

Postoperative pulmonary complications: what every general practitioner ought to know

Bedside assessment and simple laboratory tests can help physicians identify patients at risk of pneumonia and other complications after thoracic and abdominal surgery.

ABSTRACT: Postoperative pulmonary complications are common following thoracic or abdominal surgery. A comprehensive bedside assessment coupled with a few simple laboratory tests can identify patients at high risk of such complications. Smokers should be advised to quit smoking at least 2 months before surgery. Postoperatively, lung expansion modalities such as deep breathing, incentive spirometry, or continuous positive airway pressure can reduce the risk of postoperative pulmonary complications.

Postoperative pulmonary complications are common, especially in elderly patients with comorbidities. Nearly 5% of all patients undergoing noncardiac surgery experience significant pulmonary complications.¹ Postoperative pulmonary complications include respiratory failure, pneumonia, and atelectasis. Risk factors that can be assessed at the bedside include the following:

- Advanced age (e.g., age greater than 65 years increases the risk of complication 4.7-fold or by 370%).
- Smoking history (e.g., smoking history of longer than 40 or more pack-years increases the risk 5.7-fold or by 470%).
- A history of COPD (this increases the risk 4.2-fold or by 320%).
- Obesity (body mass index greater than 30 kg/m² increases the risk 4.1-fold or by 310%).
- A positive cough test (see **Table 1**; this increases the risk 4.3-fold or by 330%).
- Maximal laryngeal height of 4 cm or less (this increases the risk 6.9-fold or by 590%).
- A forced expiratory time of 9 seconds or more (this increases the risk 5.7-fold or by 470%).

- Surgical time of 2.5 hours or more (this increases the risk 2.9-fold or by 190%).²

Identification of any risk factors should prompt clinicians to perform laboratory tests for additional risk information (**Table 2**). These tests include spirometry and arterial blood gas assessment (on room air if possible). An FEV₁ (forced expiratory volume in 1 second) of less than 1 L increases the risk of postoperative pulmonary complications 7.9-fold or by 690%, while an FVC (forced vital capacity) value of less than 1.5 L increases the risk 11.1-fold or by 1000%. Hypercarbia (defined as PaCO₂ of 45 mm Hg or greater) on arterial blood gas assessment increases the risk 61-fold, while hypoxemia (defined as PaCO₂ of less than 75 mm Hg) increases the risk 13-fold.² Abnormalities identified by spirometry or arterial blood gas assessment (or both) are “red flags” and mean respiratory consultation should be sought before the operation to further assess risk for the patient.

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Postoperative pneumonia risk index

One of the most important postoperative pulmonary complications is pneumonia. The risk factors already listed can be used as guides in risk stratification for this complication. A more formal method involves the postoperative pneumonia risk index, developed by Arozullah and colleagues for patients undergoing major noncardiac surgery (**Table 3**).¹ In this index, point values are assigned to each of 14 variables and the points are added to come up with a score out of 84. This score is then used to estimate the patient's risk for postoperative pneumonia according to five classes of risk, with class 5 being the highest (**Table 4**). A major limitation of this index is the absence of arterial blood gas and spirometry values. Nevertheless, the index does help stratify risk and is a useful way to identify high-risk patients who are likely to benefit from aggressive postoperative intervention.

Interventions to reduce complications

Smokers should be advised to discontinue smoking at least 2 months before surgery (**Table 5**). Any patients with spirometric evidence of asthma or COPD should be treated aggressively with bronchodilators and inhaled corticosteroids prior to surgery, and any significant exacerbations should be treated with appropriate antimicrobials and systemic corticosteroids. Postoperatively, patients in risk class 3 or higher should be treated with lung expansion modalities such as deep breathing exercises, incentive spirometry, or continuous positive airway pressure. These modalities are equally efficacious in reducing the risk of postoperative pulmonary complications by nearly 50%. For patients who experience abdominal distension postoperatively, a nasogastric tube

Table 1. Bedside procedures for assessing risk of pulmonary complications

Test	Interpretation
Cough test Have the patient take a deep breath into maximal lung capacity and then cough once.	A positive test is defined as recurrent coughing after the first cough.
Maximal laryngeal height Use a tape measure to determine the distance between the top of the thyroid cartilage and the suprasternal notch at the end of normal expiration.	An abnormal value is defined as a distance of ≤ 4 cm.
Forced expiratory time Have the patient take a deep breath into maximal lung capacity and then forcefully expire through an open mouth to full expiration. Measure the time it takes for the patient to go from full inspiration to complete expiration.	An abnormal value is defined as a forced expiratory time of ≥ 9 seconds.

Table 2. Variables used to stratify pulmonary complication risk following major cardiac or noncardiac surgery.

