

Preoperative Evaluation and Perioperative Management

NOTE: The purpose of the preoperative evaluation is to determine a patient's relative risk of suffering medical complication from surgery, and to determine if medical therapy can be optimized to help mitigate that risk. The purpose is not to provide a "permission slip" for surgery but to broadly gauge medical risk and make a recommendation based on that risk.

Steps to the Preoperative Evaluation

1. Determine risk category of procedure*
 - i. If surgery is low-risk – no further evaluation needed
 - ii. If surgery is medium or high-risk – **proceed to #2**
2. Perform detailed pre-operative history and physical examination
3. Assess and appropriately document relevant risk scores (see [Risk Stratification section](#))
 - i. If patient is NOT at elevated risk – no further evaluation needed
 - ii. If RCRI ≥ 2 or ACS-NSQIP $> 1\%$, patient is at elevated risk – **proceed to #4**
4. Assess functional capacity**
 - i. If patient has adequate functional capacity – no further evaluation is generally needed, pending select preoperative tests (see [Preoperative Test Indications section](#))
 - ii. If patient's functional capacity is NOT adequate or is unknown – **proceed to #5**
5. Determine if any testing is needed***
 - i. If management will NOT be affected – no further evaluation needed or recommend patient not proceed with surgery on basis of unacceptable medical risk
 - ii. If management WILL be affected – **proceed to #6**
6. Obtain test(s) that are indicated
 - i. If test is normal – no further evaluation needed
 - ii. If test is abnormal – treat underlying problem, optimize medial therapy, or recommend patient not proceed with surgery on basis of unacceptable medical risk

***NOTE:** Procedure risk categories based on location/organ system or type (generalization)

- ▶ High-risk
 - ◆ Cardiac (including valvular)
 - ◆ Vascular
 - ◆ Gastrointestinal (in patients age ≥ 65 years)
- ▶ Intermediate-risk
 - ◆ Head and neck
 - ◆ Gastrointestinal/intraperitoneal
 - ◆ Orthopedic (including elective procedures)
 - ◆ Prostate
- ▶ Low-risk
 - ◆ Cataract
 - ◆ Breast

- ♦ Electroconvulsive therapy (psychosurgery)
- ♦ Superficial/cutaneous procedures
- ♦ Various non-surgical diagnostic procedures (e.g. endoscopy) not requiring general anesthesia

****NOTE:** *Functional capacity screening questions*

- ▶ “Can you walk two blocks at a normal pace without chest pain or becoming short-of-breath, dizzy, passing out, or being forced to stop or slow down?”
- ▶ “Can you climb a flight of stairs without chest pain or becoming short-of-breath, dizzy, passing out, or being forced to stop or slow down?”

If yes to both questions, then functional capacity is likely adequate.

*****NOTE:** *Questions to ask yourself before ordering preoperative tests*

- Is the test indicated given the history and physical exam (per guidelines)?
- Could an abnormal result cause the surgery to be cancelled?
- Could an abnormal result change the perioperative management?
- Could an abnormal result cause me to incur unnecessary medicolegal risk?

Preoperative History

• Background information

- Confirm surgeon’s contact information, location of surgery, and tentative date
- Confirm procedure to be performed
- Confirm patient understanding of why surgery is being done
- Confirm primary physician’s contact information

• Logistical/reconciliation

- Contacts, dentures, hearing aids
- Reconcile medications
 - Ask specifically about aspirin, anticoagulant, or NSAID usage
 - Oral steroid (prednisone) use within the past year
- Allergies to medications
- Allergies to rubber/latex
 - Cross-sensitization allergies related to latex (bananas, avocados, kiwis, apricots, chestnuts, white potato, tomato).
- Current living situation (homeless, with family, nursing home, etc.)
- Current or past occupation
- Current living will/code status

• Review of systems/high-value screening

- General ROS screening
 - Fever, cough, chest pain, SOB, dizziness, syncopal episodes
- Sleep breathing disorder screening (see chapter: [Sleep Breathing Disorders](#))
 - STOP-BANG*:

