MARMARA
MEDICAL JOURNAL

Original Article

https://dergipark.org.tr/tr/pub/marumj

Development of a scoring system to predict postoperative pulmonary complications in a tertiary care center

Ceren DEGIRMENCI[1], Ahmet Ugur DEMIR[1], Lutfi COPLU[1], Ebru DAMADOGLU[2]

[1] Department of Pulmonology, School of Medicine, Hacettepe University, Ankara, Turkiye
[2] Division of Allergy and Clinical Immunology, Department of Pulmonology, School of Medicine, Hacettepe University, Ankara, Turkiye
Corresponding Author: Ceren DEGIRMENCI
E-mail: cerencekeli@hotmail.com

Submitted: 07.10.2024 **Accepted:** 21.03.2025

ABSTRACT

Objective: There is no existing scoring system to predict postoperative risks, such as the Canet scoring system, for patients referred to pulmonology clinics.The aim of this study was to develop a scoring system to predict postoperative pulmonary complications (PPCs) in patients referred to the pulmonology clinics for preoperative evaluation.

Patients and Methods: This prospective, single-center study included patients referred for preoperative evaluation by surgical departments to the pulmonary medicine clinic at a tertiary care center. Preoperative demographic data and pulmonary evaluation results were recorded. Patients were followed postoperatively until discharge, with follow-up phone calls at the first month to assess pulmonary symptoms. Mortality data was recorded at the third month.

Results: A total of 203 patients were included between January 2018 and February 2020. Of these, 55.7% were female, with a mean age of 60.59 years. PPC rate at the first month was 36.4%, and 22.7% had ongoing symptoms or new complications. The most common complication was bronchospasm (23.2%). Significant preoperative risk factors included surgery type, preoperative cough/dyspnea, and the season of surgery ($p<0.05$). Pulmonary complications were three times more frequent in patients undergoing upper abdominal or thoracic surgery.

Conclusion: Avoiding surgery during symptomatic periods and making optimal preoperative preparations may reduce the PPC rates.

Keywords: Preoperative pulmonary evaluation, Postoperative pulmonary complication, Canet risk scoring

1. INTRODUCTION

Preoperative evaluation of patients who will undergo surgery has always been a challenging issue. Studies in this field showed that the incidence of respiratory complications after extrathoracic operations varies between 9-69% [1-3]. In the preoperative evaluation, the physician has three goals: to determine the risk of postoperative complications, to reduce the risk of perioperative complications, and to eliminate the risk factors in the patient at risk of complications in the postoperative period.

Routine consultations and diagnostic tests are not required for most of the preoperative evaluations performed; tests that will ensure the preoperative optimization should be asked for and consultations that will just cause an increase in workload and are not necessary should not be requested. Usually, minimal or no diagnostic testing is required for low-risk surgeries.

Pulmonary complications are the main cause of mortality and morbidity in the postoperative period [4]. Various national and international studies have been conducted to predict postoperative pulmonary complications (PPCs) and the Canet risk scoring has been validated [5]. Additionally, Canet risk scoring was implemented only for the general patient population. There is currently no scoring system to predict the postoperative risks for patients referred to pulmonology clinics from various surgery departments. These patients have been referred to pulmonology clinics due to a higher risk of PPCs compared to the general patient population.

The aim of the present study was to develop a scoring system to predict the PPCs in patients referred to pulmonology clinics for preoperative evaluation purposes. Secondary outcome was analysis of the risk of mortality.

How to cite this article: Degirmenci C, Demir AU, Coplu L. Damadoglu E. Development of a scoring system to predict postoperative pulmonary complications in a tertiary care center. Marmara Med J 2025;38 (2): 141-149. doi: 10.5472/marumj.1707988

ISSN: 1309-9469

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

2. PATIENTS and METHODS

In this observational study, patients referred from general surgery, orthopedics, neurosurgery, ophthalmology, otolaryngology-head and neck surgery, plastic surgery, obstetrics-gynecology, urology, and cardiovascular surgery clinics to tertiary care center pulmonology clinics for preoperative evaluation purposes between 25 July, 2018 and 01 February, 2020 were prospectively included. Patients who received general or regional anesthesia and accepted to participate in the study were included. Patients who were pregnant, were younger than 18 years of age, received local anesthesia, required preoperative intubation, had a tracheostomy, underwent reoperation within 90 days were excluded.

Initial evaluation was performed at the time of consultation, and later on the operation day. The Canet scoring system was employed to determine postoperative risks [5]. The duration and type of surgery, as well as the type of anesthesia were recorded.

The patients were followed up with daily visits in the postoperative period until hospital discharge. Cough, sputum production, dyspnea, need for supplemental oxygen, medications, and changes in chest x-ray if taken, and complications, if any, were recorded (Postoperative patients with respiratory symptoms underwent a chest X-ray and a clinical evaluation was performed). The patients were contacted via a phone call on postoperative day 30 and were questioned if any complications occurred or unplanned doctor visits occurred. They were asked whether they received bronchodilator therapy or applied respiratory physiotherapy in the postoperative period. On postoperative day 90, mortality data was checked from the web-based death notification system (link:https://obs.saglik.gov.tr/Account/ Login).

