# *Perioperative airway management and pharmaceutical care*

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# Catalogue

- Introduction of Postoperative Pulmonary Complications (PPCs)
- How do pharmacists develop Perioperative airway management to improve PPCs
- Brief introduction of a clinical case
- Summary

# Part 1

- Introduction of Postoperative Pulmonary Complications (PPCs)
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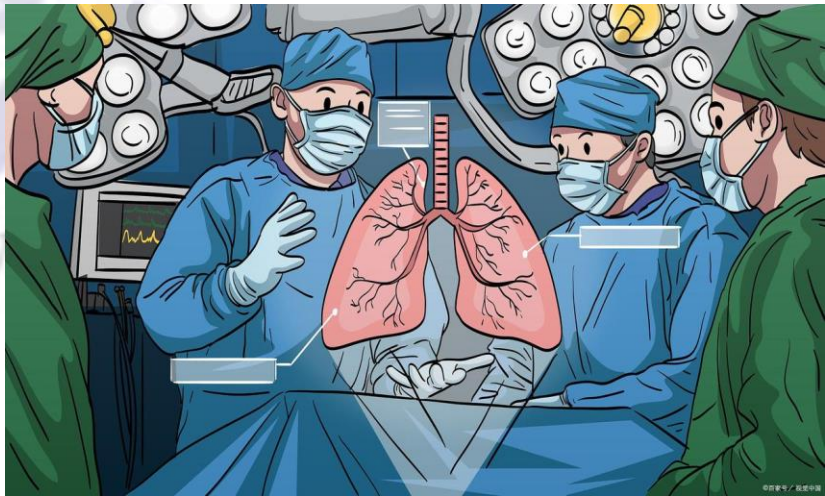
## What is Postoperative pulmonary complications (PPCs)?

Postoperative pulmonary complications are common and a major cause of perioperative morbidity and mortality. The major categories of clinically significant complications include:

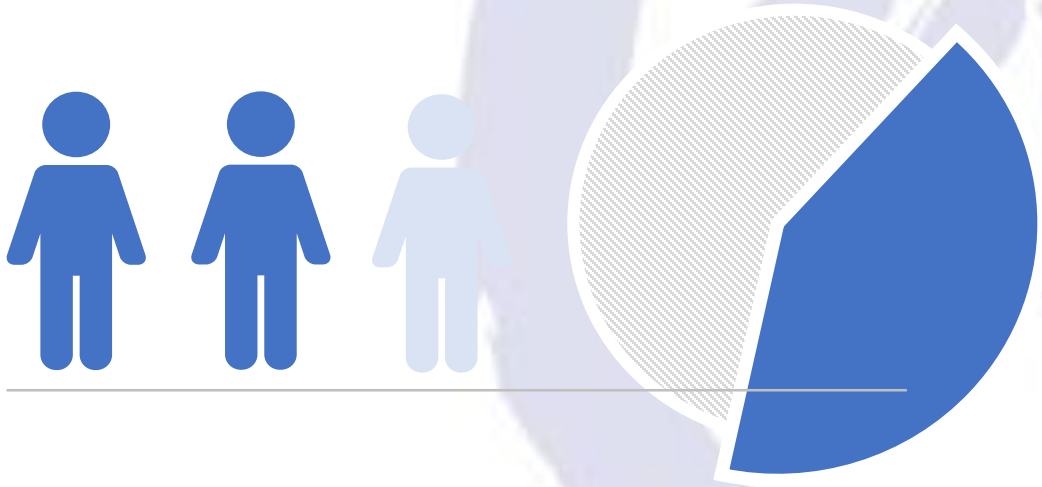
- Atelectasis detected on chest radiograph or computed tomography
- Pneumonia
- Acute respiratory distress syndrome
- Pulmonary aspiration (clinical history and imaging evidence)
- Unplanned need for supplemental oxygen or noninvasive or invasive mechanical ventilation
- Exacerbation of underlying chronic lung disease
- Bronchoconstriction



[1]Smetana GW, Lawrence VA, Cornell JE, American College of Physicians. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med 2006; 144:581.
[2]Abbott TEF, Fowler AJ, Pelosi P, et al. A systematic review and consensus definitions for standardised end-points in perioperative medicine: pulmonary complications. Br J Anaesth 2018; 120:1066.

## The epidemiology of PPCs

The reported incidence of postoperative pulmonary complications ranges from 5 to 83 percent, depending on the patient population, type of surgery performed, criteria used to define a complication, and hospital setting that was studied.



Thoracic surgery: **19-59%**

Upper abdominal surgery: **16-17%**



[1] Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med 2002; 112:219.
[2] Dimick JB, Pronovost PJ, Cowan JA Jr, et al. Variation in postoperative complication rates after high-risk surgery in the United States. Surgery 2003; 134:534.