- Snoring (“Do you snore loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night?”)
- Tired (“Do you often feel Tired, Fatigued, or Sleepy during the daytime (such as falling asleep during driving or talking to someone?”)
- Observed (“Has anyone observed you stop breathing or choking/gasping during your sleep?”)
- Pressure (“Do you have or are you being treated for high blood pressure?”)
- Body mass index ≥ 35 kg/m²
- Age >50 years
- Neck size (males: shirt collar 17 inches/43 cm or larger; females: shirt collar 16 inches/41 cm or larger)
[Measured around Adams apple]
- Gender = male
- Bleeding disorder screening
 - Easy bruising, frequent unprovoked epistaxis or gingival bleeding (“frequent nose bleeds or gum bleeding for no reason?”), hemarthrosis with mild trauma (“bleeding into joint after minor sports or recreational injury?”), prior excessive surgical blood loss, use of anticoagulants, use of nutritional or herbal supplements/remedies
 - Women: menorrhagia with iron deficiency (“Have you ever had heavy menstrual periods with prolonged or excessive bleeding which caused you to become iron deficient?”)
- Drug use screening
 - Past history of alcohol use; current alcohol use and quantity.
[See chapter: [Adult Wellness, Screening, and Primary Prevention > History and Counseling > NOTE: “A standard alcoholic “drink” and harmful alcohol consumption quantified”](#)]
 - Tobacco use and quantity (in pack-years)
 - Illegal drug use
[Inquire specifically about IV drug use]
 - Non-prescription drug use (e.g. supplements)
 - Opioid addiction history

• Medical history

- Any current medical problems
 - Inquire specifically about:
 - PMH of heart failure
 - PMH of myocardial infarction, stroke, or peripheral arterial disease (“Have you ever been diagnosed with a heart attack, stroke, or insufficient circulation in your legs?”)
[Specifically inquire if stroke or TIA was within past three months]
 - PMH of arrhythmia or structural heart disease
 - PMH of venous thromboembolism (“Have you ever had a blood clot? For example, in your legs – called a deep vein thrombosis; or in your lungs – called a pulmonary embolism”)
[Specifically inquire if VTE was within past three months]
 - PMH of sleep apnea

- If yes: inquire about compliance with PPV or other treatment (e.g. mandibular advancement device).
- PMH of COPD (“Have you ever been diagnosed with emphysema or COPD?”)
 - If yes: history of hospitalization for COPD and history of endotracheal intubation (“when you were in the hospital, did they have to place a tube down your throat to help you breathe?”)
- PMH of kidney, lung, or liver disease (“Have you ever seen a heart, lung, or kidney doctor for anything?”)
- PMH of allergic reaction to local or general anesthesia
- PSH of cardiac device implantation
 - Type and model of device, date it was implanted, date it was last interrogated for performance and battery life
- PSH of cardiac valve replacement

• Family history

- FH of bleeding diathesis (“bleeding disorder” or “easy bleeding”)
 - FH of hypercoagulopathy (e.g. Factor V Leiden), DVT, or PE (“blood clots”)
 - FH of adverse reaction to anesthesia
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NOTE: Patients with NYHA class III or IV heart failure should be evaluated by their cardiologist prior to surgery.

***NOTE:** *STOP-Bang Scoring*

- OSA/HS Low Risk: Yes to 0-2 questions
 - OSA/HS Intermediate Risk: Yes to 3-4 questions
 - OSA/HS High Risk: Yes to 5-8 questions
- or Yes to ≥ 2 of 4 STOP questions + male gender
 or Yes to ≥ 2 of 4 STOP questions + BMI >35 kg/m²
 or Yes to ≥ 2 of 4 STOP questions + neck circumference 43 cm (male) or 41 cm (female)

Risk Stratification

• Cardiac complication risk

- Revised Goldman Cardiac Risk Index (RCRI) score ([mdcalc link](#))
 - Calculates percent-chance of suffering a post-surgical "major cardiac complication," operationally defined as myocardial infarction, ventricular fibrillation or primary cardiac arrest, complete heart block, or pulmonary edema
- +/- American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) score

• Pulmonary complication risk

- ARISCAT (Canet) Preoperative Pulmonary Risk Index

• VTE risk

- Caprini Risk Assessment Model score (see [VTE Prophylaxis for Adults Undergoing Nonorthopedic General or Abdominopelvic Surgery](#) table)
- Patient Safety in Surgery (Rogers) score



Q: Which procedure types carry the highest risk for VTE?