Ethical approval of the study was obtained from Hacettepe University Non-Interventional Clinical Research Ethics Committee with project number GO 18/460 and decision number GO 18/460-11.

Statistical Analysis

SPSS statistical package version 23.0 was used for statistical analysis. A nomogram was used to calculate the sample size [6]. When we accepted the prevalence of PPCs to be 5%, a test with sensitivity of 80% and absolute precision of 0.07 estimated that the required sample size was 188 patients; a test with specificity of 80% and absolute precision of 0.07 estimated that the required sample size was 178 patients. The variables that were significant in the binary logistic regression analysis were entered to the model. The final model included 3 variables and via multiplying each β value of each variable by 10, a score for each variable was calculated. Then, a total score for each patient was calculated. A receiver operating characteristic (ROC) curve for total scores was drawn and a cut-off value with specificity of 80% was determined based on the coordinates of the ROC curve.

The determination of cut-off points was desired for scores obtained using regression coefficients. The Decision Tree method and the CHAID algorithm of this method were used to determine the cut off points for the scores obtained by using the regression coefficients and to convert them into categorical variable [7]. In determining the cut-off points for the score variable, this feature of the decision tree method was used to make the score variable into three (low, medium, high) categories [7]. A p-value less than 0.05 was considered to be statistically significant.

3. RESULTS

Patients' general characteristics

A total of 243 patients were evaluated over the course of the study. However, surgery was canceled in 23 patients due to various reasons (high pulmonary risk in 6 patients, inoperability in 7 patients other reasons in 10 patients), and surgery was performed under local anesthesia in 7 patients, (high pulmonary risk in 3, other high risks in 4). After exclusion of these 40 patients, a total of 203 patients were included in the study. Surgery was canceled in a total of 9 patients because of high postoperative pulmonary risks.

Of the patients included in the study, 55.7% (n=113) were female and 44.3% (n=90) were male. The mean age of the study population was 60.59 ± 14.93 (min-max=18-91) years. Of the patiens 57% (n=116) were ≥ 65 years, and 18.7% (n=38) were smoking. The mean body mass index was 28.33 ± 6.2 kg/m², and 70.9% (n=144) being in the abnormal weight range (n=6, <18kg/m², n=138, >25 kg/m²). The general surgery department made the highest number of referrals to the pulmonology clinics for preoperative evaluation (n=89, 43.8%). Of the surgeries performed, 70% (n=143) were other than upper abdominal or thoracic, 27.1% (n=55) being upper abdominal, and 2.5% (n=5) being thoracic surgeries. The duration of surgery was longer than 3 hours in 84%, and 77.8% of the patients were operated under general anesthesia. Autumn (n=77, 37.9%) was the highest season for surgeries.

While, no abnormal findings were detected in 87 (42.9%) of routine posterior-anterior chest radiographs taken for preoperative evaluation, cardiomegaly was seen in 21 (10.3%), and 18 (8.9%) demonstrated increased aeration (hyperinflation). Some patients could not perform pulmonary function testing due to immobilization (n=8, 3.9%) or lack of cooperation (n=16, 7.8%), and the number of patients who could perform acceptable spirometry was 178 (87.6%). The patients' mean FEV1 was 2.16 ± 0.83L, 84.26 ± 25.27%, and the mean FEV1/FVC was 76.9 ±13.77. The mean preoperative hospitalization duration of the patients was 5.4 ± 6.4 days, and the mean postoperative hospitalization duration was 6.85 ± 9.8 days. Respiratory physiotherapy was performed in the preoperative period and continued in the postoperative period in 107 (52%) patients.

Distribution of postoperative pulmonary complications (PPCs)

Postoperative pulmonary complications developed in 36.4 % (n=74) of the patients within the first month. At the end of the first month, the proportion of patients with ongoing or new complications was 22.7% (n=46). Presence of preoperative cough, sputum, dyspnea, rhonchus on chest auscultation, increased aeration on chest X-ray, duration of surgery >3 hours, operation in Autumn seasons were associated with PPCs (Table I).

