

# Perioperative Medicine

Anupa Barua, MD

Hospital medicine at THD

# Purpose of Pre op evaluation

- The main focus of the preoperative evaluation is to identify those patients at increased risk for perioperative morbidity and mortality.
- The role of the medical consultant is to risk-stratify patients, determine the need for further evaluation, prescribe possible interventions, and optimize chronic medical conditions to mitigate risk.
- Preoperative consultations often focus on cardiac risk, but it is essential to remember that poor outcomes can result from significant disease in other organ systems. Evaluation of the entire patient is necessary to provide optimal perioperative care.
- During documentation of consult instead of writing Patient “clear” patients for surgery; Better to write “patient is in optimal medical condition for planned procedure”

# Clinical Presentation

- History
- The focus of the history is to identify factors and comorbid conditions that will affect perioperative risk. Cardiac sign symptoms are particularly important.
- Evidence of active cardiac conditions:
  - Unstable angina or acute coronary syndrome
  - Recent MI (within 60 days if no coronary intervention)
  - Symptoms of decompensated congestive heart failure (CHF)
  - Significant arrhythmias (does *not* include chronic, rate-controlled atrial fibrillation)
  - Severe valvular disease
- Other significant risk factors:
  - Preexisting, stable coronary artery disease (CAD)
  - Stable CHF
  - Diabetes mellitus
  - Prior cerebrovascular accident (CVA) or transient ischemic attack (TIA)
  - Renal insufficiency (creatinine >1.5 or 2, depending on risk calculator.
  - Type of surgery Intra-abdominal, intrathoracic, or vascular surgery

## Physical Examination:

- Vital signs, particularly blood pressure (BP) and evidence of **hypertension**.
  - Systolic blood pressure (SBP)  $<180$  and diastolic blood pressure (DBP)  $<110$  mm Hg are generally considered acceptable
  - It may be reasonable to delay surgery for SBP  $>180$  or DBP  $>110$  if it is a new diagnosis of hypertension or there is evidence of end organ damage
- Murmurs suggestive of **significant valvular lesions**, particularly aortic stenosis (AS).
- Evidence of CHF (elevated jugular venous pulse [JVP], crackles, S3, etc.)

# Diagnostic Studies and Laboratory Tests

## Overview:

- Routine diagnostic testing is not indicated preoperatively in adult healthy patient undergoing minimally invasive and low risk surgery.
- **CBC, BMP- most commonly ordered test.**
- **(PT) (international normalized ratio [INR]), and partial thromboplastin time (PTT): not routinely recommended.** Should only be done
  - if coagulopathy suspected
  - if patient taking anticoagulants (eg. warfarin) where INR necessary to guide perioperative anticoagulation management.
- **Liver function tests**
  - Valuable only if acute hepatitis suspected otherwise **not indicated.**
- **Urine analysis: usually not recommended.** Only can order to evaluate and treat patients with genitourinary (GU) symptoms; may be beneficial to screen for and treat asymptomatic bacteriuria in those undergoing urologic surgery with instrumentation of GU tract; **not indicated before joint replacement**

## **Electrocardiogram**

- Electrocardiogram (ECG) for asymptomatic patients undergoing low-risk surgical procedures Not recommended
- According to the 2014 American College of Cardiology/American Heart Association (ACC/AHA) guidelines, a resting 12-lead ECG should be part of the evaluation in patients with known coronary artery disease, significant arrhythmia, peripheral arterial disease, cerebrovascular disease, or other significant structural heart disease, except for those undergoing low-risk surgery

**Chest x-ray:** almost never indicated

- Do not order routine preoperative chest radiographs or pulmonary function tests in the healthy patient
- Can order CXR in active or suspected cardiopulmonary disease based on history and abnormal chest exam.

**Pregnancy Test:** pregnancy testing in all reproductive age women prior to surgery

## **Resting 2-D echocardiograms**

- play no role in predicting risk of ischemic heart disease in surgery; should be used only for evaluating patients with valvular disease or HF

## **Left ventricular (LV) function**

- ACC guidelines say reasonable for patients with dyspnea of unknown etiology, routine preoperative evaluation of LV function not recommended, not shown to have benefit

## **Stress testing**

- This test is reasonable if elevated risk, poor functional capacity (<4 METs), if results will change management; routine screening with noninvasive stress testing not useful for low-risk noncardiac surgery;

**Routine preoperative coronary angiography not recommended**

# Perioperative Medication Management

**Most medications can safely be continued;**

- some considered essential eg cardiac medications, pulmonary medications, steroids and should be continued
- Some need not be continued (optional)
- Some require discontinuation or dose adjustment (*eg*, hypoglycemics, anticoagulants, antiplatelet drugs)

## **Medications to continue -**

- Cardiopulmonary medications should generally be continued; includes antihypertensive, antianginal, and antiarrhythmic drugs; continue beta blockers, statins, and clonidine
- Continue inhalers (beta agonists, anticholinergics, and steroid inhalers)

## **Medications to withhold the day of surgery -**

- Diuretics often withheld on morning of surgery from concern that patients might become hypovolemic or hypokalemic.
- Also ACE inhibitors and ARBs, which have been associated with more hypotension particularly during induction of anesthesia, if you stop them, restart postoperatively

## **Rheumatologic medications**

- Including DMARDs and biologics; 2017 guidelines by American College of Rheumatology (ACR) and American Association of Hip and Knee Surgeons
- NSAIDs, typically stop 1 day to 3 days before surgery because of possible bleeding or renal effects; celecoxib (COX-2 inhibitor) does not affect platelets or cause bleeding
- Methotrexate and hydroxychloroquine typically continued perioperatively
- TNF-alpha inhibitors ; includes infliximab and adalimumab; tend to stop ~2 wks before surgery; resume ~2 wks after, assuming adequate wound healing; speak to rheumatologist

