# Postoperative Arrhythmias after Cardiac Surgery AliReza MohsenipourFoumani Mansoor Mohsenabadi

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- Arrhythmias are common after cardiac surgery such as coronary artery bypass grafting
- (CABG) surgery and represent a significant source of morbidity and mortality
- Although most of these arrhythmias are transient and have a benign course, it may prolong intensive care and hospital stay, and in rare instances, it may lead to mortality









- The clinical significance of each arrhythmia depends on several factors that include underlying cardiac function, patient's comorbidities, arrhythmia duration, and ventricular response rate.
- Rapid ventricular rates with tachycardia can cause diastolic and later on systolic dysfunction, reduce cardiac output, and result in hypotension or myocardial ischemia
- Bradydysrhythmias, particularly with the loss of atrial function, may have a remarkable influence on patients with systolic or diastolic ventricular dysfunction



## Patient-related risk factor



#### ✓Age:

 Increasing age is associated with age-related structural and electrophysiological changes that may lead to postoperative atrial tachyarrhythmias in the elderly. Old age has been demonstrated to be correlated with the development of POAs

#### ✓ structural heart disease:

- Structural heart disease in the atria and ventricles provides a substrate for arrhythmia via abnormal automaticity, triggered activity, or reentry
- Cardiac surgery patients often have the substrate of atrial enlargement and elevation of atrial pressures may function as a substrate for atrial arrhythmias
- patients with ventricular dysfunction, ventricular dilation, or fibrosis are at higher risk of having ventricular arrhythmias
- severe right coronary artery stenosis ,sinus nodal or atrioventricular nodal branch disease and mitral valvular disease (particularly rheumatic mitral stenosis) hav e been reported as risk factors for POAs.





## Patient-related risk factor



#### ✓Extra cardiac:

- Non cardiac comorbidities have been reported to increase the risk of POAs especially AF.
- These include obesity ,previous stroke, and history of chronic obstructive pulmonary disease





## Surgery-related risk factors



#### ✓Trauma and inflammation:

- Cardiac surgery provokes a vigorous inflammatory response due to a variety of metabolic, endocrine, and immune changes known as the "stress response," which has important clinical implications
- Surgical trauma, blood loss or transfusion, hypothermia, and CPB are nonspecific activators of the inflammatory response
- Surgical trauma may contribute to a higher degree of the inflammatory response compared to CPB, These effects predispose to atrial and ventricular arrhythmias in the early postoperative period.
- Inflammatory mechanisms have been proposed for the development of postoperative AF(POAF) as its incidence peaks at early postoperative days
- Inflammation may be related to the development of clinically aberrant or silent pericarditis.









#### ✓ Hemodynamic stress:

- The risk factors for POAs include atrial changes at the time of cardiac surgery, such as acute atrial trauma from cannulation, enlargement, hypertension, and ischemia
- Postoperative pulmonary edema and postoperative pleural effusion requiring thoracentesis have also been described as possible risk factors
- Hemodynamic changes might trigger focal arrhythmias. It is possible that atrial stretch, hypertension, pressure and volume shifts, and heightened catecholamine states can trigger A.F foci from the pulmonary veins.

#### ✓ Ischemic injury:

- The coronary blood flow is interrupted during CABG surgery and CPB, and the heart is put under circulatory arrest. This interruption of coronary blood flow causes ischemiareperfusion injury that is exacerbated by adverse neutrophil-mediated myocardial inflammation and injury
- Atrial and ventricular ischemia or infarction triggers POAs





## Surgery-related risk factors



#### ✓ Perioperative drugs:

- Beta-blocker withdrawal has been associated with an increased rate of postoperative supraventricular arrhythmias
- preoperative digoxin use is a risk factor for POAs
- Intravenous inotropic agents may be associated with POAs, Inotropic agents increase sinoatrial node automaticity and decrease atrioventricular (AV) nodal conduction time
- Intravenous administration of the amrinone and milrinone has been reported to cause PVCs and short runs of VT