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

Table I. *Patients' demographic and clinical characteristics at initial evaluation*

Variables	Total 203 (100%)	Number of Patients in the First Month PPCs, n, %	Number of Patients at the and of the first month PPCs, n, %	p[1]	p[2]
Sex					
Female	113 (55.7)	40 (35.4)	25 (22.1)	0.770	0.358
Male	90 (44.3)	34 (37.8)	21 (23.3)		
Age					
Mean: 60.59 ± 14.93				0.883	0.358
≤ 65	116 (57.1)	43 (37.1)	29 (25)		
>65	87 (42.9)	31 (35.6)	17 (19.5)		
Smoking					
Cigarette (packs/year)	33.4 (1-100)				
Never smoked	89 (43.9)	29 (32.6)	17 (19.1)	0.159	0.412
Smoker	76 (37.4)	34 (44.7)	8 (21.1)		
Exsmoker	38 (18.7)	11 (28.9)	21 (27.6)		
Comorbidities					
Hypertension	93 (45.8)	34 (36.6)	21 (22.6)	1	0.980
Extrapulmonary malignancies	65 (32)	29 (44.6)	19 (44.6)	0.118	0.125
DM	44 (21.7)	29 (45.5)	13 (29.5)	0.215	0.218
COPD	42 (20.7)	17 (40.5)	9 (21.4)	0.591	0.830
Asthma	42 (20.7)	17 (40.5)	10 (23.8)	591	0.842
Hypothyroid	30 (14.8)	9 (30)	6 (20)	0.539	0.706
CAD	26 (12.8)	9 (34.6)	4 (15.4)	1	0.343
Previous PTE	16 (7.9)	5 (31.3)	3 (18.8)	0.790	0.697
CHF	15 (7.4)	8 (53.3)	5 (33.3)	0.173	0.305
OSAS	13 (6.4)	3 (23.1)	2 (15.4)	0.382	0.382
Lung Cancer	12 (5.9)	2 (16.7)	2 (16.7)	0.217	0.609
CRD	6 (3)	2 (33.3)	2 (33.3)	1	0.620
Symptom					
No symptoms	107 (52.7)				
Exertional dyspnea	58 (28.6)	26 (44.8)	18 (31)	0.146	0.071
Cough	53 (26.1)	26 (49.1)	17 (32.1)	0.031	0.057
Sputum	35 (17.2)	18 (51.4)	12 (34.3)	0.054	0.071
URTI in the past month	34 (16.7)	17 (50)	12 (35.3)	0.008	0.054
Dyspnea	17 (8.4)	11 (64.7)	9 (52.9)	0.017	0.002
Orthopnea	12 (5.9)	4 (33.3)	3 (25)	1	0.842
Auscultation Findings					
Normal	164 (80.7)				
Rhonchus	31 (15.3)	15 (48.4)	8 (25.8)	0.157	0.649
Rale	9 (4.4)	2 (22.2)	2 (22.2)	0.491	0.974
mMRC					
1	88 (43.3)	30 (34.1)	18 (20.5)		
2	56 (27.6)	21 (37.5)	13 (23.2)		
0	50 (34.6)	18 (36)	11 (22)		
3	8 (3.9)	5 (62.5)	4 (50)		
4	1 (0.5)	0 (0)	0 (0)		
Chest X-Ray Findings					
Normal X-Ray	116 (57.1)	40 (34.4)	27 (23.3)	0.754	0.809
Findings other than cardiomegaly or inceased aeration	48 (23.6)				
Cardiomegaly	21 (10.3)				
Increased aeration	18 (8.9)	10 (55.6)	4 (22.2)	0.121	0.963

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

Season					
Autumn	77 (37.9)	38 (49.4)	24 (31.2)	< 0.001	< 0.02
Summer	47 (23.2)	14 (29.8)	10 (21.3)		
Winter	41 (20.2)	18 (43.9)	10 (24.4)		
Sping	38 (18.7)	4 (10.5)	2 (5.3)		
URTI	34 (16.7)	17 (50)	12 (35.3)	0.008	0.054
Snoring	53 (26.1)	16 (30.8)	13 (24.5)	0.231	0.849
Daytime sleepiness	25 (12.3)	7 (28)	6 (24)	0.385	0.864
Witnessed apnea	15 (7.4)	3 (20)	3 (20)	0.265	0.798
Obesity	138 (68)	46 (33.3)	28(20.3)	0.212	0.240
Normal BMI	59 (29.1)	27 (45.8)	17 (28.8)	0.108	0.180
Incision line					
Other	143 (70.4)	41 (28.7)	24 (16.8)	<0.001	<0.001
Upper abdominal	55 (27.1)	28 (50.9)	18 (32.7)		
Thoracic	5 (2.5)	5 (100)	4 (80)		
Duration of Surgery					
2-3 hours	84 (41.4)	27 (32.1)	18 (21.4)	0.072	0.118
≥ 3 hours	84 (41.4)	38 (45.2)	24 (28.6)		
< 2 hours	35 (17.2)	9 (25.7)	4 (11.4)		
Anesthesia type					
UGA	158 (77.8)	59 (37.3)	35 (22.2)	0.308	0.409
UGA + IT	29 (14.3)	10 (35.7)	7 (24.1)		
USA	16 (7.9)	4 (25)	3 (18.8)		

p^1: Patients in the First Month PPCs, p, p^2 : Patients at the and of the first month PPCs, p, DM: Diabetes mellitus, COPD: Chronic Obstructive Pulmonary Disease, CAD: Coronary Artery Disease, PTE: Pulmonary Thromboembolism, CHF: Congestive Heart Failure, OSAS: Obstructive Sleep Apnea Sendrome, CRD: Chronic Renal Disease, URTI: Upper respiratory tract infection, BMI: Body Mass Index, UGA: Under general anesthesia, IT: Intratekal, USA: Under spinal anesthesia