A: Abdominal and pelvic procedures carry the highest VTE risk – especially if they are performed in cancer patients.

VTE Prophylaxis for Adults Undergoing Nonorthopedic General or Abdominopelvic Surgery

| VTE Risk Category | Low Bleeding Risk | High Risk for Major Bleeding |
|----------------------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Very low risk (0.5%) Caprini score 0 Rogers score <7 | Early ambulation | Early ambulation |
| Low risk (~1.5%) Caprini score 1-2 Rogers score 7-10 | Mechanical prophylaxis | Intermittent pneumatic compression device |
| Moderate risk (~3.0%) Caprini score 3-4 Rogers score >10 | LMWH or LDUH or IPC | IPC |
| High risk (~6.0%) Caprini score ≥5 | LMWH or LDUH and mechanical prophylaxis with elastic stockings or IPC | IPC until risk of bleeding diminishes and pharmacologic prophylaxis can be initiated |
| High risk (~6.0% with contraindications to LMWH/UFH) | Low-dose aspirin, fondaparinux, or mechanical prophylaxis with IPC | IPC until bleeding risk diminishes and pharmacologic prophylaxis can be initiated |
| Cancer surgery (abdominal/pelvic cancers) | Extended-duration pharmacologic prophylaxis (4 weeks) with LMWH | |

Preoperative Test Indications

- **General principles**

- No test should be ordered for any patient undergoing low-risk surgery
 - Before ordering a test, check in the chart to see if it was done within the past three months and accept any normal results for the purposes of screening (generally)
 - When possible, try to limit your testing only to what you are actually interested in – e.g. for a hemoglobin, do not run an entire complete blood count – ordering information you don't need forces you to do something about benign abnormalities and puts you on the hook from a medicolegal standpoint
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- **Urine pregnancy test**

- All women of child-bearing age undergoing medium or high-risk surgery
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- **Serum creatinine and BUN**

- Patients age ≥ 50 years undergoing high or medium-risk surgery
- Patients with or suspected of having renal disease, including asymptomatic renal disease (diabetes, hypertension)
- Patients currently taking or who will be taking nephrotoxic medications
- Patients undergoing procedure where hypotension is likely

- **Serum electrolytes**

- Consider in patients taking medications that alter renal function or otherwise interfere with electrolyte balance

- **Serum electrolytes including Mg^{2+} and phosphorus**

- Patients with or suspected of having renal disease
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- **Hemoglobin**

- Patients age ≥ 65 years undergoing high or medium-risk surgery (to establish baseline)
- Patients undergoing surgery with expected major blood loss
- Patients with symptoms of anemia
- Patients with renal disease

- **Platelet count**

- Patients undergoing neuraxial anesthesia
- Patients on anticoagulants
- Patients with hepatic disease
- Patients with preoperative history that suggests presence of a bleeding or clotting disorder

- **PT/INR and/or aPTT**

- Patients on anticoagulants
- Patients with a known clotting disorder
- Patients with preoperative history that suggests presence of a clotting disorder

- **Indirect antiglobulin test (type and screen; type and crossmatch if risk high enough that blood will need to be available in OR)**

- Patients undergoing surgery with expected major blood loss

- **AST/ALKP**

- Patients with increased risk of active hepatic disease undergoing general or neuraxial (spinal) anesthesia
 - IV drug users
 - Men who have sex with men (MSM)
 - Patients on dialysis
 - Patients with alcohol addiction
 - Patient taking high-risk medications

- **Hepatitis B serology**

- Patients at high-risk of active hepatic disease (see above) who are undergoing general or neuraxial (spinal) anesthesia

- **Hepatitis C serology**

- Patients at high-risk of active hepatic disease (see above) who are undergoing general or neuraxial (spinal) anesthesia
- Consider in individuals born between 1945 to 1965 who have never been screened

- **Serum albumin**

- Patients suspected of having hypoalbuminemia
 - Inflammatory conditions
 - Heart failure
 - Cirrhosis
 - Nephrotic syndrome
 - Kwashiorkor/acute malnutrition
 - Protein-losing enteropathy
 - Consider in patients with ≥ 1 risk factor for perioperative pulmonary complications*
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- **Clean-catch or mid-stream microscopic urinalysis**

