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Eanes Delgado Barros Pereira, Ana Luisa Godoy Fernandes, Meide da Silva Anção, Clóvis de Araújo Peres, Álvaro Nagib Atallah, Sonia Maria Faresin

Prospective assessment of the risk of postoperative pulmonary complications in patients submitted to upper abdominal surgery

Pulmonary Division, Universidade Federal de São Paulo, São Paulo, Brazil

ABSTRACT

Objective: To investigate associations between preoperative variables and postoperative pulmonary complications (PPC) in elective upper abdominal surgery.
Design: Prospective clinical trial.
Setting: A tertiary university hospital.
Patients: 408 patients were prospectively analyzed during the preoperative period and followed up postoperatively for pulmonary complications.
Measurements: Patient characteristics, with clinical and physical evaluation, related diseases, smoking habits, and duration of surgery. Preoperative pulmonary function tests (PFT) were performed on 247 patients.
Results: The postoperative pulmonary complication rate was 14 percent. The significant predictors in univariate analyses of postoperative pulmonary complications were: age $\geq$50, smoking habits, presence of chronic pulmonary disease or respiratory symptoms at the time of evaluation, duration of surgery >210 minutes and comorbidity ($p \leq 0.04$). In a logistic regression analysis, the statistically significant predictors were: presence of chronic pulmonary disease, surgery lasting >210 and comorbidity ($p < 0.009$).
Conclusions: There were three major clinical risk factors for pulmonary complications following upper abdominal surgery: chronic pulmonary disease, comorbidity, and surgery lasting more than 210 minutes. Those patients with three risk factors were three times more likely to develop a PPC compared to patients without any of these risk factors ($p < 0.001$). PFT is indicated when there are uncertainties regarding the patient's pulmonary status.
Key words: abdominal surgery, risk factor, morbidity
Abbreviations: BMI = body mass index; FEV_1/FVC = forced expiratory volume in the first second divided by forced vital capacity; PPC = postoperative pulmonary complication.

INTRODUCTION

The relationship between preoperative variables and PPCs in surgical patients has been the subject of numerous studies. Despite recent advances in preoperative management, postoperative respiratory morbidity is still a common problem, especially following upper abdominal surgery.[1-6]

The main risk factors that have been associated with PPCs are: smoking, chronic obstructive pulmonary disease, advanced age, site and duration of surgery, obesity and comorbidity.[7-13] The preoperative evaluation should include steps to prepare patients for surgery and to identify those at high risk for developing complications, thus allowing physicians to take prophylactic measures to reduce the incidence of PPCs.

The incidence of PPCs varies from 10 to 80%.[8-10] This wide range is due to the lack of explicitly standardized definition of PPCs that would reduce inter-observer disagreement. Usually a complication is defined as an unexpected second disease entity that requires special treatment, whereas a finding is an abnormality that results from an investigation. The most commons PPCs are: atelectasis,

respiratory infections, bronchoconstriction and respiratory failure.[3,11,12]

Preoperative spirometric tests have been reported to be reliable predictors of PPCs. However, the risk of PPCs is usually estimated in heterogeneous populations and in various surgical procedures,[1,13,14] making it difficult to ascertain the relationship between PPCs and previous spirometric abnormalities.

The aim of this study was to follow prospectively a group of patients undergoing an elective upper abdominal surgery to identify those factors associated with an increased risk of developing PPCs using a standard preoperative evaluation. In addition, a subgroup of these patients was submitted to spirometry to investigate the importance of this test as a predictor of PPCs in this population.

METHODS

This study was performed on 408 consecutive patients undergoing elective abdominal surgery at the Federal University of São Paulo's teaching hospital. All patients were referred for a preoperative assessment (between January 1992 and December 1992), after having been scheduled for elective upper abdominal surgery. All were operated on and observed at the same hospital.

Of the 408 patients, 206 were men and 202 were women and their mean age was 55 $\pm$ 15 years. Operative procedures are given in Table 1.

Table 1 - Types of surgery with incision above the navel mark performed on 408 patients followed up for postoperative pulmonary complications

Type of surgery	N	%
Gastroenterological	325	79.7
Gynecological	23	5.6
Abdominal wall	23	5.6
Urology	20	4.9
Vascular	9	2.2
Retroperitonium	8	2.0
Total	**408**	**100**

Preoperative Assessment

All the patients were submitted to an initial clinical evaluation with a standard questionnaire for clinical history and a complete physical examination. This procedure was previously approved by the Committee for Ethical Control of Clinical Research "In Anima Nobili" of UNIFESP (Federal University of São Paulo).