Patients with body mass index (BMI) ≤ 24.9 kg/m2 had significantly more postoperative sputum and increased oxygen demand (p values= 0.022 and 0.010, respectively). Postoperative fever and sputum were found to be significantly higher in patients with signs of increased aeration in preoperative chest X-ray (p values=0.016 and 0.004, respectively). Postoperative need for supplemental oxygen and pneumonia were found to be significantly higher in patients with presence of preoperative rhonchi (p values were= 0.020 and 0.001, respectively). Postoperative need for supplemental oxygen, development of pleural effusion, and atelectasis were higher in patients with a surgical duration of longer than 3 hours (p values were= 0.011, 0.009 and 0.002, respectively). Postoperative need for supplemental oxygen was seen more in patients with presence of malignancy (p=0.001).

Complication rate was higher among patients in the high risk group according to the Canet scoring system, when compared to patients who did not have any complications in the first postoperative month (p=0.002). Mortality rate at 90th postoperative day was 4.9% (n=10). The patients who had extrapulmonary malignancies 10.8% (n=7) showed higher mortality (p=0.013).

Development of a scoring system to predict PPCs

A scoring system was developed that will predict PPCs risk. Parameters are given in Table I. Variables significantly increasing the risk of developing PPCs within the first month were as follows: presence of preoperative cough, sputum or dyspnea, type of incision line, and season when the surgery was performed. Since, including all three of the variables of cough, sputum and dyspnea disrupt the model structure due to the significant relationship between them, we included the variable of 'cough' in the model because it contributed the most to the model. The risk of developing PPCs within 30 days in patients with preoperative cough was 1.949 times higher than in patients without cough. The reference category for the variable type of incision was chosen as "other". If the incision was in the upper abdominal or thoracic region, then the risk of developing PPCs within 30 days increased 3.71 times compared to regions of otherincisions. The reference category for the season variable was selected as "spring". In comparison to spring, the risk of developing PPCs within the first month increased 11.062 times in autumn. Regarding total score of the scoring system, the evaluation was performed with a maximum of 44 points (Table II).

At the end of the first month, a re-scoring model was established with the parameters found to be significant in patients with complications observed for one month or who developed new complications. Variables that significantly increased the risk of developing PPCs at the end of the first month were as follows: presence of preoperative cough, sputum or dyspnea, type of incision line, season when the surgery was performed and presence of upper respiratory tract infection (URTI). The reference category for dyspnea variable was chosen as "no

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

dyspnea". In comparison to no dyspnea, the risk of developing PPCs at the end of the first month increased 3.770 times in the presence of preoperative dyspnea. The reference category for type of incision variable was chosen as "other". If the incision type was upper abdominal, then the risk of developing PPCs at the end of the first month increased 3.293 times compared to other. "Spring" was selected as the reference category for the significant variable of season. Regarding total score in the scoring system, the evaluation was performed with a maximum of 47 points (Table III).

The appropriate cut-off points of the numerical independent variables in the model were determined, converted into categorical variables, and three categories were created: low, medium and high risk to predict PPCs. There was a significant association between these three categories and the incidence of PPCs, which was the dependent variable. When we categorized the risk of PPCs within a month, we determined low risk < 17 points, medium risk between 17-28 points, and high risk > 28 points. The categories for the risk of PPCs at the end of one month were determined as low risk < 19 points, medium risk between 19-30 points, and high risk > 30 points (Figure I)[7].

Table II. *Demonstration of the data associated with postoperative pulmonary complictions (PPCs) within a month in the logistic regression analysis and acquisition of risk scores*

Variables in the Model	B	S.E.	Odds Ratio	95% Confidence Interval for Odds Ratio		
				Lower Limit	Upper Limit	Risk Score
Upper abdominal incision	1.311	0.356	3.71	1.845	7461	13
Cough	0.667	0.362	1.949	0.958	3.965	7
Spring						
Winter	2.132	0.646	8.435	2.377	29.935	21
Autumn	2.403	0.609	11.062	3.354	36.479	24
Summer	1.696	0.651	5.453	1.521	19.545	17
Fixed	-3.001	0.602	0.05			

Maximum 44 points

Table III. *Demonstration of the data associated with postoperative pulmonary complications (PPCs) at the end of the first month in the logistic regression analysis and acquisition of the risk scores*

Variables in the Model	B	S.E.	Odds Ratio	95% Confidence Interval for Odds Ratio		
				Lower Limit	Upper Limit	Risk Score
Upper abdominal incision	1.192	0.375	3.293	1.578	6.873	12
Dyspnea	1.327	0.554	3.77	1.272	11.177	13
Spring						
Winter	1.744	0.842	5.723	1.099	29.803	17
Autumn	2.207	0.792	9.089	1.925	42.916	22
Summer	1.918	0.837	6.807	1.32	35.099	19
Fixed	-3.581	0.783	0.028			