## The dangers of PPCs

An increase in the number of PPCs was associated with worse prognosis and longer hospital stay. An increase in its severity is associated with a worsening chance of survival:

- Nearly 25% of postoperative mortality in the first week after surgery is related to PPCs;
- Postoperative respiratory failure with mechanical ventilation 30 days after surgery was associated with increased mortality;
- Pulmonary complications were a better predictor of long-term mortality after non-cardiac surgery than cardiac complications.



[1] Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med 2002; 112:219.

Agostini *et al. Journal of Cardiothoracic Surgery* (2018) 13:28
https://doi.org/10.1186/s13019-018-0717-6

Journal of Cardiothoracic Surgery

RESEARCH ARTICLE Open Access

# Risk factors and short-term outcomes of postoperative pulmonary complications after VATS lobectomy

Paula J. Agostini[1,2*], Sebastian T. Lugg[3], Kerry Adams[1], Tom Smith[2], Maninder S. Kalkat[1], Pala B. Rajesh[1], Richard S. Steyn[1], Babu Naidu[1,3], Alison Rushton[2] and Ehab Bishay[1]

**Table 2** Hospital morbidity and mortality in PPC compared to non-PPC group

| Outcomes | PPC ($n = 21$) | Non-PPC ($n = 264$) | $p$ value |
|---|---|---|---|
| Hospital LOS (days) median (IQR) | 4 (3) | 3 (2) | < 0.001 |
| ITU Admission (%) | 5 (23.8%)<br>[a]3 (14%) | 1 (0.5%) | < 0.001<br>0.005 |
| Hospital mortality (%) | 3 (14.3%)<br>[a]2 (9.5%) | 0 (0%) | < 0.001<br>0.003 |

*PPC*, postoperative pulmonary complication; *ITU*, intensive treatment unit; *LOS*, length of stay; [a]number of first mortality/ITU admission figure that were PPC related

## Benefits of perioperative airway management against PPCs

Perioperative airway management, including smoking cessation, optimizing the use of bronchodilators and glucocorticoids, and selecting appropriate anesthetics, can effectively reduce the likelihood of perioperative pulmonary complications, thereby benefiting patients.

- Reduce the incidence of pulmonary complications
- Accelerate postoperative recovery
- Lower readmission rates and risk of death
- Save on hospitalization costs

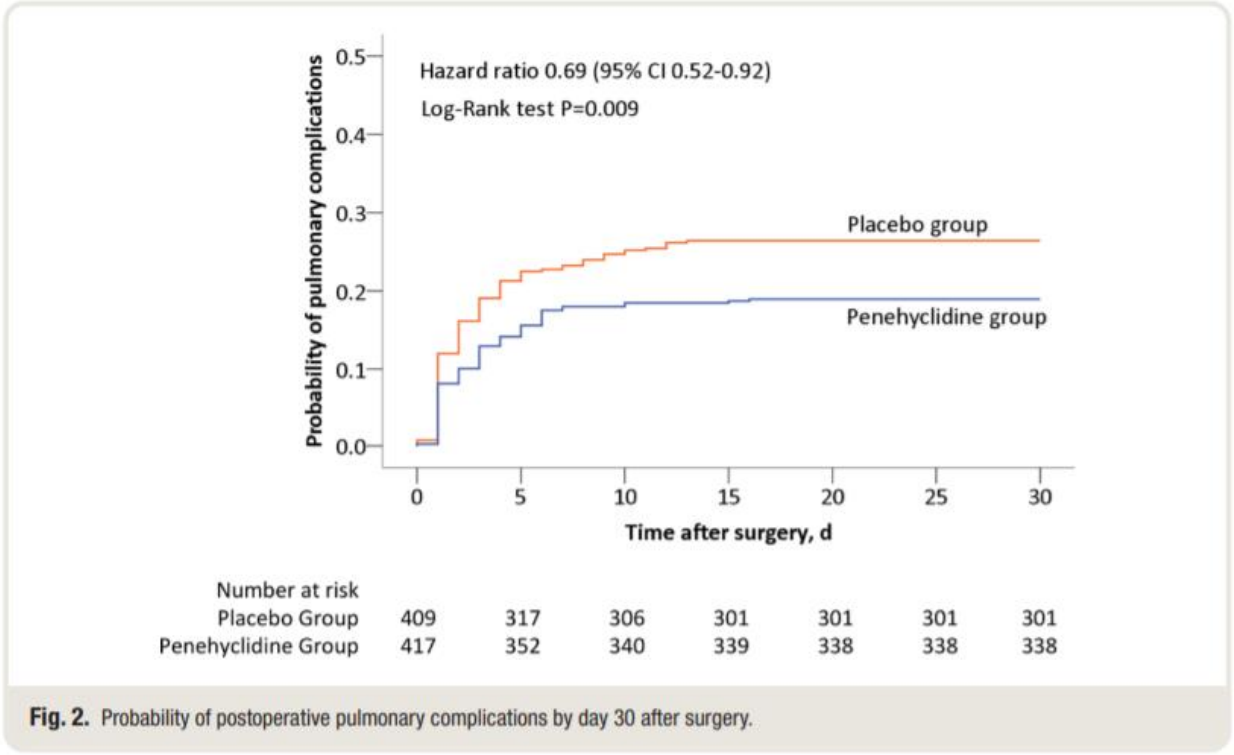



**Fig. 2.** Probability of postoperative pulmonary complications by day 30 after surgery.

Penehyclidine Inhalation and Pulmonary Complications[2]


[1] Miskovic A, Lumb AB. Postoperative pulmonary complications. Br J Anaesth 2017; 118:317.
[2] Yan T, Liang XQ, Wang GJ, et al. Prophylactic Penehyclidine Inhalation for Prevention of Postoperative Pulmonary Complications in High-risk Patients: A Double-blind Randomized Trial. Anesthesiology. 2022 Apr 1;136(4):551-566.

