mechanical circulatory support or who have refractory ventricular arrhythmias **(Costanzo *et al*, 1995).** Most of these patients have an expected 1-year survival less than 50% with current medical therapy and have severe reduction of quality of life secondary to cardiac symptoms that cannot be relieved with non-transplant therapy **(Kirklin *et al*, 2004).**

Although heart transplantation is a standard surgical procedure since decades, it remains a challenge for the cardiac anaesthetist as it requires a sophisticated monitoring and management of circulation, ventilation and homeostasis **(Koster *et al*, 2011).** The consequences of autonomic denervation of the heart should be remembered in the post-cardiopulmonary bypass period, and during any subsequent anaesthetic in transplant recipients. A major cause of morbidity and mortality in this population is related to infection due to

immunosuppression. Accordingly, special attention is needed in this area with wide implementation of strict aseptic techniques **(Westerlind, 1999).**

The better understanding of immune mechanisms in allograft rejection and development of reliable, non-invasive diagnostic studies will permit more frequent evaluations, early detection of rejection, and for effective monitoring of therapy outcomes **(Bethea *et al*, 2003; Erbasan *et al*, 2008).**

The development of new immunosuppressive treatment regimens, improved postoperative follow-up care management and new donor organ preservation and transport systems, dramatically improves survival rates for heart transplant recipients. Recent data from the International Society for Heart and Lung Transplantation (ISHLT) registry have shown that the overall graft half-time (time at which 50% of those transplanted remain alive) has been increasing steadily, reaching over 10 years **(Erbasan *et al*, 2008).**

In the short term, the future of heart transplantation is sound especially with successful immunosuppression, reduced side effects, and the promising use of genomics to assist in personalized therapy for specific patients based on pharmacogenetic polymorphisms. In the future, advances in mechanical circulatory support (MCS) devices, stem cell therapy, organ engineering and medical management may decrease or avoid the need for heart transplantation. Eventually,