Turk Thorac J 2015; 16: 43-52 DOI: 10.5152/ttd.2014.4505

MISCELLANEOUS

Summary of Consensus Report on Preoperative Evaluation

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INTRODUCTION

The clinician has three aims in the preoperative evaluation: to determine the risk of preoperative complications, to decrease the risk of perioperative complications, and to eliminate the risk factors in patients who have a risk of complications in the postoperative period. For this purpose, an accurate preoperative evaluation would allow the patient to be operated on with minimum risk.

TABLE OF CONTENTS

Received: *02.10.2014* ***Accepted:*** *04.11.2014*

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4. **Preoperative Pulmonary Evaluation**
   1) Anamnesis and Physical Examination
   2) Chest X-ray
   3) Arterial Blood Gases
   4) Pulmonary Function Test
   5) Cardiopulmonary Exercise Test
   6) Pulmonary Risk Indexes

5. **Preoperative Evaluation in Special Situations**
   1) Asthma
   2) Chronic Obstructive Pulmonary Disease
   3) Obstructive Sleep Apnea Syndrome
   4) Lung Transplantation

6. **Preoperative and Postoperative Risk Reduction Strategies**
   1) Smoking Cessation
   2) Control of Chronic Obstructive Pulmonary Disease and Asthma
   3) Preoperative Antibiotic and Mucolytic Therapy
   4) Patient Education
   5) Prophylaxis for Deep Vein Thrombosis and Thromboembolism
   6) Pulmonary Rehabilitation and Breathing Exercises

7. **Postoperative Complications and Risk Reduction Strategies**
   1) Lung Expansion Maneuvers
   2) Pain Control
   3) Early Mobilization Protocol
   4) Glycemic Control
   5) Selective Nasogastric Decompression
   6) Nutritional Support

8. **Approach in Thoracic Surgery**
   1) Preoperative Pulmonary Functions
   2) Predicted Postoperative Pulmonary Functions
   3) Arterial Blood Gases
   4) Exercise Tests
   5) Concurrent Volume Reduction Surgery
   6) Cardiovascular Risk

9. **Things To Do When Consultation Is Requested for the Patient**
   1) Multifactorial Risk Index for Postoperative Respiratory Failure
   2) Risk Index for Estimating Postoperative Pulmonary Complication

10. **Preoperative Evaluation in Pediatric Patients with Chest Diseases**
    1) Aim
    2) Preoperative Risk Assessment
       Upper Respiratory Tract Infections
       Asthma
       Bronchopulmonary Dysplasia
       Obstructive Sleep Apnea Syndrome
       Cystic Fibrosis
       Neuromuscular Diseases
       Primary Ciliary Dyskinesia

1. PERIOPERATIVE RESPIRATORY PHYSIOLOGY

Respiratory physiology in patients undergoing surgery can be investigated under two topics:

1) Anesthesia-Related Changes in Pulmonary Functions

Inhaled or intravenous anesthetic agents cause a reduction in functional residual capacity (FRC) by up to 20% by means of decreasing respiratory muscle tone. The reasons for the decrease in FRC include pain, abdominal distension, pulmonary venous congestion, and posture [1]. Reduction in functional residual capacity results in atelectasis. Atelectasis leads to ventilation/perfusion imbalance. A reduction in all lung volume components during anesthesia leads to a decrease in airway diameter and an increase in airway resistance. Decreased mucociliary clearance is caused by low inspired air temperature, inflation of the endotracheal tube cuff, and use of anesthetic agents, like halothane. All of these changes contribute to the development of hypoxia. Attention should be paid to the inhalation of a high concentration of oxygen during anesthesia. High levels of oxygen cause respiratory depression by inhibiting the respiratory center response to hypoxia.

Anesthesia-related hypercarbia may also be seen. The mechanisms of hypercarbia development include increased dead space ventilation with the anesthesia devices used, along with hypoventilation and an increase in oxygen consumption due to catecholamine release during superficial anesthesia. The elevation of partial pressure of carbon dioxide in arterial blood ($PaCO_2$) to high levels causes respiratory depression. It increases intracranial pressure, leading to cerebral vasodilation. Hypercarbia, which develops during general anesthesia, particularly during halothane use, causes serious arrhythmias. In addition to hypercarbia, hypocarbia may be seen as well during anesthesia; if the patient is hyperventilated, hypothermia, hypotension, and hypocarbia may be encountered during deep anesthesia.