## **Anti Diabetic medications**

- Oral hypoglycemic agents: discontinue 12-72 h before surgery depending upon half-life of the drug and risk of hypoglycemia
- Short-acting insulin: withhold morning of surgery
- Intermediate-acting insulin: reduce dose, typically to one half of usual dose
- Long-acting insulin: continue at previous dose or reduce dose to two thirds

**Psychiatric medications:** usually continue despite potential concerns

- SSRIs have potential for bleeding ( platelet dysfunction)
- tricyclics may be associated with arrhythmias
- lithium with nephrogenic diabetes insipidus
- MAO inhibitors exception, particularly older ones (have been associated with serotonin syndrome and hypertension); typically stopped 10 days to 14 days before surgery

## **Herbal medications**

- should be stopped 1 wk to 2 wks before surgery because may be associated with bleeding, sedation, hypoglycemia, drug interactions; include drugs like ginseng, garlic, ginkgo biloba, etc.

in practice, many patients undergo surgery have taken these drugs recently because physician did not obtain complete medication history or patient did not want to reveal use of these medications

## **Perioperative management of estrogen and related hormone OCP**

- For patients undergoing surgery with a low to moderate risk of VTE, continue without interruption (with appropriate perioperative VTE prophylaxis).
- For patients undergoing surgery with a high risk of VTE, stop 4 weeks before surgery. For women using them for contraceptive purposes, instruct on alternate forms of contraception and obtain serum pregnancy test immediately before surgery.

## **Postmenopausal hormone therapy**

- For patients undergoing surgery with a low to moderate risk of VTE, continue without interruption (with appropriate perioperative VTE prophylaxis).
- For patients undergoing surgery with a high risk of VTE, stop at least 2 weeks prior to surgery and resume once elevated risk of VTE has resolved.

## **Selective estrogen receptor modulators**

- For patients undergoing surgery with a low to moderate risk of VTE, continue without interruption (with appropriate perioperative VTE prophylaxis)
- For patients undergoing surgery with a high risk of VTE, recommendations for timing of discontinuation depend upon the specific SERM and the indication for its use:

**For raloxifene** (taken for breast cancer prevention or osteoporosis treatment/prevention), discontinue 3 days prior to surgery and resume once elevated risk of VTE has resolved

**For tamoxifen** (taken for breast cancer prevention), discontinue 2 weeks prior to surgery and resume once elevated risk of VTE has resolved

**For tamoxifen** (taken for breast cancer treatment), typically recommend continuing while providing appropriate VTE prophylaxis. However, consultation with oncology is advised



Algorithm for preoperative cardiac evaluation for noncardiac surgery

2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery

## ***Step 1: Establish the Urgency of Surgery***

- Emergency surgery (within 6 hours) warrants no further testing
- It is important to note that many surgeries, though not absolutely emergent, are urgent (within 6–24 hours) and are unlikely to allow for a time-consuming evaluation

## ***Step 2: Assess for Active Cardiac Conditions***

- 1-Acute coronary syndrome (ST-segment-elevation MI [STEMI], non-ST-segment-elevation MI [NSTEMI], unstable angina, recent MI)
  - 2-Decompensated heart failure
  - 3-Unstable arrhythmias
  - 4-Severe valvular disease
- Delaying surgery to allow for further management of these conditions is recommended

### *Step 3: Determine Perioperative Risk of Major Adverse Cardiac Events*

- It is important to determine the risks of major adverse cardiac events (MACE) in the perioperative period.
- The clinical risk factors are adapted from the **Revised Cardiac Risk Index (RCRI)**
  - Ischemic heart disease
  - History of TIA or CVA
  - History of CHF
  - Renal insufficiency (serum creatinine  $\geq 2.0$ )
  - Diabetes mellitus requiring insulin
  - Surgical risk—defined as intraperitoneal, intrathoracic, or suprainguinal vascular surgery
- Patients with **one or no clinical risk factors** are at low risk (<0.9%) and may proceed to surgery without further testing.
- Patients with **two or more clinical risk factors** are at an elevated risk of adverse cardiac events, particularly with vascular surgery. The risks and benefits of further cardiac testing should be considered.

### *Step 4: Patients at Low Risk*

- Low-risk surgery is defined as a procedure with combined patient and procedural risk <1% MACE
- Patients can generally undergo low-risk procedures without further evaluation.

### *Step 5: Evaluation of Patients at Elevated Risk*

- Elevated risk surgery is defined as a procedure with combined patient and procedural risk >1% MACE
- The 2014 AHA/ACC perioperative guidelines have combined previously labeled intermediate- and high-risk procedures into this category due to similar management recommendations
- Assess the patient's functional capacity
  - Patients with good functional capacity  $\geq 4$  metabolic equivalents of task (MET) are unlikely to suffer serious cardiovascular complications and can proceed to surgery.
  - Poor functional capacity (<4 METs) is associated with an increased risk of perioperative cardiac events.

