



SAPIENZA
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PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

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PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

Pre-op preparation is conducted during:

- **outpatient office visit**
- **hospital inpatient consultation**
- **emergency department evaluation**

The goal of pre-op evaluation is to

optimize the patient's overall status and readiness for surgery

Objectives of this lesson:

- to review the **components of risk assessment of any patient for surgery**
- to provide **basic algorithms to aid in the preparation of patients for surgery**

PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

Proper operative technique is of paramount importance for **optimizing outcome and enhancing the wound healing process**. There is no substitute for a **well-planned and conducted operation** to provide the best possible surgical outcome

DETERMINING THE NEED FOR SURGERY

- Patients are often **referred to surgeons** with a suspected surgical diagnosis
- The **surgeon's initial encounter** is based on **physical findings, clinical history, laboratory and investigative tests** (i.e.: radiologic exams)

-The surgeon has to think about:

- **The context** of the illness and the **benefit** of different surgical interventions
- The need for **further investigations**
- Possible **non-surgical alternative**
- What would happen if no intervention were undertaken

The **need for operative intervention** is made by the surgeon and discussed with the patient and family members

PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

The **MOST** important component of successful surgery is

THE CORRECT INDICATION TO SURGERY

when surgery should be carried out
and when it should NOT

PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

- The **surgeon's approach** to the patient and family during the initial encounter should be one that **fosters a bond of trust** and opens a line of **communication** among all participants
- Time has to be taken to listen to **concerns and answer questions** posed by the patient and family members
- In the end, the patient should be able to express a basic understanding of the **disease process** and the **need for further investigation** and possible **surgical management**
- A well-articulated follow-up plan is also essential

PRINCIPLES OF PRE-OPERATIVE AND OPERATIVE SURGERY

Once the operative management is decided, must be addressed

- timing and site of surgery
- type of anesthesia
- preoperative preparation necessary to understand the patient's risk and optimize the outcome

- These components of risk assessment take into account the
 - **perioperative** (intraoperative period through 48 hours postoperatively)
 - and **later postoperative (up to 30 days)** period and seek to identify factors that may contribute to patient morbidity during these periods

PREOPERATIVE EVALUATION

- Aim of this process is to to **identify and quantify any COMORBIDITY** that may affect the **operative outcome**
- This evaluation is based on **history and physical examination** and suggests **organ system dysfunction**
- The goal is to **uncover problems** that may require **further investigation** or be amenable to **preoperative optimization**

PREOPERATIVE EVALUATION

- The preoperative evaluation is used to **identify patient risk factors** for **postoperative morbidity and mortality**
- The **ACS National Surgical Quality Improvement Program (NSQIP)** has been used to develop predictive models for postoperative morbidity and mortality,
- **ACS NSQIP Risk Calculator:** it assess the probability of **postoperative morbidity and mortality** based on preoperative clinical characteristic of the patients



ACS: American College of Surgeons



Enter Patient and Surgical Information

i Procedure

Clear

Begin by entering the procedure name or CPT code. One or more procedures will appear below the procedure box. You will need to click on the desired procedure to properly select it. You may also search using two words (or two partial words) by placing a '+' in between, for example: "cholecystectomy + cholangiography"

Reset All Selections

i Are there other potential appropriate treatment options? Other Surgical Options Other Non-operative options None

Please enter as much of the following information as you can to receive the best risk estimates.
A rough estimate will still be generated if you cannot provide all of the information below.

Age Group

Under 65 years

Sex

Female

Functional Status **i**

Independent

Emergency Case **i**

No

ASA Class **i**

Healthy patient

Steroid use for chronic condition **i**

No

Ascites within 30 days prior to surgery **i**

No

Systemic Sepsis within 48 hours prior to surgery **i**

None

Ventilator Dependent **i**

No

Disseminated Cancer **i**

No

Diabetes **i**

No

Hypertension requiring medication **i**

No

Congestive Heart Failure in 30 days prior to surgery **i**

No

Dyspnea **i**

No

Current Smoker within 1 Year **i**

No

History of Severe COPD **i**

No

Dialysis **i**

No

Acute Renal Failure **i**

No

BMI Calculation: **i**

Height: in / cm

Weight: lb / kg

Back

Continue

Step 2 of 4

TABLE 11-2 Top Patient Risk Factors Most Predictive of PostOperative Mortality*

Adapted from Khuri SF, Henderson WG, Daley J, et al: Successful implementation of the Department of Veterans Affairs' National Surgical Quality Improvement Program in the private sector: The Patient Safety in Surgery study. *Ann Surg* 248:329–336, 2008.

VARIABLE	ODDS RATIO	95% CI
14 Private Sector Hospitals (N = 54,450; C-index = 0.934)		
ASA 4/5	8.1	6.0-11.0
ASA 3	3.5	2.7-4.7
Albumin g/dL	0.62	0.56-0.69
Emergency operation	2.6	2.2-3.1
Age/yr	1.04	1.03-1.04
Platelet count <150,000	1.9	1.6-2.2
Disseminated cancer	2.9	2.3-3.7
Dyspnea at rest	1.6	1.3-2.0
Dyspnea with minimal exertion	1.3	1.0-1.5
DNR	3.9	2.6-5.8
BUN >40mg/dL	1.3	1.0-1.6
Work RVU/unit	1.02	1.01-1.03

An odds ratio (OR) is a measure of association between an exposure and an outcome.

The OR represents the odds that an outcome will occur given a particular exposure or variable, compared to the odds of the outcome occurring in the absence of that exposure or variable.

A large CI indicates a low level of precision of the OR

PREOPERATIVE EVALUATION

- If pre-op evaluation shows significant **comorbidity**, consultation with a **medical subspecialist** may be required
- **Communication** between the surgeon and consultants is essential

Patient's general risk should be categorized using the **American Society of Anesthesiologist classification (ASA)** with five stratifications:

- **I** Normal healthy patient
- **II** Patient with mild systemic disease
- **III** Patient with severe systemic disease that limits activity but is not incapacitating
- **IV** Patient who has incapacitating disease that is a constant threat to life
- **V** Moribund patient not expected to survive 24 hours with or without an operation

The letter “**E**” is added to any of these for an emergency operation

SYSTEMS APPROACH TO PREOPERATIVE EVALUATION

CARDIOVASCULAR SYSTEM

- Cardiovascular disease's contribution to perioperative mortality during non-cardiac surgery is significant
- Of the 27 million patients undergoing surgery in the United States every year, 8 million, or almost 30%, have significant cardiac comorbid conditions
- **One million** of these patients will experience perioperative cardiac complications, with substantial morbidity, mortality, and costs
- **Goldman's criteria** of cardiac risk for noncardiac surgery

