18th International Congress of Anesthesiology, Critical Care and Pain

Anesthesia for non-cardiac surgery in cardiac transplant recipient

18–20 November 2026 · Tehran, Iran · From Innovation to Resilience

Introduction:

- The annual heart transplant rate is gradually increasing worldwide.

- Globally, 1% of patients with end-stage heart disease are managed with heart transplantation (HT), with roughly 5000 patients receiving heart transplants each year, 3000 of which are performed in the United States.

- With increasing survival, more HT recipients than ever are requiring non-cardiac surgery, with 15% to 47% of patients requiring post-HT procedures.

Introduction:

- A proportion of this patient population present for an elective or emergency surgery which may or may not be related to the transplanted heart.

- A thorough understanding of the physiology of denervated heart, post-transplant morbidities and pharmacology of immunosuppressants is essential for best perioperative management and improved post-operative outcome.

Case presentation:

- A 32-year-old male patient with a history of Dilated cardiomyopathy(DCM) had a heart transplant 8 years ago.

- Post-transplant course was normal until he presented with Right inguinal enlargement without pain.

- Ultrasonography findings revealed Localized swelling consistent with an inguinal hernia.

- The patient underwent herniorrhaphy, spent one day in the intensive care unit, and was then discharged without complications.

01

Physiological Changes in Transplanted Hearts

Dr.Nahid Aghdaii

Physiological changes of the transplanted heart

Changes in Atrial Geometry
Larger right and left atrial **end-diastolic** and **end-systolic volumes**
Larger right atrial **pressure**
Functional **atrio-ventricular valve regurgitation** (tricuspid valve most commonly affected)
Changes in Pacemaker function and Electrophysiology
Resting heart rate 90-110 beats per minute
Blunted **tachycardia response** to physiologic stress
Presence of "*two p-waves*" in **electrocardiogram**
Lack of functional **efferent systemic vaso-motor input**

Physiological changes of the transplanted heart

Changes in Cardiac Function
Preserved **Frank-Starling Mechanism** (normal contractile response to preload)
Heart rate responsive to increased circulating catecholamines
Accentuated **orthostatic hypotension**
Greater **left ventricular mass**
Diastolic **compliance** and **relaxation** abnormal
Lower **maximal heart rate** and **cardiac index** during exercise

Physiological changes of the transplanted heart

Changes derived from Cardiac Denervation
Heart Rate unresponsive to Systemic Blood Pressure changes (**Absent Baroreceptor Reflex**)
Heart Rate unresponsive to **Carotid Massage**
Lack of Heart Rate change to **Valsalva Maneuvers** and **Respiratory Changes**
Slower Heart Rate response to **postural changes**
Lack of **Angina Pectoris** during **myocardial ischemia** (“***silent ischemia***”)

Key Message

Know the transplanted heart,
Individualize the drugs, and
Protect hemodynamic Stability

01

Perioperative Management

Dr.Robab Azizi

Early Post-Transplant Considerations	
Consideration	**Details**
Timing of elective surgery	Defer elective surgery until at least 6–12 months post-transplant.
Identification of acute rejection	Use endomyocardial biopsy, echocardiography, and/or gene expression profiling.
Immunosuppression	Stabilize the immunosuppression regimen.
Comorbid conditions	Optimize control of any comorbid conditions, including those that may be a side effect of immunosuppression.

Late Post-Transplant Considerations			
Monitoring for acute rejection as clinically indicated or in patients with HF symptoms	Coronary angiography every 1-2 years to screen for cardiac allograft vasculopathy	Consider management of cardiac allograft vasculopathy with mTOR inhibitor	Routine echocardiography to monitor for graft dysfunction

Non-Cardiac Evaluation		
Chronic kidney disease (CKD)	Glomerular filtration rate (GFR), spot urine albumin / creatinine ratio, urinalysis	Consider decreasing calcineurin inhibitor therapy
Diabetes mellitus	Fasting serum glucose, Hemoglobin A_1c	Consider decreasing corticosteroid therapy
Hypertension	Blood pressure monitoring and control as in the general population	Recommend empiric use of angiotensin converting enzyme inhibitors or angiotensin receptor blockers if tolerated; consider adjustment of corticosteroid or calcineurin inhibitor therapy
Bone disease	Dual x-ray absorptiometry (DEXA) scans	Recommended during pre-transplant work-up, 1 year post-transplant; subsequent DEXA scans
Lipid management	Statin therapy recommended regardless of cholesterol levels	Statin therapy recommended 1-2 weeks after transplant

Immunosuppression Management in the Preoperative Period			
Overall minimization of immuncsuppression as appropriate	Avoid surgery soon after any rejection episode	Continue oral regimens it possible	Use IV corticosteroids and antiproliferative agents when oral administration is not possible. Caution with IV calcineurin inhibitors
Corticosteroids	**Calcineurin inhibitors**	**Antiproliferative agents**	**mTOR inhibitors**
Consider tapering in first 6-12 months after transplant	Continue Goal trough throughout surgery	Continue regimen throughout surgery	Stop 1 week prior to surgery and resume 10-15 days after surgery
Consider suppressed hypothalamic-adrenal axis if patient on chronic stercid therapy	Check creatinine for renal dysfunction and modify dosing if needed	Check complete blood count for leukopenia / neutropenia, anemis, and thrombocytopenia	Monitor for delayed wound healing, especially in diabetic and bariatric patients

Intraoperative Management and Anesthesia Considerations

Cardiac autonomic denervation	Pharmacology	Hemodynamic physiology	Ventilation
Resting heart rate is 90–110 bpm	Anticholinergics and muscle relaxants lack cardiac effects, but retain extra-cardiac effects	Cardiac graft is preload-dependent	Oral intubation is preferred over nasal due to increased infection risk
Carotid massage and Valsalva maneuvers are ineffective	Consider using isoproterenol for bradyarrhythmias	Careful use of vasodilatory medications (propofol, nifedipine) as reflex tachycardia is not present	Airway manipulation may induce bleeding from gingival hyperplasia
Loss of baroreceptor reflex with tracheal intubation	Digoxin has inotropic effect, but no rate-controlling effect	Consider intraoperative echocardiography or central venous pressure monitoring of hemodynamics	
Patients will often not have chest pain with ischemia	Increased efficacy of adenosine, may cause prolonged heart block	Consider alternatives to spinal anesthesia due to increased potential for hemodynamic instability	Avoid hyperventilation due to lower seizure threshold from calcineurin inhibitors

Postoperative care

- Adequate analgesia, normothermia, and hydration.
- ECG monitoring for arrhythmias
- Maintain adequate preload
- Assure adequate infection prophylaxis
- Re-initiation of immunosuppressant therapy
- Deep venous thrombosis prophylaxis

01

Pharmacology of the transplanted heart

Dr. Yasmin Chaibakhsh

Immunosuppressive agents and interaction with anesthetic drugs

- Prophylactic immunosuppressant therapy represents the basis for prevention of rejection, and the chief component in overall graft survival.

