

- Cerebrovascular
 - Stump pressure, EEG, and SEPs have been used in carotid endarterectomy.
 - CSF pressure and drainage in thoracoabdominal aneurysm repair.

Airway

- None

Preinduction/Induction

- Avoid extreme or prolonged changes in heart rate or blood pressure.
- Treat HR and BP changes aggressively.

Maintenance

- No one anesthetic agent or technique is superior; maintaining HR at a low level and hemodynamic stability are more important.
- For peripheral vascular surgery, regional anesthesia in combination with postop epidural analgesia may

decrease the incidence of graft thrombosis (see also Peripheral Vascular Disease).

- For carotid endarterectomy, maintaining cerebral perfusion pressure is an important goal.
- For abdominal aortic surgery, optimizing loading conditions, and detecting and treating myocardial ischemia and ventricular dysfunction are important, particularly around aortic clamping/unclamping.

Extubation

- Same concerns as during induction
- Rapid emergence to allow neurologic assessment after carotid endarterectomy

Adjuvants

- β -blocking agents and other antihypertensives are useful in hyperdynamic situations.

- Prophylactic nitroglycerin and Ca^{2+} -channel blockers used to treat myocardial ischemia have not been conclusively proven effective.
- Use vasoconstrictors, such as α -adrenergic agonists, with caution, to increase BP in cases of heart failure.

Anticipated Problems/Concerns

- High risk of periop myocardial ischemia (often silent).
- Avoid postop hypothermia (increases oxygen demand).
- Periop volume status important for pts with history of heart failure.
- Concern for reocclusion with peripheral revascularization procedures.
- Risk of renal dysfunction and neurologic injury in cases of aortic surgery.

Atrial Fibrillation

Sheela Pai Cole

Risk

- Isolated atrial fibrillation affects >1% of those >60 y of age.
- Overall incidence is 0.4% of adult population.
- In the postcardiac surgical population, the incidence can be as high as 27-40%.
- No racial predominance.
- Prevalence increases with older age.
- Independent risk factor for stroke.
- In pts presenting for cardiac surgery, the incidence of postop atrial fibrillation increases with increasing left atrial size, as well as in the presence of valvular abnormalities.

Perioperative Risks

- Rapid ventricular response in CHF
- May be a sign of impending or ongoing myocardial ischemia
- Embolization if persisting beyond 48 h without anticoagulation

Worry About

- Decreased cardiac output due to loss of atrial kick, especially in the presence of left ventricular hypertrophy, aortic stenosis, or diastolic dysfunction
- Myocardial ischemia secondary to increased myocardial O_2 demand
- Increasing embolization risk with increased duration

Overview

- Develops over 2 decades in 2% of pts >30 y of age.
- Related to left atrial size, underlying heart disease, and abnormal electrophysiology.
- Incidence increases with age.
- Most affected persons have underlying cardiac disease.
- Common after cardiac surgery, particularly valve surgery.

Etiology

- CAD
- RHD
- Cardiomyopathy; heart failure

- Mitral stenosis; mitral regurgitation especially with left atrial enlargement
- Htn and associated left ventricular hypertrophy
- Pericarditis
- Resp insufficiency including hypoxia and hypercarbia
- Hypercatecholamine states such as hyperthyroidism
- Subarachnoid hemorrhage
- Sarcoidosis/amyloidosis
- Idiopathic

Usual Treatment

- Cardioversion for hemodynamic instability in the first 48 h
- Amiodarone increases the chances of spontaneous conversion to sinus rhythm, especially if cardioversion is required
- Digitalis
- β -blockers
- Calcium antagonists
- Quinidine (with digitalis)

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	CHF Angina Stroke	Palpitations Chest pain Dyspnea Orthopnea	Variation in intensity of first heart sound; absence of A waves in jugular venous pulse; irregularly irregular ventricular rhythm	ECHO (if indicated)
RESP	CHF Pulm embolism	Dyspnea Orthopnea Chest pain Tachypnea	S_3 Rales Wheezing	CXR, V/Q scan (if suspicion of pulm embolism)
GI	Ischemic bowel from low flow or embolization	Abdominal pain	Acute abdomen	ABGs/lytes
RENAL	Decreased renal perfusion	Decreased urine output		BUN/Cr
CNS	Syncope, fatigue	Stroke	Neurologic deficit	Head CT

Key References: Mitchell LB, Crystal E, Heilbron B, et al: Atrial fibrillation following cardiac surgery, *Can J Cardiol*, 21(Suppl B):45B-50B, 2005; Prystowsky EN, Padanilam BJ, Fogel RI: Treatment of atrial fibrillation, *JAMA*, 314(3):278-288, 2015.

