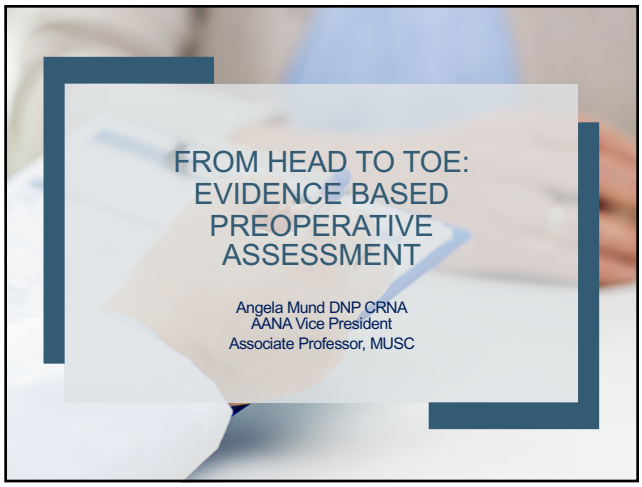
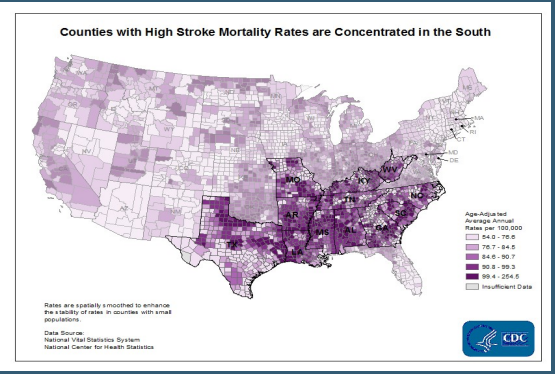


Objectives

- Recognize the risk factors for peri-anesthetic complications using a systems approach
- Describe the common risk assessment classifications
- Describe an evidence-based approach to perioperative planning and risk reduction

NEUROLOGIC ASSESSMENT

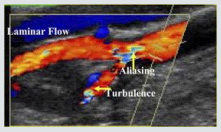


Cerebrovascular Disease & Stroke

- Three major risk factors
- Independent predictors of perioperative CVA
- Highest risk non-cardiac surgery
  - *Limb amputation > Ex lap > THA = Colectomy*
- Timing of elective surgery
  - *No clear correlation vs. increased risk for up to 9 months post CVA*
  - *Consultation*

Preanesthetic Evaluation

- Determine cause and timing of prior stroke
  - *What were the symptoms?*
  - *Was an echo performed?*
- Residual deficits
- Imaging
- Physical exam
  - *Presence of bruits*
- Anticoagulation
  - *Weight risk of thromboembolism vs. bleeding*



Patients with symptomatic carotid vascular disease or prior history of CVA with flow limiting stenosis should avoid elective surgery until carotid disease is addressed

Stroke. 2019 Aug;50(8):2002-2006. doi: 10.1161/STROKEAHA.119.024995. Epub 2019 Jun 25.

Cardiovascular Risk Scores to Predict Perioperative Stroke in Noncardiac Surgery.

Wilcox T[1], Smilowitz NR[1], Xia Y[1], Berger JS[1,2].

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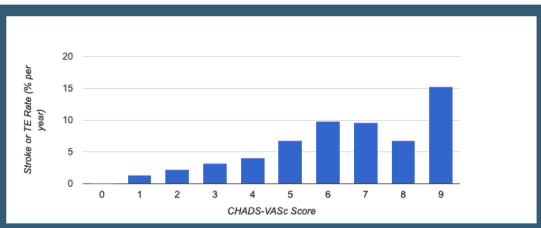
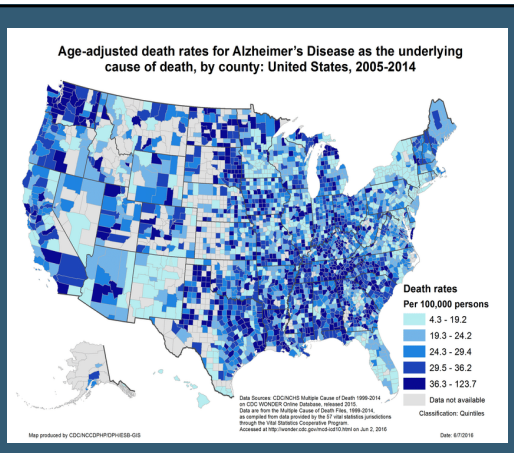
2 Department of Surgery (J.S.B.), New York University School of Medicine.



