PREOPERATIVE PULMONARY ASSESSMENT
Postoperative pulmonary complication is defined as an abnormality that produces identifiable disease or dysfunction of the lungs, is clinically significant and adversely affects the clinical course.
Complications may arise from:

- Atelectasis
- Infection (e.g., bronchitis, pneumonia)
- Prolonged mechanical ventilation and respiratory failure
- Exacerbation of an underlying chronic lung disease
- Bronchospasm
Importance of Postoperative Pulmonary Complications

- Increase perioperative morbidity and mortality
- More common than cardiac complications in patients undergoing elective surgery to the thorax and upper abdomen
- Frequency rate varies from 5-70%
- Prolong the hospital stay by an average of one to two weeks
PERIOPERATIVE PULMONARY PHYSIOLOGY

Respiratory effects of general anesthesia

- Decreased respiratory drive causing a diminished response to both hypercapnia and hypoxemia
- Drugs (neuromuscular blockers, anesthetic agents) cause diaphragm and chest wall relaxation
- This results in a marked reduction in the functional reserve capacity (FRC) and thereby decreased thoracic volume
Respiratory effects of general anesthesia

The decrease in lung volume promotes **atelectasis** in the dependent lung regions and persists for more than 24 hours in 50% of patients.

Consequently, **arterial hypoxemia** occurs from **ventilation perfusion mismatch** and increased **shunt fraction**.
Postoperative respiratory physiology in upper abdominal and thoracic surgery

- Diaphragmatic dysfunction, postoperative pain, and splinting reduce VC by 50% and FRC by 30%
- Following upper abdominal surgery, ribcage excursions and abdominal expiratory muscle activities decrease due to decreased central nervous system output to the phrenic nerves
Postoperative respiratory physiology in upper abdominal and thoracic surgery

- Tidal volume is smaller and the respiratory rate increases (i.e., rapid shallow breathing)
- Inhibition of cough and impaired mucociliary clearance because of:
  - rapid shallow breathing
  - residual effects of anesthesia and postoperative narcotics
- Risk of postoperative pneumonia increased
Postoperative respiratory physiology in upper abdominal and thoracic surgery

Other factors that may contribute to increased respiratory complications:

- Electrolyte imbalance (e.g., hypokalemia, hypophosphatemia, hypocalcemia)
- General debilitation
- Underlying lung disease (e.g., chronic obstructive lung disease [COPD])
PATIENT AND PROCEDURE RELATED RISK FACTORS

Patient-related risk factors

Age

- Advanced age is not an independent risk factor for pulmonary complications
- In a study of patients over 80 years of age, overall 30-day mortality was 6.2%, patients who belonged to ASA class II had less than 1% mortality
- Therefore, surgery should not be declined on the basis of advanced age alone
Patient-related risk factors

**Obesity (BMI > 27 kg/m\(^2\))**

- Expiratory reserve volume
- Functional residual capacity

**Morbid obesity causes**

- Restrictive lung disease
- Decreases thoracic compliance
- Leads to alveolar hypoventilation
Patient-related risk factors

- Severe obesity is associated with pulmonary hypertension, cor-pulmonale and hypercapnic respiratory failure (Pickwickian syndrome)
Patient-related risk factors

**General health status**

- Patients who have poor exercise capacity are at increased risk of developing postoperative pulmonary complications
- Inability to raise heart rate by a simple exercise predicts 79% of pulmonary complications
Patient-related risk factors

**Smoking**

- Current smokers: 2-fold increased risk of postoperative complications

  - The risk is highest in patients who smoked within the last 2 months
  - Patients who quit smoking for more than 6 months have a risk similar to the nonsmokers
  - Postoperative morbidity is not decreased in patients who quit smoking for less than 8 weeks
Patient-related risk factors

Beneficial effects of smoking cessation

- Improvement in ciliary and small airway function
- Decrease in sputum production
Patient-related risk factors

**Chronic obstructive pulmonary disease (COPD)**

- One of the most important risk factors
- Patients with severe COPD ($\text{FEV}_1$ less than 40% predicted) are 6 times more likely to have a major postoperative complication
- However, there is no prohibitive level of pulmonary function for an absolute contraindication
- The benefits of surgery must be weighed against these complications
Chronic obstructive pulmonary disease (COPD)

A careful preoperative evaluation of patients with COPD should include identification of high-risk patients and aggressive treatment.

