DM Seminar
Preoperative Evaluation of Non-Thoracic Surgery

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Introduction

- Postoperative pulmonary complications – Significant cause of morbidity & mortality
- Incidence varies from 2% to 19%

Am J Med. 2002:112:219-225

- Management requires
  - Understanding of the predictable pulmonary physiological changes with surgery & anesthesia
  - Knowledge of factors associated with development of postsurgical respiratory compromise

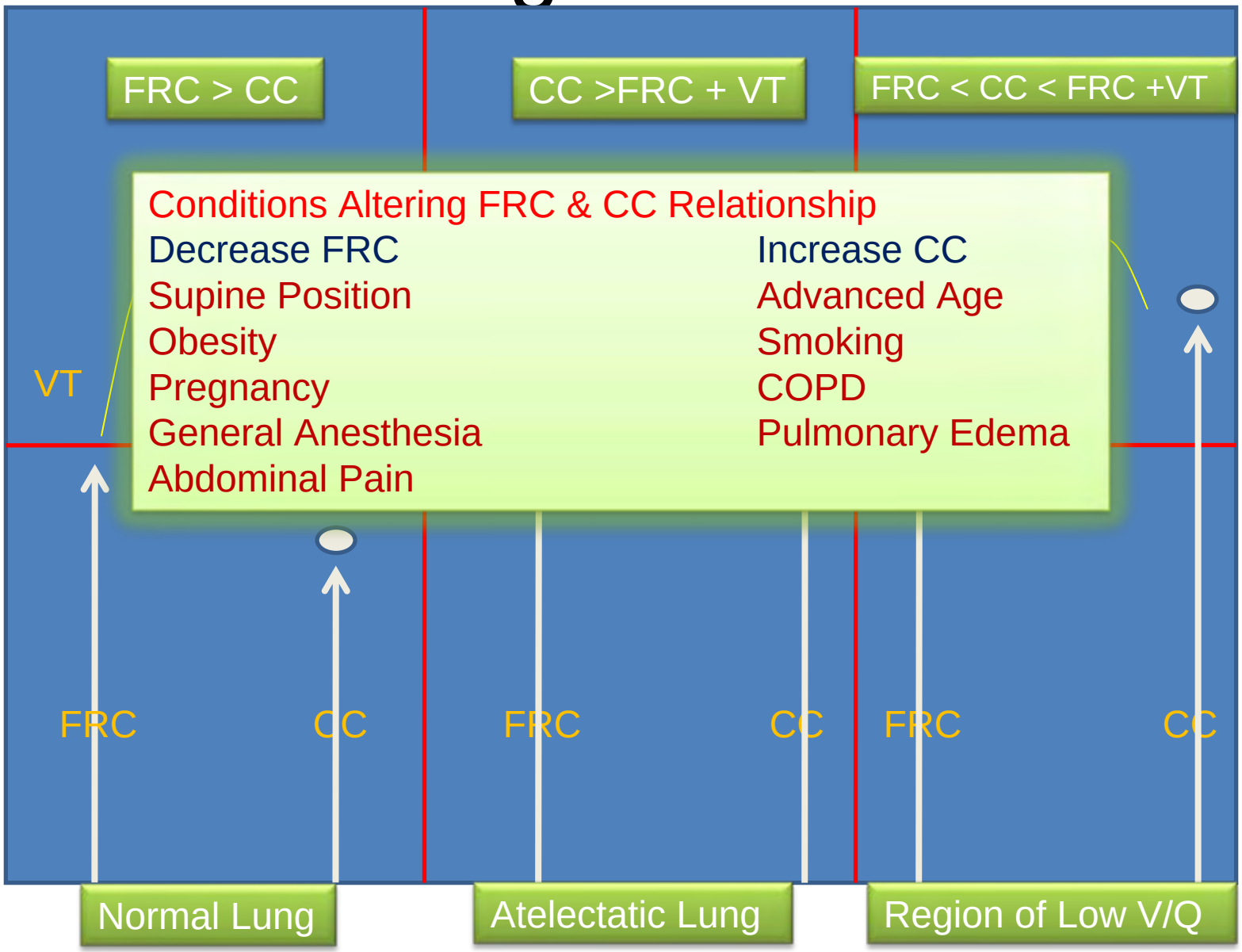
Pulmonary changes with surgery

- Lung volume
- Diaphragmatic function
- Gas exchange
- Control of breathing
- Lung defense mechanism