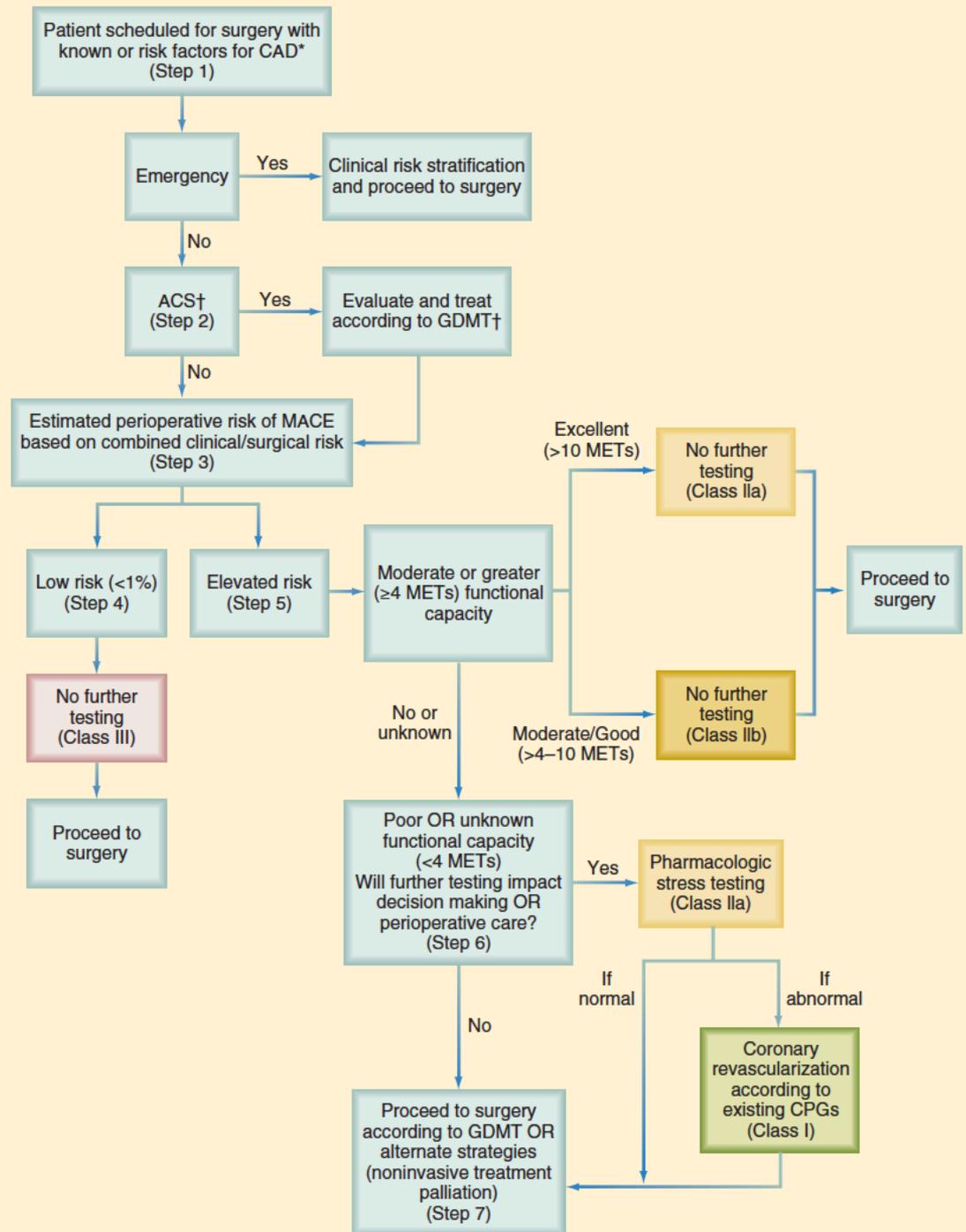
TABLE 10-7 Cardiac Risk Indices

CARDIAC RISK INDEX WITH VARIABLES	POINTS	COMMENTS
Goldman Cardiac Risk Index, 1977		
1. Third heart sound or jugular venous distention	11	Cardiac Complication Rate 0-5 points = 1% 6-12 points = 7% 13-25 points = 14% >26 points = 78%
2. Recent myocardial infarction	10	
3. Nonsinus rhythm or PAC on ECG	7	
4. >5 premature ventricular contractions	7	
5. Age >70 yr	5	
6. Emergency operations	4	
7. Poor general medical condition	3	
8. Intrathoracic, intraperitoneal, or aortic surgery	3	
9. Important valvular aortic stenosis	3	
Detsky Modified Multifactorial Index, 1986		
1. Class 4 angina	20	Cardiac Complication Rate >15 = high risk
2. Suspected critical aortic stenosis	20	
3. MI within 6 mo	10	
4. Alveolar pulmonary edema within 1 wk	10	
5. Unstable angina within 3 mo	10	
6. Class 3 angina	10	
7. Emergency surgery	10	
8. MI >6 mo ago	5	
9. Alveolar pulmonary edema resolved >1 wk ago	5	
10. Rhythm other than sinus or PACs on ECG	5	
11. >5 PVCs any time before surgery	5	
12. Poor general medical status	5	
13. Age >70 yr	5	
Eagle Criteria for Cardiac Risk Assessment, 1989		
1. Age >70 yr	1	<1, no testing 1-2, send for noninvasive test ≥3, send for angiography
2. Diabetes	1	
3. Angina	1	
4. Q waves on ECG	1	
5. Ventricular arrhythmias	1	
Revised Cardiac Risk Index		
1. History of ischemic heart disease	1	Risk for cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest: 0 predictors = 0.4% 1 predictor = 0.9% 2 predictors = 6.6% ≥3 predictors = >11%
2. History of congestive heart failure	1	
3. History of cerebrovascular disease (stroke or transient ischemic attack)	1	
4. History of diabetes requiring preoperative insulin use	1	
5. Chronic kidney disease (creatinine >2 mg/dL)	1	
6. Undergoing suprainguinal vascular, intraperitoneal, or intrathoracic surgery	1	

CARDIOVASCULAR SYSTEM

- The concept of the Goldman's criteria has been further refined in the **Revised Cardiac Risk Index**, which uses **six predictors** of complications to estimate cardiac risk
- This methodology takes into account:
 - **Previous coronary revascularization, evaluation and clinical risk assessment**, divided into major, intermediate, and minor clinical predictors
 - The next factor is the **patient's functional capacity**, which is estimated by obtaining a history of the patient's daily activities

Stepwise approach to preoperative cardiac assessment for non-cardiac surgery



CARDIOVASCULAR SYSTEM

- The standard **exercise stress test**, with or without thallium for perfusion imaging
 - Followed by functional evaluation with echocardiography
 - Angiography
-
- Once these data have been obtained, the surgeon and consultants need to **weigh the benefits of surgery against the risk** and determine whether any perioperative intervention will reduce the probability of a cardiac event
 - The intervention usually centers on **coronary revascularization** via coronary artery bypass (CABG) or percutaneous transluminal coronary angioplasty (PTCA)
 - Patients who have undergone a percutaneous coronary intervention (PCI) with stenting need to have **elective noncardiac procedures delayed for 4 to 6 weeks**
 - General recommendations are to **wait 4 to 6 weeks after MI** to perform elective surgery

CARDIOVASCULAR SYSTEM

Based on the 2014 ACC/AHA guidelines, timing of elective noncardiac surgery in patients with previous PCI is as follows:

- **Elective noncardiac surgery should be delayed 14 days after balloon angioplasty and 30 days after metal stent (BMS) implantation**
- **Elective noncardiac surgery should optimally be delayed 365 days after drug-eluting stent (DES) implantation**
- Elective noncardiac surgery after DES implantation may be considered after 180 days if the risk of further delay is greater than the expected risks of ischemia and stent thrombosis
- Elective noncardiac surgery should not be performed within 30 days after BMS implantation or within 12 months after DES implantation in patients in whom dual antiplatelet therapy will need to be discontinued perioperatively
- Elective noncardiac surgery should not be performed within 14 days of balloon angioplasty in patients in whom aspirin will need to be discontinued perioperatively

CARDIOVASCULAR SYSTEM

- An easy and inexpensive method to determine cardiovascular functional status for noncardiac surgery is the **patient's ability or inability to climb two flights of stairs.**
- In major noncardiac surgery, **an inability to climb two flights of stairs is an independent predictor of perioperative morbidity,** but not mortality