Elective surgery should be deferred in patients who are symptomatic, have poor exercise capacity or if acute exacerbation is present.
Patient-related risk factors

**Asthma**

- Inadequate control of asthma preoperatively may increase risk of postoperative complications
- Optimal asthma control is defined as absence of symptoms and forced expiratory flow ($\text{FEV}_1$) more than 80% predicted or personal best should be achieved
Patient-related risk factors

Sleep apnea

- Increased risk of developing in the postoperative period
  - Deterioration of sleep disordered breathing
  - Severe hypoxemia
  - Hypercapnia

Due to associated obesity

- Difficulties with endotracheal intubation
- Early postoperative upper airway obstruction requiring reintubation or other therapies
Procedure-related risk factors

**Surgical site**

- The incidence of complications is inversely related to the distance of the surgical incision from the diaphragm.

**Complication rates:**

- Upper abdominal surgery: 17-76%
- Lower abdominal surgery: 0-5%
- Thoracic surgery: 19-59%
Patient-related risk factors

**Duration of surgery**

- Patients undergoing procedures lasting for more than 3-4 hours have a higher incidence of pulmonary complication than for surgeries less than 2 hours (40% versus 8%)
Procedure-related risk factors

Key hole surgery

- Laparoscopic abdominal surgery, particularly cholecystectomy, is associated with fewer postoperative pulmonary abnormalities and a shorter hospital stay.

- Laparoscopic surgery causes a 23% decrease in FVC and 16% decrease in FEV₁, making it possible for patients with severe COPD to tolerate surgery.
Procedure-related risk factors

- Video-assisted thoracoscopic surgery utilizes much smaller incisions
- Hospitalization time is substantially reduced
- Smaller incisions, performed without separation of ribs and less postoperative pain leads to early ambulation and reduced pulmonary complications
Procedure-related risk factors

**Type of anesthesia**

- Data are inconsistent about whether the complication rate is lower with spinal or epidural anesthesia compared to general anesthesia.
- The spinal or epidural anesthesia is safe and should be considered in high-risk patients.
- Regional nerve block is associated with a low-risk and should be considered whenever possible for high-risk patients.
PREOPERATIVE RISK ASSESSMENT

**History**
Perform a complete history and physical examination to identify risk factors

**Focus on**
- History of smoking
- Exercise intolerance
- Unexplained dyspnea
- Cough

**Note evidence of COPD**
PREOPERATIVE RISK ASSESSMENT

Pulmonary function tests (PFT)

1. Patients undergoing cardiac or upper abdominal surgery with a history of smoking or dyspnea
2. Patients undergoing lower abdominal surgery if dyspnea or history of smoking anticipating prolonged surgery
3. Patients undergoing orthopedic surgery with uncharacterized lung disease
4. All patients undergoing lung resection
PREOPERATIVE RISK ASSESSMENT

Spirometry

An extremely useful tool for objectively evaluating the respiratory status of patients preoperatively.

Used to predict postoperative complications and to guide optimization of airflow obstruction in preparation for surgery.

High postoperative risk:
- $FEV_1 < 70\%$ predicted
- $FVC < 70$ percent predicted
- $FEV_1/FVC$ ratio $<65\%$
PREOPERATIVE RISK ASSESSMENT

ABG

A PaCO$_2$ of more than 45 mmHg indicates a high risk, although it is not necessarily prohibitive.

Hypoxemia is not a significant predictor of complications.

Patients undergoing cardiac or abdominal surgery who have dyspnea or are smokers and thoracic surgery patients should have arterial blood gas analysis.
PREOPERATIVE RISK ASSESSMENT

**Chest radiograph**

- Chest x-rays add little to the clinical evaluation in healthy patients.
- All patients older than 60 years, or with clinical findings of cardiac or pulmonary disease should have a preoperative chest x-ray unless one was done in the last 6 months.
Pulmonary Risk Index

1. Obesity (ie, body mass index more than 27 kg/m²)

2. Cigarette smoking within 8 weeks of surgery

3. Productive cough within 5 days of surgery

4. Diffuse wheezing within 5 days of surgery

5. FEV₁/FVC ratio less than 70% and PaCO₂ within 45 mmHg
American Society of Anesthesiology (ASA) Classification

- This score is based on simple clinical criteria and is easy to quantify.
- Although subjective, the scores of 2-5 indicate increasing level of severity, and increased postoperative morbidity.
ASA Classification