2) Surgical Procedure-Related Changes in Pulmonary Functions

The site, duration, and technique of surgical intervention have different effects on respiratory functions. During upper abdominal and thoracic surgeries, lung volumes decrease, leading to atelectasis and hypoxia [2]. The impairment in pulmonary functions is more pronounced in cardiac surgery. After pulmonary resection, a loss of 30% can be observed in forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC) in the early postoperative period [3].

2. PATIENT-RELATED RISK FACTORS

1) Age

In general, the incidence of postoperative complications (POPCs) was determined to be higher in cases at and over the age of 65 years [4,5].

2) Chronic Obstructive Pulmonary Disease

The incidence of POPCs increases approximately twice in the presence of COPD; however, there is no pulmonary function parameter that poses an absolute contraindication for surgery [6,7].

3) Asthma

Asthma is not a serious risk factor for pulmonary complications. The incidence of complications was determined to be higher in elder patients and in patients with uncontrolled asthma [8].

Table 1. Cardiopulmonary risk index [2]

Variable	Points
Cardiac risk index (CRI)	
Age over 70 years	5
Right heart failure (S3, jugular venous distension, left ventricular ejection fraction <40%	11
Myocardial infarction within the last 6 months	10
Premature ventricular contractions more than 5/minute	7
Premature atrial contractions or rhythm other than sinus rhythm on preoperative ECG	7
Significant aortic stenosis	3
Impaired general health status	3
Grading of CRI (Total 4 points)	
1=3-5	
2=6-12	
3=12-25	
4≥25	
Pulmonary risk index (PRI)	
Obesity (body mass index >27 kg/m^2)	1
Smoking within the last 8 weeks	1
Diffuse rhonchi or rales 5 days prior to the surgery	1
Productive cough for the last 5 days	1
FEV_1/FVC <70%	1
$PaCO_2$ >45 mm Hg	1
PRI score 6 points	
CPRI score=CRI+PRI (10 points)	

4) Smoking
The risk of complications is determined to be 1.4-4.3 times higher in smokers [9,10]. There is no definite consensus on the time of smoking cessation. In general, smoking cessation is recommended 8 weeks before surgery.

5) General Health Status
General health status is usually evaluated using the American Society of Anesthesiologists (ASA) classification. There is a good correlation between ASA classification and POPCs. While the odds ratio is 7.1 in ASA Class II and higher patients, it was found to be 3.34 in ASA Class I patients [5]. The Cardiopulmonary Risk Index (CPRI), made up of the Goldman Cardiac Risk Index and Pulmonary Risk Index, is also used, along with this classification (Table 1). Complications were determined to be 17 times higher in patients with a cardiopulmonary risk index higher than 4 as compared to patients with a cardiopulmonary risk index lower than 4 [11].

6) Obesity
It has been demonstrated that complication rates are not higher, even in morbidly obese patients, than in healthy individuals [12,13].

7) Obstructive Sleep Apnea
Obstructive sleep apnea (OSA) is a serious risk factor for POPCS [14].

8) Pulmonary Hypertension
Patients with pulmonary hypertension (PH) undergoing non-cardiac surgery (right ventricular systolic pressure >35 mm Hg) have higher risks for postoperative congestive heart failure, cardiac ischemic events, arrhythmias, stroke, respiratory failure (the most common cause of morbidity), hepatic dysfunction, renal dysfunction, or the need for postoperative positive inotropic or vasopressor agent [11].

9) Heart failure
The odds ratio for POPCs was found to be 2.93 (95% CI 1.02-8.43) in patients with heart failure [15].

10) Metabolic Condition
Both low albumin (<3 g/dL) (odds ratio=2.53) and high BUN (>30 mg/dL) (odds ratio=2.29) were determined to be significant indicators of pulmonary complications [16].

11) Upper Respiratory Tract Infection
Postponing elective surgery would be appropriate in patients with URTI.

3. RISK FACTORS ASSOCIATED WITH SURGICAL INTERVENTION

1) Site and Type of Surgery
Upper abdominal and thoracic surgeries cause significant impairments in pulmonary functions. The rate of postoperative complications is inversely proportional to the distance of the incision to the diaphragm [17] but varies depending on the surgical intervention. The rate is very high in esophageal surgery, and it was found to be 3.24 times higher in those operated on due to malignant tumor [18,19]. The type of incision, as well as the type of surgery, is important in predicting the development of POPCs. It has been reported that laparotomy performed through a transverse incision causes pulmonary complications less frequently [20].