$CHADS_2$-VASc Score and Stroke Risk

https://clincalc.com/Cardiology/Stroke/CHADSVASC.aspx

DEMENTIA



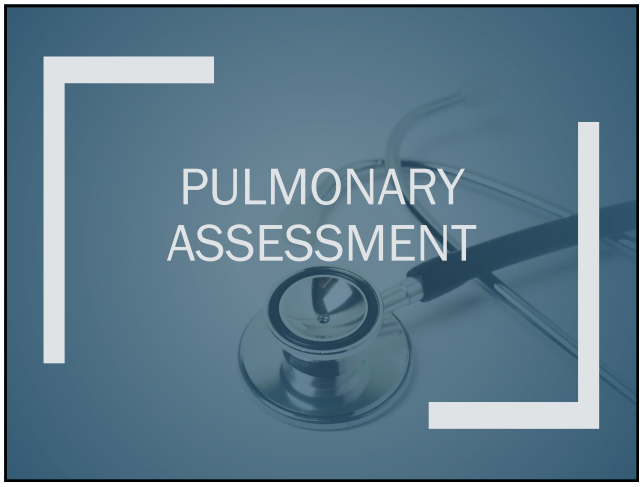
Type	Type of dementia • Parkinson's dz with dementia (5%) • Vascular dementia (10-20%) • Alzheimer's dz (60-80%)
Determine	Determine level of cognitive dysfunction • Accountability for decision-making
Evaluate	Evaluate respiratory function • Increased aspiration risk

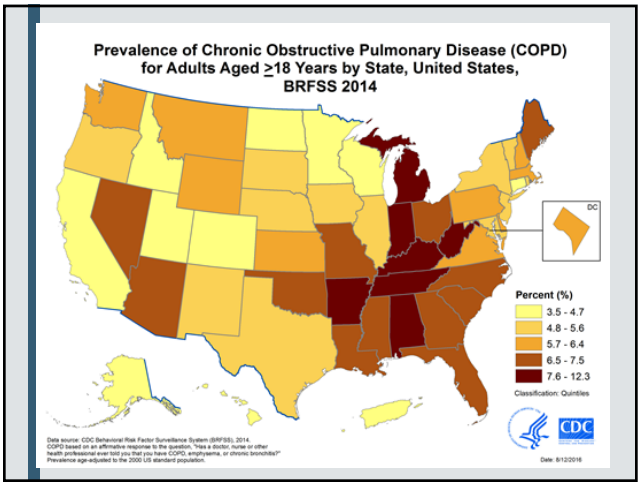
Anesthesia Considerations

- Increased risk for postoperative delirium
  - *Variable rates of occurrence depending on patient population, type of surgery, ?type of anesthetic*
  - *Risk factors*
  - *Associated with increased complications, LOS, & M/M*
- Controversy regarding regional anesthesia

Preoperative Medications

- Medications
  - *Cholinesterase inhibitors (ChEI)*
    - donepezil, rivastigmine, galantamine
  - *Disease modifying agents*
    - Memantine: NMDA receptor antagonist
    - Selegiline: MAOI
    - Vitamin E, Gingko
  - *SSRIs and neuroleptic agents*





Identify at risk patients

- Decreased activity level
- Poor general health
- Age >65
- Elevated BMI
- Other comorbid conditions
- Smoking
- Types of surgery

Smoking

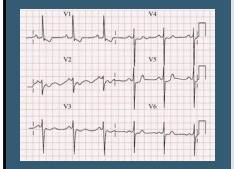
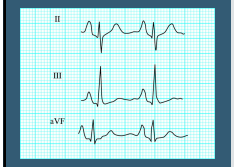
- Value of smoking cessation
  - *48 hours*
  - *Longer than 4-6 weeks*
  - *2-3 months*
- Calculate number of pack-years
  - *Directly related to changes in respiratory gas flow*
  - *Correlates to postoperative atelectasis and hypoxemia*

Pathology of Smoking

- Mucous gland enlargement/goblet cell hyperplasia
- Impairment of local lung defenses
- Small airway inflammation
- Bronchial reactivity

Preop Assessment

- Evaluate baseline symptoms, functional capacity, and current respiratory status
- Exacerbation symptoms, acute respiratory infection
  - *Postpone elective surgery and refer to pulmonologist +/- emergency room*
- No need for PFTs unless intrathoracic surgery
- What about ABGs?
- CXR?



http://usf.usfca.edu/fac_staff/ritter/Image22.gif

Pulmonary induced EKG changes

- Low voltage QRS with poor R-wave progression in precordial leads
- RA and RV strain pattern (R/S >1 in V_1)
- "p" pulmonale