# Part 2

- Introduction of Postoperative Pulmonary Complications (PPCs)
- How do pharmacists develop Perioperative airway management to improve PPCs?
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- Summary

## Perform Preoperative risk assessment of PPCs

Using a risk scoring method can help us identify patients at high risk of developing PPCs

Currently, there are multiple perioperative risk assessment tools for PPCs in clinical practice, among which the **ARISCAT** (Assess Respiratory risk In Surgical patients in Catalonia) risk index score is one of the most widely used. It is a weighted scoring system consisting of seven independent clinical variables that can classify patients into low, moderate, and high risk categories for developing postoperative pulmonary complications.

**ARISCAT risk index: Independent predictors of postoperative pulmonary complications**

| Factor | Adjusted odds ratio (95% CI) | Risk score |
|---|---|---|
| Age, years | | |
| ≤50 | 1 | |
| 51-80 | 1.4 (0.6-3.3) | 3 |
| >80 | 5.1 (1.9-13.3) | 16 |
| Preoperative $O_2$ saturation | | |
| ≥96 percent | 1 | |
| 91-95 percent | 2.2 (1.2-4.2) | 8 |
| ≤90 percent | 10.7 (4.1-28.1) | 24 |
| Respiratory infection in the last month | 5.5 (2.6-11.5) | 17 |
| Preoperative anemia - hemoglobin ≤10 g/dL | 3 (1.4-6.5) | 11 |
| Surgical incision | | |
| Upper abdominal | 4.4 (2.3-8.5) | 15 |
| Intrathoracic | 11.4 (1.9-26.0) | 24 |
| Duration of surgery | | |
| ≤2 hours | 1 | |
| 2-3 hours | 4.9 (2.4-10.1) | 16 |
| >3 hours | 9.7 (2.4-19.9) | 23 |
| Emergency surgery | 2.2 (1.0-4.5) | 8 |

| Risk class | Number of points in risk score | Pulmonary complication rate (validation sample) |
|---|---|---|
| Low | <26 points | 1.6 percent |
| Intermediate | 26-44 points | 13.3 percent |
| High | ≥45 points | 42.1 percent |

[1] Canet J, Gallart L, Gomar C, Paluzie G, Vallès J, Castillo J, Sabaté S, Mazo V, Briones Z, Sanchis J; ARISCAT Group. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology. 2010 Dec;113(6):1338-50.

## Preoperative strategies to improve PPCs

- Smoking cessation


- Optimize the use of glucocorticoids and bronchodilators

- Elective surgery for high-risk patients

- Counsel patients on preoperative oral care

## Intraoperative strategies to improve PPCs

- Optimal anesthesia program

- For patients with COPD or asthma, administer inhaled short-acting beta-adrenergic (eg, albuterol) 2 to 4 puffs within 30 minutes before intubation

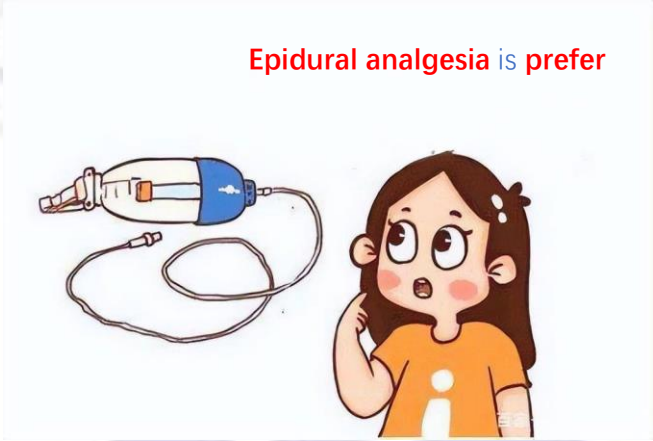
- Avoid long-acting neuromuscular blocking agents for induction or during procedure