PULMONARY SYSTEM

- **Thoracic and upper abdominal procedures can decrease pulmonary function and predispose to pulmonary complications**
- It is prudent to consider assessment of pulmonary function for :
 - all lung resection cases
 - thoracic procedures requiring single-lung ventilation (i.e.: esophagus)
 - major abdominal and thoracic cases in patients who are older than 60 years, have significant underlying medical disease, smoke, or have overt pulmonary symptomatology
- Necessary tests include:
 - forced expiratory volume in 1 second (FEV_1)
 - forced vital capacity
 - diffusing capacity of carbon monoxide
- Adults with an **$FEV_1 < \text{than } 0.8 \text{ liter/sec, or } 30\% \text{ of predicted}$** , have a **high risk** for complications and postoperative pulmonary insufficiency

PULMONARY SYSTEM

- **↑risk** for postoperative pulmonary complications:
 - Age
 - Lower Albumin Level
 - Weight Loss
 - Obesity

- The following conditions are associated with **↑risk** for post-op pulmonary complications
 - Impaired Sensorium
 - Previous Stroke
 - Congestive Heart Failure
 - Acute Renal Failure
 - Chronic Steroid Use
 - Blood Transfusion

TABLE 10-8 Risk Factors for Development of Postoperative Pneumonia and Respiratory Failure

RISK FACTOR	POSTOPERATIVE PNEUMONIA RISK INDEX, OR (95% CI)	POINT VALUE	RESPIRATORY FAILURE RISK INDEX, OR (95% CI)	POINT VALUE
Type of Surgery				
AAA repair	4.29 (3.34-5.50)	15	14.3 (12.0-16.9)	27
Thoracic	3.92 (3.36-4.57)	14	8.14 (7.17-9.25)	21
Upper abdominal	2.68 (2.38-3.03)	10	4.21 (3.80-4.67)	14
Neck	2.30 (1.73-3.05)	8	3.10 (2.40-4.01)	11
Neurosurgical	2.14 (1.66-2.75)	8	4.21 (3.80-4.67)	14
Vascular	1.29 (1.10-1.52)	3	4.21 (3.80-4.67)	14
Emergency surgery	1.33 (1.16-1.54)	3	3.12 (2.83-3.43)	11
General anesthesia	1.56 (1.36-1.80)	4	1.91 (1.64-2.21)	—
Age, yr				
>80	5.63 (4.62-6.84)	17	—	—
70-79	3.58 (2.97-4.33)	13	—	—
60-69	2.38 (1.98-2.87)	9	—	—
50-59	1.49 (1.23-1.81)	4	—	—
<50	1.00 (referent)	—	—	—
60-69	—	—	1.51 (1.36-1.69)	4
<60	—	—	1.00 (referent)	—
≥70	—	—	1.91 (1.71-2.13)	6
Functional Status				
Totally dependent	3.83 (2.33-3.43)	10	1.92 (1.74-2.11)	7
Partially dependent	1.83 (1.63-2.06)	6	1.92 (1.74-2.11)	7
Independent	1.00 (referent)	—	1.00 (referent)	—
Albumin Level				
<3.0 g/dL	—	—	2.53 (2.28-2.80)	9
>3.0 g/dL	—	—	1.00 (referent)	—
Weight loss >10% (within 6 mo)	1.92 (1.68-2.18)	7	1.37 (1.19-1.57)*	—
Long-term steroid use	1.33 (1.12-1.58)	3	—	—
Alcohol, >2 drinks/day (within 2 wk)	1.24 (1.08-1.42)	2	1.19 (1.07-1.33)*	—
Diabetes, treated with insulin	—	—	1.15 (1.00-1.33)*	—
History of COPD	1.72 (1.55-1.91)	5	1.81 (1.66-1.98)	6
Current Smoker				
Within 1 yr	1.28 (1.17-1.42)	3	—	—
Within 2 wk	—	—	1.24 (1.14-1.36)*	—
Preoperative pneumonia	—	—	1.70 (1.24-2.13)*	—
Dyspnea				
At rest	—	—	1.69 (1.36-2.09)*	—
With minimal exertion	—	—	1.21 (1.09-1.34)*	—
—	—	—	1.00 (referent)	—
No Dyspnea				
Impaired sensorium	1.51 (1.26-1.82)	4	1.22 (1.04-1.43)*	—
History of CVA	1.47 (1.28-1.68)	4	1.20 (1.05-1.38)*	—
History of CHF	—	—	1.25 (1.07-1.47)*	—
BUN Level				
<8 mg/dL	1.47 (1.26-1.72)	4	1.00 (referent)	—
8-21 mg/dL	1.00 (referent)	—	1.00 (referent)	—
22-30 mg/dL	1.24 (1.11-1.39)	2	1.00 (referent)	—
>30 mg/dL	1.41 (1.22-1.64)	3	2.29 (2.04-2.56)	8
Preoperative renal failure	—	—	1.67 (1.23-2.27)*	—

PULMONARY SYSTEM

- Specific pulmonary **risk factors** include:
 - Chronic Obstructive Pulmonary Disease (COPD)
 - Smoking, preoperative sputum production
 - Pneumonia, dyspnea
 - Obstructive sleep apnea
- **Pre-op interventions** that may decrease post-op pulmonary complications include:
 - Smoking cessation (within 2 months before the planned procedure)
 - Bronchodilator therapy
 - Antibiotic therapy for preexisting infection
 - Pretreatment of asthmatic patients with steroids

PULMONARY SYSTEM

- In addition, **encouraging exercise** preoperatively may improve a patient's recovery postoperatively. A recommendation would be to encourage the patients to **walk 3 miles in less than 1 hour several times weekly**
- **Peri-operative strategies** include the use of:
 - Epidural anesthesia
 - Vigorous pulmonary toilet and rehabilitation
 - Continued bronchodilator therapy

RENAL SYSTEM

- Approximately **5% of the adult population has some degree of renal dysfunction**
- A pre-op **creatinine level of 2.0 mg/dL** or higher is an **independent risk factor** for cardiac complications
- The cardiovascular examination seeks to document signs of **fluid overload: chest radiograph** may be helpful
- Assess the pt. with renal insufficiency with: **electrocardiogram (ECG), serum chemistry panel, and complete blood count (CBC), electrolyte or blood gas analysis**

RENAL SYSTEM

- **Anemia**: treat with **eritropoietin**
- **Platelet dysfunction** associated with **uremia** is often a qualitative one and platelet counts are usually normal: **communicate** with the anesthesiologist about improving platelet function
- **Treatment of hyperkalemia**
- **Symptomatic hypocalcemia**: replacement of **calcium**
- **Hyperphosphatemia**: **phosphate-binding antacids**
- **Metabolic acidosis**: **sodium bicarbonate** is used when serum bicarbonate levels are below 15 mEq/liter

RENAL SYSTEM

- **Hyponatremia**: treat by **volume restriction**, although **dialysis is commonly required**
- **Patients with chronic end-stage renal disease undergo dialysis before surgery** to optimize their volume status and control the potassium level
- **Intraoperative hyperkalemia** can result from surgical manipulation of tissue or transfusion of blood. Such pts are often **dialyzed** on the day after surgery
- **In the acute setting**, pts can **undergo surgery without pre-op dialysis**, provided that no other indication exists for emergency dialysis
- **Prevention of secondary renal insults** in the perioperative period include:
 - the avoidance of nephrotoxic agents
 - maintenance of adequate intra-op intravascular volume