Maximum 47 points

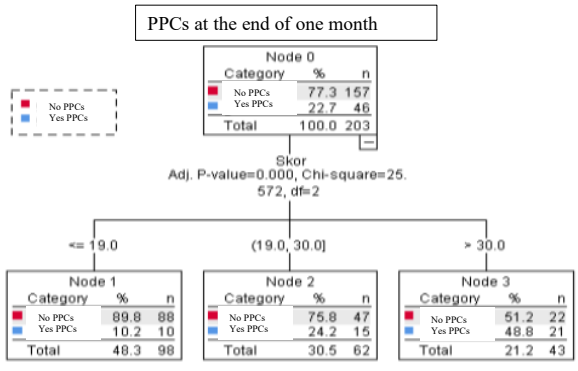

Figure 1. *Classification of postoperative pulmonary complications (PPCs) into the risk category (Node 1: Low Risk for PPCs, Node 2: Medium Risk for PPCs, Node 3: High Risk for PPCs)*

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

4. DISCUSSION

We have developed an easily applicable scoring system that can be used in patients referred to pulmonology clinicss for preoperative pulmonary assessment, aiming to identify postoperative pulmonary complications. The most frequent PPCs were pneumonia, need for supplemental oxygen, bronchospasm, atelectasis, and pleural effusion. Consistent with previous studies, we demonstrated that patients with pulmonary symptoms during the preoperative period have higher rates of PPCs [5, 8]. PPCs were more frequently observed in patients with preoperative complaints such as cough, sputum, and dyspnea. In our study population, history of an upper respiratory tract infection in the last one month increased the risk of PPCs. The type and duration of surgery were important predictors. As a valuable addition to the literature, we identified that the season in which surgery takes place is a significant predictor of PPCs.

When analyzing postoperative pulmonary complications, most studies have focused on the postoperative 30 days [8, 9], while, some have examined the first 3 to 7 days [10-13]. In our study, patients were observed for 30 days, and PPCs were categorized into two groups: those developing and resolving within the first month, and those persisting beyond the 30th day. The reason for this is that we consider the first 30 days as the early period and the time beyond that as the late (or long-term) complications.

According to our study, having a complaint of cough nearly doubles the risk of postoperative pulmonary complications, while the presence of dyspnea complaints increases the risk by about fourfold. We identified a correlation between the low, moderate, and high-risk group assessments in our patient cohort and those in the study executed by Canet et al. [5]. Significantly, patients categorized as high risk according to the Canet scoring exhibited notably elevated complication rates during both the acute period and at the end of the first month, in comparison to other risk groups. In our study, patients with pulmonary comorbidities did not yield significant results regarding postoperative pulmonary complications.We believe this is due to the small number of patients because, among multifactorial studies, the most frequently identified independent risk factor is chronic obstructive pulmonary disease [14].In our study, patients with malignancies may be considered as more at risk for surgery. Silvanus et al., showed that patients with bronchial hyperreactivity treated with albuterol and methylprednisolone for 5 days had less bronchospasm after intubation [15]. In patients experiencing exacerbation of chronic obstructive pulmonary disease (COPD), delaying surgery is highly recommended [16]. For preoperative preperation, short-acting beta-2 agonists may be administered to patients in the preoperative period. In our study, a single dose of albuterol and ipratropium was recommended preoperatively for patients with a diagnosis of asthma or COPD, audible wheezing on examination, and havingattacks in the last month. The role of this treatment may promote the lack of significance of pulmonary comorbidities in terms of PPCs.

In our study, an increase in the risk of PPCs was noticed in patients with wheezing. A multifactorial study reported that the presence of abnormal findings in respiratory system examination (such as decreased breath sounds, crackles or wheezing) is the strongest predictor of the risk of PPCs [17]. Due to the limited number of studies, the extend of this effect is uncertain. The possibility of PPCs occurance is high in individuals who have had an upper respiratory tract infection in the last month before the operation [18]. In our study, this parameter also assessed as significant (p=0.008).

It has been shown that participants who quit smoking in the preoperative period can quit at a higher rate and for a longer duration compared to those who quit at other times [17]. In the perioperative period, smokers have an increased risk of major morbidity, including PPCs, and mortality [18, 19]. Consistent with the literature, we established the impact of smoking on postoperative complications. The risk of PPCs is already lower in non-smokers, and it is found to be highest in participants who have quit smoking. However, since the information about how long patients have been smoke-free was not analyzed, clear conclusions cannot be drawn about how the duration of smoking cessation before surgery minimizes the risk of PPCs. Reviewing the literature, it has been shown that individuals who quit less than 2 months ago are the riskiest in terms of PPC. The risk of PPCs in those who quit more than 6 months ago is close to that of non-smokers [20, 21]. According to the results of the study by Warner et al., the smoking cessation period should be at least 2 months before surgery to reduce the risk of PPCs [21].