**Long**-acting neuromuscular blocking agents

**Short**-acting neuromuscular blocking agents

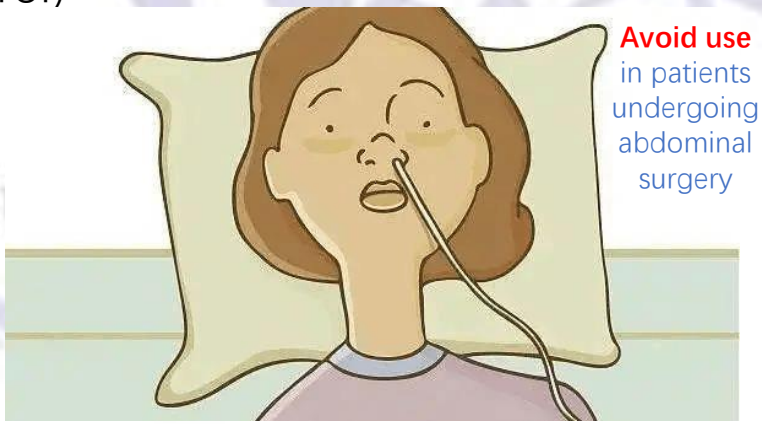
## postoperative strategies to improve PPCs

- Provide epidural analgesia in place of parenteral opioids, as appropriate




- For patients with asthma and AERD, avoid using NSAIDS for pain control (eg, ketorolac, ibuprofen)


- Avoid use of nasogastric tubes after abdominal surgery (unless needed for symptom control)



# Part 3

- Introduction of Postoperative Pulmonary Complications (POPC)
- How do pharmacists develop Perioperative airway management to improve POPC
- **Brief introduction of a clinical case**
- Summary

# Medical History Introduction

## Patient Information

Name: Qin  Gender: Male  Age: 81 years old  Marital Status: Married  BMI: 19.1

Date of Admission: August 15, 2023

## Chief Complaint

Discovery of a nodule in the upper left lung for over a month.

## Current Medical History

The patient had a chest CT scan at our hospital a month ago, which revealed a solid nodule in the upper segment of the left upper lobe (Se2: IM128), approximately 16mm x 11mm in size, with clear margins. There were multiple small nodules with a hair-like appearance in the periphery of the lobe, adjacent to the pleura. Additionally, there were several small solid nodules of varying sizes in both lungs, with clear margins and smooth edges. The largest was located in the lower segment of the left lower lobe (Se2: IM282), approximately 5mm x 5mm. The patient occasionally experiences coughing and phlegm but no hemoptysis, blood in the sputum, chest pain, shortness of breath, wheezing, or dyspnea. The patient has been in good spirits and has been sleeping well since the onset of the illness, with no significant weight loss. The patient was admitted to our department today for further diagnosis.

# Medical History Introduction

## Past Medical History

General health condition: Average.

Disease history: Chronic obstructive pulmonary disease (COPD) and asthma for over 20 years.

History of infectious diseases: None.

History of food or drug allergies: None.

History of surgery or trauma: None.

History of blood transfusion: None.

## Personal History

Smoking history: Yes (50 years, 20-40 cigarettes per day), not yet quit, no alcohol consumption.

No history of exposure to industrial toxins, dust, or radioactive substances.

No history of exposure to epidemic areas or contaminated water.

## Medications History

Budesonide and formoterol Fumarate Powder for Inhalation

# Medical History Introduction

## Admission Physical Examination

Temperature: 36.9°C

Pulse: 85 beats per minute

Respiratory rate: 20 breaths per minute

Blood pressure: 140/97 mmHg

Special examination: Respiratory rhythm is symmetrical; vocal fremitus is equal and consistent on both sides, with no increase or decrease, no pleural friction sensation, and no subcutaneous crepitus. Both lungs have clear percussion sounds, and the breath sounds are clear upon auscultation, with no dry or moist rales or pleural friction rubs. No abnormalities in vocal transmission.

## Auxiliary Examinations

- Chest CT, Plain Scan:

1. A solid nodule in the anterior segment of the upper lobe of the left lung, suspected to be an inflammatory condition, with lung cancer to be ruled out, recommendation for follow-up examination.
2. Multiple small solid nodules in both lungs, suspected to be inflammatory nodules.
3. Bronchitis and emphysema in both lungs.