Lung Volume

- Restrictive abnormalities
- Moderate to severe reduction in Vital Capacity
- Reduction in functional residual capacity
- ↓ FEV1
- No change in FEV1/FVC → No airway obstruction
- Key factor in postoperative changes in lung function is relationship between FRC & CC

Lung Volume


FRC > CC
CC >FRC + VT
FRC < CC < FRC +VT
Conditions Altering FRC & CC Relationship
Decrease FRC
Supine Position
Obesity
Pregnancy
General Anesthesia
Abdominal Pain
Increase CC
Advanced Age
Smoking
COPD
Pulmonary Edema
VT
FRC
CC
FRC
CC
FRC
CC
Normal Lung
Atelectatic Lung
Region of Low V/Q

Diaphragm Function

- Important factor contributing to postoperative reduction in lung volume

- Decreased CNS output to phrenic nerve due to inhibitory reflexes arising from
  - Sympathetic
  - Vagal
  - Splanchnic receptors

Gas Exchange

- Arterial hypoxemia – Common
- Initial Phase
  - Occurs in the first several hours
  - Residual effect of the anesthesia
    - Ventilation-perfusion mismatch
    - Anesthesia induced inhibition of hypoxic pulm vasoconstriction
    - Right to left shunting
    - Increased oxygen consumption in peripheral muscle
    - Depressed cardiac output

Gas Exchange

- Late phase
  - Persists for several days to weeks
  - Common in thoracic and upper abd surgery
  - Correlates with reduction in FRC and changes in FRC-CC relationship
  - Other process involved are:
    - Alveolar hypoventilation
    - Increased dead space ventilation due to rapid shallow breathing
    - Decreased mixed venous oxygen due to increased consumption

Control of Breathing

- Post operative respiratory depression
- Two factors are responsible
  - Residual effect of preanesthetic & anesthetic agents
    - Inhibits respiratory drive
    - Reduce ventilatory response to hypercapnia, hypoxia & acidemia
  - Postoperative Narcotics
    - Depress hypercapnic & hypoxic ventilatory drive resulting in
      - Decreased tidal volume
      - Reduced minute ventilation

Lung Defense Mechanism

- Impaired cough
  - Postoperative pain & narcotics inhibits cough
  - Altered lung mechanics reduces explosive nature of cough
- Impaired mucociliary clearance
  - Ineffective cough reflex
  - Ciliary damage due to intubation, inhalational agents
  - Inhibition of mucociliary transport due to anesthesia
  - Reduced mucus velocity due to ET tube
  - Atelectasis

Pulmonary Complications

- Five major categories of complications
  - Atelectasis
  - Infection – Tracheobronchitis & Pneumonia
  - Exacerbation of underlying chronic disease
  - Prolonged mechanical ventilation & respiratory failure
  - Thromboembolic disease

Risk Factors

Preoperative

Age is a significant risk for post operative

Smoking independently increases risk for complications

Health condition as categorized by ASA correlates with complications

Malnutrition leads to
- Decreased diaphragmatic function
- Impaired cell mediated & humoral immunity
- Alteration in the elastic properties of the lung

National VA Surgical Risk Study group reported low albumin levels as strong predictor of 30 day mortality (Arch Surg.1999:134:22-7)

Complication rates according to site are
< 1% nonthoracoabdominal surgery
<5% lower abdominal surgery
> 5% upper abdominal surgery