COPD CXR

FVC

- Amount of air exhaled after a deep inspiration
- Usually reduced in disorders of lung parenchyma or the "bellows"
- Men 4.8L; Women 3.7L
- Percent predicted (>80% considered normal)

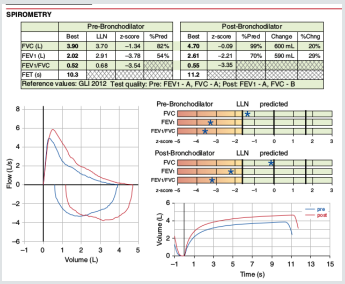
FEV_1

- Amount exhaled in the 1st second of the FVC
- Large and medium sized airway
- Indicator of airway obstruction
- Percent predicted

PFTs

Other Parameters

- FEF $_{25\%-75\%}$
  - *Mid flow measurements; ?early indicator of COPD or asthma*
  - *Fairly nonspecific*
- FEV_1/FVC
  - *Differentiate between restrictive and obstructive*
  - *Normal: Men and women 75-80%*
- V_T
  - *Men 500ml; Women 390 ml*
- TLC
  - *Men 6L; women 4.7L*



Bronchodilator Therapy with PFTs

- Assessment of the reversibility of the airway obstruction
- A 15% improvement in peak expiratory flow is considered a positive response
- Bronchodilators should be started before surgery

Postoperative Pulmonary Complications

Occurs in 3-6% of the post surgical population due to a combination of patient comorbidities and effects of anesthesia and surgery

Atelectasis, V/Q mismatch, hypoxemia and increased risk of respiratory infection

Risk Factors
- Patient, surgery, or anesthesia related

ARISCAT – Using the Model

Predictor	Multivariate Analysis OR	Risk score
Age 51-80	1.4	3
Age >80	5.1	16
Preop SpO2 91-95	2.2	8
Preop SpO2 <= 90	10.7	24
Resp infection w/in 1 mo	5.5	17
Preop hemoglobin <=10	3.0	11
Upper abdominal incision	4.4	15
Intrathoracic incision	11.4	24
Surgery >2-3 hrs	4.9	16
Surgery >3 hrs	9.7	23
Emergency procedure	2.2	8

Risk category	PPC rate
Low risk <26 points	1.6%
Intermediate risk 26-44 points	13.3%
High risk >= 45 points	42.1%

Back

https://www.slideshare.net/katejohnpunag/preop-pulmonary-evaluation-4-1615

Preoperative Optimization

- Evaluate and treat underlying infections, e.g. URI
- Evaluate for signs/symptoms of chronic hypoxia and cor pulmonale
- Smoking cessation
- Preop Medications
  - Reduce inflammation
  - Improve clearance of secretions
  - Increasing airway caliber
  - DVT/PE prophylaxis
- Evaluate the need for invasive monitoring

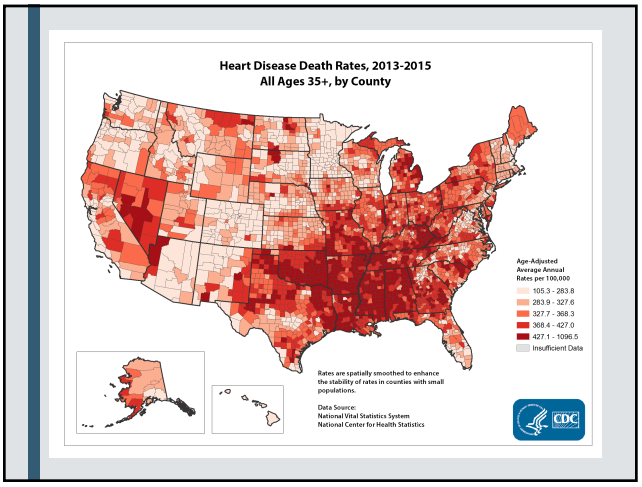
Preoperative Optimization

- Avoidance of general anesthesia
- Judicious titration of neuromuscular blockers and complete reversal
- Lung protective ventilation strategies
- Aggressively treat airflow obstruction
- Postop: good pain management, incentive spirometry, chest physiotherapy

No level of respiratory dysfunction has been identified as an absolute contraindication to surgery

Cardiovascular Risk Assessment

The risk of preoperative complications depends on the condition of the patient prior to surgery, the prevalence of co-morbidities, and the magnitude and duration of the surgery



Level of risk	Clinical Predictors
Major	Unstable coronary syndromes; Decompensated heart failure; Significant arrhythmias (high grade block, uncontrolled SVT, symptomatic vent arrhythmias) Severe valvular disease
Intermediate	Mild angina Previous MI by history or presence of Q wave Compensated or prior heart failure Diabetes mellitus, especially IDDM
Minor	Advanced age Abnormal EKG (LVH, BBB, ST abnormalities) Rhythm other than sinus Low functional capacity (<4 METs) History of CVA Uncontrolled systemic hypertension