2) Elective/Emergency Surgery
Emergency surgery is an important marker in estimating the risk of mortality; the odds ratio was reported to be 2.21 for emergency surgery [15,21].

3) Surgical Technique
Laparoscopic methods are recommended, as they reduce postoperative morbidity and shorten postoperative hospital stay [22].

4) Duration of Surgery
The risk of POPCs is 1.6-5.2-fold higher in surgeries that last for more than 3-4 hours [23].

5) Type of Anesthesia/Type and Duration of Neuromuscular Blockade
Epidural anesthesia allows better suppression of surgical stress, maintains more stable cardiovascular hemodynamics, and provides better peripheral vascular circulation and better postoperative pain control [24]. Epidural anesthesia performed in the upper regions of the spinal column (T1-T5 dermatomes) causes more significant impairments in pulmonary functions [25].

The agents that are used for anesthesia affect pulmonary functions. The risk of POPCs was found to be 3 times higher

in patients receiving long-acting neuromuscular blockers (pancuronium) as compared to those receiving short-acting neuromuscular blockers (atracurium, vecuronium) [26]. The duration of anesthesia, as well as the agents used in anesthesia, is important for the development of POPCs. It was stated that the duration of anesthesia was observed to be longer in patients that developed postoperative complications (300 minutes vs. 198 minutes) [27].

4. PREOPERATIVE PULMONARY EVALUATION

1) Anamnesis and Physical Examination

Pulmonary symptoms that have to be questioned include dyspnea, wheezing, chest pain, hemoptysis, cough, and sputum. In addition, age, history of smoking and drug use, occupational exposure, immobilization, and concomitant diseases also need to be questioned.

The physical examination should focus on information obtained from the anamnesis. All patients should undergo a cardiovascular and respiratory system examination, and underlying disease should be investigated in the presence of signs of excessive secretion, obstruction, emphysema and respiratory failure, hypertension, dysrhythmia, and tachycardia. The presence of pathology during the preoperative respiratory system examination increases the risk of POPCs by 5.8-fold [28].

2) Chest X-ray

Chest x-ray is recommended in those with cardiopulmonary disease, those over the age of 50 years, and those who undergo upper abdominal, thoracic, or abdominal aortic aneurism surgery [15].

3) Arterial Blood Gasses

Arterial blood gas analysis is recommended in patients who undergo abdominal, thoracic, or cardiovascular surgery in the presence of dyspnea or a history of smoking [29].

4) Pulmonary Function Test

The superiority of spirometric values to anamnesis and physical examination has not been shown [15]. Spirometry is indicated in patients who undergo lung resection surgery in order to determine the postoperative FEV_1 and the suitability for resection. Moreover, spirometry is indicated in all patients over the age of 60 years; with ≥20 pack-years of smoking history; with known pulmonary disease, respiratory system symptoms, and complaint of shortness of breath, together with a history of smoking; and in patients scheduled for upper abdominal or long-lasting lower abdominal surgery.

5) Cardiopulmonary Exercise Test

Cardiopulmonary exercise testing might be beneficial in elderly patients with cardiac or pulmonary disease in estimating whether the patient can tolerate surgery [30]. Routine use is not recommended, except for thorax surgery.

6) Pulmonary Risk Indexes

The rate of postoperative complications was found to be 22 times higher in those with a cardiopulmonary risk index score higher than 4 as compared to those with a cardiopulmonary risk index score lower than 4. It was observed that complications do not develop in those with a cardiopulmonary risk index score ≤2 [31].

5. PREOPERATIVE EVALUATION IN SPECIAL SITUATIONS

1) Asthma

The first thing to do in the preoperative evaluation is to assess whether the patient's asthma is under control or not. It is not necessary to perform pulmonary function tests in an asymptomatic patient with controlled asthma. Control of arterial blood gases during attacks is important.