# Medical History Introduction

## Auxiliary Examinations

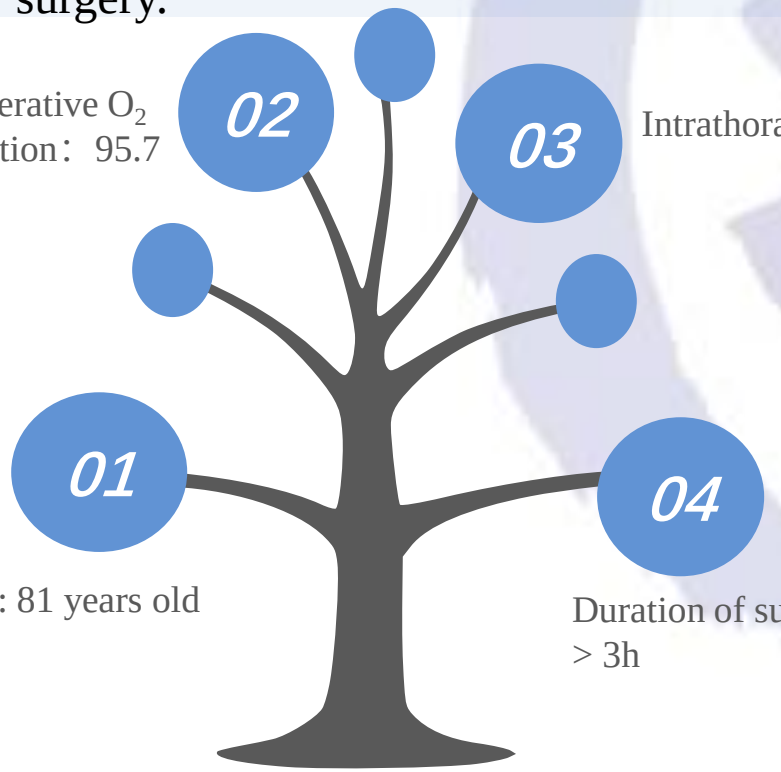
- Sinus CT, Plain Scan: Mild inflammation in the left maxillary sinus.
- Bronchodilator Test Report: Negative bronchodilator test (after inhalation of 400μg salbutamol via a spacer device, the increase in FEV1 and FVC from baseline is less than 12%, and the absolute increase is less than 200ml) (the patient had used Budesonide and formoterol Fumarate Powder for Inhalation before the test).
- Pulmonary Function Test Report: Severe mixed ventilatory impairment. Note: The patient cooperated well with the examination, and the quality of the examination was good, with FVC and FEV1 both graded as A.

## Admission Diagnosis

- Nodule in the upper left lung.
- Asthma-COPD overlap syndrome.
- Prostatic hyperplasia with calcification.
- Renal cyst.
- Hepatic cyst (multiple)

# Preoperative Discussion

The patient has a clear indication for surgery. Preoperative examinations show no absolute contraindications for surgery. The patient will undergo a video-assisted thoracic surgery (VATS) for a sublobar resection of the left upper lobe under general anesthesia. If necessary, a lobectomy will be performed. Attention should be paid to potential complications such as bleeding, difficulty in expectoration, pulmonary infection, and hypoxemia during and after the surgery.




Age: 81 years old

Preoperative $O_2$ saturation: 95.7

Intrathoracic

Duration of surgery > 3h

**ARISCAT risk index: Independent predictors of postoperative pulmonary complications**

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| High | ≥45 points | 42.1 percent |

According to the ARISCAT risk index assessment, this patient has a **high incidence rate** of PPCs, and the pharmacist should focus on monitoring them.

**Strategies to reduce postoperative pulmonary complications in patients at increased risk**

| |
|---|
| **Preoperative strategies** |
| Smoking cessation: preferably more than eight weeks prior to surgery (however, briefer periods of cessation are not harmful and may still provide nonrespiratory benefits) |
| For patients with COPD or asthma, optimize control with inhaled bronchodilators and possibly inhaled glucocorticoids |
| For patients with a flare of COPD or asthma, administer systemic glucocorticoids (eg, prednisone 40 mg/day for five days) and delay elective surgery until COPD/asthma is under good control and has returned to baseline |
| Reserve preoperative antibiotics for patients with symptoms and signs of lower respiratory infection* |
| Delay elective surgery for at least two weeks for patients with influenza A, COVID-19, or lower respiratory tract infections; for patients with more severe disease delay up to 7 weeks may be appropriate |
| Counsel patients on preoperative oral care (eg, dental hygienist visit, preoperative chlorhexidine mouthwash) |
| Provide preoperative education regarding lung expansion maneuvers |
| For patients at increased risk of pulmonary complications, initiate chest physical therapy (eg, aerobic exercises, breathing exercises, inspiratory muscle training) up to two weeks before surgery |
| **Intraoperative strategies** |
| Choose shorter procedure (less than three hours) when possible |
| Choose less invasive procedure when possible (eg, laparoscopic), as long as operative time not prolonged |
| Consider neuraxial anesthesia rather than general anesthesia |
| Utilize regional anesthesia (nerve block) when this is an option |
| For patients with COPD or asthma, administer inhaled short-acting beta-adrenergic (eg, albuterol) 2 to 4 puffs within 30 minutes before intubation |
| When invasive mechanical ventilation is used, use lung-protective ventilation methods (ie, lower tidal volume [6 to 8 mL/kg], higher positive end-expiratory pressure [6 to 8 cm $H_2O$], alveolar recruitment maneuvers) |
| Avoid long-acting neuromuscular blocking agents for induction or during procedure |
| Assure full reversal of neuromuscular blocking agents with appropriate use of reversal agents and quantitative monitoring, if available |
| **Postoperative strategies** |
| Initiate deep breathing exercises or incentive spirometry in high-risk patients; noninvasive ventilatory support (CPAP, high-flow nasal oxygen, or noninvasive ventilation) may also be beneficial in patients with early respiratory compromise |
| Provide epidural analgesia in place of parenteral opioids, as appropriate |
| For patients with asthma and AERD, avoid using NSAIDS for pain control (eg, ketorolac, ibuprofen) |
| Avoid use of nasogastric tubes after abdominal surgery (unless needed for symptom control) |
| Use enhanced recovery pathways and goal-directed hemodynamic therapy in high-risk patients if appropriate resources and protocols available |

AERD: aspirin exacerbated respiratory disease; COPD: chronic obstructive pulmonary disease; CPAP: continuous positive airway pressure; ICU: intensive care unit; NSAIDS: nonsteroidal anti-inflammatory drugs.