RENAL SYSTEM

- Peri-op pharmacokinetics of many drugs may be unpredictable: adjust dosing
 - **Narcotics** for pain may have prolonged effects
 - **NSAIDs** are usually avoided

HEPATOBIILIARY SYSTEM

- **Hepatic dysfunction** may follow **viral-, drug-, and toxin-mediated disease**
- A patient with liver dysfunction requires **careful assessment** of the degree of functional impairment
- **Effort has to be made to void additional liver insult perioperatively**
- History: pts. usually know whether **hepatitis has been diagnosed**
- A **review of systems** specifically inquires about symptoms such as **pruritus, fatigability, excessive bleeding, abdominal distention, and weight gain**
 - **Encephalopathy or asterixis** may be evident
 - **Muscle wasting or cachexia**

HEPATOBIILIARY SYSTEM

- Evidence of hepatic dysfunction may be seen on physical examination:
 - **Jaundice and scleral icterus** may be evident with serum bilirubin levels higher than 3 mg/dL
 - Skin changes include **spider angiomas, caput medusae, palmar erythema,** and **clubbing of the fingertips**
 - **Abdominal examination** may reveal distention, evidence of fluid shift, and hepatomegaly.



HEPATOBIILIARY SYSTEM

- A patient with liver dysfunction should undergo **standard liver function tests: transaminase levels**
- Serologic testing for **hepatitis A, B, and C**
- Alcoholic hepatitis** is suggested by **lower transaminase levels** and an aspartate aminotransferase-to-alanine transaminase ratio (**AST/ALT ratio**) **higher than 2**
- Chronic hepatitis or cirrhosis are investigated with *tests of hepatic synthetic function*:
 - **Serum albumin**
 - **Prothrombin**
 - **Fibrinogen levels**

HEPATOBIILIARY SYSTEM

- Pts. with evidence of **impaired hepatic synthetic function** also have to be tested for **CBC and serum electrolyte analysis**
- Type and screen** are indicated when **blood loss** is anticipated
- A pt. with **acute hepatitis and elevated transaminase levels** is managed **nonoperatively**, when feasible
- In an acute setting, ↑ morbidity and mortality** in case of surgery are reported

HEPATOBIILIARY SYSTEM

• **Cirrhosis** may be assessed with the **Child-Pugh classification**, which **stratifies operative risk** according to a score based on

- **albumin and bilirubin levels**
- **prolongation of the prothrombin time (PT)**
- **degree of ascites**
- **degree of encephalopathy**

• Pts with **Child class A, B, and C** cirrhosis have **mortality rates of 10%, 31%, and 76%** respectively, during abdominal operations

Other factors that affect outcomes:

- **emergency nature** of a procedure
- **prolongation of the PT more than 3 seconds above normal**
- **refractory to correction with vitamin K**
- **presence of infection**

TABLE 10-10 Child-Pugh Scoring System

PARAMETER	POINTS		
	1	2	3
Encephalopathy	None	Stage I or II	Stage III or IV
Ascites	Absent	Slight (controlled with diuretics)	Moderate despite diuretic treatment
Bilirubin (mg/dL)	<2	2-3	>3
Albumin (g/liter)	>3.5	2.8-3.5	<2.8
PT (prolonged seconds)	<4	4-6	>6
INR	<1.7	1.7-2.3	>2.3

Class A, 5-6 points; class B, 7-9 points; class C, 10-15 points.
INR, international normalized ratio; *PT*, prothrombin time.

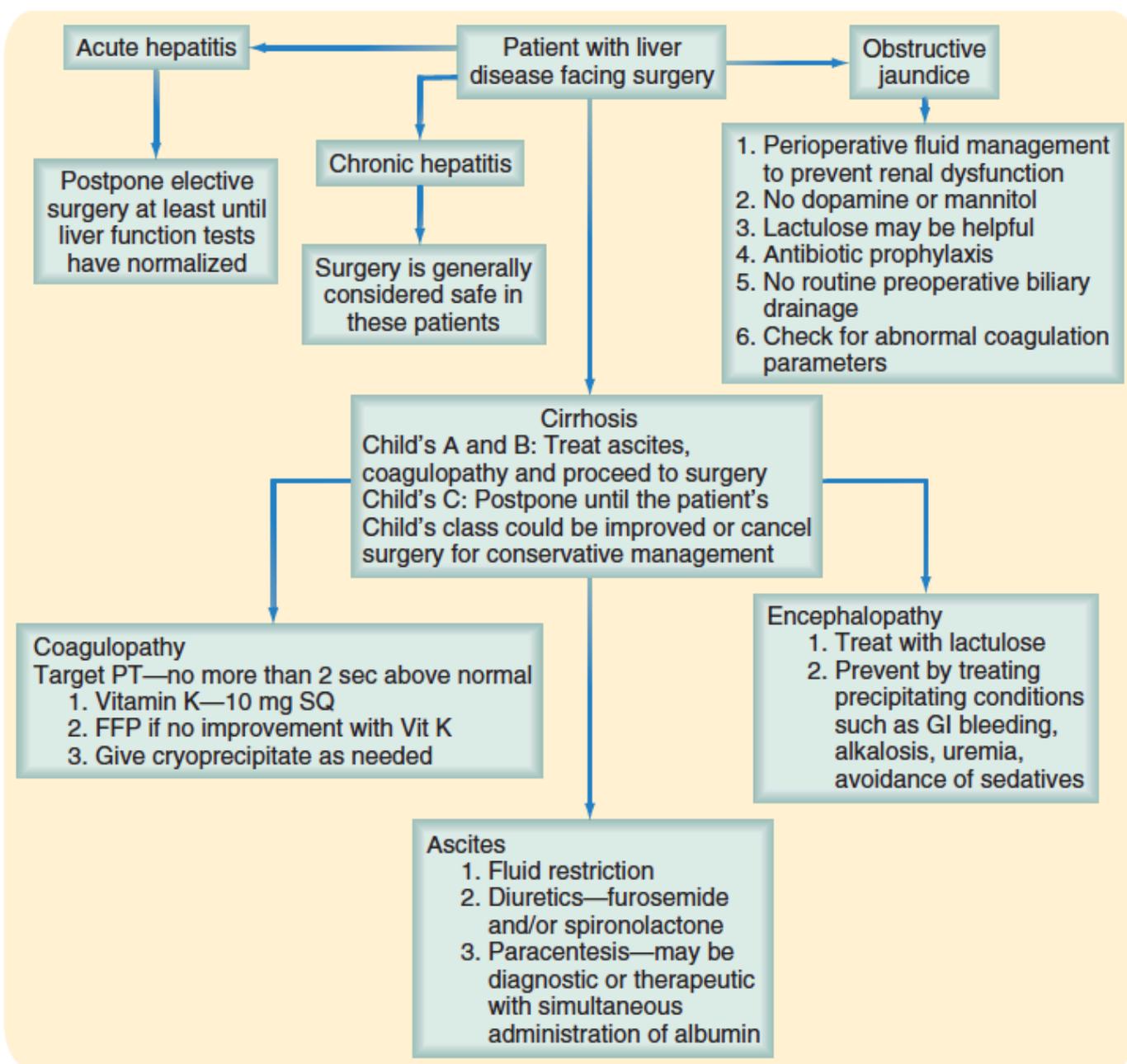


FIGURE 10-2 Approach to a patient with liver disease. *FFP*, fresh-frozen plasma; *GI*, gastrointestinal; *PT*, prothrombin time; *SQ*, subcutaneous. (From Rizvon MK, Chou CL: Surgery in the patient with liver disease. *Med Clin North Am* 87:211–227, 2003.)