The drugs received by the patient are reviewed, and the pulmonary functions of the patient are aimed to be brought to baseline or close to it. In newly diagnosed or non-compliant patients, 40 mg of oral methyl prednisolone may be given for 5 days prior to surgery [32]. Prophylactic systemic steroid therapy is also recommended in patients with a history of systemic steroid therapy within the last 6 months [33]. The recommended inhaled anesthetic agent is sevoflurane [34]. A laryngeal mask airway may be preferred, since tracheal intubation can lead to a reversible increase in airway resistance [35]. The patient should be hydrated over the course of the surgery, keeping in mind that overhydration might lead to pulmonary congestion and bronchospasm.

2) Chronic Obstructive Pulmonary Disease

Things to do in the preoperative period in the case of COPD include smoking cessation at least 8 weeks prior to surgery, correction of mineral and electrolyte deficiency, providing additional nutrition in those with serious malnutrition, commencing bronchodilators in those with airway obstruction, and starting patient education, including lung expansion maneuvers. In COPD patients, initiation of bronchodilator inhalation as premedication, limiting the duration of surgery to 3 hours, preferring less invasive interventions if possible, and using spinal-epidural or troncular anesthesia are recommended. In the postoperative period, extubation and spontaneous ventilation should be provided as soon as possible, inhaled bronchodilators should be used, deep breathing exercises or incentive spirometry (IS) should be performed, bronchial secretions should be removed, and epidural or troncular analgesia should be used [36].

3) Obstructive Sleep Apnea Syndrome

In the preoperative period, patients with suspected OSAS should be either referred to surgery by considering them at "high risk for OSAS" or transferred to a sleep center for further analysis and treatment, based on the urgency of the surgery. The patients that have been diagnosed with OSAS via polysomnography are usually treated with preoperative CPAP [37]. Regional anesthesia can be preferred to general anesthesia in patients with OSAS. Short-acting agents should be preferred for ideal general anesthesia. Emergency airway intervention tools should be easily accessible. The most important postoperative problems are hypoxemia and hypercapnia. Therefore, performing CPAP in the early period would be beneficial [38].

4) Lung Transplantation

Candidates of transplantation need to be in adequate physical condition to tolerate the expected perioperative and postoperative complications and the toxicity of immunosuppressive drugs, in addition to having the psychosocial

power and support necessary to adopt major changes in their lifestyles that transplantation brings along. They are not supposed to have uncontrollable or untreatable serious cardiac, liver, kidney, and bone marrow, problems [39]. The patient should have a certain level of exercise and rehabilitation potential before transplantation. A body mass index over 30 is considered a relative contraindication for transplantation [40].

6. PREOPERATIVE AND POSTOPERATIVE RISK REDUCTION STRATEGIES

1) Smoking Cessation

The idea of smoking cessation at least 8 weeks before surgery to reduce the rate of complications in patients undergoing elective surgery has been supported by many studies [41,42]. Medical therapy (nicotine replacement therapy, bupropion, or varenicline) may be recommended for smoking cessation in patients with a history of smoking [43]. Initiation of incentive spirometry in the preoperative period and bronchodilators in suitable cases, based on PFT, may be recommended.

2) Chronic Obstructive Pulmonary Disease and Asthma Control

Appropriate bronchodilators (preferably a long-acting beta-2 agonist, long-acting anticholinergic, and theophylline) and inhaled corticosteroid therapies need to be given to COPD cases, as recommended in the guidelines. Nevertheless, short-term oral corticosteroids may be added to the treatment in COPD cases that have moderate-severe obstruction in the spirometry. Breathing exercises and respiratory physiotherapy should be performed in suitable patients. It may be appropriate for patients with moderate or severe impairments in pulmonary function testing to switch to nebulizer treatment from the inhaled form in their on-going treatment before surgery [44]. The surgery is postponed in the event of pulmonary infection or acute exacerbation of COPD. Treatment for respiratory tract infection should be performed with an antibiotic of the appropriate spectrum for the appropriate time. Oxygen should be given if the patient has hypoxemia, and non-invasive mechanical ventilation should be performed if $PaCO_2$ is high, particularly in patients in type 2 respiratory failure [45].

Optimal treatment should be arranged to keep FEV_1 or peak flow rate (PEF) over 80% in asthmatic patients who undergo elective surgery. Inhaled bronchodilator use in asthmatic patients should continue until just before the surgery. It is convenient for patients with asthma that is not under adequate control to switch from the inhaled form to the the nebule form of the drug that they have been receiving 1-2 days before surgery [44]. In addition, intravenous steroids reduce perioperative bronchospasm in such patients [46]. In asthmatic patients with an FEV_1 of less than 80%, 0.5-1 mg/kg prednisone should be given for 5-7 days preoperatively and discontinued on the first postoperative day. If the patient has a history of systemic steroid use for longer than 2 weeks within the last 6 months or on-going systemic steroid use, 100 mg hydrocortisone should be initiated at 8-hour intervals 24 hours before surgery and then continued by gradually decreasing the dose until oral therapy is initiated [45].