Perioperative Implications**Preoperative Preparation**

- Search for precipitating causes: new onset may signify acute disease process, which may delay surgery
- Control ventricular response or perform synchronized cardioversion to normal sinus rhythm if unstable

- If AFIB has been present for longer than 48 h, presence of clot in left atrium needs to be ruled out before cardioversion

Monitoring

- ECG with ST-segment analysis
- Additional monitoring such as use of arterial line or pulm artery catheter should be predicated on type of surgery, additional comorbidities, or hemodynamic instability

Airway

- None; consider intubation if shock present

Preinduction/Induction

- Avoid excessive sympathetic stimulation.
- Maintain oxygenation/ventilation.

Maintenance

- Monitor oxygenation, maintain normocarbica, and correct electrolyte imbalances.
- Control ventricular response.

Extubation

- Avoid excessive sympathetic stimulation.

Adjuvants

- Amiodarone may potentiate hypotension when administered along with anesthetic agents.
- Digitalis has little effect on anesthetic agents.
- Ca²⁺ antagonists can decrease AV conduction and increase NM blockade.
- β-blocker agents can cause decreased AV conduction.

- Addition of β-blockers and Ca antagonists such as diltiazem may potentiate refractory bradycardia.
- Quinidine (with digitalis) can increase NM blockade.

Postoperative Period

- Maintain adequate analgesia.
- New onset may require prompt treatment based on hemodynamic status.
- If duration is greater than 48 h, anticoagulation may need to be instituted.

Anticipated Problems/Concerns

- Rapid ventricular response may result in significant fall in cardiac output.
- DC synchronized cardioversion establishes sinus rhythm in >90%.
- Pretreatment with amiodarone increases chances of remaining in sinus rhythm.

Atrial Flutter

Megha Parekh | Marek Brzezinski

Risks

- AFLT occurs <1/10 as often as AFIB.
- Usually occurs in elderly pts with structural heart disease (those with LV dysfunction, RV dysfunction, pulm vascular disease, RHD, or CHD).
- Other risk factors include COPD, hypertension, obesity, and male sex.
- Occurs with relative frequency after cardiac surgery (peaks on postop d 2 to 4) but seldom after noncardiac surgery.

Perioperative Risk

- Circulatory insufficiency or myocardial ischemia from extremes of heart rate, especially in pts with CHD
- Increased risk of thromboembolism
- Associated disease, especially adequacy of CV and pulm function

Worry About

- Heart rate-related: Hemodynamic instability, myocardial ischemia, Pulmonary edema, or heart failure
- Thromboembolism-related: Stroke, MI, or bowel ischemia
- Increased proarrhythmia risk with drugs for pharmacologic cardioversion

Overview

- Mechanism is atrial macro-reentry; circuit is usually in the right atrium.
- Type I or typical AFLT: Most common form is characterized by regular atrial rates of 240 to 340 bpm with fixed (often 2:1) AV conduction.
- Type II or atypical AFLT: Less commonly presents with regular atrial rates of 340 to 450 bpm, with variable or fixed AV conduction that may result in irregular QRS complex and pulse; re-entry is usually around previous atrial scars.

Etiology

Usual Treatment

- Goals include restoring and maintaining normal sinus rhythm, control of ventricular rate, and anticoagulation to prevent systemic embolization depending on risk of thromboembolism and length of time in AFLT (if sinus rhythm is not restored).
- Cardioversion can be accomplished pharmacologically (flecainide, dofetilide, propafenone, IV ibutilide, or amiodarone) or with direct current cardioversion. External pacing may be required in pts receiving rate-controlling medications.