HEPATOBIILIARY SYSTEM

- Evaluate **hernia (umbilical and groin) and cholecystitis**
- **An umbilical hernia** best to treat after the ascites has been reduced - **the procedure is associated with mortality rates as high as 14%**
- Repair of **groin hernias** in the presence of ascites **is less risky** in terms of recurrence and mortality
- **Laparoscopic cholecystectomy** best than open in case of cirrhosis and ascites: lower morbidity (infections and blood loss)
- **Malnutrition** is common in cirrhotic patients, due to ↓ **hepatic glycogen stores** and ↓ **protein synthesis**

ENDOCRINE SYSTEM

- A patient with **diabetes mellitus, hyperthyroidism or hypothyroidism, or adrenal insufficiency** is subject to additional **stress** during surgery

Perioperative diabetic management

- Evaluation of a diabetic patient for surgery includes
 - **Assessment of the adequacy of glycemic control**
 - **Identification of diabetic complications**
- **History and physical examination** search for diabetic complications:
 - **Cardiac disease**
 - **Circulatory abnormalities**
 - **Retinopathy**
 - **Neuropathy**
 - **Nephropathy**

Perioperative Diabetic Management

- Preoperative testing may include:
 - fasting and postprandial glucose
 - hemoglobin A1C levels
 - serum electrolyte
 - blood urea nitrogen
 - creatinine levels (for renal involvement)
 - urinalysis (proteinuria as evidence of diabetic nephropathy)
 - an ECG (for patients with long-standing disease)

- Intermediate- and long-acting insulin preparations are administered the night before (1/3 usual dose) and the morning the day of surgery (1/2 usual dose)

- Assess pt. with frequent **bedside glucose determination** and treatment with **short-acting insulin**, as needed

- Infusion of dextrose 5% the morning of surgery

ENDOCRINE SYSTEM

- Pts who take **oral hypoglycemic agents** (sulfonylureas, such as chlorpropamide and glyburide) typically **withhold their normal dose the day of surgery**
- Pts can resume their oral agent once diet is resumed
- **An exception is metformin:**
 - if the patient has **altered renal function**, this agent needs to be **discontinued** until renal function normalizes to avoid **potential lactic acidosis**

ENDOCRINE SYSTEM

Management of Other Endocrinopathies

- **Hyperthyroidism** (↓TSH): surgery is deferred until a **euthyroid state has been achieved**
 - **Electrolyte levels and ECG** need to be carried out pre-operatively
- If signs of **airway compromise** (large goiter) further imaging may be warranted
- A pt with hyperthyroidism who takes **antithyroid medication** (propylthiouracil or methimazole) has to **continue this regimen** on the day of surgery
- **Beta blockers or digoxin** also need to be continued

ENDOCRINE SYSTEM

- **Urgent surgery** in a **thyrotoxic pt** at risk for thyroid storm: treat with **adrenergic blockers** and **glucocorticoids**
- Pts with **newly diagnosed hypothyroidism** generally **do not require** pre-op treatment
- **Severe hypothyroidism (high TSH level)** can be associated with:
 - Myocardial dysfunction
 - Coagulation abnormality
 - Electrolyte imbalance
 - Hypoglycemia

Severe hypothyroidism needs to be corrected before elective surgery

ENDOCRINE SYSTEM

- A pt with a **history of steroid use** may require **supplementation** for a presumed abnormal adrenal response to perioperative stress
- Patients who have taken more than **5 mg of prednisone (or equivalent)/day for more than 3 weeks** are considered at risk when undergoing **major surgery**
 - Lower doses of steroid or minor procedures are not generally associated with adrenal suppression
- A **low-dose (1 µg) ACTH stimulation test** may demonstrate abnormal response to adrenal stimulation and suggest the need for perioperative steroid supplementation

ENDOCRINE SYSTEM

- **Minor operations** such as hernia repair under local anesthesia may **not require** any additional steroid
- **Moderate operations** such as open cholecystectomy or lower extremity revascularization require 50 to 75 mg/day of hydrocortisone equivalent for 1 or 2 days

ENDOCRINE SYSTEM

- Pts with **pheochromocytoma** require **preoperative pharmacologic management** to prevent intraoperative **hypertensive crises or hypotension**
- The state of catecholamine excess is controlled by a combination of **α -adrenergic** (phenoxybenzamine or prazosin) **and β -adrenergic blockade** before surgery
- **Sodium-restricted diet** as part of their *hypertension management* - hydration
- **β blockade** is initiated several days after the α -adrenergic agent and it **inhibits tachycardia** that accompanies nonselective α blockade and to **control arrhythmia**
- Pts may undergo surgery when pharmacologic blood pressure control is achieved

IMMUNE SYSTEM

- Goal is **optimize immunologic function before surgery** and minimize risk of infection and wound breakdown in immunodepressed pts
- **Pre-op assessment includes:**
 - **thorough history** of the pt's underlying disease and current functional status
 - a **history of immunosuppressive treatment**
 - **changes in weight**
- The **physical examination** seeks to document any signs of organ dysfunction
- **Lab: CBC with differential and platelet count, electrolytes, and liver function tests**
- **ECG and chest radiograph** are obtained when **age or physical findings** suggest risk

IMMUNE SYSTEM

- Possible sites of infection must be investigated
- Studies of **T cell, B cell, polymorphonuclear, or complement** function may be helpful
- **Neutropenia, anemia, or thrombocytopenia** may accompany the underlying disease process or result from treatment with immunosuppressive medication
- Decisions regarding **red blood cell transfusion** or the use of **synthetic erythropoietin or colony-stimulating factors** are often based on the degree of dysfunction and other patient risk factors
- Careful attention is paid to **nutritional deficiency**, with supplementation indicated in the perioperative period
- **Appropriate antibiotic prophylaxis is critical**

HEMATOLOGIC SYSTEM

Anemia

- The history and physical show **energy loss, dyspnea, palpitations, pallor and cyanosis**
- Evaluate for **lymphadenopathy, hepatomegaly, or splenomegaly**

Obtain:

- CBC and reticulocyte count**
- Serum iron**
- Total iron-binding capacity**
- Ferritin**
- vitamin B₁₂ and folate level**
- Preoperative treatment and optimization** are performed

HEMATOLOGIC SYSTEM

Anemia

- The **decision to transfuse** perioperatively is made upon
 - risk factors for **ischemic heart disease**
 - estimated magnitude of blood loss during surgery
 - potential for improving outcomes after surgery with a preoperative transfusion
- Pts with **normovolemic anemia without significant cardiac risk or anticipated blood loss** can be **managed safely without transfusion**, with most healthy patients tolerating hemoglobin levels of 6 or 7 g/dL

HEMATOLOGIC SYSTEM

Guidelines for Red Blood Cell Transfusion for Acute Blood Loss

- Estimate the risk for ischemia
- Estimate or anticipate the degree of blood loss
- Measure the hemoglobin:
 - **<6g/dl transfusion usually required**
 - **6-10 g/dl transfusion dictated by clinical circumstance**
 - **>10 g/dl transfusion rarely required**
- Measure **vital signs and tissue oxygenation** when HB 6-10 g/dl. **Tachicardia and hypotension** refractory to volume suggest the need for transfusion
- **Assess bleeding risk: history of abnormal bleeding, easy bruising, history of liver or kidney dysfunction, recent common bile obstruction, and nutritional status**
- **Medications:** anticoagulants, salicylates, NSAIDs, antiplatelet drugs