- The fine line between adequate immunosuppression and avoidance of infection is one of the upmost important factors responsible for overall survival after OHT.
- Infection is a predictor of poor outcome (CNS and Lung infection.)

Immunosuppressive agents and interaction with anesthetic drugs

- The commonly used immunosuppressive agents are:
  - Calcineurin Inhibitors (cyclosporine A)
  - Antiproliferative Agents (azathioprine)
  - Antilymphocyte globulin
  - Monoclonal antibodies
  - Corticosteroids.
- Recently, tacrolimus and mycophenolate have replaced cyclosporine and azathioprine, respectively, in some immunosuppression protocols.
- Major side effects of immunosuppressants :
  - Fever, anemia, leucopenia, thrombocytopenia, hypertension, diabetes, renal dysfunction, neurotoxicity, Osteoporosis and anaphylaxis.

corticosteroids:

- The most common immunosuppression combination in the early post transplant period includes corticosteroids plus a calcineurin inhibitor (ie, cyclosporine or tacrolimus) and an antiproliferative agent (ie, azathioprine or mycophenolate).

- Patients receiving more than 20 mg/day of prednisone or its equivalent for more than 3 weeks (as is common during the first 2-3 months after transplant) should be considered to have a suppressed hypothalamic-adrenal axis and are at high risk.

- The hypothalamic-adrenal axis is not suppressed with doses of less than 5 mg/day of prednisone or its equivalent

Calcineurin Inhibitors:

- Over the past decade, tacrolimus has replaced cyclosporine.
- Perioperatively, calcineurin inhibitor trough levels should generally remain unchanged.
- particular attention should be given to postoperative renal function.
- calcineurin inhibitors are nephrotoxic and dose reductions or even temporary cessation can be required.

Table 2: Drugs that interact with cyclosporine A and tacrolimus			
Drug class	**Drug**	**Effect on blood level**	**Intervention[7-12]**
BZP	Diazepam, midazolam, alprazolam, flurazepam and clonazepam	↑ BZP	Consider for BZP dose alteration
Antibiotics	Erythromycin, clarithromycin	↑ cA and T level	Consider substitute (azithromycin)
	Co-trimoxazole, metronidazole, norfloxacin, levofloxacin		Monitor cA and T concentration and adjust the dose
Antimycobacterial	Rifampin	↓ cA and T level	Monitor cA and T concentration
Antimalarial	Chloroquine, mefloquine	↑ cA and T level QTc prolongation in patients with T therapy	Monitor cA and T concentration as well as QTc interval
Antifungal	Ketoconazole, fluconazole, itraconazole and voriconazole	↑ cA and T level QTc prolongation in patients (fluconazole or voriconazole therapy)	Decrease the dose of antifungals by 40%
Anti-retroviral	Ritonavir, atazanavir, darunavir, cobicistat, delavirdine	↑ cA and T level	Monitor cA and T concentration Consultation with retroviral therapist is mandatory
Cardiovascular drugs (antiarrhythmics and CCBs)	Amiodarone, lidocaine, quinidine, verapamil, diltiazem, amlodipine, felodipine	↑ cA and T level QTc prolongation by amiodarone and quinidine↑statin concentration	Monitor cA and T concentration Avoid QTc prolonging agent Avoid simvastatin Avoid using maximum dose of other statins
Statins	Simvastatin, atorvastatin, lovastatin, pravastatin		
Anticoagulants	Apixaban, dabigatran, rivaroxaban	↑ anticoagulant concentration	Monitor for signs of excessive anticoagulation Avoid these anticoagulants in patients receiving cA and T with renal insufficiency
Hypoglycemic	Both sulfonylureas and biguanides	↑ cA level	
GI	Metoclopramide, omeprazole, lansoprazole, octreotide	↑ cA and T level Octreotide with T leads to QTc prolongation	Monitor QTc interval
Hormones	Estrogen and testosterone preparation	↑ cA and T level	
Antipsychotics	Haloperidol, desipramine, fluoxetine, trazadone	↑ cA and T level↑pimozide level	Avoid pimozide if QTc prolongation is present
Others	Bosentan	↓ cA and T level	
	Carbamazepine		

Antiproliferative Agents:

- The 2 antiproliferative agents that are used in cardiac transplant recipients are azathioprine and mycophenolate.

- Mycophenolate has largely replaced azathioprine due to its greater efficacy in preventing acute and chronic rejection as well as lower rates of post transplant malignancy.

- Follow the complete blood count.

- Both azathioprine and mycophenolate are available in IV formulations.

Mammalian Target of Rapamycin Inhibitors:

- These drugs are commonly used as a treatment to delay or prevent the development of coronary allograft vasculopathy.
- The 2 mTOR inhibitors used in cardiac transplantation are sirolimus and everolimus.
- Both of these agents have been noted to lead to impaired wound healing.
- mTOR inhibitors should generally be stopped at least 1 week prior to surgery with resumption approximately 10 to 15 days after surgery

Anaesthetic agent	Resultant effect with immunosuppressants
Inhalational agents Isoflurane	The clearance of oral cA decrease with isoflurane anaesthesia
Thiopentone	Nil
Midazolam	↑ Blood level of BZP
Propofol	Nil
Etomidate	Nil
Muscle relaxants	Most of the muscle relaxants can be used safely
Neostigmine	Neostigmine usually has no effect on transplanted heart
Opioids	Cyclosporine increases the analgesic effect produced by fentanyl
Local anaesthetics	Bupivacaine can be safely used through regional routes

Perioperative Monitoring

01

Dr. Maryam Ghanbari



Standard monitoring

- ECG (Electrocardiographic Monitoring)for ST changes
- NIBP
- SPO2
- EtCO2
- Neuromuscular monitoring
- Tempreture (core & peripheral)
- BIS

Invasive & Advanced Hemodynamic Monitoring

- Arter line(Invasive Arterial Blood Pressure Monitoring)
- CVP (Central Venous Pressure Monitoring)
- HemoSphere / FloTrac (Advanced Hemodynamic Monitoring)
- PAC (pulmonary artery catheter)

Cardiac Function & Organ Perfusion Monitoring

- TEE (Transesophageal Echocardiography)
- TTE (Transthoracic Echocardiography)
- NIRS (cerebral and tissue Oxygenation Monitoring)
- Urine output and End-Organ Perfusion Monitoring