Age

Age related changes in respiratory function & postoperative complications	
Age Related Changes	Clinical Consequences
↓ Chest wall compliance	↑ Work of Breathing ↓ Ventilatory response to exercise
↑ Lung Compliance	
↑Respiratory system resistance	
↑ Residual volume	Impaired gas exchange
↑ Small airway closure	
↑ Ventilation perfusion mismatch	
↓ Respiratory muscle strength	↓ Secretion clearance ↑Risk of aspiration
↑ Protective cough & swallow reflex	
Altered Control of Breathing	
↓Responsiveness to imposed respiratory	Hypoventilation Hypoxemia and hypercarbia Respiratory failure in early postoperative period
↓Responsiveness to hypoxemia and	
↑Sensitivity to anesthetic agents and opiods	

Effects of General Anesthesia

- Decreases number & activity of alveolar macrophages
- Increases alveolar capillary permeability
- Inhibits surfactant release
- ↑ activity of pulmonary nitric oxide synthetase
- Enhances sensitivity of the pulmonary vasculature to α-adrenergic agonists

Effects of General Anesthesia

- Produces significant effects on diaphragmatic movement with near uniform motion of the diaphragm along the ventral-dorsal axis
- Results in more ventilation of the superior portion of the lung (less perfusion) and less ventilation of the lung in the dependent portions (more perfusion)
- V/Q inequality leads to shunt & dead space ventilation
- ↑ alveolar-arterial oxygen gradient

Components of Preoperative Evaluation

- Clinical history, physical examination
- Medical summary
- Evidence based risk assessment
- Risk reduction strategy
- Communication of risk and strategy to patients, surgeons and anesthesiologist

CARE Study

Am J Resp Crit Care Med 2002;167:741-4

- Specific history & physical examination useful in identifying patients at risk for PPC
- Prospectively enrolled 272 consecutive patients
- 22 (8%) pulmonary complications

CARE Study (History)

Am J Resp Crit Care Med 2002;167:741-4

Variable	Odds Ratio (95% CI)	P value
Smoked > 40 pack years	5.7 (2.3-14.2)	0.0002
Age > 65	4.7 (1.6-14.4)	0.006
History of COPD	4.2 (1.6-11.3)	0.007
Exercise < 1 flight stairs/2 blocks	3.0 (1.1-7.8)	0.05
Ever smoked	2.2 (0.8-5.8)	0.16
History of asthma	2 (0.6-6.4)	0.41
Daily productive cough	1.9 (0.6-6.1)	0.45
Male	1.03 (0.6-1.8)	0.91
Current smoker (within 2 wks)	0.7(0.2-2.3)	0.69
Recent URTI	0.7(0.2-3.3)	0.95

CARE Study (Examination)

Am J Resp Crit Care Med 2002;167:741-4

Variable	Odds Ratio (95% CI)	P value
Maximum laryngeal ht < 4 cm	**6.9 (2.7-17.4)**	**0.0001**
Forced exp time > 9 sec	5.7 (2.3-14.2)	0.0002
Positive cough test	4.3 (1.5-12.3)	0.01
BMI > 30	4.1 (1.6-10.4)	0.004
Positive wheeze test	3.4 (1.2-9.4)	0.04
Operation > 2.5 hours	2.9 (1.2-7.0)	0.03

CARE Study (Laboratory)

Am J Resp Crit Care Med 2002;167:741-4

Variable	Odds Ratio (95% CI)	P value
PCO_2 > 45 mm Hg	61 (3.8-986.4)	0.001
PO_2 < 75 mm Hg	13.4 (1.3-14.1)	0.008
FVC < 1.5 L/min	11.1 (2.2-56.4)	0.005
FEV_1 < 1 L/min	7.9 (1.7-37)	0.002
Abnormal CXR	1.7 (0.6-4.9)	0.40