ACC/AHA Practice Guidelines 2006

Considerations

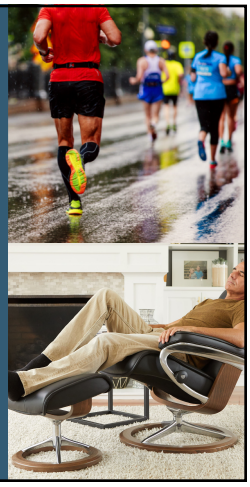
- Is surgery urgently required or do you have time for testing?
  - Is testing necessary?
- Recent MI (8 -30 days) versus Acute MI (7 days or less)
- Has the patient recently undergone revascularization?
- Has the patient been reevaluated for CAD in the past 2 years?
- Is the patient at risk for adverse cardiac events?
- What is the patients functional capacity?
- What is the probability of complications?
  - Do the benefits of the surgery outweigh the probability of postop cardiac complications?
- What is needed to modify perioperative care to reduce probability of post op cardiac complications?

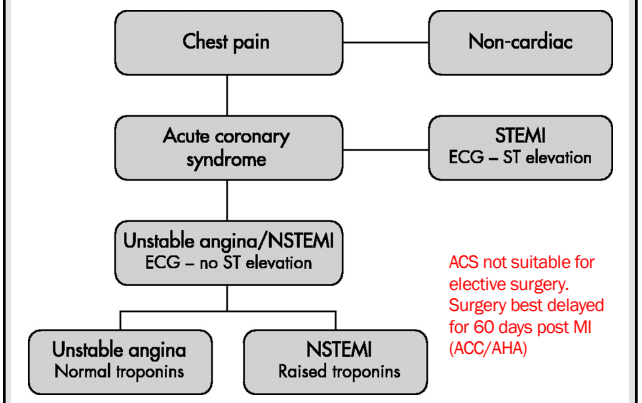
Mehta (2005)

Functional Capacity (Cardiac Reserve)

- Metabolic Equivalents
  - *1 MET (poor)*
    - ADLs, light housework, walk 1-2 block slowly on level ground
  - *4 METs (moderate)*
    - Climb 1 flight of stairs, heavy housework, moderate recreational activities, e.g. golf, dancing
  - *>10 METs (excellent)*
    - Strenuous sports

1 MET = basal metabolic rate = metabolic demand at rest





Stents

- AHA/ACC Advisory: caution on premature discontinuation of anti platelet therapy
  - *Most important to wait until no longer taking a thienopyridine*
- Recommendations for emergency surgery
  - *Higher rates of occlusion with both stents in emergency surgeries*
  - *Close monitoring requirement perioperatively*
  - *In E-cases: no increased incidence of blood transfusion requirements or bleeding complications*

ACC/AHA: EKG Recommendations

Class Iia (benefit >>risk)
Preoperative resting 12-lead electrocardiogram (ECG) is **reasonable** for patients with known coronary heart disease, significant arrhythmia, peripheral arterial disease, cerebrovascular disease, or other significant structural heart disease, except for those undergoing low-risk surgery (Level of Evidence: B)

Class Iib (benefit >= risk)
Preoperative resting 12-lead ECG **may be considered** for asymptomatic patients without known coronary heart disease, except for those undergoing low-risk surgery (Level of Evidence: B)

Class III: No Benefit
Routine preoperative resting 12-lead ECG is **not useful** for asymptomatic patients undergoing
low-risk surgical procedures (Level of Evidence: B)

ACC/AHA Rec's for Exercise Testing

Class IIa (benefit >>risk)
For patients with elevated risk and excellent (>10 metabolic equivalents [METs]) functional capacity, it is **reasonable** to forgo further exercise testing with cardiac imaging and proceed to surgery. (Level of Evidence: B)

Class IIb (benefit >= risk)
For patients with elevated risk and unknown functional capacity, it **may be** reasonable to perform exercise testing to assess for functional capacity if it will change management (Level of Evidence: B)

For patients with elevated risk and poor (<4 METs) or unknown functional capacity, it may be reasonable to perform exercise testing with cardiac imaging to assess for myocardial ischemia if it will change management. (Level of Evidence: C)

Class III: No Benefit
Routine screening with noninvasive stress testing is **not useful** for patients at low risk for noncardiac surgery (Level of Evidence: B)