## *Step 6: Evaluation of Patients at Elevated Risk with Poor or Unknown Functional Capacity*

- It is important to develop a plan for patients at elevated risk, MACE > 1%, and poor (<4 METs) or an unknown functional capacity
- Pharmacologic stress testing may be indicated if the additional diagnostic information will affect management decisions
- Guidelines: revascularization before noncardiac surgery **recommended** in cases where revascularization would otherwise be indicated according to existing clinical practice guidelines; **not recommended** exclusively to reduce perioperative cardiac events

## *Step 7: Proceeding to Surgery in Patients at Elevated Risk*

- Many patients with elevated perioperative risk will proceed to surgery without pharmacologic stress testing
- Alternative therapies such as noninvasive treatments or palliation should be considered in patients at greatest risk of a cardiac complication

# METABOLIC EQUIVALENTS (METs) FOR CERTAIN ACTIVITIES

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**METs**

**Representative Activities**

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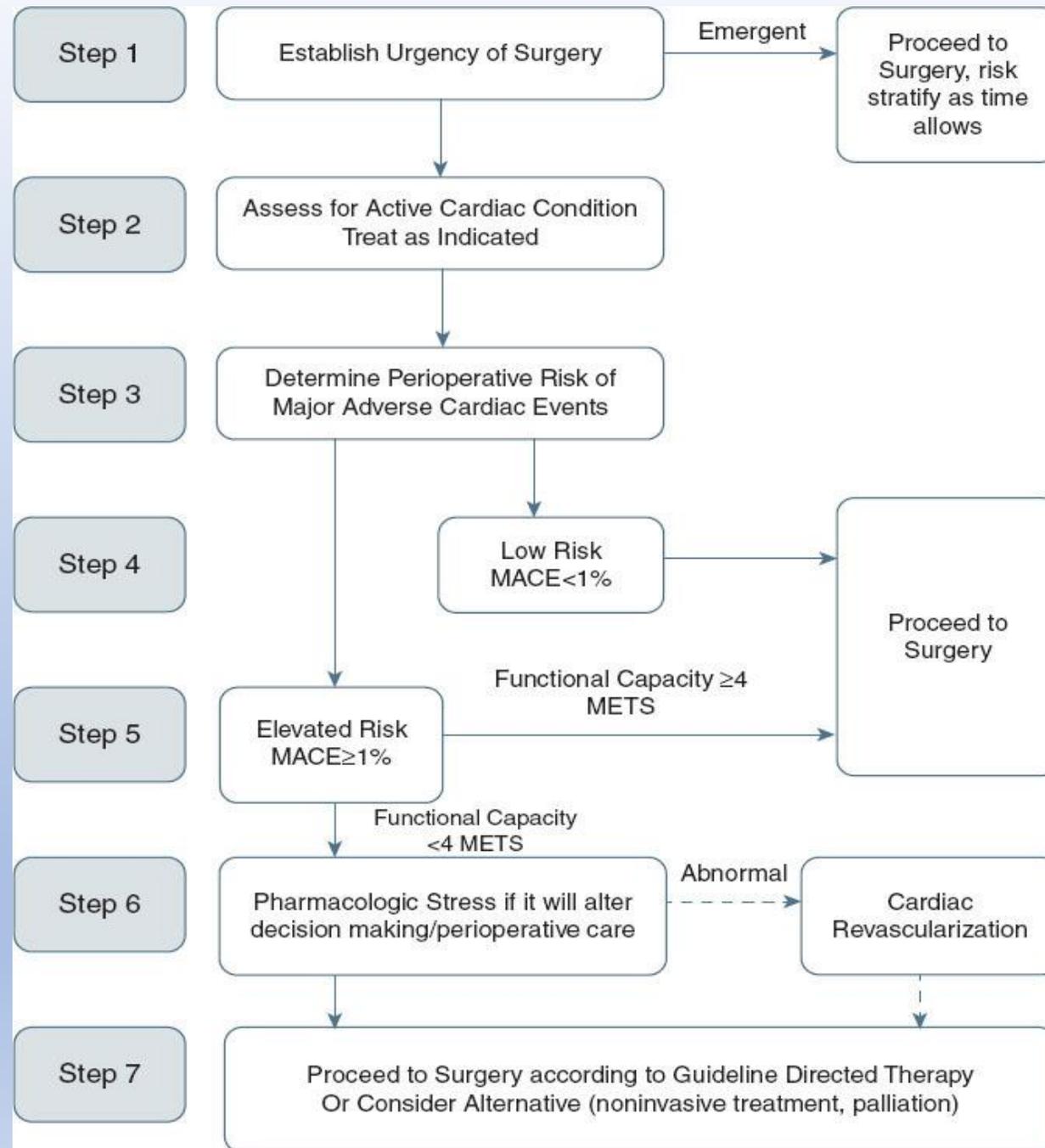
$\geq 4$

Walking at 4 mph on level ground, climbing stairs, climbing hills, riding a bicycle at 8 mph, golfing, bowling, throwing a baseball/football, carrying 25 pounds (groceries from the store to the car), scrubbing the floor, raking leaves, mowing the lawn

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$> 7$

Jogging at 5 mph on level ground, carrying a 60-pound object



## **Risk calculators: 3 types of risk calculators used**

- A. Revised cardiac risk Index (RCRI): most commonly used.
- B. MI or Cardiac Arrest (MICA) Risk Calculator:
- C. American College of Surgeons (ACS) NSQIP Surgical Risk Calculator

## Revised cardiac risk Index (RCRI)

- Most commonly used; by Tom Lee and colleagues; derived from >4300 patients aged  $\geq 50$  yrs undergoing major non cardiac surgery, with expected length of stay of  $\geq 2$  days; should not be used for minor surgery or ambulatory procedures because will overestimate risk
- ***6 independent predictors of major cardiac complications:*** 1- high-risk surgery, 2-history of ischemic heart disease, 3- HF, 4- stroke or TIA, 5- diabetes treated with insulin, and renal insufficiency (defined as creatinine  $> 2$ )
- ***Predicted complications*** — in-hospital complications, not 30 days; included myocardial infarction (MI), pulmonary edema, ventricular fibrillation, cardiac arrest, and complete heart block during hospitalization
- Patients grouped by number of risk factors; more risk factors meant higher risk; with new ACC guidelines, 0 or 1 risk factor, risk  $< 1\%$  (low risk); having  $\geq 2$ , elevated risk