* Does not refer to perioperative antibiotic prophylaxis for wound infection.

# Pharmacist Monitoring Record

Course Record:

- Date: 2023-8-16
- Patient's Condition: The patient reported no significant discomfort, no cough or phlegm, and no chest tightness or dyspnea.
- Physical Examination: Vital signs were stable, with clear breath sounds in both lungs and no obvious dry or wet rales.

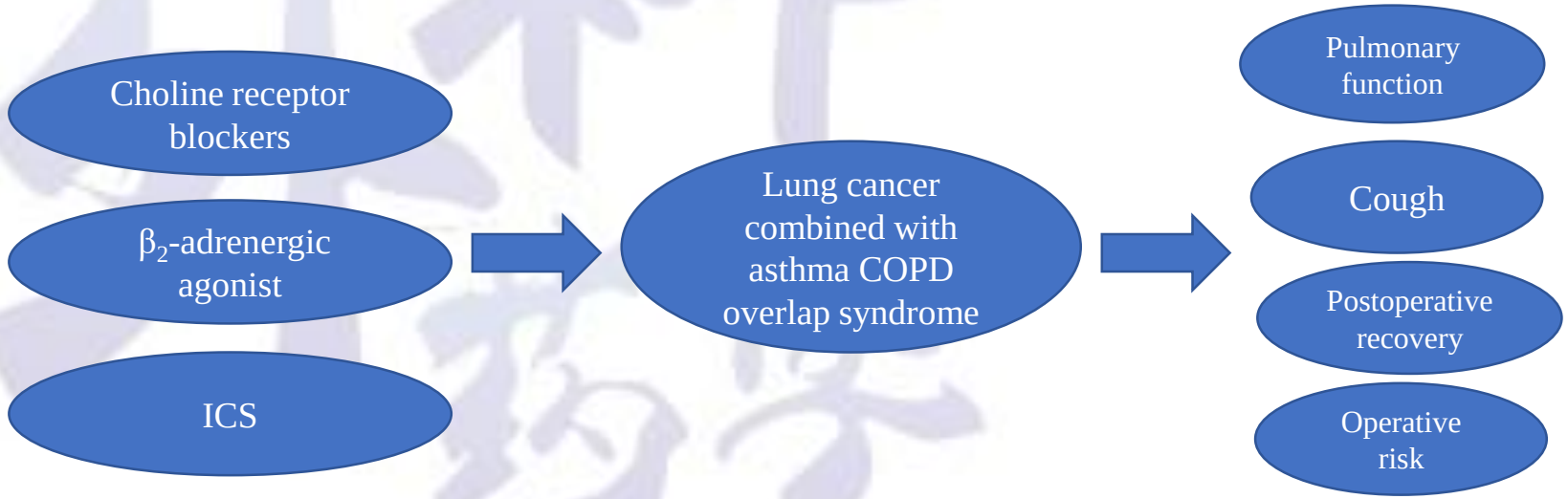
Clinical Pharmacotherapy Monitoring Issue:

The patient is scheduled for a left upper lobe sublobar resection under general anesthesia. Considering the patient has lung cancer with an overlap of asthma and COPD (Chronic Obstructive Pulmonary Disease), there is a high risk of perioperative airway complications. The clinical pharmacist is asked to provide recommendations on how to prevent these complications through medication.

# Pharmacist Monitoring Record

## Pharmacist's Analysis:

The patient has lung cancer with an overlap of asthma and COPD. According to relevant guidelines and consensus, postoperative airway complications are one of the main risks during the perioperative period of thoracic surgery. Chronic obstructive pulmonary disease and asthma are high-risk factors for postoperative airway complications.




## Pharmacist's Monitoring and Suggestions:

- It is suggested to replace the Budesonide and formoterol Fumarate Powder for Inhalation with a combination of ipratropium bromide, terbutaline/salbutamol, and budesonide for nebulized treatment. Monitor the patient for any adverse reactions such as tremors, headache, or tachycardia.
- Dynamically monitor blood lactate levels and blood gas analysis for any changes.