3) Preoperative Antibiotic and Mucolytic Therapy

Preoperative antibiotic use is not beneficial for the prevention of pneumonia in patients with stable COPD or controlled asthma, unless other disorders, such as acute bronchitis, bronchiectasis, or immune deficiency, are present. Elective surgery should be cancelled until the completion of treatment in patients with purulent sputum or a change in character sputum and in those having an underlying disease, like COPD. Regular treatment with mucolytic agents and fluid intake may be recommended in patients with underlying hypersecretory diseases, such as chronic bronchitis or bronchiectasis. N-acetylcysteine can be given regularly for the excretion of postoperative secretions more easily [44].

4) Patient Education

If possible, patients should be educated 2-3 days before surgery. The importance of coughing, respiratory physiology, and patient compliance during weaning from the ventilator should be explained to the patient. In patients with hypersecretion before surgery, secretion drainage should be provided by teaching the techniques, including postural drainage, vibration, percussion, coughing, flutter use, huffing, and humidification. Rapid mobilization should be provided after the surgery. [47].

5) Prophylaxis for Deep Vein Thrombosis and Pulmonary Thromboembolism

Prophylactic interventions to prevent postoperative deep vein thrombosis (DVT) include leg elevation; use of elastic bandages, compression socks, and pneumatic compression devices; lower extremity exercises; and early mobilization. Moreover, attention should be paid to bed sheet-cloth folds, cross-legged positioning, catheter contacts, and compression, which impair blood circulation.

The agents that are most commonly used in venous thromboembolism (VTE) prophylaxis include:

Unfractionated heparin: It is recommended to be initiated at a dose of 5000 IU 2 hours before surgery and at a dose of 5000 IU at 12-hour intervals thereafter.

Low-molecular-weight heparin and fondaparinux: Enoxaparin is recommended to be started just before surgery and then used at 12-hour intervals at a dose of 40 mg; dalteparin is recommended to be used at a dose of 500 IU/day, nadroparin is recommended to be used at a dose of 3500 IU/day; and fondaparinux is recommended to be used at a dose of 2.5 mg/day via subcutaneous route [48].

6) Pulmonary Rehabilitation and Breathing Exercises

a) Pulmonary rehabilitation in the preoperative period

Preoperative pulmonary rehabilitation should include chest physiotherapy, an aerobic exercise program, and smoking cessation [49]. In general, the exercise program that is recommended in the preoperative period consists of multidimensional aerobic and strengthening exercises, including lower and upper extremity exercises, that are performed 2-3 times weekly for 6-8 weeks.

b) Pulmonary rehabilitation in the postoperative period

Early mobilization, along with breathing control, to provide normal FRC and alveolar ventilation should be started in the

early postoperative period unless there is any condition that might be a contraindication. Moreover, coughing and deep breathing exercises should be performed hourly to increase alveolar volume and regulate the distribution of ventilation [50]. Postoperative hypoxemia and atelectasis can be prevented by incentive spirometry devices, which enable effective coughing by increasing inspiratory capacity. Incentive spirometry is particularly recommended in patients who are unable to perform breathing exercises and have a risk of atelectasis. It has been proven that CPAP prevents atelectasis and pneumonia development more than deep breathing exercises, incentive spirometry, and coughing techniques [51].

7. POSTOPERATIVE COMPLICATIONS AND RISK REDUCTION STRATEGIES

1) Lung Expansion Maneuvers

Lung expansion maneuvers consist of incentive spirometry, deep breathing exercises, postural drainage, percussion/vibration, mobilization, and positive airway pressure therapies, such as CPAP, bi-level positive airway pressure (BiPAP), and intermittent positive pressure breathing (IPPB). Implementation of these methods should be decided on an individual patient basis, considering accessibility, cost, and experience regarding the method that would be preferred in moderate- and high-risk patients for postoperative pulmonary complications. CPAP could be the primary method in high-risk patients and particularly in patients who can not adhere to other methods.