ACC/AHA: LV Assessment

Class IIa: Reasonable (benefit >>risk)
Patients with **dyspnea of unknown origin** to undergo preoperative evaluation of left ventricular (LV) function. (Level of Evidence: C)

Patients with heart failure (HF) with **worsening dyspnea or other change in clinical status** to undergo preoperative evaluation of LV function. (Level of Evidence: C)

Class IIb (benefit >= risk)
Reassessment of LV function in **clinically stable patients** with previously documented LV dysfunction **may be considered** if there has been no assessment within a year. (Level of Evidence: C)

Class III: No Benefit
Routine preoperative evaluation of LV function is not recommended (Level of Evidence: B)

ACC/AHA Anesthesia Recommendations: Intraoperative Mgmt and Anesthetic technique

Class IIa

The emergency use of **perioperative TEE** is reasonable in patients with hemodynamic instability undergoing noncardiac surgery to determine the cause of hemodynamic instability when it persists despite attempted corrective therapy, if expertise is readily available. (Level of Evidence: C)

Class IIa

Use of **either a volatile anesthetic agent or total intravenous anesthesia** is reasonable for patients undergoing noncardiac surgery, and the choice is determined by factors other than the prevention of myocardial ischemia and MI (Level of Evidence: A)

Neuraxial anesthesia for postoperative pain relief can be effective in patients undergoing **abdominal aortic surgery** to decrease the incidence of perioperative MI (Level of Evidence: B)

Class IIb

Perioperative **epidural analgesia** may be considered to decrease the incidence of preoperative cardiac events in patients with a **hip fracture** (Level of Evidence: B

Patient-Specific Clinical Variables			Points
Coronary artery disease			
	Myocardial infarction within 6 months		10
	Myocardial infarction more than 6 months ago		5
	Canadian Cardiovascular Society angina		
		Class 3	10
		Class 4	20
	Unstable angina within 3 months		10
Alveolar pulmonary edema			
	Within one week		10
	Ever		5
Suspected critical aortic stenosis			20
Arrhythmias			
	Sinus rhythm plus atrial premature beats or rhythm other than sinus on last preoperative electrocardiogram		5
	More than 5 ventricular premature beats at any time prior to surgery		5
Poor general medical status*			5
Age over 70 years			5
Emergency operation			10

Detsky's Modified Cardiac Risk Index (1986)

Revised Cardiac Risk Index (2007)

1. History of IHD
2. History of CHF
3. History of CVD
4. History of DM
   1. *May not be a great indicator*
5. Chronic Kidney Disease
   1. *GFR <30ml/min*
6. Surgery type: intrathoracic, suprainguinal vascular, intraperitoneal

- RCRI Calculator
- Risk:
  - *0 predictors: 0.4% risk*
  - *1 predictor: 0.9% risk*
  - *2 predictors: 6.6% risk*
  - *>= 3 predictors: >11% risk*

NSQIP MI/Cardiac Arrest Risk Calculator (MICA) (2011)

- 5 predictors of risk
  - *Type of surgery (21 categories)*
  - *Dependent functional status*
  - *Abnormal creatinine (>1.5 mg.dl)*
  - *PS class*
  - *Increasing age*

HEPATOBILIARY ASSESSMENT

In the absence of a positive history and physical or known liver disease, preoperative lab testing unnecessary

Risk Factors

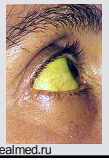
- Alcohol use
- Sexual activity
- IV drug use
- Transfusion history
- Tattoos and body piercing
- Travel
- Obesity
- Jaundice following surgery
- Family history
  - Hemochromatosis
  - α1-antitrypsin deficiency
- Medications
  - Dose related insult: acetaminophen
  - Idiosyncratic insult: halothane
  - Statins; herbals; Indocin, MAOIs

Assessment for liver injury/failure

- Fatigue, weakness, malaise
- Anorexia, weight loss, generalized abd pain, RUQ pain, bloating
  - RUQ pain from irritation of Glisson's capsule
  - Bloating from ascites
- Jaundice, dark urine, pruritis
  - Jaundice – bilirubin >2.5mg/dL
  - Jaundice without dark urine – high indirect bilirubin
  - Pruritis – early manifestation of obstructive disease