Anemia increases pulmonary complications during the perioperative period [22, 23]. Low hemoglobin and hematocrit levels were found to be significant for the risk of PPCs in the study conducted by Canet et al., and were included in the scoring system. In our study, the average Hb was 12.22 g/dL (p=0.044), which was considered as significant.

Smetana et al., conducted a systematic review that examined 14 studies evaluating the ability of spirometry to predict the risk of PPCs [23-31]. In one study, among 22 patients with abnormal spirometric results, PPCs was observed in 6 (27%), while among 100 patients with normal spirometry results, PPCs has developed in 16 (16%) [25]. In 3 out of 4 studies examining mean FEV1 values and 3 out of 3 studies examining mean FVC values, lower FEV1 and FVC values were found in patients with PPCs compared to those without PPCs. However, these differences were considered as not large enough and were considered as differences with low possibility of assisting clinicians in risk classification. In our study, spirometric values were not found to be essential in predicting PPCs.

At our hospital, chest X-rays are taken for all patients as a standard in the preoperative period. Upon reviewing the chest X-rays of preoperative patients referred to our department, findings were indicated that increased aeration had more postoperative symptoms of fever and sputum, and this difference was found to be significant (p=0.016, and p=0.004, respectively). However, 14 out of 18 patients with increased aeration were found to have COPD, and the presence of sputum complaints due to COPD was an expected finding. Additionally, the effects of anesthesia may lead to more sputum due to atelectasis in the postoperative period.

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

In the systematic review by Joo et al., abnormal findings in preoperative chest X-rays were observed to increase with age and some other risk factors, but most abnormalities were considered as chronic findings[27]. According to the results of the study conducted by Smetana et al., preoperative chest X-rays are recommended for patients with known cardiopulmonary disease, those with abdominal aortic aneurysms, and those over 50 years old who had thoracic or upper abdominal surgery [32]. In our study, routine chest X-rays were found to be useful for patients over 60 years old due to the observed increase in the risk of PPCs in this age group.

In a systematic review, postoperative pulmonary complication rates were analised for upper abdominal, lower abdominal, and any abdominal surgery from 43 studies; these rates were 19.7%, 7.7%, and 14.2%, respectively [32]. In our study, participants were categorized into upper abdominal, thoracic, and other surgeries. It was detected that upper abdominal surgeries had significantly the highest risk of PPCs ($p \leq 0.001$). Due to the limited number of patients, the risk for thoracic surgery may not be precisely assessed. Cardiac surgeries were excluded from the study due to the high cardiopulmonary risk, and abdominal surgery was identified as having the highest risk score for PPCs in our study. Another important parameter in our study was the duration of surgery. As the surgical duration increased, a development of pleural effusion, oxygen requirement, and atelectasis was observed.

Pulmonary embolism is a serious complication that can develop in the postoperative period due to patients remaining immobilized for extended periods and not receiving effective prophylactic anticoagulant therapy. However, in our study, postoperative pulmonary embolism was not detected in any of the patients. This finding can be explained by the early mobilization of patients and the timely and appropriate administration of prophylactic anticoagulant therapy. Additionally, factors such as careful assessment of individual risk factors, strict adherence to treatment protocols, and the adoption of a multidisciplinary approach at our hospital further reinforce this positive outcome.

As an additional finding to the current literature, we identified the lowest rate of PPCs in individuals undergoing surgery operation in the spring season. In one study by Lapar et al., investigating the impact of seasonal variation on postoperative consequences in patients with lung cancer undergoing resection surgery, the lowest mortality rate was observed in the spring, while the complications were most common in the fall [33]. In another study by Qingwei Hu et al., conducted on people undergoing obesity surgery, more cases of deep vein thrombosis and sepsis were observed in winter, but this difference was not statistically significant [34]. In our study, the lowest incidence of PPCs was observed in spring, while the highest incidence was in fall. The possible reasons for this could be the initiation of the influenza season or patients undergoing surgery after experiencing an upper respiratory tract infection within the last month. Alternatively, complication frequency may have increased during exacerbation periods of respiratory diseases such as COPD or asthma. Similar rates of complications were observed in the summer and winter seasons. The protective effect of pneumococcal and influenza vaccines could also be a significant factor here. The vaccination status of patients was not questioned in this study.

One of the limitations of the study was inclusion of small number of patients and its single-center design. Additionally, a group of patients with high PPCs risk scores according to the Canet scoring system, were not operated on because of the surgeon's desicion. Our scoring system may not be capable of evaluating severely ill patients. It was not possible to determine the incidence of PPCs in patients undergoing thoracic surgery, as only a limited number of these patients were referred to the Pulmonology Department for preoperative evaluation. Because the preoperative evaluations of patients scheduled for thoracic surgery are mostly conducted by the thoracic surgeons themselves. Cardiac surgeries, which are naturally high-risk procedures, were excluded from the study. When considering the strengths of the study, it is important that follow-ups were conducted via phone calls after patients were discharged from the hospital. In other words, without distinguishing how many days patients spent in the hospital during the postoperative period, symptoms were inquired a via phone calls on the 30th day after the surgery. The number of female and male participants in our study is approximately equal. In comparison with the study conducted by Arozullah et al., although, the total number of patients in their study is larger, the number of female patients was disproportionately fewer[8].