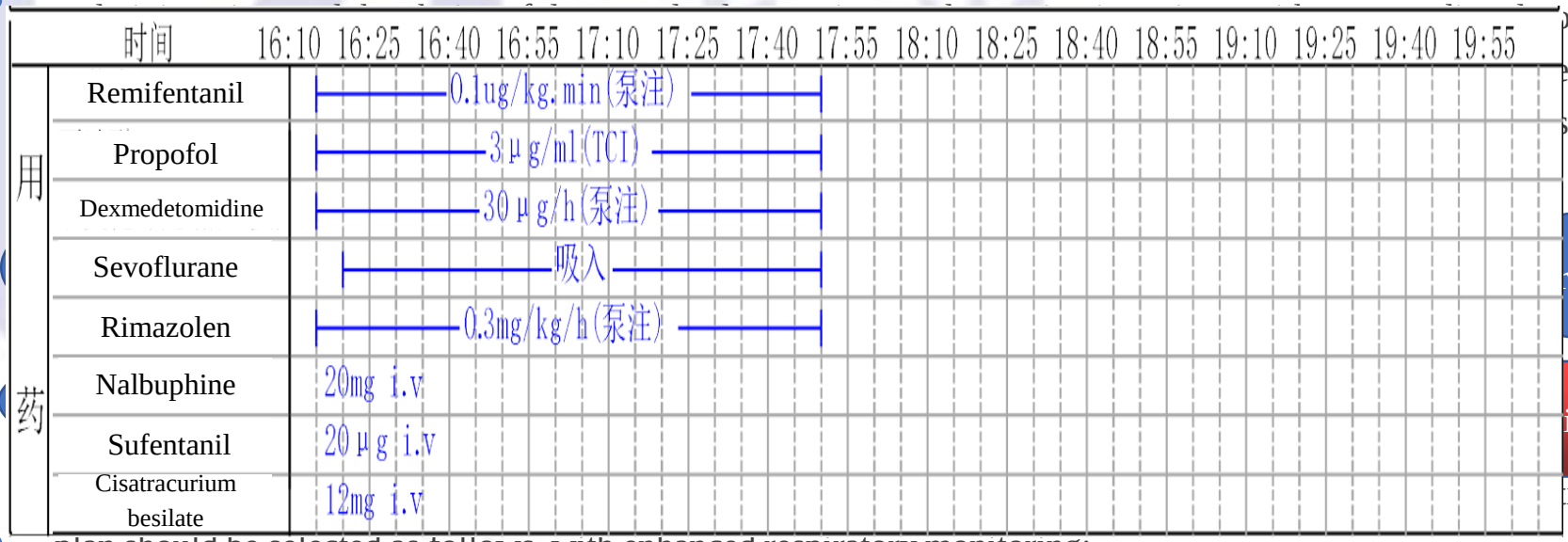
# Pharmacist Monitoring Record

Clinical Pharmacotherapy Monitoring Issue:

The patient is scheduled for a left upper lobe sublobar resection under general anesthesia. Considering the patient has lung cancer with an overlap of asthma and COPD (Chronic Obstructive Pulmonary Disease), there is a risk of respiratory depression during the anesthetic process. The clinical pharmacist is asked to provide recommendations on how to formulate an anesthetic plan.

## Pharmacist's Analysis:

The relevant guidelines and consensus indicate that excessive doses of anesthetics or analgesics, rapid




## Pharmacist's Monitoring and Suggestions:

plan should be selected as follows, with enhanced respiratory monitoring:

# Pharmacist Monitoring Record

Course Record:

Date: 2023-8-17

- Surgical Procedure: The surgery went smoothly with 10ml of intraoperative bleeding. No blood transfusion was required.
- Postoperative Management: The patient received fluid replacement, analgesia, and infection prevention measures.

Date: 2023-8-19

- Patient's Condition: The patient has experienced an increased heart rate recently, without difficulty breathing, wheezing, nausea, or vomiting. The patient is alert and mentally tired.
- Wound Status: The left chest surgical area dressing is clean with no seepage. A chest drainage tube is in place, connected to a water seal bottle, with a small amount of bloody fluid drained, and water column fluctuation is visible in the bottle. The patient is instructed to cough to expel air bubbles.
- Physical Examination: Clear breath sounds on the right lung, diminished breath sounds on the left lung, slight dry rales upon exhalation in the lower left lung, regular heart rhythm, strong heart sounds, and no pathological murmurs in the valvular areas.

# Pharmacist Monitoring Record

Clinical Pharmacotherapy Monitoring Issue:

The patient has a recent increase in heart rate. It is uncertain whether this is an adverse drug reaction, and there is a question of whether medication is needed to slow the heart rate. A consultation with a clinical pharmacist is requested for advice.

## Pharmacist's Analysis:

The patient experienced an increased heart rate after treatment with salbutamol, ipratropium bromide, and budesonide nebulization, with recent heart rates ranging from 90 to 115 beats per minute. It is likely that the increased heart rate is an adverse reaction to salbutamol. For patients with a fast heart rate or those with cardiovascular diseases, terbutaline is a better choice due to its higher selectivity for β2 receptors compared to salbutamol, which reduces the risk of cardiovascular adverse events.

## Pharmacist's Monitoring and Suggestions:

- It is recommended to switch from salbutamol to terbutaline and to closely monitor the patient's heart rate.
- After discharge, the nebulized medication can be changed to Budesonide, Glycopyrronium Bromide and Formoterol Fumarate Inhalation Aerosol.
- If the heart rate remains elevated, a selective β1 receptor blocker such as bisoprolol may be added, with attention to monitoring heart rate and blood pressure changes.