Physical Exam: Adv Liver Disease

- Muscle wasting, weight loss
- Presence of icterus
- Pleural effusion
- Hepatomegaly, ascitis
- Mental status changes
- Spider angiomata
- Palmar erythema and excoriation
- Caput medusa



www.healmed.ru

- NASH, drug toxicity, chronic viral hepatitis
  - *Mildly elevated ALT and AST (3x normal)*
- Acute hepatitis or chronic exacerbation (ETOH)
  - *Large increases in ALT and AST (4-22x normal)*
- Drug/toxin induced hepatocellular necrosis, severe viral hepatitis, **ischemic hepatitis complicating circulatory shock**
  - *Largest increases in ALT and AST*
- AST/ALT ratio
  - *Ratio >2 – ETOH liver disease*
  - *Ratio <1 - Viral Hepatitis*
- Hepatocellular damage
  - *Elevated ALT and AST with normal alk phos*

Differential Dx

Normal AST: 10-40 IU/L
Normal ALT: 10-60 IU/L
Normal alk phos: 30-120 IU/L

Differential Dx

Alkaline phosphatase

- Found in multiple organs
  - *Mild elevations non-specific*
- Elevations disproportionate to AST and ALT
  - *Intra or extra-hepatic obst to bile*
  - *Highly sensitive for biliary system*
- Increased with some infiltrative disorders, e.g. metastatic cancers

Bilirubin

- Conjugated and unconjugated
- Measures severity of jaundice and extent of conjugation
- Unconjugated 1-4 mg/dL
  - *Disorder of bilirubin metabolism*
  - ***Even in cases of severe hemolysis - total bilirubin<5***
- Unconjugated >5
  - *Liver disease*
- Unconjugated >35
  - *severe liver disease in association with hemolysis or renal failure*

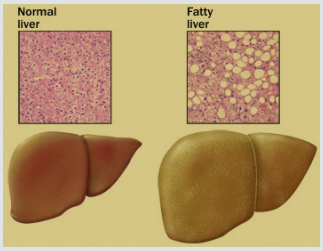
NAFLD & NASH

Fat builds up in the liver causing scar tissue.

Associated with DM, protein malnutrition, obesity, CAD and corticosteroids.

Similar to that of alcoholic liver disease except ETOH use

Biopsy is needed for diagnosis.



www.extremeliversupport.com

Modified Childs-Pugh Classification

- Three different classes (1-month mortality rates for patients undergoing surgery)
  - *A = low risk (5-10%)*
  - *B = moderate risk (14-30%)*
  - *C = high risk (51-80%)*

Non-cardiac elective surgery is not recommended for patients with Class C cirrhosis

TABLE 3. Child-Pugh classification system for liver dysfunction

Factors	1 Point	2 Points	3 Points
Albumin	>3.5 g/dL	2.8-3.5 g/dL	<2.8 g/dL
Ascites	None	Controlled	Refractory
Bilirubin	<2 mg/dL	2-3 mg/dL	>3 mg/dL
Encephalopathy	None	Controlled	Advanced
Prothrombin time	1-3 sec	4-6 sec	>6 sec

Score: Class A, 5-6 points; class B, 7-9 points; class C, 10-15 points
Data from Rosemurgy A and Zervos E,[2] Krige JE and Beckingham IJ,[4] and Durand F and Valla D.[5]

Model for Endstage Liver Disease (MELD) Score

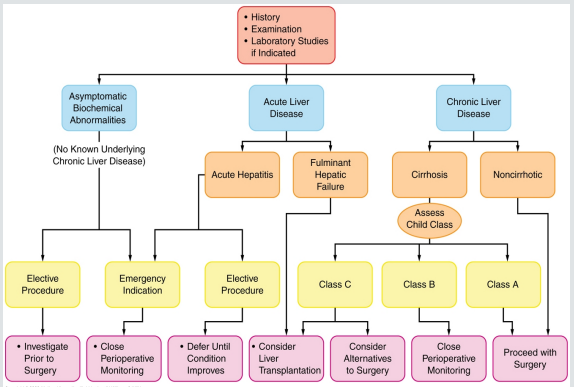
MELD = 3.78[Ln serum bilirubin (mg/dL)] + 11.2[Ln INR] + 9.57[Ln serum creatinine (mg/dL)] + 6.43

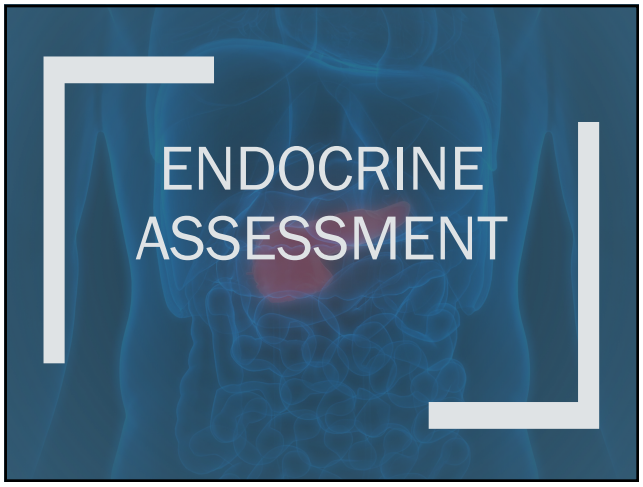
- 3-month mortality rates according to MELD score
  - *40 or more — 71.3% mortality*
  - *30–39 — 52.6% mortality*
  - *20–29 — 19.6% mortality*
  - *10–19 — 6.0% mortality*
  - *<9 — 1.9% mortality*