Specific Monitoring Considerations in Heart Transplantation

monitoring	Clinical Status
Compensatory tachycardia may not develop; assess blood pressure and cardiac output.	hypovolemia
Heart rate is not a reliable metric; blood pressure and other clinical indicators are important.	Pain during the procedure .
Pay attention to real-time blood pressure, perfusion, and response to treatment.	hypotention
An ECG and the assessment of ventricular function are important.	Myocardial ischemia
In case of clinical suspicion, echocardiography is helpful.	Graft dysfunction
Continuous ECG monitoring and preparedness for the management of rhythm disturbances are essential.	arrhythmia

FloTrac indication

- A history of heart transplantation alone is not an indication for the use of FloTrac.
- Its selection depends on the patient's cardiac functional status, surgical risk, and the likelihood of hemodynamic fluctuations.
- Situations where its use is more appropriate include:
- Major surgeries with a risk of hemorrhage and volume fluctuations:
- Major abdominal surgeries, such as gastrectomy, hepatectomy, and pancreatectomy
- Major vascular surgeries, such as aortic and aneurysm surgery
- Extensive spinal surgeries
- Major orthopedic surgeries, particularly those involving significant blood loss
- Extensive pelvic surgeries

FloTrac indication

- Long and high-risk surgeries
- Extensive cancer surgeries
- Prolonged urological surgeries
- Complex head and neck surgeries
- Extensive reconstructive surgeries
- Especially if there is a possibility of significant changes in preload, afterload, or cardiac output

FloTrac indication

- Heart Transplant Patient with Cardiac Dysfunction
- In this group, even moderate-risk surgeries may require advanced monitoring:
- Reduced Ejection Fraction (EF)
- Right ventricular dysfunction
- History of, or suspected, rejection
- Cardiac Allograft Vasculopathy
- Pulmonary hypertension
- Heart failure
- Hemodynamic instability or the need for vasoactive medications
- For these patients, in addition to FloTrac, more invasive monitoring or Transesophageal Echocardiography (TEE) may be necessary.

HemoSphere and FloTrac Technology

- The FloTrac system is connected to an arterial catheter and continuously analyzes the arterial pressure waveform.
- Using advanced algorithms, it estimates several important hemodynamic parameters:
- Cardiac Output (CO)
- Cardiac Index (CI)
- Stroke Volume (SV)
- Stroke Volume Variation (SVV)
- Systemic Vascular Resistance (SVR)An important point is that FloTrac estimates these parameters but does not directly measure myocardial contractility or cardiac filling pressures.

Intraoperative Hemodynamic Interpretation

- One of the most important advantages of advanced hemodynamic monitoring is helping us identify the possible mechanism of hypotension.
- three common scenarios:
- Vasodilation If blood pressure decreases, SVR is low, but cardiac output remains relatively preserved, vasodilation may be the underlying mechanism.
- Hypovolemia If stroke volume and cardiac output decrease, accompanied by an increase in SVV, reduced preload and hypovolemia should be considered.
- Graft Dysfunction If cardiac output and cardiac index and SV decrease while SVR increases, impaired cardiac function should be considered.These patterns are suggestive rather than diagnostic and require clinical correlation.