# Revised cardiac risk index (RCRI)

## **6 independent predictors of major cardiac complications<sup>[1]</sup>**

High-risk type of surgery (examples include vascular surgery and any open intraperitoneal or intrathoracic procedures)

History of ischemic heart disease (history of myocardial infarction or a positive exercise test, current complaint of chest pain considered to be secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q waves; do not count prior coronary revascularization procedure unless one of the other criteria for ischemic heart disease is present)

History of heart failure

History of cerebrovascular disease

Diabetes mellitus requiring treatment with insulin

Preoperative serum creatinine >2.0 mg/dL (177 micromol/L)

## **Rate of cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest according to the number of predictors<sup>[2]</sup>**

No risk factors – 0.4% (95% CI 0.1-0.8)

1 risk factor – 1.0% (95% CI 0.5-1.4)

2 risk factors – 2.4% (95% CI 1.3-3.5)

3 or more risk factors – 5.4% (95% CI 2.8-7.9)

## **Rate of myocardial infarction, pulmonary edema, ventricular fibrillation, primary cardiac arrest, and complete heart block<sup>[1]</sup>**

No risk factors – 0.5% (95% CI 0.2-1.1)

1 risk factor – 1.3% (95% CI 0.7-2.1)

2 risk factors – 3.6% (95% CI 2.1-5.6)

3 or more risk factors – 9.1% (95% CI 5.5-13.8)

## **Categories of Surgery**

- A. High risk (reported risk of cardiac death or nonfatal myocardial infarction [MI] often)** 1-aortic and major vascular surgery, 2- intraperitoneal and 3- intra thoracic surgery.1
- B. Intermediate risk (reported risk of cardiac death or nonfatal MI generally 1 to 5 percent):** 1-Carotid end arterectomy, 2- Head neck surgery, 3- Orthopedic surgery 4- prostate surgery
- C. Low risk (reported risk of cardiac death or nonfatal MI generally less than 1 percent)** - ambulatory surgery, endoscopic procedure, superficial procedure, cataract surgery, breast surgery.

## MI or Cardiac Arrest (MICA) Risk Calculator

- MICA; published by Gupta and colleagues; used National Surgical Quality Improvement Project (NSQIP) database to develop and validate it, using each one with several hundred thousand patients
- 5 predictors of complications MI and cardiac arrest
- 30-day endpoints, not in-hospital complications
- *predictors* —1- type of surgery, 2-dependent functional status, 3-renal insufficiency (defined as creatinine  $>1.5$ , not  $>2$  as in RCRI), 4- ASA class, and 5- increasing age
- Not true comparison to RCRI because different endpoints; believed it to be better discriminative and predictive ability for MI or cardiac arrest

## **American College of Surgeons (ACS) NSQIP Surgical Risk Calculator**

- most comprehensive and more cumbersome
- need to know Current Procedural Terminology (CPT) code for procedure (of >1500 procedures)
- 20 variables; predicts cardiac risk, mortality, serious complications, any complications, pulmonary complications, others

# Timing of elective surgery in patient with prior Revascularizations

- Recommend that elective noncardiac surgery should be delayed  $\geq 30$  days after bare-metal stenting, and optimally 6 mos after drug-eluting stent implantation
- Elective noncardiac surgery after drug-eluting stent placement in patients in whom P2Y12 inhibitor( eg. Plavix, ticagrelor, effient) must be stopped may be considered after 3 mos, but if risk of further delay of surgery greater than expected risk of stent thrombosis
- If stent had been placed in setting of acute coronary syndrome, recommendation for dual antiplatelet therapy for 12 mos , may be reasonable to continue aspirin when potential for increased cardiac events outweighs risk of bleeding.

# Peri operative cardiac medications

## Antiplatelet therapy

**Stopping antiplatelet therapy:** if surgery mandates discontinuation then

- stop aspirin 3 days to 7 days before surgery
- clopidogrel 5 days to 7 days before
- prasugrel 7 days before.
- ticagrelor 5 days before.

## Statins

- Continue in patients currently on them who are undergoing noncardiac surgery.
- Reasonable to initiate in patients undergoing vascular surgery.
- Consider starting in patients with diabetes, peripheral arterial disease, hyperlipidemia going for elevated-risk procedures.
- Probably use more potent statin; perhaps  $\geq 50\%$  of maximum dose initially
- May be benefit in starting early, even 24 hrs or 1 wk before; no evidence of harmful effects

## Beta blockers

- Guidelines recommend continuation BB in patients using them chronically.
- If ischemia on stress test or if  $\geq 3$  or more RCRI risk factors, may be reasonable to begin perioperative beta blockers
- If starting beta blockers before surgery, do so  $\geq 1$  day before; recommend  $\geq 1$  wk to 2 wks before; do not start on day of surgery (shown to be harmful in POISE study)
- More cardio selective drugs may be better than metoprolol
- Prophylactic beta blockers rarely started now

**Alpha-2 agonists (eg, clonidine):** not recommended for prevention of cardiac events; no benefit; no reduction in perioperative MI and death; if patient using, continue to avoid rebound

**ACE inhibitors:** associated with hypotension with induction of anesthesia. Usually withheld on the morning of surgery. Only continued for patients with HF or uncontrolled hypertension

# Pulmonary Perioperative management

**Overview:** postoperative pulmonary complications more common than cardiac complications; Pulmonary complications account for more than 50% of adverse perioperative events and have higher mortality and cost than postoperative cardiac problem. The common complications include-

- 1- Pneumonia
- 2- Respiratory Failure.
- 3- Atelectasis.
- 4- Exacerbation of underlying chronic lung disease.