HEMATOLOGIC SYSTEM

- Physical examination: **bruising, petechiae, or signs of liver dysfunction**

- Pts with **thrombocytopenia**
 - **qualitative** defects may respond to medical management of the **underlying disease**
 - **quantitative** defects may require **platelet transfusion** when **<50,000/mL** in a pt at risk for bleeding

- Coagulation studies are needed** in pts with history of coagulopathy or bleeding risk during surgery

- Pts with documented coagulative disorders may require perioperative **management of factor disorders**

HEMATOLOGIC SYSTEM

- **Anticoagulation therapy** usually require preoperative reversal of the anticoagulant effect: **low-molecular-weight heparin (LMWH)**
- **Warfarin** withheld for **5 scheduled doses** preoperatively to allow the **INR* <1.5**
- **Warfarin can be restarted the day of or day after surgery** because it will take up to five doses to become therapeutic

*INR: international normalized ratio

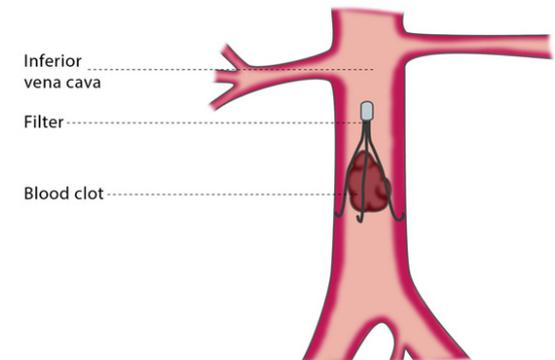
TABLE 10-13 Recommendations for Perioperative Management of Patients on Long-Term Anticoagulation

INDICATION FOR LONG-TERM ANTICOAGULATION	PATIENT CHARACTERISTICS	PERIOPERATIVE MANAGEMENT
Prosthetic heart valves	High risk Recent (<6 mo) stroke or TIA Any mitral valve Caged ball or tilting disc aortic valve	Strongly recommend bridging
	Moderate risk—bileaflet aortic valve with ≥ 2 risk factors for stroke* Low risk—bileaflet aortic valve with <2 risk factors for stroke*	Consider bridging based on individual No bridging
Chronic atrial fibrillation	High risk Recent (within 3 mo) stroke or TIA Rheumatic valvular heart disease	Strongly recommend bridging
	Moderate risk—chronic atrial fibrillation with ≥ 2 risk factors for stroke* Low risk—chronic atrial fibrillation with <2 risk factors for stroke*	Consider bridging No bridging
VTE	High risk Recent (≤ 3 mo) VTE Severe thrombophilia (e.g., deficiency of protein C, protein S, or antithrombin; antiphospholipid antibody†) Major comorbid disease (cardiac or pulmonary)	Strongly recommend bridging
	Moderate risk VTE within the past 3-12 mo Recurrent VTE Nonsevere thrombophilia (e.g., heterozygous factor V Leiden or prothrombin gene mutation)	Consider bridging
	Low risk—VTE >12 mo previous and no other risk factor	No bridging

HEMATOLOGIC SYSTEM

- Pts. **on LMWH**: give the last dose **20 to 24 hours prior to surgery**, restart approximately **12 to 24 hours postoperatively**
- For procedures with a **high risk of postoperative bleeding** consider using prophylactic-dose **LMWH**
- When possible, surgery is postponed **1 month** after an episode of venous or arterial **thromboembolism**
- Patients taking anticoagulants for less than 2 weeks for **pulmonary embolism (PE) or proximal deep venous thrombosis (DVT)**, or those for whom the **risk of perioperative bleeding** is high, should be considered for **retrievable inferior vena cava filter placement** before surgery

Inferior vena cava (IVC) filter



HEMATOLOGIC SYSTEM

- Assess risk for **venous thromboembolism** and **adequate prophylaxis**
- Ask for **family history** suggestive of a hypercoagulable state. Levels of **protein C, protein S, antithrombin III, and antiphospholipid antibody** can be determined
- Risk factor stratification is based on:
 - **Age**
 - **type of surgical procedure**
 - **previous thromboembolism**
 - **cancer**
 - **obesity**
 - **varicose veins, cardiac dysfunction, indwelling central venous catheters, inflammatory bowel disease, nephrotic syndrome, pregnancy, and estrogen or tamoxifen use**

HEMATOLOGIC SYSTEM

- Treatment includes
 - **Unfractionated heparin**
 - **LMWH**
 - **Intermittent compression devices**
 - **Early ambulation**
- Initial prophylactic doses of heparin is given pre-op **within 2 hours of surgery**, and with **compression devices**
- **Very high-risk patients** (orthopedic procedures, multiple risk factors): continuation of **venous thromboembolism (VTE) prophylaxis** may be considered **after discharge from the hospital**

TABLE 10-14 Caprini Risk Assessment Model for Venous Thromboembolism in General Surgical Patients

1 POINT	2 POINTS	3 POINTS	4 POINTS
Age 41-60 yr	Age 61-74 yr	Age \geq 75 yr	Stroke <1 mo
BMI >25 kg/m ²	Arthroscopic surgery	Prior episodes of VTE	Fracture of hip, pelvis, or leg
Minor surgery	Laparoscopy >45 min	Family history for VTE	Elective arthroplasty
Edema in the lower extremities	Major open surgery >45 min	Prothrombin 20210 A	Acute spinal cord injury <1 mo
Varicose veins	Cancer	Factor V Leiden	
Pregnancy or postpartum	Plaster cast	Lupus anticoagulants	
Oral contraceptive	Bed bound for >72 hr	Anticardiolipin antibodies	
Hormonal therapy	Central venous access	High homocysteine in the blood	
Unexplained or recurrent abortion		Heparin-induced thrombocytopenia	
Sepsis (<1 mo)		Other congenital or acquired thrombophilia	
Serious lung disease such as pneumonia (<1 mo)			
Abnormal pulmonary function test			
Acute myocardial infarction			
Congestive heart failure (<1 mo)			
Bed rest			
Inflammatory bowel disease			

From Caprini JA: Thrombosis risk assessment as a guide to quality patient care. *Dis Mon* 51:70–78, 2005; and Bahl V, Hu HM, Henke PK, et al: A validation study of a retrospective venous thromboembolism risk scoring method. *Ann Surg* 251:344–350, 2010.

BMI, body mass index; VTE, venous thromboembolism.

ADDITIONAL PRE-OP CONSIDERATIONS

AGE = presence of comorbid illness and limited reserve: optimize the patient's condition before surgery

• **Predicting and preventing post-op delirium** in older adults. Pts with **≥ 3** or more factors have a 50% risk for postop delirium:

- 70 years or older
- alcohol abuse
- poor cognitive status
- poor functional status
- abnormal preoperative serum sodium, potassium, and/or glucose level
- noncardiac thoracic surgery
- aortic aneurysm surgery

ADDITIONAL PRE-OP CONSIDERATIONS

Malnutrition

- Evaluation of **nutritional status** is part of the pre-op evaluation
- A history of **weight loss greater than 10%** of body weight **over a 6-month** period or 5% over a 1-month period is significant
- **Albumin or prealbumin levels** identify patients with some degree of malnutrition
- **The degree of malnutrition** is estimated on
 - **weight loss**
 - **physical findings**
 - **plasma protein level**

ADDITIONAL PRE-OP CONSIDERATIONS

- **Severe malnutrition: pre-op nutrition** (enteral, if possible)

Obesity

- **↑perioperative mortality in severe obesity** (BMI 40 kg/m², or BMI 35 kg/m² with significant comorbid conditions)