The MELD score is a superior predictor of surgical risk with cirrhosis

Fuller & Chu

Surgical Risk Prediction Models





DIABETES MELLITUS

System	Signs/Symptoms
Cardiovascular	Myocardial ischemia (may be silent), Blood pressure, heart rate, orthostatic hypotension, peripheral pulses (vascular pathology)
Neurologic	History of Stroke, TIA, peripheral neuropathy, autonomic dysfunction, erectile dysfunction
Gastrointestinal	Gastroparesis, gastroesophageal reflux, early satiety
Renal	Renal function, diuretic and/or dialysis dependence Volume status, skin turgor, mucous membranes, neck veins
Endocrine	Glucose control, history of diabetic ketoacidosis, or hyperosmolar coma or other endocrine disorders
HEENT	History of difficult intubation, complete airway evaluation including assessment of next mobility

Preoperative Evaluation

- What type of agents, e.g. oral, insulin, pumps?
- Patient usual blood sugar range
  - *Do they check their blood sugar?*
  - *How often do they have hypoglycemic episodes? Symptoms?*
  - *Why do we care about this?*
  - *Discuss with patient how to handle DOS hypoglycemia*
- Recent $HbgA_1C$
- Scheduled first case of the day (? Is this reasonable)
- Pre, intra, post-op glucose should be obtained

Blood Glucose Management

- Until day of surgery, continue all insulin regimens. DOS:
  - *Type 1 – 1/3 to 1/2 of normal long acting insulin dose (NPH, lente)*
  - *Type 2 – take none or up to ½ of their long acting*
  - *Patients with insulin pump, continue basal rate*
- Short acting oral agents and metformin discontinue on day of surgery
- How about an peri-operative insulin infusion?
- Role of insulin resistance, stress induced hyperglycemia, PONV prophylaxis, pain
  - *Decadron will increase blood glucose about 120 mins after administration*
- High risk patient populations

DIAGNOSTIC TESTING

Test	Rationale
Electrocardiogram	Information about ischemic cardiac disease
Electrolyte panel	Information on volume, osmolarity and acid/base status
Blood glucose	Information about glucose control and serve as a marker of illness
HbA_1C	Long-term glucose control and associated complications
Other cardiac testing	Information about CAD in patients with asymptomatic disease

Rational Use of Resources

Glycosylated hemoglobin (HbA_1C)

HbA_1C of < 7% for DM II Measure of long-term glucose control

An elevated HbA_1C = greater risk of cardiovascular events (primarily microvascular and neuropathic complications)

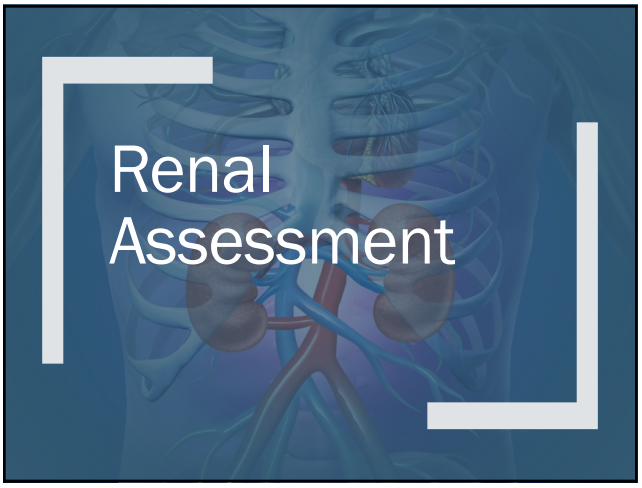
Recommendations from the American Diabetic Assn

- Consider lower values in patients with new diagnosis/greater life expectancy (and is attainable)
- Less stringent goals may be okay in patients with considerable complications/difficulty with hypoglycemia/lower life expectancy

ADA Recs for in-hospital glucose management

- Initially treat any BG >180; then target goal of 140-180 in critically ill and non-critically ill adults
- More stringent goals (100-140) may be appropriate in selected populations, e.g. cardiac surgical patients, as long as hypoglycemia is avoided.
- Use of infusions with a basal is recommended while avoiding a pure sliding scale approach