2) Pain control

Postoperative epidural and "patient-controlled analgesia" (PCA) and intravenous analgesia are more successful than conventional opioid therapy in preventing postoperative pulmonary complications [52].

3) Early Mobilization Protocol

The early mobilization protocol consists of shorter preoperative fasting, patient-controlled epidural analgesia via epidural catheter, starting enteral feeding on the night of surgery, and patient mobilization.

4) Glycemic Control

Providing glycemic control in the medical and surgical patient population is associated with a decrease in the duration of mechanical ventilation. However, the effect of glycemic control on postoperative complications is not known. What the optimal blood glucose level should be in effective glycemic control is another issue being discussed [53].

5) Selective Nasogastric Decompression

It is thought that bowel function returns to normal more rapidly and that the risk of aspiration is reduced via routine nasogastric (NG) decompression after abdominal surgery.

6) Nutritional Support

The presence of hypoalbuminemia and malnutrition enhances postoperative complications. It has been demonstrated that total parenteral nutrition (TPN) does not provide any additional contribution as compared to total enteral nutrition (TEN) except for the presence of severe malnutrition (>10% weight loss in 6 months) or prolonged inadequate enteral nutrition (longer than 10-14 days) [52]. Further studies that evaluate the effects of enteral formulas, which are considered to strengthen the immune system, are needed. Intestinal villus atrophy and related bacterial translocation from the intestinal mucosa and sepsis might develop due to inadequate oral intake after surgery. Starting oral intake immediately after surgery should be targeted to prevent these complications.

8. APPROACH IN THORACIC SURGERY

1) Preoperative Pulmonary Functions

It was observed that postoperative mortality was 40% in cases having a maximum voluntary ventilation (MVV) of less than 50% and an FVC of less than 70% [54]. The fact that maximum voluntary ventilation is an individual effort-dependent test prevents its use in the routine examination. Forced expiratory volume in 1 second has become the primary spirometric measurement in the preoperative evaluation. Current guidelines report that cases with an FEV_1 of 2 L (or >80% of predicted) could tolerate pneumonectomy and that those with an FEV_1 of 1.5 L could tolerate lobectomy [55,56]. Nevertheless, measuring DLCO levels has also been recommended in patients with severe exercise dyspnea or interstitial lung disease. It was reported that further physiological tests are not necessary in cases with a preoperative FEV_1 and DLCO >80% of the predicted values for each [56].

2) Predicted Postoperative Pulmonary Functions

Postoperative pulmonary function is predicted by determining perioperative FEV_1 or DLCO values and their contribution to lobar or total function of the whole lung by means of quantitative pulmonary perfusion scintigraphy or quantitative computed tomography (CT) of the lungs. Alternatively, predicted postoperative FEV_1 can also be calculated by the following formula:

Predicted postoperative FEV_1=preoperative FEV_1 X (number of remaining lung segments/total number of lung segments) [57].

Increased risk for pulmonary resection has been reported in those with a postoperative FEV_1 and DLCO $\leq$ 40% than the predicted values for each [56]. Preoperative exercise tests are recommended for such cases to determine the surgical risk level. The 2009 ERS/ESTS guidelines recommend using 30% instead of 40% as the cut-off value for predicted postoperative FEV_1 and DLCO. Moreover, an evaluation by cardiopulmonary exercise test before deciding surgery was deemed to be necessary [58].

3) Arterial Blood Gases

Preoperative baseline PaO_2 value is not an important criterion for the development of postoperative complications and mortality. Hypercapnia is generally considered an important risk factor for pulmonary resection [59].

4) Exercise tests

The use of exercise tests in the preoperative evaluation of patients undergoing thoracotomy has recently become a current issue. Stair-climbing test is a traditional test that has been used for a long time for the evaluation of patients. Although its

standardization is thought to be poor, this test enables the identification of high-risk patients for pulmonary resection [60].

The measurement that best correlates with postoperative complications in cardiopulmonary exercise test is the level of achieved work, which is measured as VO_{2max}. It was observed that cases with a VO_{2max}<10 mL/kg/min have a substantially high risk for perioperative complications and mortality [61].