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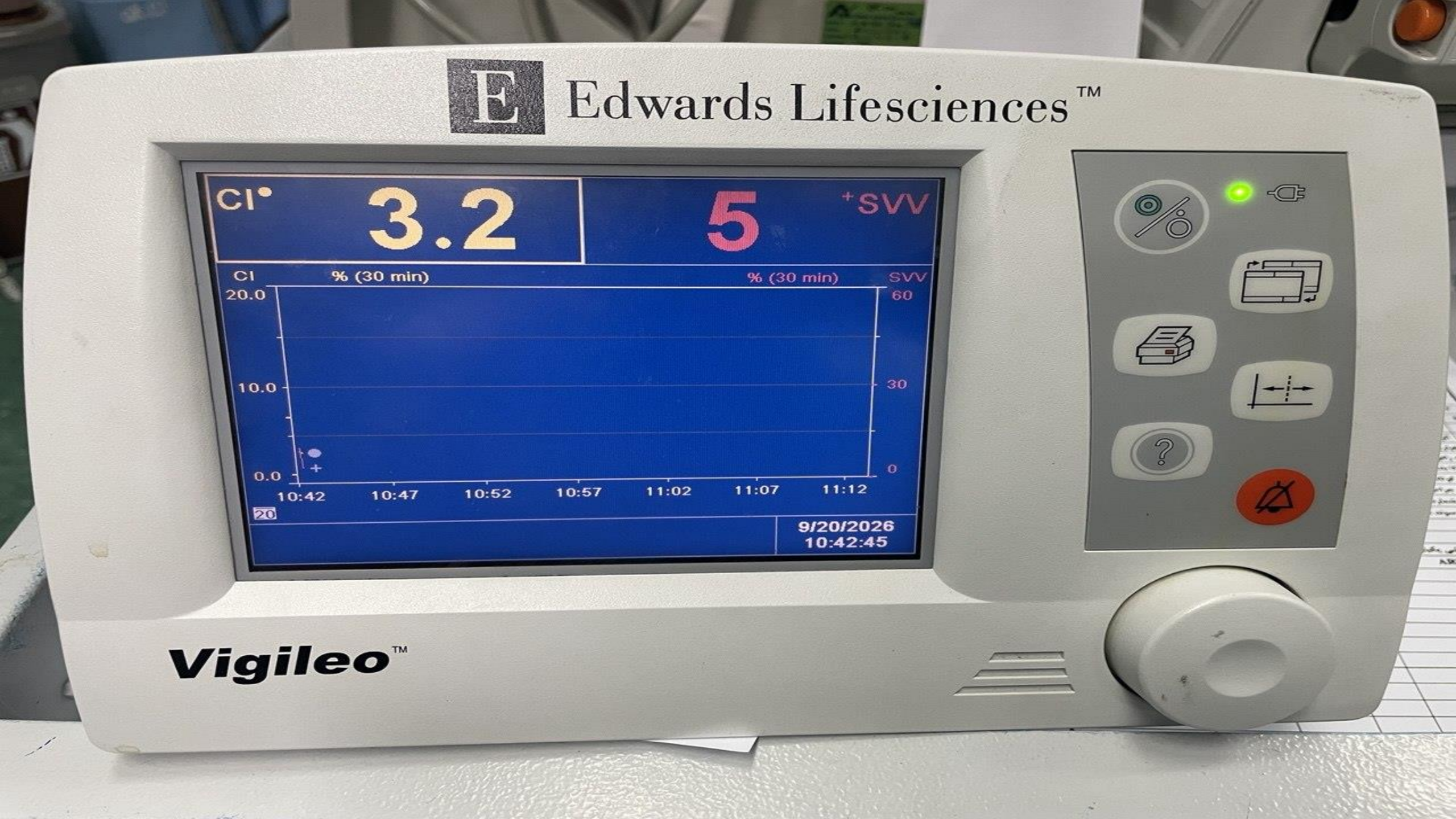
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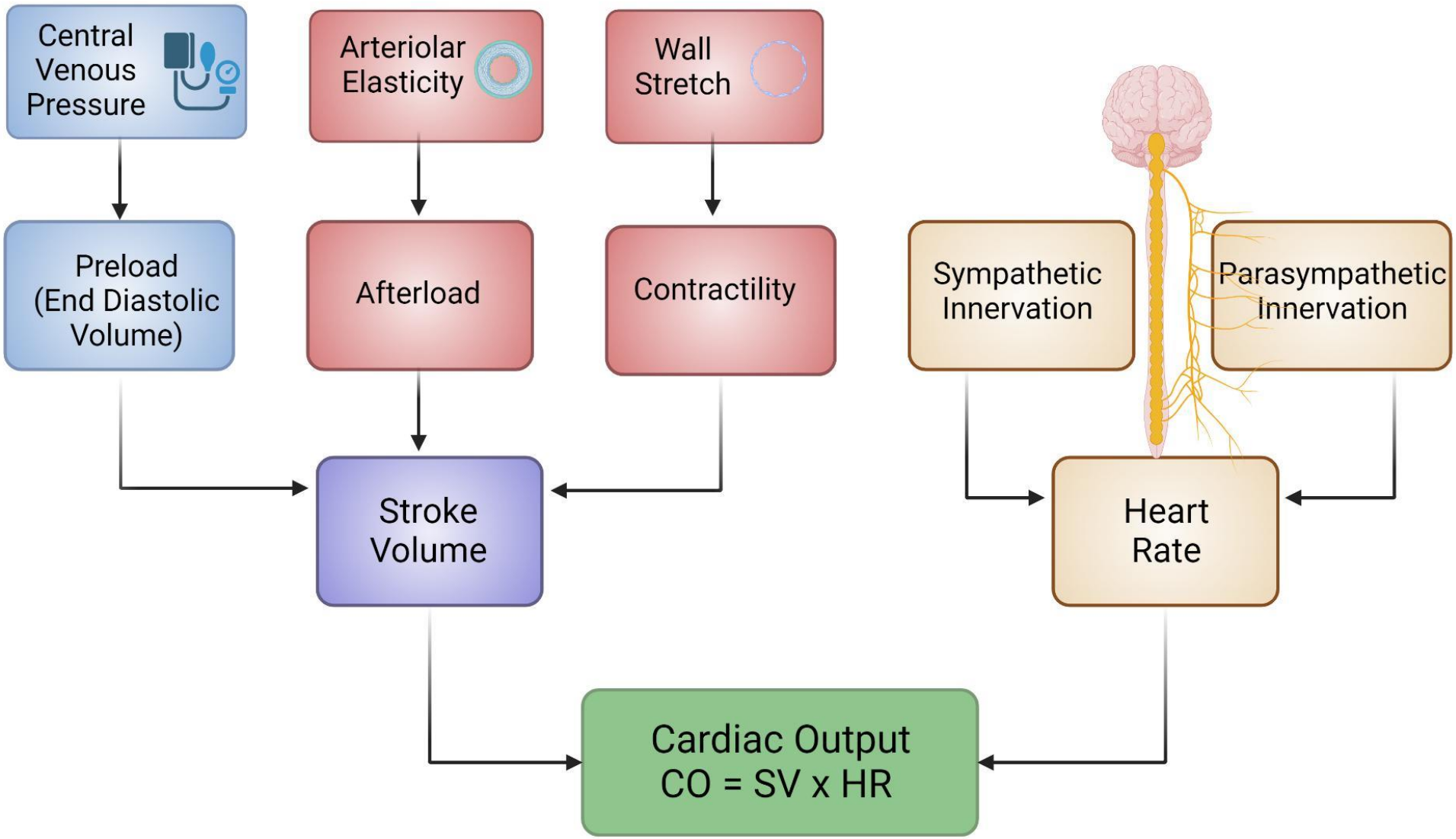
When is FloTrac not an appropriate choice ?

- This is a crucial point, as FloTrac results can be misleading in patients who have undergone a heart transplant.
- Significant limitations include:
- Arrhythmias and irregular heartbeats
- Ventilation with low tidal volume
- Spontaneous breathing
- Open chest (open thoracic cavity)

When is FloTrac not an appropriate choice?

- Increased intra-abdominal pressure
- Severe alterations in vascular tone, particularly vasoplegia and sepsis
- Significant changes in SVR (systemic vascular resistance) resulting from the administration of vasopressors
- A key limitation in heart transplant patients: If the patient experiences impaired vascular tone or drastic changes in vascular resistance, the cardiac output (CO) estimate provided by FloTrac may lack sufficient accuracy. Furthermore, stroke volume variation (SVV) should not be used as the sole basis for fluid administration.

Relationship of Cardiac Output Stroke Volume and Heart Rate



Fluid Management

- Another important consideration is fluid management in heart transplant recipients. Some of these patients have impaired left ventricular relaxation and reduced ventricular compliance. Therefore:
- Inadequate fluid administration may reduce preload and cardiac output.
- Excessive fluid administration may increase cardiac filling pressures and cause pulmonary congestion.
- For this reason, fluid therapy should be individualized and guided by stroke volume, cardiac output trends, SVV under appropriate conditions, and echocardiographic assessment when necessary.

01

Perioperative Arrhythmias

Dr.Fatemeh Shima Hadipourzadeh

Introduction And Clinical Significant

The transplanted heart differs significantly from the native heart in term of **autonomic innervation**, **electrophysiological properties**, **atrial anatomy** and **pharmacological responses**.

Several factors contribute to an increased susceptibility to perioperative arrhythmias including:

- Cardiac autonomic denervation.
- Surgical atrial anastomosis and myocardial scarring
- Acute or chronic allograft rejection.
- Cardiac allograft vasculopathy (CVA)
- Sinus node dysfunction and conduction abnormalities
- Immunosuppressive drug-related adverse effects
- Electrolyte and metabolic disturbance

A Key Clinical Principle:

A newly developed arrhythmia in a heart transplant recipient should not considered an isolated electrical disturbance until underlying graft dysfunction, rejection or cardiac allograft vasculopathy has been excluded.