**Risk factors divided into**

- 1- Patient-related and**
- 2- Procedure-related**

## Major Risk Factors for Postoperative Pulmonary Complications

### Procedure-Specific

Emergency surgery

Prolonged surgery (>3 h)

Thoracic surgery

Abdominal surgery

Head and neck surgery

Aortic surgery (open)

General anesthesia

### Patient-Specific

Advanced age

ADL functional limitations

ASA class 2 or higher

COPD

Smoking within past year

Preoperative sepsis; obstructive sleep apnea; pulmonary hypertension

Major Risk Factors  
for Postoperative  
Pulmonary  
Complications

**All surgical patients should be screened for OSA with a validated tool such as the STOP-BANG survey**

Patients with a STOP-BANG score greater than or equal to 5 have an increased risk for severe OSA and postoperative morbidity.

Conservative postoperative measures that may reduce the risk of pulmonary complications from suspected OSA include

- 1- Non supine positioning (keeping the head of the bed at 30 degrees).
- 2- Careful use of sedatives and opioids,
- 3- Continuous pulse oximetry.

The American Society of Anesthesiology recommends **only initiating CPAP for patients at risk for OSA who develop hypoxia or apneic episodes.**

# STOP-Bang Questionnaire

Please answer the following questions by checking "yes" or "no" for each one

	Yes	No
<b>S</b> noring (Do you snore loudly?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>T</b> iredness (Do you often feel tired, fatigued, or sleepy during the daytime?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>O</b> bserved Apnea (Has anyone observed that you stop breathing, or choke or gasp during your sleep?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>H</b> igh Blood <b>P</b> ressure (Do you have or are you being treated for high blood pressure?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>B</b> MI (Is your body mass index more than 35 kg per m <sup>2</sup> ?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>A</b> ge (Are you older than 50 years?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>N</b> eck Circumference (Is your neck circumference greater than 40 cm [15.75 inches]?)	<input type="checkbox"/>	<input type="checkbox"/>
<b>G</b> ender (Are you male?)	<input type="checkbox"/>	<input type="checkbox"/>

Score 1 point for each positive response.

Scoring interpretation: 0 to 2 = low risk, 3 or 4 = intermediate risk,  $\geq 5$  = high risk.

# Perioperative Management to reduce pulmonary risk

## **Modifiable patient-related risk factors:**

- Smoking cessation has been shown to decrease postoperative pulmonary complications if patients stop smoking at least 8 weeks before surgery.
- COPD therapy should be optimized. Symptoms should be aggressively managed preoperatively

## **Modifiable procedure-related risk factors:**

- Consideration of alternative procedures with the lowest possible pulmonary risk should be undertaken for high-risk patients. Laparoscopic procedures cause less disruption of lung function postoperatively

## **Postoperative interventions:**

- Lung expansion maneuvers, such as incentive spirometry or deep breathing exercises, should be employed.
- CPAP should be used routinely in patients with known sleep apnea. These patients should also be monitored with continuous pulse oximetry.
- Over sedation must be carefully avoided.
- When appropriate, NSAIDs, acetaminophen, and regional analgesia should be considered.
- A strategy of selective nasogastric tube placement rather than routine use has also been shown to decrease the risk of pulmonary complications.<sup>[51](#)</sup>

# Hematologic Perioperative management

## **A. Venous Thromboembolic prophylaxis**

**main risk factors for VTE include**

- Older age,
- Orthopedic surgery or trauma,
- Past or current history cancer,
- Prior VTE, thrombophilia, and immobilization;

- **American College of Chest Physicians (ACCP) guidelines:** published in 2012; *4 categories of patients* — very low risk (0.5%); low risk (1.5%); moderate risk (3%); high risk (6%); based on Rogers and Caprini scoring systems
- For very low risk- recommend early ambulation;
- for low risk, recommend mechanical prophylaxis with intermittent pneumatic compression or sequential compression devices
- For moderate and high risk- pharmacologic therapy, low-dose unfractionated heparin or low-molecular-weight (LMW) heparin
- For highest-risk group, LMW weight heparin or low-dose unfractionated heparin plus mechanical prophylaxis.
- For high bleeding risk, mechanical prophylaxis

## Caprini Venous Thromboembolism Risk Assessment Scoring Method

Number of Points for Each Risk Factor	Risk Factors
1	Age 41-60 y; minor surgery; BMI >25; leg edema; varicose veins; recent or current pregnancy; estrogen use; recurrent spontaneous abortion; recent sepsis (<1 mo)/pneumonia (<1 mo); severe lung disease; abnormal pulmonary function; inflammatory bowel disease; acute MI; recent HF (<1 mo); medical patient at bed rest
2	Age 61-74 y; arthroscopic surgery; major surgery lasting >45 min; malignancy; bed rest for >72 h; immobilizing cast; central venous access
3	Age $\geq 75$ y; personal history of VTE; family history of VTE; congenital or acquired thrombophilia; HIT
4	Stroke or spinal cord injury within 1 mo; elective arthroplasty; hip, pelvis, or leg fracture

ACCP risk group	Patients categorized by Caprini score		Patients categorized by Rogers score	
	Caprini score	Patients in risk group	Rogers score	Patients in risk group
Very low risk	0	0 (0.0)	<7	29 (0.2)
Low risk	1–2	18 (0.1)	7-10	6532 (36.9)
Moderate risk	3–4	527 (3.0)	>10	11,152 (63.0)
High risk	≥5	17,168 (96.9)	<sup>a</sup>	<sup>a</sup>

Data are presented as n (percentage). Patients were categorized into the ACCP risk groups first by Caprini score and then by Rogers score. The group the patients were placed in differed, depending on which score was used.