## Surgery-related risk factors



#### ✓ Electrolytes disorders:

- Hypokalemia leads to alteration of the electrophysiologic properties of cardiac myocytes with an increase in the action potential duration (increase in phase-3 depolarization), enhanced automaticity (increased slope of diastolic depolarization), and decreased conduction velocity
- Preoperative serum potassium levels of <3.5 mmol/L have a significant association with perioperative arrhythmias in patients undergoing elective CABG surgery
- Catecholamine release increases cellular potassium uptake and thus decreases serum potassium levels
- Serum potassium levels greater than 5.5 mmol/L appear to be associated with the development of POAF and atrial flutter (AFL)
- The low serum magnesium levels—which is frequently seen after cardiac surgery—correlate with an increased incidence of POAs













- POAF usually occurs within 2–4 days after cardiac surgery, with a peak incidence on the second postoperative day
- In POAF patients without a prior history of atrial arrhythmias, AF is usually selflimited.
- About 15–30% of POAF convert to sinus rhythm within 2 h and up to 80% within 24 h







- AF is the most common complication seen after CABG surgery. The incidence of POAF is approximately 30% after isolated CABG, 40% after valve replacements or repair, and about 50% after combined CABG and valve surgeries
- POAF is often self-limiting, its clinical effects depend on ventricular rate, ventricular function, arrhythmia duration, symptoms, hemodynamic stability, and risk of thromboembolism.
- POAF is associated with increased postoperative thromboembolic risk and stroke
- PAOF management starts with the optimization of medical comorbidities, if possible (e.g., hypoxia), and the correction of underlying electrolyte disturbances (e.g., potassium and magnesium abnormalities)
- POAF is treated similarly to AF in nonsurgical patients by rhythm control via pharmacological or electrical approach or heart rate control, and appropriate antithrombotic therapy.



























- Treatment strategies of POAF aim to reduce symptoms, limit adverse hemodynamic effects, decrease the length of hospital stay, prevent readmissions, and improve survival
- The rhythm control strategy :using a direct current cardioversion (electrical cardioversion) or antiarrhythmic drugs (pharmacological cardioversion)
  has the advantage of a rapid conversion to sinus rhythm, which restores atrial
- has the advantage of a rapid conversion to sinus rhythm, which restores a activity, functional capacity, and might reduce thromboembolic.
- The rate control strategy: useing beta-blockers, calcium channel blockers, digoxin, has the advantage of avoiding the potential adverse effects of antiarrhythmic drugs and complications associated with cardioversion















- AFL and ATs that developed late after cardiac surgery are believed to be due to scars created by incisions applied to the right and/or left atrium either for establishing extracorporeal circulation or access to intra cardiac structures (coronary sinus, interatrial or interventricular septum, atrioventricular valves, etc.)
- The scars created by these incisions play a significant role in the development of ATs, months or years after surgery
- AFL in the early postoperative period is managed as POAF with rate control or rhythm control and anticoagulation based on arrhythmia duration and patient risk factors. On long-term catheter ablation of AFL is an effective, safe, and potentially curative procedure.































It is typical of a sudden or paroxysmal onset and includes AV nodal reentrant tachycardia (AVNRT), AV reentrant tachycardias (AVRT), and atrial tachycardias.















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### Orthodromic

## Antidromic











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## **Antidromic AVRT**





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#### ✓ Supraventricular tachycardia (SVT)

- The incidence of persistent SVT in non cardiac surgery patients was 2%during surgery and 6% in the post operative period
- ATs occur most frequently 2–3 days post surgery and are likely related to sympathetic stimulation associated with an inflammatory response
- SVT is often associated with a high sympathetic tone
- Before initiating specific drug therapy for acute SVT in hemodynamically stable patients, it is important to assess and correct possible precipitating factors such as respiratory failure or electrolyte imbalance
- Adenosine might be used if there is no contraindication. SVT also responds to rate control drugs such as beta-blockers (e.g., esmolol, metoprolol,) or calcium channel antagonists (e.g., diltiazem, verapamil).
- digoxin, amiodarone, adenosine, IV or oral beta-blockers, diltiazem, and verapamil are potentially harmful in acute treatment in patients with pre-excited AF