Three major questions should be addressed:

1) What types of arrhythmias may occur in heart transplant recipients?
2) How should theses arrhythmias be diagnosed and managed perioperatively?
3) How does cardiac denervation alter the response to anesthetic and antiarrhythmic medications?

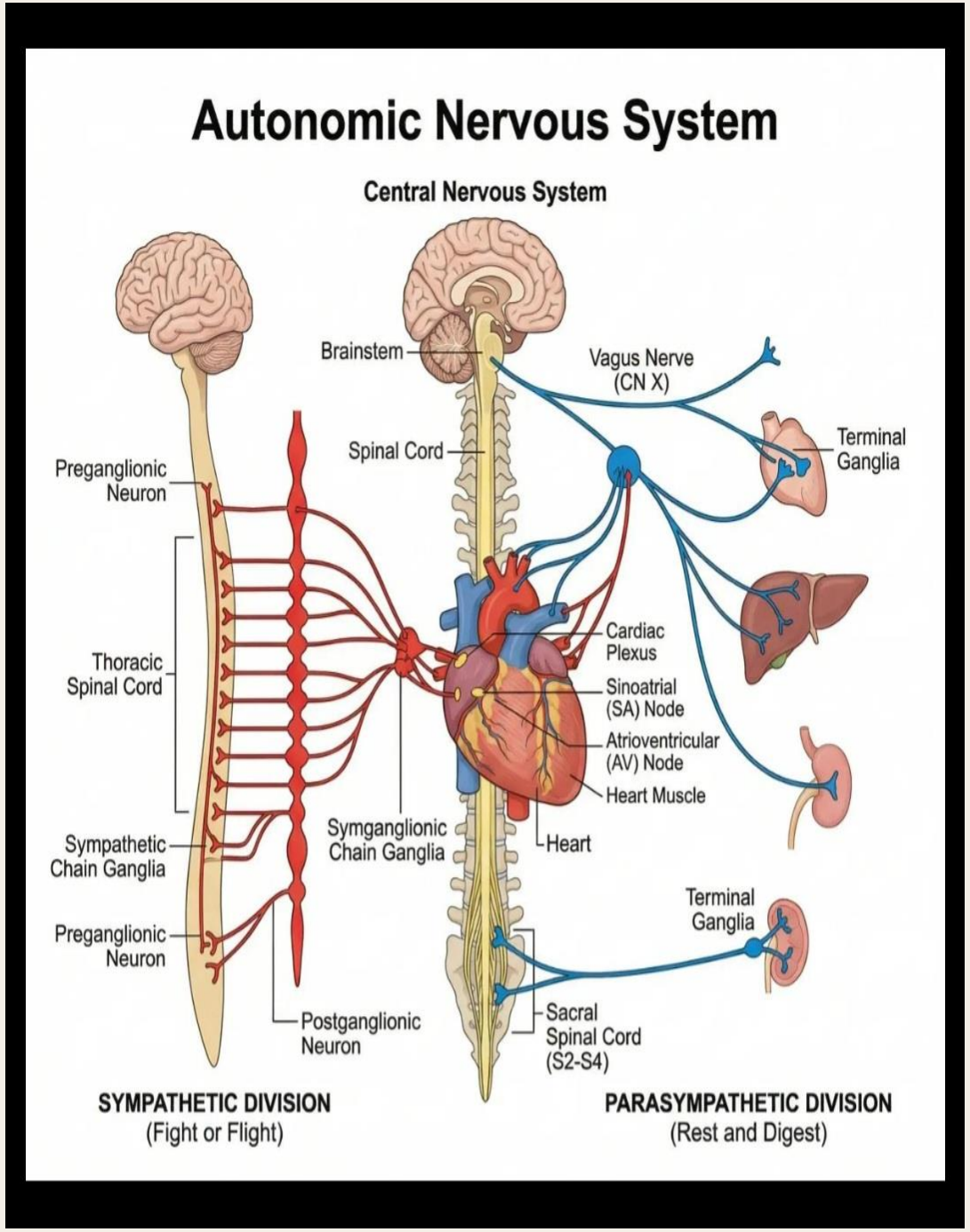
Cardiac Autonomic Denervation

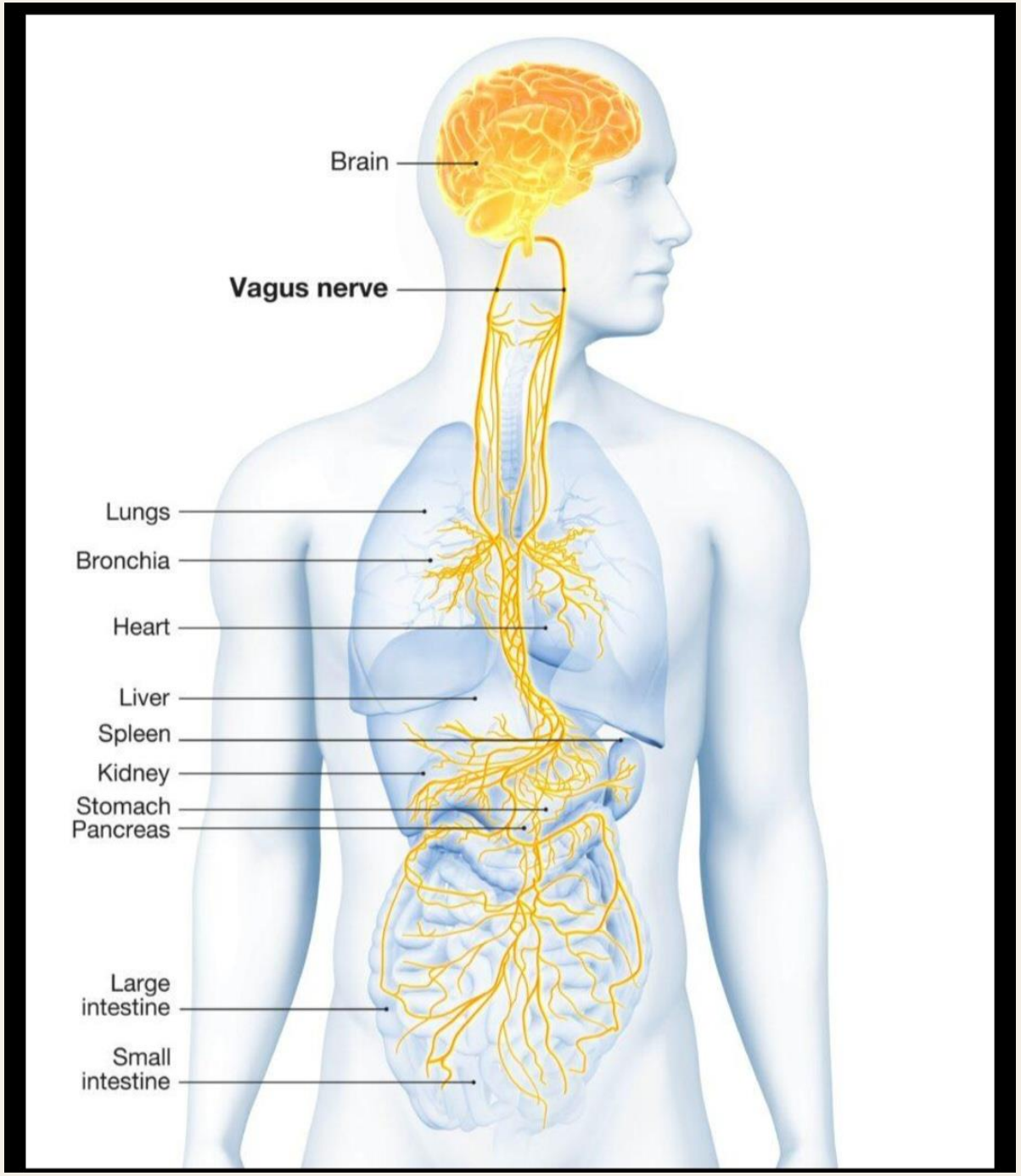
Following orthotopic heart transplantation, sympathetic and parasympathetic neural connections between the heart and the central nervous system are disrupted.