ACCP, American College of Chest Physicians.

<sup>a</sup> Rogers scores are not listed for the high-risk ACCP group; only a Caprini score is provided.

Barber & Clarke-Pearson. VTE risk assessment tools in gynecology oncology. *Am J Obstet Gynecol* 2016.

## Recommended VTE prophylaxis in post op patient

- Recommended agents include LMW heparin, any direct-acting oral anticoagulants (DOACs; *eg*, apixaban, dabigatran, rivaroxaban), fondaparinux, low-dose unfractionated heparin, adjusted-dose coumadin, aspirin; combine with pneumatic compression devices
- For knees, recommend duration 10 days to 14 days
- For hips, recommend extended-duration prophylaxis  $\leq 35$  days
- For patients undergoing abdominal surgery for cancer (gynecologic and gastrointestinal [GI] cancer surgery), recommend 28 days of prophylaxis

# Perioperative Management of Anticoagulant Therapy

## **Bridging of AC during surgery:**

**For high thrombotic risk patients, suggest considering bridging therapy;**

### **A- For mechanical heart valves:**

Any mitral valve prosthesis

Any caged ball/ tilting disc aortic valve prosthesis.

Recent stroke or TIA within 6 months.

### **B- Atrial Fibrillation:**

- CHA<sub>2</sub>DS<sub>2</sub>-VASc score of  $\geq 6$  (or CHADS<sub>2</sub> score of 5-6)
- Recent (within three months) stroke or transient ischemic attack

### **C-VTE:**

Recent (within three months) VTE.

Severe thrombophilia (eg, deficiency of protein C, protein S, or antithrombin; antiphospholipid antibodies; multiple abnormalities)

- **Warfarin:** For bridging therapy, stop warfarin 5 days before, give either LMW heparin, (more commonly used), or intravenous unfractionated heparin perioperatively while INR subtherapeutic
- LMW heparin stopped 24 hrs before surgery; resume warfarin as soon as possible after surgery
- DOACs: can be either continued or stopped; **no need for bridging;** short half-lives; stop 1 day to 3 days before

## Stopping DOAC

- if normal renal function and low bleeding risk, usually stop drugs  $\geq 1$  day before (*ie*, do not take on morning of surgery or day before); last dose 36 hrs before
- for high-bleeding-risk procedure or impaired renal function, 2 days before
- both impaired renal function and high bleeding risk, 3 days before
- Urgent surgery: reversal agents for DOACs include idarucizumab (for dabigatran) and andexanet alfa (for rivaroxaban and apixaban)

## Restarting DOACs

- if low-bleeding-risk procedure, can restart anticoagulation 24 hrs postoperatively
- if high-bleeding-risk procedure, wait  $\geq 48$  hrs to 72 hrs, or when adequate hemostasis, and when okay with surgeon
- in interim, can use pharmacologic VTE prophylaxis; should not use bridging therapy with DOACs (they achieve full anticoagulation in 1 hr to 4 hrs)

## **Procedures that can be performed without stopping anticoagulation**

- Dental procedures
- GI procedures (upper endoscopy and colonoscopy without biopsy or without polypectomy; some gastroenterologists do biopsies and polypectomies on full anticoagulation)
- Ophthalmologic surgery typically does not require stopping anticoagulation

# Perioperative Transfusion

**Anemia:** associated with increased perioperative morbidity and mortality;

- American Association of Blood Banks recommends transfusion if hemoglobin is  $<7$  g/dL, if hemodynamically stable and asymptomatic, or
- Transfuse with hemoglobin  $<8$  if underlying cardiovascular disease, or after cardiac or orthopedic surgery

**Thrombocytopenia:**

- if  $<20,000$ , can have excess bleeding with low-risk surgery
- if  $<50,000$ , excess bleeding with most surgeries
- $<100,000$  (80,000-100,000 minimum) for cardiac or neurosurgery

# Perioperative management Endocrine disease

## **Adrenal disorders and patients on steroids:**

- continue corticosteroids and mineralocorticoids
- **consider supplemental or stress-dose steroids; if Hypothalamic pituitary axis (HPA ) is thought to be inhibited.**
- hypothalamic-pituitary-adrenal (HPA) axis not inhibited on any dose <3 wks, alternate-day therapy, or <5 mg prednisone or equivalent
- impaired with  $\geq 20$  mg prednisone, Cushingoid appearance, or primary adrenal insufficiency
- unclear for intermediate range (5-20 mg prednisone)

- options include cosyntropin, or ACTH stimulation test, baseline cortisol, or give empiric steroids without testing; A cortisol level  $>18$ , 30 minutes after administration of cosyntropin, confirms a normal functioning HPA. Administration of perioperative stress-dose steroids should be considered in patients with a level  $<18$
- In **patients whose HPA status is uncertain** and there is inadequate time to perform a cosyntropin stimulation test, corticosteroids can be administered preoperatively with dosing determined by the expected amount of surgical stress
- **dosing based on stress of procedure**; If low-stress procedure, can continue usual steroids or give 25 mg hydrocortisone preoperatively; if intermediate-stress procedure, 50 mg hydrocortisone then 25 mg every 8 hrs for 1 day; if high-stress procedure, 75 mg to 100 mg hydrocortisone then 50 mg every 8 hrs for 1 day to 3 days