It has been reported that cases with a VO_{2max}<10 mL/kg/min or 15 mL/kg/min and predicted postoperative FEV_1 and DLCO values <40% of expected values have a high risk for perioperative mortality and cardiopulmonary complications [56]. If predicted postoperative FEV_1 or DLCO level is <30%, then the predicted postoperative VO_{2max} is calculated. If the predicted postoperative VO_{2max} is <10 mL/kg/min or <35% of the expected value, options other than surgery should be preferred. Surgery is not absolutely contraindicated when the estimated postoperative VO_{2max} is >10 mL/kg/min or >35% of the expected value. Nevertheless, the patients should clearly understand these increased risks while making decisions because of the increased risk that might be brought along with low predicted postoperative FEV_1 and DLCO values [58].

5) Concurrent Volume Reduction Surgery

This surgery is recommended in cases with a tumor located in an emphysematous upper lobe and in those with both the predicted postoperative FEV_1 and DLCO levels >20% of the expected values [56].

6) Cardiovascular Risk

The cases with lung cancer and COPD risk generally have a coronary heart disease risk that might require a preoperative evaluation. Therefore, a detailed cardiac examination should be performed in cases who undergo surgery for lung cancer.

9. THINGS TO DO WHEN CONSULTATION IS REQUESTED FOR THE PATIENT

Examination for chest diseases begins with a detailed anamnesis and physical examination. Laboratory analyses that investigate pathological conditions are requested based on the anamnesis and physical examination findings. Chest x-ray should be considered for high-risk patients over the age of 50 years and for patients thought to have cardiac or pulmonary disease [62]. Pulmonary function test is recommended before all kinds of surgery in patients having dyspnea and exercise intolerance. Routine spirometry is not recommended for risk assessment in asymptomatic patients undergoing surgery other than cardiothoracic surgery [6].

Pulmonary risk indexes can be used for the assessment of postoperative risks.

1) Multifactorial Risk Index for Postoperative Respiratory Failure

The multifactorial risk index has been defined for the estimation of postoperative respiratory failure (Table 2) [16]. Among procedure-related risk factors, the types of surgery and emergency surgery are introduced as the most important predictors. It is not suitable to be used in daily practice, as it is complex and contains 28 independent risk factors.

Table 2. Arozullah respiratory failure risk index [10]

Preoperative risk factors	Score
Type of surgery	
Abdominal aortic aneurysm	27
Thorax	21
Brain surgery, upper abdomen, peripheral vascular surgery	14
Neck	11
Emergency surgery	11
Albumin <3.0 g/dL	9
BUN >30 mg/dL	8
Dependent functional status	7
History of COPD	6
Age	
>70 years	6
60-69 years	4

2) Risk Index for the Estimation of Postoperative Pulmonary Complications

The Canet Risk Index can be used (Table 3) [63]. Being easily applicable and containing already existing clinical information are among the advantages of this index.

Perioperative therapeutic approaches should be implemented to reduce the risk in patients considered to be at moderate risk. It is not appropriate to make recommendations on the anesthesia technique that is going to be performed. Another issue is refraining from the issues that are irrelevant to the procedure. The consulting clinician should evaluate the patient in terms of surgery, perioperative risk, and necessity for further analysis and intervention. Other issues (patient education, immunization, etc.) can be planned after surgery or on admission to the outpatient clinic. After consultation, some patients may ask questions about whether surgery could be performed. The patient may be informed about perioperative pulmonary complications, stating that the last decision needs to be made by the surgeon, together with the patient.

10. PREOPERATIVE EVALUATION IN PEDIATRIC PATIENTS WITH CHEST DISEASE

1) Aim

The aim of the preoperative pulmonary evaluation is to determine the risk of postoperative pulmonary complications, which is approximately 9.6% in children with pulmonary problems, and to minimize the potential problems [64]. Clinically significant postoperative pulmonary complications include atelectasis; infections, like bronchitis and pneumonia; prolonged mechanical ventilation and respiratory failure; exacerbation of underlying chronic pulmonary disease; and bronchospasm [65]. Patient-related risk factors for perioperative pulmonary complications include general health status, age, upper respiratory tract infection, asthma, chronic pulmonary disease, and obstructive sleep apnea syndrome. Surgery-related known risk factors include thoracic and upper abdominal surgeries and surgical procedures lasting longer than 3 hours [4,66].

