Assessment Points

System	Effect	Assessment by Hx	PE	Tests
GENERAL	Poor general health (malnutrition, poor dentition) hypothermia/hyperthermia withdrawal	Drugs and alcohol	Temperature, trauma, tracking Diaphoresis, tremors, N/V	Blood, urine toxicology screens
HEENT	Miosis (opioids), mydriasis (stimulants)		Pupils	
CV	Sympathetic stimulation, arrhythmias, ischemia/MI (cocaine, amphetamines), cardiomyopathy (opioids, ETOH, cocaine), aortic dissection (cocaine, amphetamines), endocarditis (IVDU)	Palpitations, SOB on exertion, chest pain	BP/HR, murmur, SVR, long QT	ECG ECHO Troponins
RESP	Bronchoconstriction, pulmonary Htn, interstitial fibrosis, pneumonia, pulmonary hemorrhage (cocaine), resp depression (heroin, opiates, PCP)/stimulation (amphetamines, LSD), emphysema (tobacco/marijuana)	SOB on exertion, hemoptysis	RR, O_2 sats, air entry, wheeze	CXR if indicated
GI	Cirrhosis (ETOH), salivation (PCP)	Anorexia, N/V, bleeding	Hepatomegaly, ascites	LFTs
RENAL	Retention (marijuana), ARF, ESRF (cocaine, amphetamines), hyponatremia (MDMA)		Oliguria Anuria (rhabdomyolysis)	Urea and lytes, CK and Cr Urine myoglobin
ENDO/METAB	Serotonin syndrome (cocaine, amphetamines, buprenorphine, LSD)		BP, temp, tremors, diaphoresis, confusion, seizures	
CNS	Altered mental state SAH, CVA (cocaine)	Anxiety, hyperactivity, euphoria. Aggression, hallucinations	Neuro exam, MSE	CT, MRI
PNS	Peripheral neuropathy (ETOH)	Altered sensation	Neuro exam	
OB	IUGR, preterm labor, placental abruption	Exposure, abdominal pain, bleeding	Vaginal bleeding	US

Key References: Lüscher C: Drugs of abuse. In: Katzung BG, Trevor AJ, editors, *Basic and clinical pharmacology,* ed 13, New York, 2015, McGraw-Hill; Bryson EO, Frost EAM, editors: *Perioperative addiction: clinical management of the addicted patient,* New York, 2012, Springer.

Perioperative Implications

Preoperative Preparation

- D&A Hx: CAGE-AID questionnaire, drugs abused, duration, frequency, route of administration
- Consideration of drug and toxicology screening (has limitations)
- Addiction specialist consultation recommended
- Acutely intoxicated: Delay of treatment wherever possible due to hemodynamic instability
- Chronic use: Management of pharmacotherapy, including opiate-replacement therapy as appropriate and prevention of withdrawal

Monitoring

- Standard ASA monitors; consider invasive monitoring for cardiovascular instability or end-organ dysfunction.

Airway

- Consider rapid-sequence induction in intoxication.
- Nasal septal/soft palate necrosis; drug-associated pulmonary disease (see Assessment Points table).

Preinduction/Induction

- Consider premedication: benzodiazepines, dexmedetomidine, or beta-blockers.
- Propofol (no specific contraindications); relative contraindications: Cocaine: etomidate, succinylcholine, ketamine. PCP & LSD: Ketamine. Marijuana: Barbiturates

Maintenance

- Autonomic dysfunction common; anticipate hemodynamic instability, myocardial ischemia, arrhythmias, myocardial depression, diminished or exaggerated responses to vasopressors.
- Consider decreased MAC (chronic opioid, cocaine, amphetamine use) and increased MAC (stimulant intoxication).

Postoperative Period

- Depressed airway reflexes and respiratory depression; postop apnea monitoring (recommended).
- Anticipate agitation, confusion, hallucinations, withdrawal, seizures, delayed return of motor function, fever, and hemodynamic instability.
- Withdrawal management (e.g., lorazepam, haloperidol, clonidine).
- Pain management: Consideration of alternative multimodal analgesia, including alternative routes, local anesthetics, regional blocks, nonsteroidals, ketamine, alpha blockers, and gabapentin; may require opiate doses 2-3× more than in opiate-naïve pts.
- In pts drinking >4 drinks/d, 2–3× increased risk for postop complications.