## Diabetes

- target glucose perioperatively 140 mg/dL to 180 mg/dL;
- tight control associated with hypoglycemia and bad outcomes;
- withhold oral hypoglycemics on morning of surgery;
- in patient on basal insulin, usually continue full dose but may decrease if history of hypoglycemia, decreased caloric intake, or chronic kidney disease; more current recommendation almost suggesting slight decrease of 10% to 20% preoperatively (other guidelines say not to change);
- if patient on neutral protamine Hagedorn (NPH) insulin, typically give one-half to two-thirds and hold all short-acting insulin on morning of surgery

## Thyroid disease

- Mild to moderate hypothyroidism okay, no increased risk
- Ideally, have patient euthyroid preoperatively
- Hyperthyroidism is problematic in the perioperative setting because it is more likely to cause arrhythmias and heart failure
- Elective surgery should be delayed to achieve a euthyroid state in patients with clinical hyperthyroidism. If surgery is urgently required, patients should be managed with aggressive  $\beta$ -blocker therapy. Consultation with an endocrine specialist is also warranted to determine other appropriate therapy

# Perioperative management in a patient with liver disease

- Patients with cirrhosis (with or without portal hypertension) suffer an increased risk of morbid outcomes when undergoing surgery such as increased in-hospital mortality and hospital length of stay. They can have increased frequency of other complications as well, such as bleeding, sepsis, encephalopathy, and renal failure. Patients at risk must be identified and medically optimized prior to surgery to reduce postoperative complications

## Classification

- The best validated measure of perioperative risk in patients with cirrhosis is the Child-Pugh score, and recent evidence suggests the Model for End-stage Liver Disease (MELD) score can also be used
- **Child-Pugh class C and MELD score >15** are considered contraindications to elective surgeries
- MELD score: includes bilirubin, INR, and serum creatinine; score <8 okay; 8 to 14 intermediate risk; undergo elective or semi urgent procedures with caution.  $\geq 15$  means elective surgery contraindicated
- Child-Pugh classification: *5 parameters* — ascites, bilirubin, albumin, PT or INR, and encephalopathy on 1- to 3-point basis; 5 to 6 points class A, okay; 7 to 9 class B; 10 to 15 class C, avoid elective surgery

## Management

- patients with mild to moderate chronic liver disease without cirrhosis (includes patients with mild chronic hepatitis or fatty liver) tolerate surgery well
- highest-risk patients should postpone elective surgery; includes acute hepatitis, either alcoholic, viral, or drug induced (includes Child-Pugh class C, MELD score  $\geq 15$ , fulminant hepatic failure, and severe coagulopathy);
- Maintain platelet count  $\geq 50,000$  to 100,000
- Treat ascites with diuretics or paracentesis
- Correct electrolytes
- Provide nutritional support
- Encephalopathy- should be treated with lactulose and Rifaximin. Sedative and narcotic should be used cautiously to prevent encephalopathy.

# Perioperative care of CKD and ESRD

**Chronic kidney disease (CKD)** is an independent risk factor for **perioperative cardiac complications**, so many patients with renal disease will need appropriate cardiac risk stratification. **Patients with end-stage renal disease (ESRD)** have a substantial mortality risk when undergoing surgery

- dialyze patient day before (not morning of) surgery
- consider checking potassium on morning of surgery

# Neurologic Disease

- Continue most neurologic medications (*eg*, antiepileptic drugs for seizures and parkinsonian medications).
- Postoperative stroke risk generally low for most noncardiac, non neurologic surgery.
- Delirium is particularly common in elderly surgical patients, but perioperative risk factors and treatment are similar to those for delirium in the general hospital setting

# Case # 1

- A 66-year-old man who was admitted to the hospital after undergoing urgent sigmoid colectomy for a perforated diverticulum is evaluated for co-management of his medical problems. He tolerated general anesthesia well and had no immediate perioperative complications. He is fully awake, alert, and breathing comfortably with adequate control of postoperative pain. Additional history provided by his wife indicates that he snores loudly when sleeping and occasionally seems to gag and stop breathing. He reports no daytime somnolence. Medical history includes hypertension and hyperlipidemia. Medications are lisinopril, simvastatin, and as-needed oxycodone.
- On physical examination, blood pressure is 156/94 mm Hg, and respiration rate is 18/min. Oxygen saturation on pulse oximetry is 97% with the patient breathing ambient air. BMI is 45. Cardiovascular examination is normal. The lungs are clear to auscultation. The left lower quadrant surgical incision is intact with minimal tenderness to palpation; bowel sounds are present, and the abdomen is not distended.
- Laboratory studies on admission were significant for a hemoglobin level of 14.6 g/dL (146 g/L), a leukocyte count of 18,000/ $\mu$ L ( $18 \times 10^9$ /L) with 95% neutrophils, and a normal basic metabolic panel.
- In addition to continuous pulse oximetry, which of the following is the most appropriate respiratory management of this patient?
  - **A-** Insert a nasogastric tube
  - **B-** Keep the head of the bed elevated at 30 degrees
  - **C-** Start nebulized albuterol
  - **D-** Start nocturnal continuous positive airway pressure ventilation

- Conservative postoperative measures that may reduce the risk of pulmonary complications from suspected OSA include non supine positioning (keeping the head of the bed at 30 degrees), careful use of sedatives and opioids, and continuous pulse oximetry. The American Society of Anesthesiology recommends only initiating CPAP for patients at risk for OSA who develop hypoxia or apneic episodes.