- Patients undergoing procedures in which GU instrumentation is planned
[These patients will require treatment of asymptomatic bacteriuria]
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- **Pulmonary function tests**

- Patients undergoing lung resection surgery
 - Patients with COPD or asthma with non-optimal reduction in airflow obstruction (compared to their “best” baseline)
 - Patients with dyspnea or exercise intolerance of unclear origin (cardiac disease vs. deconditioning)
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- **EKG**

- Patients with RCRI ≥ 1 undergoing medium or high-risk surgery (for both screening purposes and to establish a baseline)
 - Patients undergoing vascular surgery
 - Patients with known coronary artery disease, heart failure, cerebrovascular disease, peripheral vascular disease, arrhythmia, or structural heart disease
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- **Chest X-ray (PA and Lateral)**

[ACP guidelines (first two); AHA addition (third)]

- Patients with cardiac or pulmonary disease
- Patients undergoing abdominal aortic aneurysm surgery
- Patients age ≥ 50 years undergoing upper abdominal/thoracic surgery
- Patients with severe obesity (BMI ≥ 40 kg/m²)

- **Tuberculosis screening**

- Patients with known exposure
- Patients who are HIV-positive

- **Pharmacologic Cardiac Stress Test**

- See [Steps to Pre-Operative Clearance](#)
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NOTE: *Surgeries with heightened pulmonary risk*

Any surgery involving the upper airway (e.g. head and neck) or in close proximity to the diaphragm including intrathoracic and intraabdominal surgeries. Pain as a result of abdominal procedures leads to reduced lung volumes. The highest-risk surgeries are those involving the esophagus or abdominal aorta.

***NOTE:** *Risk factors for postoperative pulmonary complications*

- COPD
- Congestive heart failure
- Age >60 years
- ASA-Class ≥ 2
- Functionally dependent

Perioperative Medication Management

- Herbal supplements
 - Discontinue 2 weeks prior to surgery
- Metformin
 - Discontinue 12 hours before surgery
 - Resume upon discharge (do NOT continue in the inpatient setting)
- Sulfonylureas
 - Discontinue 24 hours before surgery
 - Resume upon discharge (do NOT continue in the inpatient setting)
- Statins
 - Continue in the perioperative period
- ACE inhibitors and ARBs
 - Discontinue 24 hours before non-cardiac surgery
- Beta blockers
 - Continue in the perioperative period (regardless of surgery type)
 - For patients who cannot resume PO medications within 12 hours following surgery: Switch to equivalent IV formulation peri- and post-operatively, as necessary

- Alpha-2 agonists
 - Continue in the perioperative period (regardless of surgery type)
 - For patients unable to resume PO medications within 12 hours following surgery:
 - 3 days before surgery, start equivalent dose of transdermal clonidine while simultaneously tapering PO agent.
 - Resume PO medication, keeping in mind transdermal clonidine effect persists for 24-48 hours after patch removal.
- Diuretics
 - Patients taking for hypertension
 - Discontinue on the morning of surgery
 - Resume when patient is taking oral fluids
 - Patients taking for heart failure
 - Administer or hold perioperatively as needed depending on volume status
- Proton-pump inhibitors and H₂ blockers
 - Continue in the perioperative period
 - Patients unable to resume PO medications within 12 hours following surgery:
 - Administer IV PPI or H₂ blocker
- Oral contraceptives
 - Continue in the perioperative period for low VTE-risk surgeries
 - Discontinue 6 weeks prior to surgery for moderate-high VTE-risk surgeries
- Selective estrogen receptor modulators
 - Continue in the perioperative period (for low VTE-risk surgeries)
 - Discontinue 4 weeks prior to surgery (for moderate-high VTE-risk surgeries)
- Levothyroxine
 - Continue in the perioperative period (for non-thyroid surgeries)
 - For patients who cannot resume oral intake within 5 days
 - Administer IV or IM T₄ at ~80% of patient's oral dose
- Alpha-1 antagonists
 - Continue in the perioperative period (for non-ophthalmologic surgeries)
- Anti-epileptics
 - Generally, continue in the perioperative period
- Leukotriene inhibitors (zafirlukast and montelukast)
 - Continue in the perioperative period
- Colchicine
 - Discontinue on the day of surgery
 - Resume when patient can tolerate oral intake
- Hypouricemic agents (allopurinol and probenecid)
 - Discontinue on the day of surgery
 - Resume when patient can tolerate oral intake
- Inhaled β -agonists and inhaled anticholinergics
 - Continue in the perioperative period