Supratentorial Brain Tumors

Tod B. Sloan | Antoun Koht

Risk

- Highest incidence age is 3–12 y and 55–65 y.
- Account for 80% of adult CNS tumors; incidence of primary tumor is ~15–20:100,000 per y.
- Account for one-third of childhood CNS tumors.

Perioperative Risks

- Increased ICP: Headache, seizures, neurologic deficit/dementia, visual and hearing changes, focal neurologic changes (hemiparesis, numbness, ataxia), and/or visual deficits if pituitary tumor present
- Endocrinopathy, fluid, and electrolyte imbalance

Worry About

- AEDs: Dilantin, keppra, tegretol. Adequate levels needed to avoid postop seizures.
- Raised ICP and brain edema: May lead to herniation (transtentorial [dilate ipsilateral] pupil), subfalcine (leg weakness), tonsillar (neck stiffness, spasticity, extensor-plantar response), and upward transtentorial (small pupils, extensor rigidity).
- Dexamethasone Rx may lead to hyperglycemia.
- Hyperglycemia may cause more retractor-induced ischemic injury to adjacent brain tissues.
- Endocrinopathy, particularly diabetes insipidus, if near pituitary.

Overview

- Portion of brain superior to tentorium cerebella.
- 13,000 deaths per y; third leading cause of death in pts 15–34 y of age.
- Brain edema surrounding malignant tumors causes initial Sx; often improve initially after corticosteroids.
- Seizures due to local neuronal irritation; 30–70% incidence related to tumor type.
- Obstructive hydrocephalus if the tumor is near third ventricle or foramen of Monro.

Etiology

- In adults, 85% of primary tumors occur in anterior two-thirds of cortex (most benign): glioma (45–50%), medulloblastoma, ependymoma, low-grade lymphoma (children: astrocytoma, medulloblastoma). 15% are meningiomas. Common presentation age is 55–65 y (1% of all cancers).
- Many supratentorial tumors are metastases (20–30%): Melanoma, breast cancer, small-cell lung, non-Hodgkin's lymphoma, colon, renal, nasal/throat. 50% have multiple metastases (25% of all pts with cancer have brain metastases), usually located at white-gray border.

- Associated Dx includes neurofibromatosis and von Hippel-Lindau syndrome.
- Brain tumors rarely metastasize outside the brain.
- Pediatric (uncommon >age 2) <1 y present when large (pliable skull, glioma 50%; (astrocytoma). Most are low-grade and deep midline; others are ependymoma, medulloblastoma, and PNET (primitive neuroectodermal tumors).

Usual Treatment

- Dexamethasone for initial Sx (reduce vasogenic edema).
- Usually surgery with almost all tumors for diagnostic biopsy/resection/debulking.
- Surgical techniques; neuronavigation, neuroendoscopy, ultrasound, fluorescence-guided resection, intraop MRI, and IC Green.
- Radioactive implants, antibodies against tumor-specific antigens, or radiosensitizing agents may be used.
- Radiation/Gamma Knife (common with metastasis) and chemotherapy.
- Children may need anesthesia for Gamma Knife. Linear accelerator, and proton-beam treatments.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Cartilaginous overgrowth in acromegaly Skin: Melanoma with metastases		Acromegalic features third nerve palsy, papilledema, vision changes, hearing changes, macrocrania, bulging fontanel (infant)	Lateral neck x-ray
CV	Age effect: CHF, ASCVD, chemotherapy cardiomyopathy, including ICP	DOE, edema, angina	Gallop, rales, jugular distention, Htn, bradycardia	CXR, ECG, ECHO
RESP	COPD: Primary lung tumor with cerebral metastases	Dyspnea, cough, sputum	Signs of COPD, altered breathing pattern	FEV_1, FVC (if indicated)ABG CXR
RENAL/GI	Dehydration, SIADH, colon, renal tumor with metastases	Mannitol, diuretics, decreased intake, vomiting (especially children)	Dry mucous membranes	Urine SG, sodium, Cr
ENDO	Iatrogenic Cushing syndrome due to decadron, infertility	Improved level of consciousness with decadron	Cushingoid appearance	Glucose levels
HEME	Anemia, paraneoplastic syndrome, increased thromboembolism	Occult GI bleeding caused by primary tumor	Pale conjunctiva, positive occult fecal blood	Hct, Hgb, T&C
CNS	Seizures (50% as presenting symptom), somnolence, hydrocephalus	Headache, confusion, ataxia, neck stiffness	Altered consciousness, personality changes, memory loss, speech changes	MRI, CT, note peritumoral edema, loss ventricles, basilar cisterns, midline shift
PNS	Hemiparesis	Clumsiness	Weakness, numbness, hemiparesis, tingling, spasticity, or rigidity	Nerve conduction velocity