## Case # 2

- A 74-year-old woman is seen for preoperative evaluation for arthroscopic repair of a right rotator cuff tear. The pain and weakness significantly limit her activities of daily living and have been unresponsive to acetaminophen, NSAIDs, and physical therapy. Medical history is notable for severe aortic stenosis diagnosed 6 months ago. She reports no cardiac symptoms, and her functional status has not changed in the last 6 months. She does not currently meet criteria for aortic valve replacement. Current medications are acetaminophen and ibuprofen.
- On physical examination, blood pressure is 142/78 mm Hg, and pulse rate is 76/min. There is a grade 3/6 crescendo-decrescendo murmur at the cardiac base with radiation to the carotid arteries and a diminished S<sub>2</sub>. Right shoulder findings include supraspinatus muscle weakness, weakness with external rotation, and a positive drop-arm test in the right arm.
- An echocardiogram from 6 months ago reveals an ejection fraction of 65% and severe aortic stenosis (aortic valve area: 1 cm<sup>2</sup>; aortic valve mean gradient: 42 mm Hg; aortic valve peak velocity: 4.1 m/s).
- An electrocardiogram from 5 months ago is normal. Treadmill exercise stress testing as part of aortic stenosis evaluation and risk stratification 5 months ago showed the patient achieving 4 metabolic equivalents (METs) and 90% of maximum predicted heart rate; she stopped the test due to knee pain but had normal blood pressure response to exercise and no symptoms or electrocardiographic changes with exercise.
- Which of the following is the most appropriate management?
  - **A-** Cancel surgery
  - **B-** Perform dobutamine stress echocardiography
  - **C-** Proceed to surgery
  - **D-** Repeat echocardiography

- Elective noncardiac surgery is reasonable to perform in patients with **asymptomatic** severe aortic stenosis with appropriate intraoperative and postoperative hemodynamic monitoring.

## Case # 3

- A 68-year-old man is seen for a preoperative evaluation for a total left knee arthroplasty. He engages in no exercise and does minimal walking due to his knee pain. He reports no other symptoms. Medical history is notable for hypertension, for which he takes losartan.
- On physical examination, blood pressure is 130/74 mm Hg. Cardiovascular examination is normal. The left knee shows changes compatible with severe osteoarthritis.
- Laboratory studies show a normal serum creatinine level.
- Which of the following should be performed preoperatively?
- **A-** Noninvasive pharmacologic cardiac stress testing
- **B-** Resting echocardiography
- **C-** Serum troponin measurement
- **D-** No further diagnostic testing

- If a patient has no history, symptoms, or risk factors for coronary artery disease, no preoperative coronary evaluation is necessary.

## Case # 4

- A 66-year-old man was diagnosed with stage III colon cancer and underwent laparotomy with resection of the tumor and colostomy placement yesterday. He tolerated general anesthesia without complications and had approximately 100 mL of blood loss during the procedure. He is ambulating, eating, and voiding without problems. He has been wearing intermittent pneumatic compression devices on his legs when in bed since admission. He is also prescribed acetaminophen and oxycodone as needed for postoperative pain.
- On physical examination, vital signs are normal. The abdominal incision is intact with no surrounding erythema, induration, tenderness, or exudate. The abdomen is soft and nontender with normal bowel sounds. There is no peripheral edema.
- Laboratory studies are significant for a hemoglobin level of 13.8 g/dL (138 g/L) (14.2 g/dL [142 g/L] before surgery), a platelet count of 308,000/ $\mu$ L ( $308 \times 10^9$ /L), and a normal serum creatinine level.
- Which of the following is the most appropriate management for venous thromboembolism prophylaxis?
  - **A-** Continue intermittent pneumatic compression only until hospital discharge
  - **B-** Initiate aspirin for up to 35 days after surgery
  - **C-** Initiate prophylactic-dose enoxaparin for up to 28 days after surgery
  - **D-** Initiate prophylactic-dose enoxaparin only until hospital discharge
  - **E-** Initiate therapeutic warfarin for up to 35 days after surgery

- The most appropriate venous thromboembolism prophylaxis in patients who have undergone cancer surgery is prophylactic-dose low-molecular-weight heparin for up to 28 days after surgery.

## Case # 5

- A 58-year-old man is seen for preoperative evaluation prior to umbilical hernia repair scheduled in 1 week. He has been in good health except for increasing pain at the site of his umbilical hernia. He has experienced no incarceration of his hernia. He exercises regularly without symptoms. He has no history of stroke or transient ischemic attack. Medical history is notable for aortic valve replacement with bileaflet mechanical prosthesis performed 3 years ago for a bicuspid aortic valve and decreasing exercise capacity. Medications are warfarin and low-dose aspirin.
- On physical examination, blood pressure is 124/72 mm Hg, and pulse rate is 70/min. Cardiovascular examination reveals a regular rhythm, a mechanical S<sub>2</sub>, and a grade 1/6 early systolic crescendo-decrescendo murmur at the cardiac base without radiation.
- Laboratory studies show a normal serum creatinine level.
- An electrocardiogram performed 2 months ago showed normal sinus rhythm with normal intervals. An echocardiogram from 2 months ago showed normal left ventricular function and normal function of the mechanical aortic valve prosthesis.
- In addition to continuing aspirin and stopping warfarin 5 days before surgery, which of the following is the most appropriate management for preoperative anticoagulation bridging?
- **A-** Intravenous unfractionated heparin
- **B-** Prophylactic-dose subcutaneous enoxaparin
- **C-** Therapeutic-dose subcutaneous enoxaparin
- **D-** No bridging anticoagulation

- Contemporary mechanical aortic valve prostheses have a low (<5%) annual risk of thromboembolism, and guidelines recommend no anticoagulation bridging for patients with these prostheses if they are in sinus rhythm and have no additional risk factors for arterial thromboembolism

**THE END**