- **Severe obesity is associated with:**
 - essential hypertension
 - pulmonary hypertension
 - left ventricular hypertrophy
 - congestive heart failure
 - ischemic heart disease
 - post-op wound infection
 - DVT and PE: begin appropriate prophylaxis

PRE-OP CHECKLIST

The **preoperative evaluation** concludes with a **review** of all information obtained

- **Informed consent** is recorded
- **Give to the pt. written instructions** (time of surgery, fasting, bowel preparation, medication use)

Antibiotic Prophylaxis

- **Appropriate antibiotic prophylaxis** in surgery depends on the **most likely pathogens** encountered during the surgical procedure
- The **type of operative procedure** is helpful for deciding the appropriate antibiotic spectrum

Antibiotic Prophylaxis

- **Prophylactic antibiotics are not generally required for clean (class I) cases**, except in the setting of indwelling prosthesis placement, or when bone is incised
- **Clean-contaminated (class II)** procedures benefit from a **single dose** of an appropriate antibiotic administered before the skin incision. **For abdominal (hepatobiliary, pancreatic, gastroduodenal) cases, cefazolin is generally used**
- **Contaminated (class III)** cases require mechanical preparation or **parenteral antibiotics with aerobic and anaerobic activity**. This is the case of **emergency abdominal surgery**, as for suspected **appendicitis, and trauma cases**
- **Dirty or infected cases (class IV)** often require **antibiotics with aerobic and anaerobic activity**

Antibiotic Prophylaxis

- **The appropriate antibiotic is administered before the skin incision.** Repeat dosing occurs at interval (usually) 3 hours for abdominal cases or twice the half-life of the antibiotic
- Consider that patient's renal function may alter the timing
- Prophylaxis is not continued beyond the day of surgery
- **Minimally access surgery: decreases use of antibiotic since risk of wound infection is extremely low**
- For example, routine antibiotic prophylaxis for laparoscopic cholecystectomy (for uncomplicated symptomatic cholelithiasis) is questionable

TABLE 10-17 Surgical Wound Classifications as Defined by ACS NSQIP*

Clean	Uninfected operative wounds in which no inflammation is encountered and the respiratory, alimentary, genital, and uninfected urinary tracts are not entered
Clean/contaminated	Operative wounds in which the respiratory, alimentary, genital, or urinary tract is entered under controlled conditions and without unusual contamination
Contaminated	Open, fresh, accidental wounds; operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract; and incisions in which acute, nonpurulent inflammation is encountered
Dirty	Old traumatic wounds with retained devitalized tissue and wounds that involve existing clinical infection or perforated viscera.

From Eisenberg D: Surgical site infections: Time to modify the wound classification system? *J Surg Res* 175:54–55, 2012.

ACS NSQIP, American College of Surgeons National Surgical Quality Improvement Program.

*User Guide for the 2008 ACS NSQIP Participant Use Data File.

TABLE 10-18 Analysis of Postoperative Surgical Site Infections Stratified by Wound Classification (Traditional versus ACS NSQIP)

	CLEAN (%)	CLEAN/CONTAMINATED (%)	CONTAMINATED (%)	DIRTY (%)
Traditional	1-5	3-11	10-17	>27
ACS NSQIP SSI	2.58	6.67	8.61	11.80
Superficial SSI	1.76	3.94	4.75	5.16
Deep incisional SSI	0.54	0.86	1.31	2.10
Organ/space SSI	0.28	1.87	2.55	4.54

From Ortega G, Rhee DS, Papandria DJ, et al: An evaluation of Surgical Site Infection by wound classification system using the ACS-NSQIP. *J Surg Res* 174:33–38, 2012.

ACS NSQIP, American College of Surgeons National Surgical Quality Improvement Program; SSI, surgical site infection.

TABLE 10-19 Recommendations for Surgical Antimicrobial Prophylaxis

TYPE OF PROCEDURE	RECOMMENDED AGENTS ^{a,b}	ALTERNATIVE AGENTS IN PATIENTS WITH β -LACTAM ALLERGY	STRENGTH OF EVIDENCE ^c
Cardiac coronary artery bypass	Cefazolin, cefuroxime	Clindamycin, ^d vancomycin ^d	A
Cardiac device insertion procedures (e.g., pacemaker implantation)	Cefazolin, cefuroxime	Clindamycin, vancomycin	A
Ventricular assist devices	Cefazolin, cefuroxime	Clindamycin, vancomycin	C
Thoracic noncardiac procedures, including lobectomy, pneumonectomy, lung resection, and thoracotomy	Cefazolin, ampicillin-sulbactam	Clindamycin, ^d vancomycin ^d	A
Video-assisted thoracoscopic surgery	Cefazolin, ampicillin-sulbactam	Clindamycin, ^d vancomycin ^d	C
Gastroduodenal ^e procedures involving entry into lumen of gastrointestinal tract (bariatric, pancreaticoduodenectomy ^f)	Cefazolin	Clindamycin or vancomycin + aminoglycoside ^g or aztreonam or fluoroquinolone ^{h,i}	A
Procedures without entry into gastrointestinal tract (antireflux, highly selective vagotomy) for high-risk patients	Cefazolin	Clindamycin or vancomycin + aminoglycoside ^g or aztreonam or fluoroquinolone ^{h,i}	A
Biliary tract open procedure	Cefazolin, cefoxitin, cefotetan, ceftriaxone, ^k ampicillin-sulbactam ^b	Clindamycin or vancomycin + aminoglycoside ^g or aztreonam or fluoroquinolone, ^{h,i} metronidazole + aminoglycoside ^g or fluoroquinolone ^{h,i}	A
Laparoscopic procedure			
Elective, low-risk ^l	None	None	A
Elective, high-risk ^l	Cefazolin, cefoxitin, cefotetan, ceftriaxone, ^k ampicillin-sulbactam ^b	Clindamycin or vancomycin + aminoglycoside ^g or aztreonam or fluoroquinolone, ^{h,i} metronidazole + aminoglycoside ^g or fluoroquinolone ^{h,i}	A
Appendectomy for uncomplicated appendicitis	Cefoxitin, cefotetan, cefazolin + metronidazole	Clindamycin + aminoglycoside ^g or aztreonam or fluoroquinolone, ^{h,i} metronidazole + aminoglycoside ^g or fluoroquinolone ^{h,i}	A
Small intestine			
Nonobstructed	Cefazolin	Clindamycin + aminoglycoside ^g or aztreonam or fluoroquinolone ^{h,i}	C
Obstructed	Cefazolin + metronidazole, cefoxitin, cefotetan	Metronidazole + aminoglycoside ^g or fluoroquinolone ^{h,i}	C
Hernia repair (hernioplasty and herniorrhaphy)	Cefazolin	Clindamycin, vancomycin	A
Colorectal ^m	Cefazolin + metronidazole, cefoxitin, cefotetan, ampicillin-sulbactam, ^h ceftriaxone + metronidazole, ⁿ ertapenem	Clindamycin + aminoglycoside ^g or aztreonam or fluoroquinolone, ^{h,i} metronidazole + aminoglycoside ^g or fluoroquinolone ^{h,i}	A
Head and neck clean	None	None	B
Clean with placement of prosthesis (excludes tympanostomy tubes)	Cefazolin, cefuroxime	Clindamycin ^d	C
Clean-contaminated cancer surgery	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin-sulbactam	Clindamycin ^d	A
Other clean-contaminated procedures with the exception of tonsillectomy and functional endoscopic sinus procedures	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin-sulbactam	Clindamycin ^d	B
Neurosurgery elective craniotomy and cerebrospinal fluid–shunting procedures	Cefazolin	Clindamycin, ^d vancomycin ^d	A