ADA Diabetes Standard of Care 2016



History and Physical

- General Appearance
  - *Pallor and/or bruising*
- Cardiac Evaluation
  - *CHF*
  - *Dysrhythmias, primarily atrial fibrillation*
  - *Murmurs (AR and PR)*
  - *CAD*
- Musculoskeletal
  - *Related to potential cause of RF*
- Hepatorenal Syndrome
- Abscess and/or sepsis

**CKD is an independent risk factor for CAD

Identify high risk patients and procedures

- Underlying systemic diseases
  - Hypertension, heart failure
  - Diabetes and/or obesity
  - Cirrhosis
  - Infections: urinary, systemic and urinary tract obstruction
  - Family hx of kidney disease, hx of AKI
  - Autoimmune diseases, e.g. SLE
- Procedures
  - Exposure to nephrotoxic drugs
  - CPB, aortic crossclamp, pneumoperitoneum
  - Emergency surgery

History and Physical

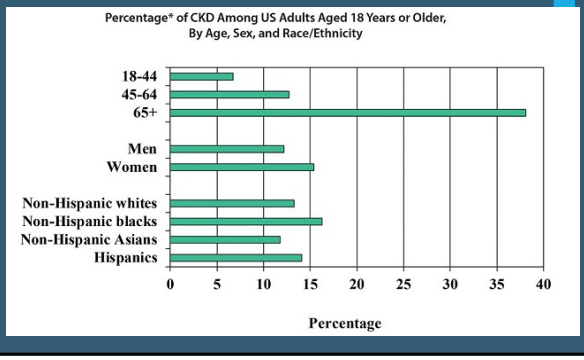
Hx of Renal Disease

- Cause of RF
- Extent of co-existing diseases
- Medications
- Prior surgery/anesthesia
- Dialysis history
- Vascular access
- Transfusion history

Dialysis Patient

- Last dialysis run
- Weight (pre and post)
- Electrolytes
- Anuric?
- Type of dialysis
- Presence of fistula

WHAT ABOUT SOCIOECONOMIC FACTORS ?



The Big Issues (other than cardiac)

- What to do about hyperkalemia?
  - *Good to go with K<5.5*
  - ***Chronically*** *between 6-6.5 without EKG changes and cardiac issues= okay to go*
  - *Have a plan to monitor and treat*
  - *Consider facility resources*
- Uremic bleeding
  - *Only good reason to give intraop DDAVP for bleeding*

Diagnostic testing considerations

- Labs
  - *Electrolytes*
  - *Hgb/Hct*
  - *BUN/Cr*
  - *CrCl/GFR*
  - *Coags*
  - *Albumin (serum and urine)*
- CXR
  - *If suspicion of pericardial or plural effusions*
- Cardiac Testing
  - *ECG*
    - Indicted in pts with Cr. >2.0
    - hyperkalemia
  - *Echo*
    - + murmur
  - *Stress test*
    - CAD

Preanesthetic risk reduction

- Cardiac evaluation for BP and functional capacity
- Maintain euvolemia and perfusion pressure
  - *Avoid diuretics*
- Arterial line and volume responsiveness
- Limit duration of insult
- Caution with contrast (CIN)
- Continue statins – anti-inflammatory effects
- Dexmedetomidine low dose infusion beneficial (dose dependent)
- Any vasopressor is okay
- Avoid hypochloremia
- ACEI and ARB: To hold or give

General Surgery AKI Risk Index

Kheterpal, et al 2009

Risk factor
Age ≥ 56 yr
Male sex
Active congestive heart failure
Ascites
Hypertension
Emergency surgery
Intraperitoneal surgery
Renal insufficiency–mild or moderate*
Diabetes mellitus–oral or insulin therapy

Five General Surgery Acute Kidney Injury Risk Inde
number of risk factors the patient possesses: clas
factors), class II (three risk factors), class III (four risl
factors), and class V (six or more risk factors).
* Preoperative serum creatinine value > 1.2 mg/dl

Kheterpal S, Tremper KK, Heung M, et al. Development and validation of an acute kidney injury risk index for patients undergoing general surgery: results from a national data set. Anesthesiology 2009; 110:505–515

Table 4 Preoperative risk classes LOE:2++

Risk class	Number of risk factors	Relative risk for the development of AKI (95% CI)
Class I	0–2	
Class II	3	4.0 (2.9–5.4)
Class III	4	8.8 (6.6–11.8)
Class IV	5	16.1 (11.9–21.8)
Class V	6 and more	46.3 (34.2–62.6)

NSQIP SURGICAL RISK CALCULATOR

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