In this study, we focused on identification of preoperative risk factors for PPCs among patients referred to pulmonology clinics for preoperative evaluation. We observed complications within 30 days and on the 30th day, looked at mortalities on the 90th day and we developed separate logistic regression models for each of these groups. The models we developed may be useful in future studies aiming to decrease PPCs rates. Our study can be useful in future research to assess patient-specific and procedure-specific risk factors before the operation. Another significant outcome of our study is to reveal the importance of seasonal variables in determining the timing of elective surgeries. We observed that the type and duration of the performed surgery can affect the risk, highlighting the importance of respiratory examination and pulmonary complaints, as well as the correlation between individual-specific risk factors, such as BMI, with PPCs. We anticipate that the clinical use of our PPCs risk scoring will lead to an increased awareness of the PPCs. Furthermore, we hope that researchers can plan future interventions to reduce PPCs rates by using the scoring system developed in this study.

Compliance with Ethical Standards

Ethical approval: Ethical approval of the study was obtained from the Hacettepe University Non-Interventional Clinical Research Ethics Committee with the project number GO 18/460 and decision number GO 18/460-11. The participants were informed about the purpose and content of the study. The study was conducted following the Declaration of Helsinki. Informed

http://doi.org/10.5472/marumj.1707988
Marmara Med J 2025;38(2): 141-149

consent forms were obtained from all participants included in the study.

Conflict of interest: The authors declare that there are no conflicts of interest.

Financial support: This study received no specific grant from any funding agency in the public, commercial or not-for-profit sector.

Author contributions: CD: Writing – reviewing and editing, writing – original draft, validation, resources, project administration, methodology, investigation, formal analysis, data curation, LC: Methodology, ınvestigation, project administration, AUD: Methodology, formal analysis, data curation, supervision, EC: Visualization, supervision, conceptualization, project administration. All authors read and approved the final version of the manuscript.

REFERENCES

[1] Mitchell CK, Smoger SH, Pfeifer MP, et al. Multivariate analysis of factors associated with postoperative pulmonary complications following general elective surgery. Arch Surg 1998;133:194-8.doi: 10.1001/archsurg.133.2.194.

[2] Ferguson MK. Preoperative assessment of pulmonary risk. Chest 1999;115:58S-63S.doi: 10.1378/chest.115.suppl_2.58S.

[3] Brooks-Brunn JA. Predictors of postoperative pulmonary complications following abdominal surgery. Chest 1997;111: 564-71.doi: 10.1378/chest.111.3.564

[4] Türk Toraks Derneği Preoperatif Uzlaşı Raporu. 2024. https://toraks.org.tr/site/sf/books/2024/10/8facb51b01e0786bc1bfd711d114fbdbc30658f657f88212066ba7d9ab598db0.pdf (Access date: 23.01.2025)

[5] Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology 2010;113:1338-50. doi: 10.1097/ALN.0b013e3181fc6e0a.

[6] Malhotra RK, Indrayan A. A simple nomogram for sample size for estimating sensitivity and specificity of medical tests. Indian J Ophthalmol2010;58:519-22. doi: 10.4103/0301-4738.71699.

[7] Song YY, Ying L. Decision tree methods: applications for classification and prediction. Shanghai Arch Psychiatry2015;27:130. doi: 10.11919/j.issn.1002-0829.215044.

[8] Arozullah A, Daley J, Henderson WG, Khuri SF. Multifactorial risk index for predicting postoperative respiratory failure in men after major noncardiac surgery. The National Veterans Administration Surgical Quality Improvement Program. Ann Surg2000;232:242-53. doi: 10.1097/00000.658.200008000-00015.

[9] Hua M, Brady JE, Li G. A scoring system to predict unplanned intubation in patients having undergone major surgical procedures. Anesth Analg 2012;115:88-94. doi: 10.1213/ANE.0b013e318257012b.

[10] Kor DJ, Warner DO, Alsara A, et al. Derivation and diagnostic accuracy of the surgical lung injury prediction model. Anesthesiology 2011;115:117.doi: 10.1097/ALN.0b013e31821b5839

[11] Ramachandran SK, Nafiu OO, Ghaferi A, Tremper KK, Shanks A, Kheterpal S. Independent predictors and outcomes of unanticipated early postoperative tracheal intubation after nonemergent, noncardiac surgery. Surv Anesthesiol 2012;56:137-8. doi: 10.1097/ALN.0b013e31821cf6de.