Implantation of intrathecal pumps	Cefazolin	Clindamycin, ^d vancomycin ^d	C
Cesarean delivery	Cefazolin	Clindamycin + aminoglycoside ^a	A
Hysterectomy (vaginal or abdominal)	Cefazolin, cefotetan, cefoxitin, ampicillin-sulbactam ^b	Clindamycin or vancomycin + aminoglycoside ^a or aztreonam or fluoroquinolone, ^{h,i} metronidazole + aminoglycoside ^a or fluoroquinolone ^{h,i}	A

REVIEW OF MEDICATION

- Pts taking **cardiac drugs, pulmonary drugs or anticonvulsivant or psychiatric drugs** have to take them with a sip of water on the morning of surgery
- **Lipid-lowering drugs and vitamins** can be omitted on that day
 - Perioperative discontinuation of beta-blockers increases cardiovascular morbidity
 - Abrupt cessation of antihypertensive clonidine causes rebound hypertension
- **Pts NPO can be switched to IV**
- Pts must return to their normal medication regimen asap

PRE-OPERATIVE FASTING

- **Aspirin and clopidogrel** (Plavix) are withheld for 7-10 days pre-op
- **NSAIDs** are withheld for 1-3 days (depending on drug half-life)
- **Estrogen and tamoxifen** have to be withheld for 4 weeks (possible DVT and PE)
- Use of **herbal medication** is stopped before surgery (not valerian)
- **NPO past midnight**: reduction of acid and volume of the stomach contents
- **ASA recommends** that adults stop intake of **solids for at least 6 hours and clear fluids 2 hours**

ERAS: ENHANCED RECOVERY AFTER SURGERY

POTENTIAL CAUSES OF INTRAOPERATIVE INSTABILITY

Myocardial infarction

- 1.5% of pts undergoing non-cardiac surgery will suffer peri-operative MI
- Presentation: ECG changes, dysrhythmias, hypotension
- Any evidence of pt instability should lead to termination of the procedure

Pulmonary embolism

- 2%** of pts undergoing hip surgery will have PE during the procedure
- Signs of PE:** new tachycardia, evidence of right heart strain, hypotension, complete cardiovascular collapse. Onset is sudden, and **rapid diagnosis and treatment are paramount**
- Intraoperative transesophageal echocardiography (TEE)** identify PE: right ventricular dysfunction, tricuspid regurgitation, leftward bowing of interatrial septum

POTENTIAL CAUSES OF INTRAOPERATIVE INSTABILITY

Pulmonary embolism

- If the patient is unstable: abort the procedure and address PE
 - Cardiovascular support, thrombolytics – severe cases: embolectomy

Pneumothorax

- Complication of laparoscopy. **The main risk is tension pneumothorax:** cardiovascular collapse, deoxygenation, hypercarbia, and hypotension with ECG changes
- Abdominal insufflation should be released
- Needle decompression or tube thoracostomy should be performed
- If the patient becomes stable, the procedure can be completed

POTENTIAL CAUSES OF INTRAOPERATIVE INSTABILITY

Anaphylaxis

- **Intra-op anaphylaxis** 1/4500 surgical cases / 3-6% mortality
- **Causative agents:** muscle relaxants, latex, anesthetic induction agents (etomidate and propofol), narcotic drugs. Dyes, colloid solutions, blood products, protamine, mannitol
- **Manifestations:** mild cutaneous eruptions, hypotension, cardiovascular collapse, bronchospasm, and death
- **Therapy:** discontinue the causative agent and give epinephrine 0.3-0.5 mL of a 1:1000 solution sub-q.
- Repeat at 5-10 min IV in severe anaphylaxis
- Histamine (H1) blockade with diphenhydramine, H2 blockade with ranitidine, hydrocortisone, are usually required
- In case of hemodynamic or respiratory collapse **fluid bolus, pressors, orotracheal intubation, nebulized Beta2-adrenergic agonists can be used**
- **Post-op monitoring in ICU is required**

POTENTIAL CAUSES OF INTRAOPERATIVE INSTABILITY

Latex allergy

- Check medical history
- Test latex allergy if history is consistent
- Ensure latex-free environment

Malignant hyperthermia

- 1/15.000 in boys younger than 15 years (group at higher risk)
- Caused by halogenated anesthetic agents or succinylcholine. Inherited: autosomal dominant pattern
- Manifestation: **increased sympathetic nervous system activity, muscle rigidity, high fever**
- Associated to: **hypercapnia, arrhythmia, acidosis, hypoxemia, rhabdomyolysis**
- **Treatment:** discontinue the causing agent, changing the anesthesia circuit – administer **DANTROLENE** sodium 2-3mg/kg IV
- Active or passive cooling, and pharmacologic treatment of arrhythmia, hyperkalemia and acidosis

WRONG-SITE SURGERY AND UNIVERSAL PROTOCOL

- Protocol includes pre-op marking of the surgical site, confirmation of the site, consent, mark, pt identification
 - Surgical Safety Checklist

TABLE 11-12 Antimicrobial Prophylaxis for Surgery

Treatment guidelines from the Medical Letter 7(82):47-52, 2009.

NATURE OF OPERATION	COMMON PATHOGENS	RECOMMENDED ANTIMICROBIALS	ADULT DOSAGE BEFORE SURGERY ^a
Cardiac	<i>Staphylococcus aureus</i> , <i>S. epidermidis</i>	Cefazolin <i>or</i>	1-2 g IV ^b
		Vancomycin ^c	1 g IV
Gastrointestinal			
Esophageal, gastroduodenal	Enteric gram-negative bacilli, gram-positive cocci	<i>High risk^d only:</i> Cefazolin ^g	1-2 g IV
Biliary tract	Enteric gram-negative bacilli, enterococci, clostridia	<i>High risk^e only:</i> Cefazolin ^g	1-2 g IV
Colorectal	Enteric gram-negative bacilli, anaerobes, enterococci	<i>Oral:</i> Neomycin + erythromycin base ^f <i>or</i>	
		Metronidazole ^f	
		<i>Parenteral:</i> Cefoxitin ^g <i>or</i>	1-2 g IV
		Cefazolin <i>plus</i>	1-2 g IV
		Metronidazole ^g <i>or</i>	0.5 g IV
		Ampicillin-sulbactam	3 g IV

Appendectomy, nonperforated ^h	Enteric gram-negative bacilli, anaerobes, enterococci	Cefoxitin ^g <i>or</i>	1-2 g IV
		Cefazolin plus	1-2 g IV
		Metronidazole ^g <i>or</i>	0.5 g IV
		Ampicillin-sulbactam	3 g IV
Genitourinary	Enteric gram-negative bacilli, enterococci	<i>High riskⁱ only:</i> Ciprofloxacin	500 mg PO or 400 mg IV
Gynecologic and Obstetric			
Vaginal, abdominal, or laparoscopic hysterectomy	Enteric gram-negative bacilli, anaerobes, group B streptococci, enterococci	Cefoxitin ^g <i>or</i> cefazolin ^g <i>or</i>	1-2 g IV
		Ampicillin-sulbactam ^g	3 g IV
Cesarean section	Same as for hysterectomy	Cefazolin ^g	1-2 g IV after cord clamping
Abortion	Same as for hysterectomy	<i>First trimester, high risk^j:</i> Aqueous penicillin G <i>or</i>	2 million U IV
		Doxycycline	300 mg PO ^k
		<i>Second trimester:</i> Cefazolin ^g	1-2 g IV