Key References: Rahimi E, Manninen PH: Routine craniotomy for supratentorial masses. In Mongan P, Soriano S, Sloan T, editors: *A practical approach to neuroanesthesia,* Philadelphia, 2013, Wolters Kluwer, pp 37–52; McClain CD, Soriano SG: Anesthesia for intracranial surgery in infants and children, *Curr Opin Anaesthesiol* 27(5):465–469, 2014.

Perioperative Implications

Preoperative Preparation

- Neurologic exam: LOC, pupil size, reactivity.
- Evaluation: Is pt a candidate for awake stereotaxic surgery.?
- Focal neurologic symptoms; new weakness within 1 y (avoid succinylcholine)
- Is there elevated ICP to start with? (headache, N/V, loss of vision, or diplopia)
- Delayed gastric emptying or N/V with increased ICP.
- Dexamethasone: May lower ICP initially, but ICP may increase with small change in physiology.
- Temporal lobe lesion with impending herniation.
- Imaging studies; massive peritumor edema with shift of midline.
- Seizure behavior; AED adequate; beware postop seizure.
- Assess volume status (dehydration).
- Implants affecting MEP or MRI.
- Paraneoplastic syndromes, hypercoagulopathy.

Monitoring

- Consider arterial line: BP control, frequent ABGs, glucose; avoid dec PaO_2.
- Monitor CPP (MAP–ICP), BP transducer at ear level, Foley.
- $ETCO_2$ as rough guide only; rely on $PaCO_2$ and avoid including CO_2
- ICP: Zero at ear level, for postop use
- If lumbar CSF drains are used, connect to transducer, leave closed until head open and surgeon ready, then drain slowly as needed by surgeon.
- Optimize hyperventilation (25–30 mm Hg $PaCO_2$), mannitol, 3% hypertonic saline Rx.
- Diagnostic if pt is slow to awaken from anesthetic.
- NMB: Increased receptor density in paretic extremities gives false twitch data. Use nonparetic arm/leg.
- ECoG used if surgery to treat seizure disorder or brain mapping.
- Positioning occipital and pineal tumors: Mild head up; if sitting, then monitor for air embolism (precordial Doppler, CVP, etc).

Airway

- Cushingoid facies may result in difficult mask ventilation.
- Acromegaly causes laryngeal compromise by cartilaginous overgrowth. Anticipate difficult intubation; may require smaller endotracheal tube. Consider lateral neck x-ray for airway abn, such as enlarged epiglottis, narrowed cricoid ring.
- Stereotactic frame may inhibit laryngoscopy (may need LMA).

Preinduction/Induction

- Induction with agents that act to decrease cerebral blood flow (avoid ketamine).
- Opioids prn to avoid hemodynamic responses during induction, pinning, and incision.
- Avoid increased BP with intubation/head pins.
- Avoid brain swelling due to venous outflow occlusion: Do not permit overflexion or excessive rotation of neck.
- Eye protection from prep solution and pressure while face covered by drapes, instruments.
- Use soft bite block, and check tongue and lips (especially with MEP).
- Local anesthesia for reduced bleeding of incision.

Maintenance

- Goal is normovolemia, normotension, normonatremic fluids; replace diuresis if needed.
- Avoid hyperglycemia, hypo-osmolality (<290 mOsm/kg).
- Low intrathoracic pressure (reduced cerebral venous pressure).
- Monitor $PaCO_2$, esp with COPD.
- Mannitol at 0.5–1 g/kg per surgeon (but occasionally hypertonic saline).
- No painful structures below dura: Implement minimal anesthetic requirement with brain manipulation, low-dose inhalation agent, and/or propofol infusion.
- Avoid N_2O, use inhalational agent <1 MAC, <½ MAC if SSEP, ECoG, or MEP. Implement TIVA if EP signals are poor.
- Consider high dose short-acting opioids.
- Avoid NMB during MEP or EMG monitoring.
- Maintain good cerebral perfusion but not Htn.
- Antibiotics; redose at appropriate interval.