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Smoking

- Those who quit smoking for more than six months had complications rates similar to those who had never smoked (11% vs. 11.9%)

Anaestheseology 1984;60:380-

- Smoking history of 40 pack years or more was strongly associated with increased risk of pulmonary com[illegible]

Am J Respir Crit Care Med

COPD

- Severe COPD patients are six times more likely to have major postoperative complication

Anaestheseology 1984;60:380-

- Careful preoperative evaluation of patients with COPD should include
- identification of high-risk patients
- optimizing their treatment before surgery

Pulmonary Function Test

- ACP consensus statement recommends preoperative PFT in two
  - Patients undergoing coronary bypass or upper abdominal surgery with a history of smoking or dyspnea
  - Patients undergoing head and neck, orthopedic, or lower abdominal surgery with unexplained dyspnea or pulmonary symptoms
- Preoperative PFT does not identify patients in whom the risk is so high that surgery should be cancelled

Am J Respir Crit Care Med

Spirometry

- No single value on spirometry can absolutely contraindicate non-thoracic surgery
- There is higher risk of postoperative pulmonary complications in patients with
  - FEV_1 or FVC < 70% predicted
  - FEV_1/FVC ratio of < 65%

Chest 1986;89:127-

- An ambigous clinical picture regarding
  - Severity of bronchospasm
  - Presence of COPD
  - Response to bronchodilators
  - Unexplained shortness of breath

Preoperative Risk Factor	Point Value
Type of Surgery	
•Abdominal aortic aneu	15
•Thoracic	14
•Upper abdominal	10
•Neck	8
•Neurosurgery	8
•Vascular	3
Age	
•> 80 years	17
•70-79 years	13
•60 - 69 years	9
•50 – 59 years	4
Functional Status	
•Totally dependent	10
•Partially dependent	6
Weight loss > 10% in past 6 mont	7
History of chronic obstructive pu	5
General anesthesia	4
Impaired sensorium	4
History of cerebrovascular accident	4
Blood urea nitrogen level	
•8 mg/dl	4
•22 - 30 mg/dl	2
•> 30 mg/dl	3
Transfusion > 4 units	3
Emergency surgery	3
Steroid use for chronic condition	3
Current smoker within 1 year	3
Alcohol intake > 2 drinks/day in past 2 weeks	2

The PPRI classifies patients into five levels of risk for postoperative pneumonia with good discrimination

Index Score	Probability
0-15	0.2
16-25	1.2
26-40	4.0
41-55	9.4
>55	15.3

Annals of Internal Medicine | Clinical Guidelines

Risk Assessment for and Strategies To Reduce Perioperative Pulmonary Complications for Patients Undergoing Noncardiothoracic Surgery: A Guideline from the American College of Physicians

Recommendation 6

The following procedures should not be used solely for reducing postoperative pulmonary complication risk:

1)Right-heart catheterization

2)Total parenteral nutrition or total enteral nutrition (for patients who are malnourished or have low serum albumin levels).

vomiting, inability to tolerate oral intake, or symptomatic abdominal distention).

- *Head and neck surgery*
- *Vascular surgery*
- *Aortic aneurysm repair*
- *Emergency surgery*
- *General anesthesia.*

Ann Intern Med 2006,144:575-580

Risk Reduction Strategies

Preoperative
- Smoking cessation - 8 wks
- Treat airflow obstruction
- Antibiotics & delay surgery if infection
- Patient education for lung exapansion maneuvers

Intraoperative
- Limit surgery < 3 hrs
- Spinal or epidural anesthesia
- Laproscopic procedure if possible

Postoperative
- Deep breathing exercises and incentive spirometry

Supplemental oxygen therapy
- Decreases heart rate
- Increases arterial oxygen saturation Anesthesiology 1999:90:380-4
- Decreases postoperative nausea & vomiting
- Decreases surgical wound infection by 50% N Engl J Med 2000:342:161-7