**ASA Class I:** A normal, healthy patient without organic, physiologic or psychiatric disturbance; e.g., healthy with good exercise tolerance

**ASA Class II:** A patient with controlled medical conditions without significant systemic effects; e.g. controlled hypertension or controlled diabetes without systemic effects, cigarette smoking without COPD, anemia, mild obesity, age less than 1 or greater than 70 year, pregnancy
ASA Classification

ASA Class III

A patient having medical conditions with significant systemic effects, intermittently associated with significant functional compromise; e.g., controlled CHF, stable angina, old MI, poorly controlled hypertension, morbid obesity, bronchoscopastic disease with intermittent symptoms, chronic renal failure
ASA Classification

ASA Class IV

A patient with a medical condition that is poorly controlled, associated with significant dysfunction and is a potential threat to life; e.g., unstable angina, symptomatic COPD, symptomatic CHF, hepatorenal failure
ASA Classification

ASA Class V: A patient with a critical medical condition that is associated with little change of survival with or without the surgical procedure; e.g., multiorgan failure, sepsis syndrome with hemodynamic instability, hypothermia, poorly controlled coagulopathy

ASA VI: A patient who is brain dead and undergoing anesthesia care for the purposes of organ donation
PREOPERATIVE EVALUATION: THORACIC SURGERY

Lung Resection

Preoperative assessment identifies patients at greatest risk for postoperative complications and those patients with severe impairment, where risk of surgery is prohibitive.

- In-hospital patient mortality rates:
  - 3.8% after wedge resection
  - 3.7% after segmental resection
  - 4.2% after lobectomy
  - 11.6% after pneumonectomy
PREOPERATIVE EVALUATION: THORACIC SURGERY

Significant predictors of mortality are:
- Age > than 60 years
- Extended resection
- Chronic heart or lung disease
- low FEV$_1$

The following are recommended:
- Preoperative pulmonary function
- Calculation of predicted postoperative pulmonary function
- Gas exchange
- Exercise testing
Preoperative pulmonary function

- **Forced expiratory volume in 1 second (FEV₁)** is the primary value used for resectability.
- **FEV₁** predicts pulmonary reserve and is a strong predictor of postoperative complications.
- **Pneumonectomy:** preoperative FEV₁ of greater than 2 L/sec is required.
- **Lobectomy:** 1 L/sec
Preoperative pulmonary function

**Diffusion capacity**
- A good predictor of morbidity and mortality after lung resection
- A diffusion capacity of below 60% predicted was found to have a patient mortality rate of 24%
- A diffusion capacity of < 40% with borderline FEV$_1$ criteria is associated with high mortality and morbidity and may be prohibitive
Preoperative pulmonary function

**Predicting postoperative pulmonary function**

- Predicted postoperative function = (Preoperative function) × (% of function contributed by the lung that will remain postoperatively)
- This measurement improves the predictive value of preoperative testing
- Based upon a combination of spirometry and quantitative perfusion lung scan, a predicted postpneumonectomy FEV₁ more than 0.8 L/sec. is suggested as the lower limit
Preoperative pulmonary function

The percentage of predicted value is a better measure as it reflects differences in size, age, gender, and race.

The predicted postoperative FEV$_1$ of 40% more is associated with the least mortality.

A predicted FEV$_1$ of 40% predicted is required for performance of minimal activities of daily living without dyspnea.
Preoperative pulmonary function

- $\text{FEV}_1$ of less than 30% is associated with 20 to 30% 5-year survival rates.
- Postoperative $\text{FEV}_1$ less than 30% will cause immediate postoperative morbidity and mortality and also excessive longer term mortality.
- Use of radionuclide lung scanning to calculate this value is required.
- If the predicted postoperative $\text{FEV}_1$ is less than 0.8 L/sec or less than 40% predicted, the patient is unresectable.
Preoperative pulmonary function

**Radionuclide quantitative lung scanning**

- Radionuclide scanning is used to quantitate the function of a lung or a lobe, which will be resected.
- Therefore, the function of the remaining lung can be calculated.
- Postpneumonectomy $\text{FEV}_1 < 0.8 \text{ L/sec}$ is associated with prohibitive risk.
Measurement of gas exchange

- **Gas exchange**: diffusing capacity and ABG
- **Postoperative Diffusion**: of less than 40% predicted: high morbidity and mortality
- A low resting arterial PaO₂ is not a strong predictor, but hypercapnia (PaCO₂ > 45 mmHg) has been considered a significant risk factor, though not proven
Exercise testing

- This may be done as:
  - Stair climbing
  - Complete cardiopulmonary exercise testing

Stair climbing has been shown to identify patients at increased risk for lung resection.