The major physiological consequences include:

- Increased resting heart rate, typically approximately 90-110 beats/min
- Reduced vagal influence on heart rate.
- Altered responses to autonomic stimuli
- Reduced or unpredictable chronotropic response to atropine
- Delayed heart rate response to exercise and physiological stress
- Greater dependence on circulating catecholamines for chronotropic and inotropic responses.

Because the transplanted heart is denervated its response to hypovolemia, pain, hemorrhage and changes in anesthetic depth may differ from that of a non transplanted heart.


Autonomic Nervous System
Central Nervous System
Brainstem
Vagus Nerve (CN X)
Spinal Cord
Terminal Ganglia
Preganglionic Neuron
Cardiac Plexus
Thoracic Spinal Cord
Sinoatrial (SA) Node
Atrioventricular (AV) Node
Heart Muscle
Sympathetic Chain Ganglia
Symganglionic Chain Ganglia
Heart
Terminal Ganglia
Preganglionic Neuron
Postganglionic Neuron
Sacral Spinal Cord (S2-S4)
SYMPATHETIC DIVISION
(Fight or Flight)
PARASYMPATHETIC DIVISION
(Rest and Digest)


Brain
Vagus nerve
Lungs
Bronchia
Heart
Liver
Spleen
Kidney
Stomach
Pancreas
Large intestine
Small intestine

Major Types Of Arrhythmias Following Heart Transplantation

- ***Supraventricular arrhythmias***
  - Atrial fibrillation
  - Atrial flutter
  - Atrial tachycardia
- ***Bradyarrhythmias and sinus node dysfunction***
- ***Atrioventricular conduction disorders***
  - First-degree AV block
  - Mobitz type I second-degree AV block
  - Mobitz type II second- degree AV BLOCK
  - Complete heart block
- ***Ventricular arrhythmias***
  - Premature ventricular complexes(PVCs)
  - Non-sustained ventricular tachycardia (NSVT)
  - Sustained ventricular tachycardia (VT)
  - Ventricular fibrillation (VF)
  - Torsad de Pointes

Perioperative Factors Predisposing To Arrhythmias

Perioperative factor	Arrhythmogenic mechanism
Hypoxia	Increased myocardial electrical instability
Hypercapnia	Changes in pH and myocaedial conduction
Hypokalemia	Increased risk of PVC and VT
Hypomagnesemia	Increased risk of QT prolongation and Torsades
Hypovolemia	Impaired perfusion and catecholamine release
Anemia	Increased myocardial oxygen demand
Pain	Increased circulating catecholamines
Sepsis	Metabolic disturbances and myocardial dysfunction
Hypothermia	Altered conduction and increased arrhythmia risk

Preoperative Assessment

A: Clinical history

- Time since heart transplantation
- Original indication for transplantation
- Previous episodes of rejection
- History of arrhythmias or syncope
- Presence of an ICD or permanent pacemaker
- History of cardiac allograft vasculopathy
- Functional capacity
- Current immunosuppressive medications

Diagnostic Investigations

Investigation	Clinical purpose
12-lead ECG	Rhythm, PR interval, QRS duration, QTc
Echocardiography	LV and RV function and valvular assessment
Serum electrolytes	K, Mg, Ca
Renal function	Drug dosing and assessment of nephrotoxity
Tacrolimus/Cyclosporine Level	Assessment of drug exposure when indicated
Troponin	Evaluation of suspected myocardial injury
Coronary angiograghy or appropriate CVA imaging	Investigation suspected allograft vasculopathy
Endomyocardial biopsy	Evaluation of suspected rejection when indicated

Patients Requiring Further Evaluation

- New-onset or uncontrolled arrhythmias
- Reduced left ventricular ejection fraction
- Syncope or presyncope
- Evidence of myocardial ischemia
- Signs of heart failure
- Newly developed conduction abnormalities
- Recent episodes of graft rejection

Anesthetic Considerations

A: Induction of anesthesia

The primary objective is to maintain hemodynamic stability:

- Maintaining adequate preload
- Avoiding significant hypotension
- Preventing excessive tachycardia
- Maintaining coronary perfusion
- Avoiding hypoxia and hypercapnia

B: Maintenance of anesthesia

- Continuous ECG monitoring, preferably with ST-segment analysis
- Close blood pressure monitoring
- Arterial catheterization for major or high-risk procedures when indicated
- Correction of k and Mg
- Avoidance of major intravascular volum fluctuations
- Monitoring for QT prolongation
- Immediate availability of defibrillation and pacing equipment

Perioperative Arrhythmia Management

New-onset arrhythmia in a heart transplant recipient

↓

Assess ABCs, blood pressure, perfusion, and ECG

↓

Hemodynamic instability

Hypotension, shock, ischemia, or altered consciousness

- Unstable tachyarrhythmia with pulse: synchronized cardioversion.
- VF/pulseless VT: defibrillation and CPR.
- Symptomatic bradycardia: direct adrenergic agents and pacing.

Hemodynamic stability

Stable patient

- Identify the arrhythmia.
- Correct reversible causes.
- Initiate rhythm-specific treatment.
- Continue ECG monitoring.