Aspirin and Thienopyridines

- Aspirin
 - Patients taking for primary prevention:

- Generally, discontinue 1 week prior to surgery
- Resume at discretion of prescribing/managing physician
- Patients taking for secondary prevention:
 - Consult surgeon and/or prescribing physician
- Thienopyridines/P2Y₁₂ inhibitors (clopidogrel, prasugrel, ticagrelor, ticlopidine)
 - Patients taking for primary prevention:
 - Generally, discontinue 1 week prior to surgery
 - Resume at discretion of prescribing/managing physician
 - Patients taking for secondary prevention:
 - Consult surgeon and/or prescribing physician
 - Patients <12 months post-PCI with placement of drug-eluting stents, patients <1 month post-PCI with placement of bare metal stents, and patients undergoing cataract surgery without bulbar block
 - Generally, continue in the perioperative period

Warfarin

- Generally, discontinue five days before surgery (elective surgery) – check PT/INR on day before surgery
 - If INR >1.5, administer low-dose oral vitamin K (1-2mg) and recheck the following day
 - Surgery generally safe when INR <1.4; more aggressive lowering may be needed in patients undergoing intracranial, spinal, or urologic surgery, or if neuraxial anesthesia will be used.
- Resume at discretion of prescribing/managing physician

Other Anticoagulants

- Enoxaparin (Lovenox®)
 - Patients on prophylactic dose (40mg/daily):
 - Generally, discontinue 24 hours prior to surgery
 - Resume in consultation with the surgeon (depends on surgical bleeding risk)
 - Neuraxial anesthesia
 - Wait 12 hours after last dose before spinal/epidural catheter placement
 - Resume 6-8 hours after catheter removal
 - Patients on therapeutic dose (1mg/kg BID):
 - Generally, discontinue in consultation with the surgeon and/or prescribing physician
 - Resume in consultation with the surgeon (depends on surgical bleeding risk)
 - Patients undergoing neuraxial anesthesia:
 - Wait 24 hours after last dose before spinal/epidural catheter placement
 - Resume 24 hours after catheter removal
- Dabigatran (Pradaxa®)

- Generally, discontinue 2-3 day before surgery (4 days in patients with moderately severe renal dysfunction)
- Resume in consultation with the surgeon (depends on surgical bleeding risk)
- Rivaroxaban (Xarelto®)
 - Generally, discontinue 2-3 days before surgery
 - Resume in consultation with the surgeon (depends on surgical bleeding risk)
 - Anti-factor Xa level may be used in select patients to evaluate whether drug has adequately cleared prior to high-risk surgery

Insulin

- Type I diabetics: Consult endocrinology
- Type II diabetics (non-insulin treated)
 - Check preoperative and postoperative glucose
 - If patient is transitioned to IV glucose and insulin infusion during surgery, continue infusion and short-interval BG checks; when patient begins tolerating oral intake, stop infusion and transition back to SUBQ insulin.
- Type II diabetics (insulin-treated)
 - Preoperative: Administer 60-80% basal insulin evening prior to surgery and use correction scale
 - Perioperative: Administer IV glucose at 5g/hr, initiate insulin infusion, and monitor BG to titrate
 - Postoperative: Continue infusion and short-interval BG checks; when patient begins tolerating oral intake, stop infusion and transition back to SUBQ insulin

NOTE: POC glucose is not as reliable in patients who are critically ill, especially those on vasopressors. In these cases, venous or arterial blood testing may be required.