Table 3. Canet risk index

Factor	Adjusted odds ratio (95% CI)	Risk score
Age (year)		
≤50	1	
51-80	1.4 (0.6-3.3)	3
>80	5.1 (1.9-13.3)	16
Preoperative O_2 saturation		
≥%96	1	
%91-95	2.2 (1.2-4.2)	8
≤%90	10.7 (4.1-28.1)	24
Respiratory tract infection within the last month	5.5 (2.6-11.5)	17
Preoperative anemia - hemoglobin ≤10 g/dL	3.0 (1.4-6.5)	11
Surgical incision		
Upper abdomen	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 classification	Points in the risk score	Rates of pulmonary complication (in validation sample)
Low	<26 points	%1.6
Moderate	26-44 points	%13.3
High-risk	≥45 points	%42.1

2) Preoperative Risk Assessment

Anamnesis and physical examination are the keystones of the preoperative risk assessment. Measurement of oxygen saturation by a pulse oximeter is beneficial in assessing the risk before high-risk surgical interventions. Laboratory tests that could be requested in the preoperative period include pulmonary function test, arterial blood gases, and chest x-ray [67]. Criteria that are suggestive of enhanced risk in the preoperative period include [68] FEV_1 <70% (of the predicted value), FVC <70% (of the predicted value), and FEV_1/FVC <65% (of the predicted value). It has been emphasized that the risk of postoperative pulmonary complications is high in patients with $PaCO_2$ >45 mm Hg [69].

Upper respiratory tract infections: In patients with a body temperature >38.5°C, purulent nasal discharge, and symptoms of a lower respiratory tract infection (productive cough, rales, rhonchi, and positive chest x-ray finding), surgery should be postponed for 4-6 weeks until the disappearance of symptoms [70].

Asthma: Frequent use of bronchodilators, acute asthma attacks in recent times, and hospital admissions pose important risks for perioperative bronchospasm. The primary goal in an asthmatic patient is to perform the surgical procedure during the asymptomatic period [71]. The patient has to be free of wheezing, and peak expiratory flow should be at the best personal value or higher than 80% of the predicted value before surgery [72]. An inhaled beta-2 adrenergic agonist can be used 1-2 hours before the surgery in patients with controlled asthma. Inhaled corticosteroid and regular use of inhaled beta-2 agonists 1 week before the surgery are appropriate in patients with moderately controlled asthma. In patients with poorly controlled asthma, one of the following should be added to the treatment that is given to patients with moderately controlled asthma: oral prednisone (1 mg/kg/day, maximum dose: 60 mg/day) or oral dexamethasone (0.6 mg/kg/day, maximum dose: 16 mg/day) 3-5 days before surgery or oral methylprednisolone (1 mg/kg/day) for 2 days before surgery [73].

Bronchopulmonary Dysplasia: Room air oxygen saturation, $PaCO_2$, blood gas, baseline oxygenation, and acid/base balance should be analyzed. The probability of pulmonary hypertension should be kept in mind, and electrocardiography and an echocardiographic examination should be requested when necessary [74]. BPD patients with airway hyperactivity may benefit from short-acting beta-2 agonists given 1-2 hours before the induction of anesthesia.

Obstructive sleep apnea syndrome: In the preoperative period, serum electrolytes, blood gases (high bicarbonate levels may be encountered as a metabolic response to chronic hypercarbia), room air oxygen saturation measured by a pulse oximeter, and hematocrit level (hematocrit levels may be elevated as a response to chronic hypoxia) should be analyzed in such children [75].

Cystic Fibrosis: In the preoperative period, chest x-ray, pulmonary function test, blood glucose, sputum culture and antibiogram, hepatic function tests, serum electrolyte levels, and complete blood count should be requested [76]. If needed, coagulation tests, blood gases, and an echocardiographic examination should be considered. Signs of active infection in the preoperative period necessitate hospitalization and preoperative intensive pulmonary treatment [77].

Neuromuscular Diseases: Oxygen saturation (pulse oximeter), blood gas ($PaCO_2$), respiratory function test (the risk increases if FVC is <50%), and echocardiography should be requested [78,79]. Education on non-invasive mechanical ventilation should be given to patients with a risk of hypoventilation in the preoperative period, and education on the mechanical insufflation-exsufflation device should be given to patients who can not cough effectively [79,80].

Primary Ciliary Dyskinesia: In the preoperative preparation of primary ciliary dyskinesia, the active pulmonary infection is treated, and the presence of any organ inversion (inverted location) is investigated [73].

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