Investigate underlying graft pathology

Rejection | CAV | Graft dysfunction | Electrolyte disturbances | Drug interactions

Consult the heart transplant team and determine postoperative monitoring requirements

Pharmacological Responses In Heart Transplant Recipients

Drug	Expected response	Important clinical consideration
Atropine	Often ineffective or less effective	Not reliable for severe bradycardia
Glycopyrrolate	Reduced or unpredictable effect	
Epinephrine	Direct increase in heart rate and contractility	Useful for hemodynamic support
Isoproterenol	Increased heart rate	Important option for symptomatic bradicardia
Dopamine	Increased heart rate and hemodynamic support	Direct adrenergic effects
Dobutamine	Increased HR and hemodynamic support	Direct adrenergic effects
phenylephrine	Increased systemic vascular resistance	Limited dependent on baroreflexes
Ephedrine	Potentially reduced response	Partly dependent on endogenous norepinephrine release

Pharmacological Responses In Heart Transplant Recipients

Drug	Expected response	Important clinical consideration
Adenosine	Increased sensitivity and prolonged AV block	Requires particular caution
Beta-blocker	Reduced heart rate and AV conduction	Use according to graft function
Verapamil/ Diltiazem	Direct AV nodal suppression	Important immunosuppression interaction
Amiodarone	Effective antiarrhythmic activity	Bradycardia,QT prolongation and drug interactions
Neostigmine	Potential severe bradycardia or AV block	Important during neuromuscular blockede reversal

Reversal Of Neuromuscular Blockeade

Neostigmine deserves particular attention.

By increasing acetylcholine concentration, neostigmine may cause significant bradycardia or AV block in heart transplant recipients

Important considerations:

Avoid indiscriminate administration of neostigmine

Rocuronium followed by Sugammadex may be a useful alternative when clinically appropriate

Sugammadex is not entirely free of cardiovascular adverse effects; severe bradycardia has been reported

Continuous ECG and hemodynamic monitoring are essential during reversal

Postoperative Management

- Continuous ECG monitoring in high risk patients
- Correction of electrolyte abnormalities
- Adequate analgesia and oxygenation
- Prevention of hypothermia
- Surveillance for myocardia and heart failure
- Timely resumption of immunosuppressive medications
- Evaluation of new arrhythmias before discharge

Arrhythmias According To Time After Transplantation

Post transplant period	Common arrhythmias	Potential underlying causes
Early postoperative period	Sinus bradycardia, SND,Avblock,atrial arrhythmias	Surgical injury, sinus node ischemia, postoperative disturbance
First several months	AF,atrial flutter, atrial tachycardia	Rejection, infection, electrolyte abnormalities
Late postoperative period	New-onset AF, VT, AV block, bradicardia	CVA, chronic rejection, graft dysfunction

Three Important Warning Signs

1) New-onset AF: Evaluate for rejection, CVA and sepsis

2) Late-onset bradycardia or Avblock: Investigate rejection and ischemic injury to the conduction system

3) New-onset VT or VF: Urgently evaluate for myocardial ischemia, CAV and graft dysfunction

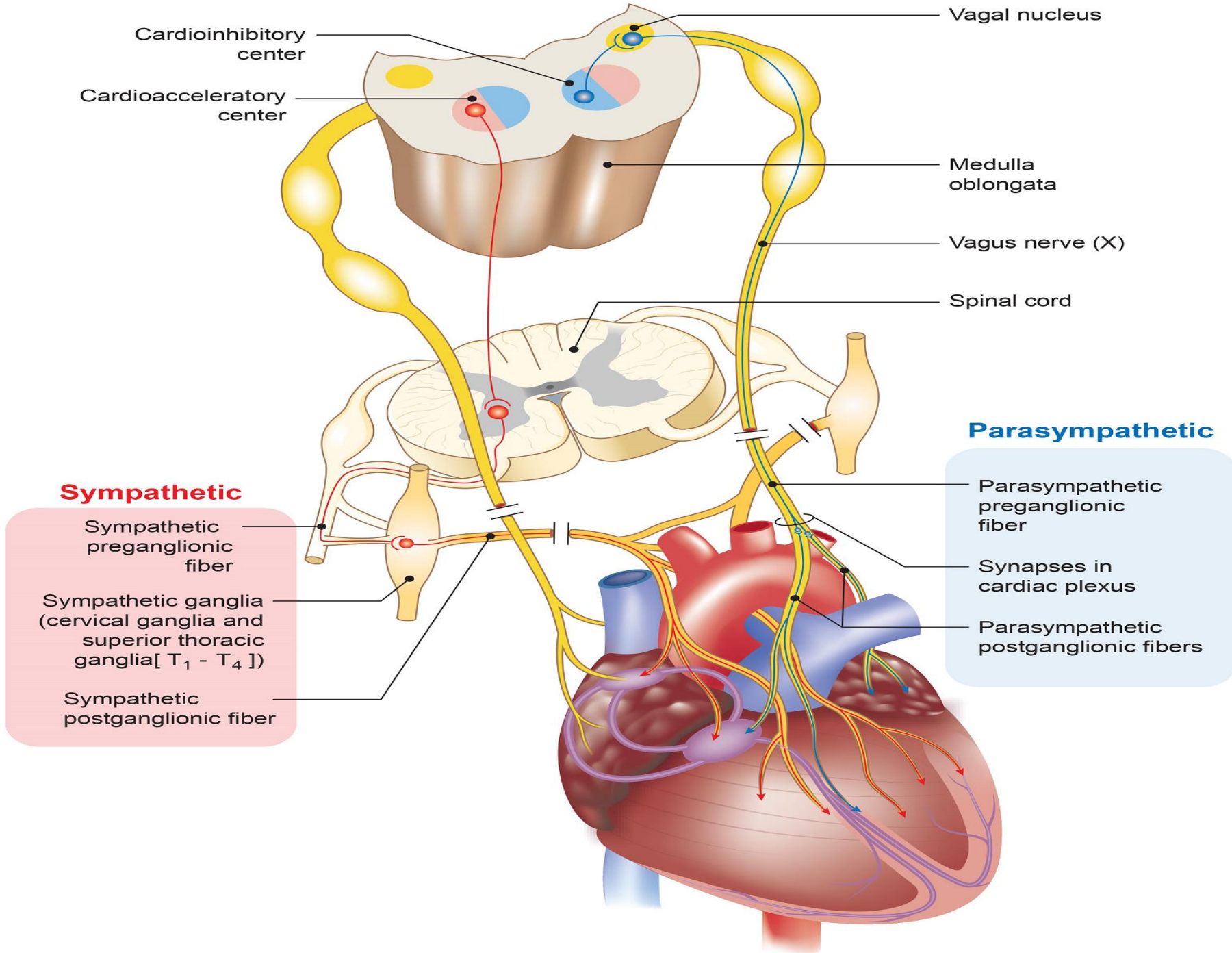
01

Neuraxial vs General Anesthesia

Dr. Touraj Babaei



Anaesthetic techniques (general, regional, neuroleptic) have been successfully used in patients with a transplant history.