Extubation

- Extubate in head up position to dec bleeding.
- Awake: Implement normocarbia, early neurologic assessment (risk of coughing, straining, possible hematoma formation, with risk of increasing postop Htn).
- Deep: Avoid coughing; may be Htn (transient $PaCO_2$ about 50 mm Hg until pt awakens and use deep extubation only if there is no brain edema during craniotomy and no anticipated airway problems).
- Htn on awakening. Consider prophylactic beta blockers/antihypertensives.
- Consider postop intubation/ventilation with preop poor mental status.

Adjuvants

- Decadron, mannitol, and Lasix.
- Profound paralysis: May minimize need for inhalation agents.
- For muscle relaxants, expect nondepolarizing NMB will be shorter acting with most AED (except keppra).
- Expect hemodynamic effects from epinephrine in local infiltrated into scalp incision site.
- Antiemetics (differentiate PONV vs. increased ICP).
- Vasoactive compounds.
- Consider first-line Htn treatment with labetalol.
- Consider cerebral vasodilators: Hydralazine, sodium nitroprusside if severe Htn.

Anticipated Problems/Concerns

- Intraop brain swelling (head up, decreased CO_2, including venous drainage, decreased inhaled anesthesia, propofol/barbiturates, dexamethasone, correct hypoxemia)
- Air embolism with tumors near dural sinuses and sitting position
- Intracranial bleeding (dural sinuses, vascular tumors)

- Postop, including ICP due to loss autoregulation
- Delayed awakening, especially with depressed consciousness preop
- Postexcision brain swelling; seizures
- Postop arterial Htn/bleeding
- Postop endocrine problems, diabetes insipidus

Awake Craniotomy

- Awake craniotomy with mapping to remove tumors near motor strip or speech centers
- Good communication
- Controlled sedation, short-acting medications, and LMA for lost airway
- Scalp blocks, one side, bilateral, long-acting medication, pins sites, specific scalp nerves, ring block, and possible high doses
- Methods: Awake, sedated/awake/sedated, asleep/awake/sedated
- Mapping: Speech, reading, counting, motor, observed movements or EMG, sensory

Complications

- Seizures, cold irrigation, short-acting medications
- Vomiting, hypoxemia, respiratory depression
- Air embolism
- Nose itching, dry mouth, and urinary urgency (males)

Supraventricular Tachycardia (Tachyarrhythmias)

Gina Whitney | Lee A. Fleisher

Risk

- SVT is associated with advancing age and significant cardiac and pulm disease.
- PSVT is associated with WPW, congenital heart disease, and mitral valve prolapse. It is more common in younger pts. The mechanism is reentrant in nature.
- AAT may be automatic, triggered, or reentrant. It is seen more commonly in children and those with a Hx of prior atrial surgery. It is rare in adults, although it can be associated with digitalis toxicity and hypokalemia.
- MAT is seen in adult pts with critical illness or advanced pulm disease.

Perioperative Risks

- Myocardial ischemia associated with tachycardia and resulting coronary insufficiency.
- Circulatory compromise.
- Increased risk of atrial thrombus.
- Chronic sustained tachycardia can result in irreversible cardiomyopathy.

Worry About

- Lyte and acid-base balance (K^+, Mg, alkalosis)
- Digitalis toxicity

Overview

- Tachycardia (HR >100 in adults) with origin above the bundle of His in sinus node, atrial, or junctional tissue. It may be reentrant, automatic, or triggered in origin.
- SVT may be paroxysmal (PSVT) or gradual in onset (sinus tachycardia, atrial tachycardia, or multiform atrial tachycardia). Tachycardia mechanisms vary (reentrant vs. triggered and automatic); treatment varies accordingly.
- PSVT is a reentrant arrhythmia usually seen more commonly in children. The reentrant circuit usually involves an accessory conducting pathway and the AV node.
- AAT is more commonly seen in the pediatric population owing to the enhanced automaticity seen in children.