[12] Blum JM, Stentz MJ, Dechert R, et al. Preoperative and intraoperative predictors of postoperative acute respiratory distress syndrome in a general surgical population. Surv Anesthesiol2013;57:308-9. doi: 10.1097/ALN.0b013e318.279.4975.

[13] Brueckmann B, Villa-Uribe JL, Bateman BT, et al. Development and validation of a score for prediction of postoperative respiratory complications. Surv Anesthesiol2013;57:309. doi: 10.1097/ALN.0b013e318293065c.

[14] Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med2002;112:219-25. doi: 10.1016/s0002-9343(01)01082-8.

[15] Silvanus MT, Groeben H, Peters J. Corticosteroids and inhaled salbutamol in patients with reversible airway obstruction markedly decrease the incidence of bronchospasm after tracheal intubation. Anesthesiology2004;100:1052-7. doi: 10.1097/00000.542.200405000-00004.

[16] Hong CM, Galvagno SM Jr. Patients with chronic pulmonary disease. Med Clin North Am2013;97:1095-107. doi: 10.1016/j.mcna.2013.06.001.

[17] Lawrence VA, Dhanda R, Hilsenbeck SG, Page CP. Risk of pulmonary complications after elective abdominal surgery. Chest 1996;110:744-50. doi: 10.1378/chest.110.3.744.

[18] Mazo V, Sabaté S, Canet J, et al. Prospective external validation of a predictive score for postoperative pulmonary complications. Anesthesiology 2014;121:219-31. doi: 10.1097/ALN.000.000.0000000334.

[19] Bluman LG, Mosca L, Newman N, Simon DG. Preoperative smoking habits and postoperative pulmonary complications. Chest 1998;113:883-9. doi: 10.1378/chest.113.4.883.

[20] Theadom A, Cropley M. Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complications in adult smokers: a systematic review. Tob Control 2006;15:352-8. doi: 10.1136/tc.2005.015263.

[21] Warner MA, Offord KP, Warner ME, Lennon RL, Conover MA, Jansson-Schumacher U. Role of preoperative cessation of smoking and other factors in postoperative pulmonary complications: a blinded prospective study of coronary artery bypass patients. Mayo Clin Proc 1989;64:609-16. doi: 10.1016/s0025-6196(12)65337-3.

[22] Leichtle SW, Mouawad NJ, Lampman R, Singal B, Cleary RK. Does preoperative anemia adversely affect colon and rectal surgery outcomes? J Am Coll Surg 2011;212:187-94. doi: 10.1016/j.jamcollsurg.2010.09.013.

[23] Hare GM, Baker JE, Pavenski K. Assessment and treatment of preoperative anemia: Continuing Professional Development.

Can J Anaesth 2011;58:569-81. English, French. doi: 10.1007/s12630.011.9498-2.

[24] Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20:705-6. doi: 10.1093/sleep/20.9.705.

[25] Smetana GW. Preoperative pulmonary evaluation. N Engl J Med 1999;340:937-44.doi: 10.1056/NEJM199.903.253401207.

[26] Miller MR, Crapo R, Hankinson J, et al. ATS/ERS Task Force. General considerations for lung function testing. Eur Respir J 2005;26:153-61. doi: 10.1183/09031936.05.00034505.

[27] Joo HS, Wong J, Naik VN, Savoldelli GL. The value of screening preoperative chest x-rays: a systematic review. Can J Anaesth 2005;52:568-74. doi: 10.1007/BF03015764.

[28] Anthonisen NR, Wright EC, Hodgkin JE. Prognosis in chronic obstructive pulmonary disease. Am Rev Respir Dis 1986 ;133:14-20. doi: 10.1164/arrd.1986.133.1.14.

[29] Olsson G. Bronchospasm during anaesthesia. A computer-aided incidence study of 136,929 patients. Acta Anaesthesiol Scand 1987;31:244-52.doi: 10.1111/j.1399-6576.1987.tb02560.x.

[30] Wightman J. A prospective survey of the incidence of postoperative pulmonary complications. J Br Surg 1968;55:85-91.doi: 10.1002/bjs.180.055.0202.

[31] Eichenberger A, Proietti S, Wicky S,et al. Morbid obesity and postoperative pulmonary atelectasis: an underestimated problem. Anesth Analg 2002;95:1788-92. doi: 10.1097/00000.539.200212000-00060.

[32] Smetana GW, Lawrence VA, Cornell JE. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med 2006;144:581-95.doi: 10.7326/0003-4819-144-8-200604.180.00009.

[33] LaPar DJ, Nagji AS, Bhamidipati CM, et al. Seasonal variation influences outcomes following lung cancer resections. Eur J Cardiothorac Surg 2011;40:83-90. doi: 10.1016/j.ejcts.2010.11.023.

[34] Hu Q, Shi L, Chen L, et al. Seasonality in the adverse outcomes in weight loss surgeries. SurgObesRelatDis2018;14:291-6.doi: 10.1016/j.soard.2017.11.029.