Cardioinhibitory center
Cardioacceleratory center
Vagal nucleus
Medulla oblongata
Vagus nerve (X)
Spinal cord
Sympathetic
Sympathetic preganglionic fiber
Sympathetic ganglia (cervical ganglia and superior thoracic ganglia[T_1 - T_4])
Sympathetic postganglionic fiber
Parasympathetic
Parasympathetic preganglionic fiber
Synapses in cardiac plexus
Parasympathetic postganglionic fibers

several possible explanations for the relative haemodynamic stability

- Firstly, denervated heart has an intact Frank–Starling mechanism
- Secondly, heart transplant recipients exhibit an increase in blood pressure and heart rate in response to exercise
    - driven by circulating catecholamines from the adrenal medulla
- Finally, there is evidence that the transplanted heart undergoes partial reinnervation

Baricity, Dosage, and Additives in Intrathecal Solutions

- Intrathecal isobaric ropivacaine has been demonstrated to cause less hypotension compared to hyperbaric bupivacaine when administered for caesarean section in the obstetric population
- Bupivacaine and ropivacaine of varying baricity and doses have also been used with similar haemodynamic stability in the heart transplant recipient population.
- It remains unclear how larger doses or additives (e.g. alpha-2 agonists, opioids, adrenaline) may influence haemodynamics in these patients.

Anaesthesia Reports 2023, 11, e12263 doi:10.1002/anr3.12263

Case Report

Spinal anaesthesia with intravenous sedation for total hip arthroplasty in two patients with a history of orthotopic heart transplantation

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1 Resident, 2 Fellow, 3 Attending Physician, Department of Anaesthesiology, Columbia University Irving Medical Center, New York, NY, USA

Summary

Many patients with orthotopic heart transplantation later undergo non-cardiac surgery. Historically, neuraxial anaesthesia has been avoided in these patients because the denervated heart is unable to compensate for hypotension via the baroreceptor reflex. Here, we present the cases of two patients with prior heart transplantation who underwent total hip arthroplasty under spinal anaesthesia with intravenous sedation. In both cases, this technique was well-tolerated haemodynamically. We propose that spinal anaesthesia with intravenous sedation can be a safe and efficacious anaesthetic technique for selected patients with a history of orthotopic heart transplantation, with careful intraoperative fluid and pharmacological management.

Case Report

Anaesthesia for non-cardiac surgery in a cardiac transplant recipient

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Access this article online
Website: www.ijaweb.org
DOI: 10.4103/0019-5049.84849
Quick response code

ABSTRACT

Cardiac transplantation has become the standard therapy for idiopathic dilated cardiomyopathy and end-stage ischaemic heart disease. With the introduction of newer immunosuppressants, together with better patient selection, improved perioperative monitoring and care, the overall survival of recipients has improved. An increasing number of patients who received a transplant present for either elective or emergency non-cardiac surgery. We hereby discuss the perioperative management of such a patient who came to our set-up for bipolar haemiarthroplasty.

Key words: Anaesthesia, cardiac transplant, graft function, immunosuppressants, non-cardiac surgery

Qi *et al. SpringerPlus (2016) 5:993*
DOI 10.1186/s40064-016-2701-8

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CASE STUDY Open Access

Anesthesia management for cesarean section 10 years after heart transplantation: a case report

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Abstract

Introduction: Pregnancy after organ transplantation is becoming increasingly common. However, reports of the anesthesia for such patients are rare. Heart transplant recipients are always accompanied with pathophysiological changes and present anesthesiologists with challenge.

Case description: We reported a case of anesthesia management of gravida undergoing cesarean section 10 years after cardiac transplantation. We used two points spinal and epidural anesthesia, combined with phenylephrine throughout the surgery. The course was absolutely successful and both mother and baby got good results.

Discussion and evaluation: Physiology of heart transplant recipients and key points of anesthesia management were discussed.

Conclusions: Spinal anesthesia can be performed in heart transplant recipients, however, we have to think twice before anesthesia for this kind of patients.

Keywords: Anesthesia, Cardiac transplantation, Cesarean section, Pregnancy

Case Report

Anesthetic considerations for non-cardiac surgeries in orthotopic heart transplant recipients

ABSTRACT

The number of heart transplants performed each year is steadily increasing around the world. Anesthesia and perioperative management are different in these cases. For an optimal perioperative management and improved postoperative outcome, a full understanding of the physiology of the denervated heart, post-transplant morbidities, and immunosuppressant pharmacology is required. We hereby discuss the perioperative management of a patient who had undergone orthotopic heart transplant and presented to our setup for left ureteroscopy.

Key words: Anesthesia, cardiac transplant, immunosuppressants, non-cardiac surgery

Clinical Points:

- First point: appropriate anesthesia level must be controlled.
- Second point: appropriate fluid infusion.
- Third point: Inotropes and vasoconstrictors
- Fourth point: antiseptic technique.

Key Message

Transplantated Heart is not simply a denervated heart; it is a unique physiological system that requires a different approach to perioperative care.

References

1. Bierer JD, Stanzel R, Henderson M, Sapp J, Andreou P, Marshall JS, et al. The immunomodulatory effect of continuous ultrafiltration during pediatric cardiac surgery. Perfusion. 2025; doi:10.1177/02676591251374252.

2. Tomulić Brusich K, Acan I. Anesthetic considerations in transplant recipients for nontransplant surgery. In: Organ Donation and Transplantation. IntechOpen; 2018. doi:10.5772/intechopen.74329.

3. Chow J, Walborn A, Petrucci K, Choi HS, Kacha AK. Caring for the transplant patient for non-transplant anesthesia. Int Anesthesiol Clin. 2025;63(3):30-41

4. Tseng L, Al-Saidi I, Channagiri V. Spinal anaesthesia with intravenous sedation for total hip arthroplasty in two patients with a history of orthotopic heart transplantation. Anaesth Rep. 2023;11(2):e12263.

5. Deep V, Vinayak PS, Ramachandra K. Anesthetic considerations for non-cardiac surgeries in orthotopic heart transplant recipients. Saudi J Anaesth. 2023;17(1):104-106.

6. Choudhury M. Post-cardiac transplant recipient: Implications for anaesthesia. Indian J Anaesth. 2017 Sep;61(9):768-774.

7. Navas-Blanco JR, Modak RK. Perioperative care of heart transplant recipients undergoing non-cardiac surgery. Ann Card Anaesth. 2021;24(2):140-148

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Questions and Discussion

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