Disease Modifying Antirheumatic Drugs

- Methotrexate
 - Continue in the perioperative period (for patients without renal impairment)
 - Discontinue 2 two weeks prior to surgery in patients with renal impairment, evidence of bone marrow suppression, or active infection
- TNF-alpha inhibitors (etanercept (Enbrel®), infliximab (Remicade®), adalimumab (Humira®)
 - Consult prescribing rheumatologist
- Sulfasalazine
 - Discontinue 1 week prior to surgery
 - Resume when patient is tolerating oral intake
- Azathioprine
 - Discontinue 1 week prior to surgery
 - Resume when patient is tolerating oral intake

Glucocorticoids

- Oral glucocorticoids
 - Patients taking for less than <3 weeks or taking chronic alternate-day therapy:

- Continue in the perioperative period
- Patients taking >20 mg/day of prednisone for ≥3 weeks or patients with a Cushingoid appearance:
 - Give increased dose perioperatively
- Patients taking 5-20 mg/day of prednisone for >3 weeks:
 - Undergo testing for empiric glucocorticoid coverage
- Inhaled glucocorticoids
 - Continue in the perioperative period

Psychiatric Drugs

- Antipsychotics
 - Consult prescribing psychiatrist and/or clinical pharmacist
- Benzodiazepines
 - Continue in the perioperative period
 - In patients taking benzodiazepines chronically who cannot tolerate oral intake, administer parenteral lorazepam or diazepam
- Buspirone
 - Continue in the perioperative period
 - Do not use meperidine or tramadol (due to serotonergic effect)
- Mood-stabilizing agents (lithium, valproate)
 - Generally, continue in the perioperative period.
 - If continued in the perioperative period:
 - Closely monitor fluid/electrolytes
 - Obtain TSH and free T4 prior to surgery
 - In patients on lithium who cannot take oral medications within 24 hours:
 - Substitute parenteral valproate or second-generation antipsychotics (e.g. risperidone, aripiprazole, olanzapine, or ziprasidone)
- Selective serotonin reuptake inhibitors (SSRIs) and selective norepinephrine reuptake inhibitors (SNRIs)
 - Generally, continue in the perioperative period
 - Patients may have a slightly increased bleeding risk, especially when antiplatelet agents are also continued in the perioperative period
- Bupropion
 - Continue in the perioperative period
- Tricyclic antidepressants
 - Continue in the perioperative period
- Monoamine oxidase inhibitors
 - Consult prescribing psychiatrist and clinical pharmacist
 - If continued in the perioperative period:
 - Document note recommending avoidance of meperidine and dextromethorphan
 - Inpatient diet orders should strictly specify low tyramine diet

NOTE: Antipsychotics are problem in the perioperative period for multiple reasons:

- Discontinuation of these agents can exacerbate psychoses in vulnerable patients
- They cause QTc prolongation

- They potentiate sedative and hypotensive effects of anesthetics and opioid analgesics
- They cause varying degrees of cytochrome P450 inhibition, thereby interfering with the metabolism of common perioperative agents (e.g. antibiotics, midazolam, ketamine, etc.)
- They have widely varying half-lives

For this reason, it is reasonable to consult the prescribing psychiatrist if complete discontinuation is required several days prior to surgery. A clinical pharmacist may also be useful in gauging interaction risk and offering parenteral alternatives.

Medications to Consider Adding in Perioperative Period

- Beta-blockers
 - Consider initiating in RCRI ≥ 2 patients without a long-term indication for beta-blockers
 - Begin IV formulation on the day of surgery – titrate to maintain HR of 60-80 without hypotension; continue for 30 days following surgery, switching to PO formulation as necessary
 - Consider initiating in RCRI ≥ 2 patients with a long-term indication for beta-blockers
 - Administer and titrate dose of PO formulation over a period of several weeks prior to surgery
 - Do not start in patients with acute decompensated heart failure or other absolute contraindication
- Statins
 - Consider initiating in patients undergoing urgent or emergent vascular surgery
- Anticoagulation
 - Should be considered based upon the VTE risk category and bleeding risk of surgery
 - Warfarin-to-heparin bridging should be used for VTE high-risk patients (atrial fibrillation, mechanical heart valve, VTE or ischemic stroke < 3 months ago, presence of acquired or inherited hypercoagulopathy – among other indications)

NOTE: *Warfarin-to-heparin bridge (typical protocol)*

- Stop warfarin 5 days prior to surgery; 2 days later, begin therapeutic dose LMWH or unfractionated heparin (UFH) infusion
- Administer last dose of LMWH 24 hours prior to surgery (or stop UFH infusion 4-6 hours prior to surgery)
- Check INR 24 hours prior to surgery
- Resume therapeutic dose LMWH or UFH infusion 48-72 hours after high bleeding-risk surgery (or 24-hours after low bleeding risk surgery); Reinitiate warfarin at the same time (can restart warfarin sooner in some cases, as its onset of action is much longer)
- Monitor INR and discontinue LMWH/UFH when therapeutic INR is reached