Etiology

- PSVT is due to reentry, which generally involves the AV node and an accessory pathway. Accessory pathways are relatively common in children. It is also assoc with WPW and LGL.
- AAT is much more common in children and thought to stem from areas of enhanced automaticity of sites, which are usually found at the mouth of either atrial appendage, the orifices of the pulm veins, or the crista terminalis.

Usual Treatment

- PSVT: Drugs, which alter the refractoriness of tissue within the reentrant circuit, may terminate tachycardia. Adenosine delivered by IV push is commonly used to terminate tachycardias. Other agents that may be used include procainamide, propafenone, amiodarone, sotalol, esmolol, and verapamil.
- PSVT may also be terminated by cardioversion or rapid atrial pacing; includes placement of a pacemaker.
- AAT may be treated using amiodarone, sotalol, flecainide, or beta blockers.
- MAT may be managed using beta blockers or calcium-channel blockers to slow the ventricular rate and improve cardiac function. Underlying cardiopulmonary disease must be addressed as well.
- Consider cath ablation in recurrent symptomatic conditions.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Arrhythmia	Palpitations, presyncope or syncope, angina, dyspnea Failure to thrive (pediatrics)	Regular (PSVT, AAT) or irregular pulse (MAT)	ECG, Holter, EP study
	LV function Ischemia	CHF, exercise intolerance Angina	Signs of CHF (S_3, rales, edema, wheezing) Diaphoresis	CXR, ECHO Angiogram Scintigram
RESP	CHF, COPD	Dyspnea, orthopnea, cough	S_3, rales, wheezing	CXR, PFTs
GI	Hypoperfusion	Abdominal discomfort, diarrhea		
RENAL	Hypoperfusion	Oliguria, polyuria	UO	BUN/Cr, FENa

Key References: Thompson A, Balser JR: Perioperative cardiac arrhythmias, *Br J Anaesth* 93(1):86–94, 2004; Price A, Santucci P: Electrophysiology procedures: weighing the factors affecting choice of anesthesia, *Semin Cardiothorac Vasc Anesth* 17(3):203–211, 2013; Page RL, Joglar JA, Caldwell MA, et al: 2015 ACC/AHA/HRS guideline for the management of adult patients with supraventricular tachycardia: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society, *Circulation* 133(14):e506–e574, 2016.

Perioperative Implications

Preoperative Preparation

- PSVT: Adenosine, esmolol, and amiodarone should be available.
- AAT: Check and optimize electrolyte (K^+, Mg) and acid-base status. Rule out digitalis toxicity.
- MAT: Optimize status of various organ systems including cardiac, pulm, renal, and metabolic.
- Check pacemaker function.

Monitoring

- ECG, ST-segment analysis.
- Ability to monitor pacemaker if appropriate.
- Consider arterial pressure or PAC monitoring depending on anticipated case and pt status.

Induction

- In the setting of LV dysfunction or cardiomyopathy, aim for hemodynamically stable induction.
- AAT and MAT: Use caution with medications or situations that increase pt's heart rate (ketamine, pancuronium, desflurane, beta agonists, light anesthesia).

Maintenance

- Volatile agents with the possible exception of desflurane are not thought to increase the incidence of PSVT, AAT, or MAT.
- Prophylactic beta blockade may be useful intraop if the pt is able to tolerate it.

Extubation

- Avoid excessive sympathetic stimulation around the time of extubation because this increases the incidence of tachyarrhythmias. Strategies aimed at mitigating airway stimulation and hyperdynamic circulation are helpful in this regard.

Adjuvants

- Avoid use of beta agonists and histamine-releasing drugs if at all possible

Postoperative Period

- Ensure adequate sedation and pain control.
- Use of beta blockers as tolerated will reduce incidence of MAT and AAT postop.
- Optimize cardiopulmonary and metabolic status.

Anticipated Problems/Concerns

- PSVT: Be prepared to treat atrial fibrillation/flutter with rapid ventricular rate or ventricular fibrillation with cardioversion and/or defibrillation, particularly in pts with WPW or LGL.
- Cardioversion of AAT or MAT may result in life-threatening arrhythmias.