# Pharmacist Monitoring Record

Course Record:

- Date: 2023-8-20
- Patient's Condition: The patient had no fever the previous day, and this morning the body temperature was 36.2°C. The patient was alert but appeared fatigued.
- Respiratory Support: The patient was on non-invasive ventilator support (PCV mode) with the following settings: FiO2 45%, IPAP 14 cmH2O, EPAP 4 cmH2O, respiratory rate (f) 18 breaths per minute.
- Vital Signs: Oxygen saturation (SpO2) was between 98-100%, heart rate (HR) was between 66-79 beats per minute, respiratory rate (RR) was between 20-30 breaths per minute, and arterial blood pressure (ABP) was between 107-163/60-94 mmHg.
- Laboratory Results: Blood lactate level was 1.4 mmol/L.

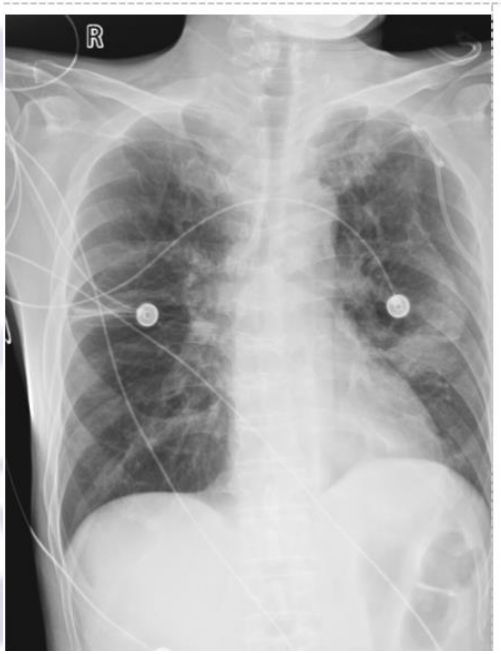
## Clinical Medication Monitoring and Follow-up:

After switching from salbutamol to terbutaline, the patient's heart rate returned to a range of 66-79 beats per minute. It is recommended to continue to closely monitor the patient's heart rate and respiratory function.

# Pharmacist Monitoring Record

Course Record:

- Date: 2023-8-22
- Patient's Condition: The patient reported a significant improvement in the pain at the surgical incision site. There were no symptoms of chills or fever, and the general condition was good.
- Physical Examination: Vital signs were stable, the surgical incision was free from redness and swelling, with no seepage of blood or fluid, and the dressing was clean and dry.
- Chest X-ray (PA and Lateral Views): Postoperative changes in the left lung, with most of the remaining left lung expanded. There was a reduction in the minor effusion areas in the remaining left lung and the right lung compared to previous imaging.




Left Image (August 17th),


Right Image (August 21st)

# Pharmacist Monitoring Record

Course Record:

Date: 2023-8-23

- Patient's Condition: The patient reported a significant improvement in the pain at the surgical incision site. There were no symptoms of chills or fever, and the general condition was good.
- Physical Examination: Vital signs were stable, the surgical incision was free from redness and swelling, with no seepage of blood or fluid, and the dressing was clean and dry.
- Laboratory Tests:

Potassium level: 3.41 mmol/L

Serum bicarbonate (HCO3) level: 31.2 mmol/L

- Postoperative Recovery: The patient's postoperative recovery was good, and the overall condition was stable, allowing for discharge from the hospital.

# Analysis

Considering the characteristics of lung cancer patients with an overlap of asthma and COPD (Chronic Obstructive Pulmonary Disease), this group is at a **high risk** for PPCs in thoracic surgery. To reduce the incidence of perioperative airway complications, **personalized anesthesia and perioperative airway nebulization plans** have been developed in accordance with authoritative guidelines from both domestic and international sources. Additionally, **smoking cessation education** has been provided to effectively decrease the occurrence of airway complications such as respiratory depression, bronchial spasms, and coughing, thereby promoting and accelerating pulmonary rehabilitation.

# Part 4

- Introduction of Postoperative Pulmonary Complications (POPC)
- How do pharmacists develop Perioperative airway management to improve POPC
- Brief introduction of a clinical case
- **Summary**

# Summary

**Understanding PPCs**

- PPCs are common and a major cause of perioperative morbidity and mortality;
- Thoracic surgery and upper abdominal surgery caused the most PPCs;
- PPCs lead to worse prognosis, higher mortality, longer hospital stay and higher hospitalization cost.

**Pharmacists can be involved in airway management to improve PPCs**

- Perform Preoperative risk assessment of PPCs;
- Preoperative/Intraoperative/postoperative strategies:

such as smoking cessation, optimize the use of glucocorticoids and bronchodilators/anesthetics/ neuromuscular blocking agents, counsel patients on preoperative oral care.

# *Thank You For Your Attention*