Postoperative Management

- Be aware of common postsurgical complications
 - Postoperative fever
 - Low-grade fever in the first 48 hours postoperatively
 - Normal sequelae of inflammation or hematoma absorption (NOT due to atelectasis)
 - Does not typically require intervention
 - Temperatures $>38.5^{\circ}\text{C}$ at ≥ 48 hours post-surgery requires further evaluation
 - Surgical wound infection
 - Commonly occurs 5-10 days postoperatively
 - Postoperative ileus
 - Common after GI surgery, but can occur after any type of surgery
 - Ileus appears on plain film classically with uniform air distribution throughout the bowel
 - Abdominal CT with enteric contrast is most sensitive and specific (~100%) test to distinguish postoperative ileus vs. obstruction
 - Myocardial infarction
 - Carries double the mortality of non-postoperative MI
 - ~67% of patients with postoperative MI have no ischemic symptoms
 - *Type I postoperative MI*
 - Caused by plaque rupture and thrombus formation
 - Treated as normal ACS (see chapter on [Chest Pain/ Acute Coronary Syndrome](#))
 - *Type II postoperative MI*
 - Caused by supply/demand mismatch.
 - Major causes include tachycardia, hypovolemia, anemia, postoperative pain, and/or discontinuation of chronic β -blockers
 - Thought to be more common than type I
 - EKG is not very sensitive in diagnosing
 - Treatment is to correct myocardial oxygen supply/demand mismatch (optimizing hemodynamics through correction of dysrhythmia, transfusion, volume resuscitation, etc.)
 - *Nonischemic myocardial injury with necrosis*
 - Presence of elevated cardiac-specific biomarkers without evidence of ischemia
 - Occurs in sepsis, heart failure, and renal failure, among other conditions
 - May be caused by circulating inflammatory mediators (e.g. TNF)
 - Heart failure
 - Typically occurs within the first 36 hours after surgery
 - Excessive use of intraoperative and postoperative IV fluids is a major contributor
 - Prevent by discontinuing unnecessary IV fluids
 - (See chapter on [Acute Decompensated Heart Failure](#))

- Atrial fibrillation
 - Typically occurs within 24-48 hours after surgery
 - ~25% of cases resolve with no intervention, but most will need rate control with parenteral β -blockers or nondihydropyridine calcium channel blockers (see chapter on [Atrial Fibrillation and Atrial Flutter](#))
- Atelectasis
 - Reversible alveolar collapse which occurs in ~90% of patients receiving general anesthesia
 - Caused by a combination of CNS respiratory drive suppression, supine position, and use of positive pressure ventilation
 - Typically manifests as dyspnea or tachypnea with persistent postoperative hypoxemia in the absence of other plausible diagnoses
 - Typically resolves within 24 hours in normal subjects, may persist past 48 hours following major surgery
 - Contrary to popular belief, studies have not shown it to be a cause of postoperative fever (which is more likely a result of the inflammatory response to surgery)
- Pneumonia
 - *Healthcare-acquired pneumonia*
 - Early-onset (less than 5 days into hospital admission) is more likely caused by antibiotic-sensitive pathogens
 - Late-onset (>5 days into admission) is more likely to be caused by MDR pathogens
 - (See chapter on [Pneumonia](#))
- Mitigating postoperative pulmonary risk (especially important after abdominal or thoracic procedures)
 - Elevate head of bed 15-30°
[Unless surgical contraindication]
 - Pulse oximetry with centralized monitoring
 - Discontinue unnecessary IV fluids
 - Early mobilization
 - Encourage coughing; Incentive spirometry
 - NSAID analgesia (use as adjunct to decrease opioid doses)
 - Minimize opioid and nonopioid sedatives
 - +/- CPAP
[Patients with sleep-breathing disorders; those treated at home should use their own machine in the hospital]
 - +/- Nasogastric tube decompression
[Consider following abdominal surgery if postoperative nausea or vomiting, inability to tolerate oral intake, or symptomatic abdominal distention occur]

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