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- Premature ventricular complexes (PVCs)
- Isolated PVCs including nonsustained ventricular tachycardia (NSVT) are seen in about 50% of patients during and after cardiac surgery [134]. PVCs can be related to electrolyte or other metabolic imbalances
- frequent PVCs (>30 per hour) may reduce ventricular function and therefore have an adverse impact on the short-term outcome
- patients with LVEF of <40% had a 75% mortality rate and 33% incidence of sudden death
- Hemo dynamically stable and asymptomatic PVCs do not usually need treatment with antiarrhythmic therapy on short or long-term.
- Lidocaine has been used with a successful result in reducing hemodynamically significant or symptomatic PVCs, but without improving mortality

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#### ✓ Ventricular tachyarrhythmias:

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- Ventricular tachyarrhythmias:
- Sustained VT and VF rarely occur after cardiac surgery with an incidence of 3.1% has been reported
- VAs after cardiac surgery may include: increased age, female gender, presence of unstable angina, congestive cardiac failure, hemodynamic instability, preoperative use of inotropes, preoperative use of IABP, emergency surgery, electrolyte disturbances, hypoxia, hypovolemia, myocardial ischemia/infarction, acute graft closure, reperfusion after cessation of CPB, and inotropes antiarrhythmic drugs use, on-pump surgery
- postoperative patients require close attention to the identification and treatment of reversible causes of arrhythmia like electrolyte or other metabolic disturbances, myocardial ischemia, or mechanical complications of surgery
- Hemodynamically stable sustained VTs may be initially treated with antiarrhythmic drugs infusion(Amiodarone, Lidocaine)

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- Ventricular tachyarrhythmias:
- Nonpharmacological management:
- Overdrive pacing: in patients with slower VTs who have ventricular epicardial wires, overdrive pacing may be performed. Electrical cardioversion/defibrillation should be easily available because of the possibility of acceleration of the VT or degeneration to VF
- Electrical cardioversion/defibrillation: in patients with cardiac arrest, basic life support (BLS) and advanced cardiovascular life support (ACLS) should be followed.
- Emergency mechanical support: in postoperative patients who are not responding to standard resuscitation maneuvers, initiation of emergency CPB in the intensive care unit may be considered.
- Implantable cardioverter-defibrillator (ICD) therapy: Patients with NSVT, prior MI, and left ventricular dysfunction (LVEF <40%) may be considered for electrophysiology testing and implantation of an ICD if a sustained ventricular arrhythmia is in the following and the second second

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#### Treatment by Cardioversion

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- 1. Presence of initial 'r' wave in aVR
- 2. Presence of initial 'r' or 'q' wave of > 40ms duration

All the above features are indicative of VT

- 3. Presence of notch in descending limb of negative onset and predominantly negative QRS
- 4. Vi/Vt ≤ 1

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oVR

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 If the electrocardiogram (ECG) shows VF/pulseless ventricular tachycardia (VT), you may delay external cardiac massage for up to one minute to administer shocks. (Class IIA, Level B

- For patients with VF or pulseless VT, three sequential shocks should be given without intervening ECM. (Class I, Level B)
- For VF or pulseless VT, emergency sternotomy should be performed after three failed attempts at defibrillation, with ECM started as a bridge to
- internal massage. (Class I, Level B)

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H	Hypovolemia	Нурохіа	Hydrogen Ion (acidosis)	Hypo/Hyper- kalemia	Hypothermia
	Loss of fluid volume in the circulatory system.	Deprivation of an adequate oxygen supply can be a significant contributing	Obtain an arterial blood gas to determine respiratory acidosis.	Both a high and low K+ can cause cardiac arrest.	If a patient has been exposed to the cold, warming measures should
	Look for obvious blood loss.	cause of cardiac arrest.	Provide adequate	Signs of high K+ include taller, peaked T-waves, and widening of	be taken.
	Most important intervention is to obtain IV access and	Ensure that the airway is open.	ventilations.	the QRS complex.	Core temp. should be raised above 86 F and 30 C
	administer IV fluids.		Use sodium bicarbonate to	te to Signs of low K+ include flattened	as soon as possible.
	Use a fluid challenge to	Ensure adequate ventilation, and bilateral breath sounds.	prevent metabolic acidosis if necessary.	T-waves, prominent U-waves and possibly widened QRS complex.	The patient may not
	determine if the arrest is related to hypovolemia	Ensure oxygen supply is connected properly.		Never give undiluted intravenous potassium.	respond to drug or electrical therapy while hypothermic.