 Patients capable of climbing 3 or more flights of stairs have lower complication rates.
Exercise testing

**VO₂ max of less than 1 L/min have excess mortality**

A VO₂ max of more than 20 ml/kg/min is associated with least postoperative complications

Value of less than 10 ml/kg/min may be prohibitive because of the high morbidity and mortality

A VO₂ max of between 10-20 ml/kg/min may have increased but an acceptable risk
Smoking cessation

- Instruct patients undergoing elective surgery to abstain from smoking for **8 weeks** before surgery
  - Use of counseling
  - Nicotine replacement therapies
  - Bupropion
Chronic obstructive pulmonary disease

- Aggressively treat patients with COPD to achieve the best possible baseline function
- Use of bronchodilators, smoking cessation, antibiotics, and chest physical therapy may reduce significantly pulmonary complications
- Treat patients who have a persistent wheeze, functional limitation, or severe air flow obstruction with perioperative steroids
Asthma

- Optimize asthma control prior to surgery
- Perioperative systemic corticosteroids are recommended for persistent symptoms if the peak flow rate and FEV$_1$ are less than 80% predicted or previous best
- The safety of perioperative corticosteroid use is well established
- Risk of death, serious infections, or adrenal suppression is not increased
Asthma

- Hypothalamic-pituitary-adrenal axis suppression should be assumed to be present in patients who receive systemic steroids for more than 3 weeks in the past 6 months

- Cover perioperatively (Hydrocortisone 100 mg IV Q8H)
Preoperative antibiotics

Indiscriminate use of prophylactic antibiotics does not lead to a reduction in pulmonary complications.

These drugs should be used in patients with a clinically apparent respiratory infection.

Cancel elective surgery if patient has active infection.
PREPARATION FOR SURGERY

**Patient education**
- Lung expansion
- Deep breathing and coughing
- Incentive spirometry
Type of anesthesia

The type of anesthesia and neuromuscular blockage affect the incidence of postoperative pulmonary complications.

Intermediate and shorter acting agents (e.g., vecuronium, rocuronium) are preferred, as residual neuromuscular blockade from longer acting agents may contribute to pulmonary complications.
Type of anesthesia

Spinal anesthesia may be safer than general anesthesia; considered for high-risk patients.

Depending on the type and duration of surgery, endotracheal intubation and mechanical ventilation may be preferable, because of the ability to monitor and control respiratory rate and tidal volume.
INTRAOPERATIVE STRATEGIES

Type of neuromuscular blockade

- Pancuronium, a long-acting neuromuscular blocker, may lead to residual effects, cause hypoventilation, and increase complications.
- Use the intermediate-acting agents (e.g., vecuronium, atracurium) in high-risk pulmonary patients.
Duration and type of surgery

- When available, a less ambitious, shorter procedure should be considered in extremely high-risk patients.

- As upper abdominal and thoracic operations carry the greatest risk, a percutaneous (laparoscopic) procedure should be substituted for an open procedure if possible.
POSTOPERATIVE STRATEGIES

- **Lung expansion** maneuvers
  - Deep breathing
  - Incentive spirometry
- Regular physiotherapy visits
- **Intermittent positive pressure breathing**: The cost and potential for abdominal distension does not warrant its use.
- **Continuous positive airway pressure**: Shown to be beneficial as a secondary intervention for refractory atelectasis
POSTOPERATIVE STRATEGIES

Pain control

Adequate postoperative pain control will minimize the pulmonary complications by encouraging earlier ambulation and performance of lung expansion maneuvers.

Management of postoperative pain includes narcotics and narcotics-like medications administered peripherally, into the epidural or intrathecal space.
Prevention of Pulmonary Complications
- A team Effort

- Pulmonologist
- Surgeon
- Anesthesiologist
- Respiratory Physiotherapist
- Nursing Staff
All the best..