Variables	Odds ratio
History	
Age > 65 years	4.7
Smoking history > 40 pack-years	5.7
Current smoker	1.3
History of COPD	4.2
Weight loss of > 10% in last 6 months	1.9
Totally or partially dependent on others for care and ambulation	1.8–2.8
Physical exam	
Obesity as defined by a body mass index of 30 kg/m ² or greater	4.1
Positive cough test	4.3
Maximal laryngeal height < 4 cm	6.9
Forced expiratory time of 9 seconds or greater	5.7
Operative factors	
Surgical time greater than 2.5 hours	2.9
Aortic aneurysm repair	4.3
Thoracic surgery	3.9
Abdominal surgery	2.7
Laboratory factors	
FEV ₁ < 1 L	7.9
FVC < 1.5 L	11.1
PacO ₂ \geq 45 mm Hg	61.0
PaO ₂ < 75 mm Hg	13.0

can be used judiciously to decompress the abdomen. If at all possible, patients should receive epidural analgesia with local anesthetics rather than systemic opioids, which have the potential to depress the respiratory centre and contribute to postoperative pulmonary complications.

Conclusions

Postoperative pulmonary complications are common following thoracic or abdominal surgery. A comprehensive bedside assessment coupled with spirometry and arterial blood gas assessment can identify patients at high risk, who may then be referred for more comprehensive risk assessment through specialty clinics. Smokers should be advised to quit smoking at least 2 months before surgery. Postoperatively, lung expansion modalities should be used to reduce the risk of postoperative pulmonary complications. For patients at high risk of postoperative complications, epidural analgesia with local anesthetics or analgesics should be used whenever possible in lieu of systemic narcotics or other respiratory depressants.

Competing interests

Dr Sin has received honoraria for speaking from GlaxoSmithKline (GSK), research funding from GSK, AstraZeneca, and Boehringer Ingelheim, and served as a consultant to GSK and AstraZeneca.

References

1. Arozullah AM, Khuri SF, Henderson WG, et al. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med* 2001;135:847-857.
2. McAlister FA, Khan NA, Straus SE, et al. Accuracy of the preoperative assessment in predicting pulmonary risk after nonthoracic surgery. *Am J Respir Crit Care Med* 2003;167:741-744.

Table 3. Postoperative pneumonia risk index.¹

Preoperative factors	Point value
Type of surgery	
Abdominal aortic aneurysm repair	15
Thoracic	14
Upper abdominal	10
Neck	8
Neurosurgery	8
Vascular	3
Age (years)	
≥80	17
70–79	13
60–69	9
50–59	4
Functional status	
Totally dependent	10
Partially dependent	6
Weight loss >10% in past 6 months	7
History of COPD	5
General anesthesia	4
Impaired sensorium	4
History of cerebrovascular accident	4
Blood urea nitrogen (mmol/L)	
<2.86	4
7.85–10.7	2
≥10.7	3
Transfusion > 4 units	3
Emergency surgery	3
Oral steroid use for chronic condition	3
Current smoker within 1 year	3
Alcohol intake >2 drinks/day in past 2 weeks	2
Total possible score	84


3. Smetana GW. A 68-year-old man with COPD contemplating colon cancer surgery. *JAMA* 2007;297:2121-2130. 

Table 4. Classes of risk according to postoperative pneumonia risk index scores.

Risk class	Postoperative pneumonia risk (%)
1 (0–15 points)	0.24
2 (16–25 points)	1.25
3 (26–40 points)	4.00
4 (41–55 points)	9.40
5 (>55 points)	15.30

Table 5. Interventions to reduce the risk of postoperative pulmonary complications.³

Preoperative interventions

- Counsel for smoking cessation to ensure patient is a nonsmoker at least 2 months before surgery
- Treat any infections (e.g., COPD exacerbations) prior to surgery with appropriate antibiotics and systemic corticosteroids (if indicated).
- Recommend a regular exercise program (e.g., walking, upper limb exercises, swimming, pool exercises, etc.).
- Treat patients with established asthma with inhaled corticosteroids.
- Treat patients with established COPD with regular bronchodilators.

Postoperative interventions

- Recommend regular (hourly) lung expansion modalities such as:
 - Deep breathing exercises.
 - Incentive spirometry.
 - Use of continuous positive airway pressure device.
- Perform selective decompression of abdominal contents using nasogastric tube if patient is experiencing symptomatic gastric distension.
- Whenever possible, use epidural analgesia with local anesthetics or analgesics. Avoid large doses of systemic narcotics or other respiratory depressants.
- As soon as possible after surgery, have the patient sit up in a chair.
- Have patient resume use of preoperative inhalers.