- Consider emergency R-wave synchronized DC-cardioversion if pt is hemodynamically unstable.
- Ventricular rate control strategies include β-blockers, nondihydropyridine Ca²⁺-channel blockers such as diltiazem and verapamil (alone or in combination). When unsuccessful or contraindicated, digoxin or amiodarone can be considered. Pts with chronic AFLT who failed pharmacologic rate control may benefit from AV nodal ablation with permanent ventricular pacing (not a treatment for acute AFLT).
- Anticoagulation should be considered for AFLT lasting >48 h or sooner if at high risk of thromboembolism (e.g., high CHA₂DS₂-VAS_c score, impaired renal function, or low cardiac output).
- Although warfarin remains the most commonly used anticoagulant (target INR of 2.5), the new oral anticoagulants (dabigatran, rivaroxaban, and apixaban) offer a reasonable alternative in patients without a prosthetic heart valve, severe renal impairment, or risk of GI bleed. Use of aspirin may be considered in pts with CHA₂DS₂-VAS_c score of 1.
- Prophylactic amiodarone, diltiazem, and β-blockers lower the risk for AFLT after cardiac surgery.

Assessment Points

System	Effect	Assessment by PE	Exercise	Test
CV	Atrial flutter, left ventricular function, coronary disease severity	Palpitations, dizziness, weakness, lethargy, orthopnea, cough dyspnea, exercise intolerance, symptoms of angina	Irregular pulse/pulse deficit, S ₁ -S ₂ intensity rales, and wheezes	ECG, Holter monitoring, EP studies, ECHO, exercise ECG, MRI, cardiac cath, stress ECG, diprydamole scintigraphy, angiography
RESP	CHF COPD	Dyspnea, orthopnea, cough Dyspnea, wheezing	S ₃ , rales, wheezes	CXR, PFTs
GI	Decreased perfusion	GI distress, diarrhea		
RENAL	Decreased perfusion	Polyuria (nocturnal)		BUN/Cr
NEURO	Ischemia or stroke	Syncope, mental changes, paresis/paralysis, dementia	Mental deficits Neurologic exam	See CV

Key References: January CT, Wann LS, Alpert JS, et al: 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the Heart Rhythm Society, *Circulation* 130(23):e199–e267, 2014; Frenkl G, Sodickson AC, Chung MK, et al: 2014 AATS guidelines for the prevention and management of perioperative atrial fibrillation and flutter for thoracic surgical procedures, *J Thorac Cardiovasc Surg* 148(3):e153–e193, 2014.

Perioperative Implications

Preoperative Preparation

- Adequate ventricular rate control (80 to 100 bpm) with β-blockers or Ca²⁺-channel blockers with AV conduction-slowing properties.
- Treat CHF if present; otherwise, optimize cardiopulmonary function.
- If acute onset (<48 h), consider cardioversion.
- When AFLT is of >48-h duration, intracardiac thrombus must be excluded before cardioversion (e.g., TEE) or the pt should receive a course of anticoagulation before and after cardioversion.

- Consider prophylactic amiodarone, diltiazem, or β-blockers to lower the risk for AFLT after cardiac surgery.

Monitoring

- ECG with ST-T trending and strip-chart recorder for documentation of new arrhythmias or myocardial ischemia.
- Consider extended monitoring, including direct arterial catheter, cardiac output monitoring, and TEE in the presence of concomitant left ventricular dysfunction depending on the type of procedure.

Anesthesia Induction

- Left ventricular dysfunction and AFLT increase risk for hypotension during induction with agents such as thiopental or propofol.

- Desflurane, ketamine, and pancuronium may accelerate ventricular rate.

Maintenance

- Expect increased circulatory instability and less tolerance of large fluid shifts or blood loss.
- No anesthetic drugs are especially contraindicated; caution should be used with drugs that speed conduction.
- Optimize electrolyte levels.
- Limit use of catecholaminergic inotropic agents.

Tracheal Extubation

- Possible increased risk for thromboembolism with hyperdynamic circulatory state.
- Sympathomimetic or antimuscarinic drugs may accelerate ventricular rate.