Г	Toxins	Tamponade	Tension Pneumothorax	Thrombosis (heart: acute, massive MI)	Thrombosis (lungs: massive PE)
	Accidental overdose : Some of the most common include: tricyclics, digoxin, betablockers, and calcium channel blockers).	Fluid build-up in the pericardium results in ineffective pumping of the blood which can lead to pulseless arrest.	Tension pneumothorax shifts in the intrathroacic structure and can rapidly lead to cardiovascular collapse and death.	Causes acute myocardial infarction. ECG signs: 12 lead ECG with ST- segment changes, T-wave inversions, and/or Q waves.	Can rapidly lead to respiratory collapse and sudden death. ECG signs of PE: Narrow QRS Complex and rapid
	<u>Cocaine</u> is the most common street drug that increases incidence of pulseless arrest.	ECG symptoms: Narrow QRS complex and rapid heart rate.	ECG signs: Narrow QRS complexes and rapid heart rate.	Physical signs: elevated cardiac markers on lab tests, and chest pain/pressure.	heart rate. Physical signs: No pulse felt with CPR. distended
	Physical signs include bradycardia, pupil symptoms, and other neurological changes.	Physical signs: jugular vein distention (JVD), no pulse or difficulty palpating a pulse, and muffled heart sounds.	Physical signs: JVD, tracheal deviation, unequal breath sounds, difficulty with ventilation, and no pulse felt with CPR.	Treatments: use of fibrinolytic therapy, PCI (percutaneous coronary intervention).	neck veins, positive d- dimer test, prior positive test for DVT or PE. Treatment: surgical
	Poison control can be utilized to obtain information about toxins and reversing agents.	Perform: pericardiocentesis to reverse.	Treatment: Needle decompression.	The most common PCI procedure is coronary angioplasty with or without stent placement.	intervention (pulmonary thrombectomy) and fibrinolytic therapy.

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- Bradyarrhythmias (BAs) are common after cardiac surgery, but it mostly consists of transient episodes of low ventricular heart rate
- The conduction defects post cardiac surgery include sinus node dysfunction, partial and complete bundle branch blocks, and various degrees of atrioventricular (AV) block.
- The right bundle branch block (RBBB) was the most frequently noted abnormality
- Bradyarrhythmias may decrease cardiac output in patients with relatively fixed stroke volumes.
- The risk of developing conduction disturbances after CABG or valvular surgery leading to permanent pacemaker (PPM) implantation is about 0.4–1.1% of patients after isolated CABG and 3–6% after heart valve operations
- Conduction disorders after cardiac surgery are explained by one of the following two mechanisms:
- (1) direct trauma to the conduction system in operative procedures in proximity to the
- sinoatrial or AV nodes or the His bundle;
- (2) ischemic injury to the conduction system due to extensive coronary artery disease might compromise myocardial protection during intraoperative cardioplegic

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- The risk factors for POBAs may be classified as preoperative, operative, and postoperative factors. Preoperative risk factors include age >75 years, the use of rate lowering cardiac medications(e.g., beta-blockers, calcium channel blockers, digoxin, and antiarrhythmic drugs),
- The presence of conduction system disease preoperatively, right bundle branch block (RBBB) or left bundle branch block (LBBB), first-degree AV block or left anterior fascicular block (LAFB)
- Operative risk factors include myocardial ischemia, inadequate cardiac protection during surgery, and direct surgical injury to conduction system, prolonged CPB time and cross-clamp time, and reoperation
- Postoperative risk factors include postoperative conduction disturbances and highgrade AV block

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#### Management:

- If the ECG shows asystole, you may delay external massage for as long as a minute to maximize the temporary pacemaker output. (Class IIA, Level C)
- For asystole or severe bradycardia, connect the epicardial pacing wires and set to DDD mode at 80 to 100 beats per minute at the maximum atrial and ventricular output voltages. If the pacing generator has an emergency pacing button, it may be used. (Class I, Level C)
- Chronotropic medications, such as theophylline or aminophylline, have been used for sinus bradycardia after transplantation to improve SSS or high-grade AVB and may decrease the need for permanent pacing but its long-term effect is not encouraging
- Implant a PPM if postoperative symptomatic complete AVB or severe sinus node dysfunction persists longer than 5–7 days

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## **Thanks For Attention**

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