Data was obtained from a questionnaire on the presence of respiratory symptoms during the week preceding surgery, as well as clinically in regard to chronic lung disease, smoking habits, nutritional status and comorbidity presented by the patients.

In order to place the patients being studied into categories, the following definitions were used:

- Patient with Respiratory Symptoms: one suffering from at least one of the following symptoms:
  Cough - Positive answer when asked the question: "Have you got a cough at the moment?"
  Chronic Cough - Positive answer to at least one of the following question: "Do you cough habitually?" and "Do you cough frequently during the day, for at least four days a week and for at least three consecutive months or more during the year?"
  Sputum - Positive answer to the following question: "Do you habitually cough up sputum from the lungs?"
- Chronic Pulmonary Disease: pulmonary illness of chronic evolution, symptoms undergoing treatment at present, or not, and with diagnosis previously established or made at the time of pre-operative evaluation. Within this heading were included the presence of bronchitis-emphysema, chronic obstructive pulmonary disease, asthma, bronchiectasis and interstitial lung disease.[15-17]
- Current Smoker - one saying that he had smoked at least one cigarette a day for more than a year and who was using cigarettes at that moment or who had stopped smoking less than eight weeks ago. The consumption of cigarettes was expressed in packet-years, that is to say the product between the time of consumption in years and the number of packets (groups of 20 cigarettes) smoked per day.

- Nutritional Status: evaluated by the body mass index (BMI), as calculated by the following relation: weight in Kg divided by height in meters squared. The population studied was classified as dystrophic (BMI <21Kg/m^2 or ≥30Kg/m^2) or eutrophic (BMI ≥21Kg/m^2 and <30Kg/m^2).[18,19]
- Comorbidity: including the occurrence of one or more of the following diseases: active systemic arterial hypertension, cardiopathology and diabetes mellitus.

Pulmonary function tests were performed upon 247 patients, according to ATS criteria[20] and fulfilling those established by Houston et al[3]: candidates for upper abdominal surgery over 60 years of age, those with pulmonary disease present at the time of evaluation, those with morbid obesity (weight more than 150% over ideal body weight), current smokers and bearers of respiratory symptoms.

After concluding the evaluation, appropriate prophylactic measures were suggested for the pre- and postoperative periods for each patient, including: interruption of the smoking habit, use of bronchodilators, courses of systemic steroids, orientation for respiratory physiotherapy exercises[21] and the use of low doses of heparin for the prophylaxis of pulmonary thromboembolism.

Postoperative Assessment

Patients were accompanied daily during the postoperative period by the same medical team which assessed the preoperative period, until they were discharged or died. The following pulmonary complications and acute respiratory infections were monitored:

- Pneumonia: presence of pulmonary infiltration on the chest x-ray associated with at least two of the following signs: purulent tracheobronchial secretion, elevation of body temperature (above 38.3ºC) and increase of leukocytes in circulation (over 25% above the base count).[22]
- Tracheobronchitis: increase in the quantity or changing of the color or purulent aspect of tracheobronchial secretion with normal chest x-ray.[22]
- Atelectasis with clinical repercussion: evidence of pulmonary atelectasis on the chest x-ray

Table 2 - Factors related to postoperative pulmonary complications

Variable	Rate of PPC	$\chi 2$	p-value
CPD	35/120 (29%)	31.161	0.0001*
Respiratory symptoms	41/183 (22%)	18.247	0.0001*
Duration of surgery >210min.	45/268 (17%)	8.248	0.03*
Comorbidity	34/173 (20%)	7.282	0.007*
Age > 50 years old	46/273 (17%)	4.694	0.03*
•Smoking (packet-years)	41/239 (17%)	4.087	0.04*
••Current Smoking	26/136 (19%)	4.020	0.04*
BMI ≤ 21 Kg/m^2 and > 30 Kg/ m^2	22/188 (12%)	1.806	0.1

* Statistically Significant (P < 0.05); CPD: Chronic pulmonary disease; BMI: Body mass index; •including current smokers and ex-smokers; ••including those that smoked until surgery

Table 3 - Multivariate analysis of the three main risk factors for postoperative pulmonary complications

Effect	Estimate	Standard error	$\chi 2$	p-value	OR (95% CI)
Intercept	-1.7921	0.1970	70.29	<0.0001*	
CPD	-0.8095	0.1527	28.10	<0.0001*	2.24 (1.66-2.97)
DS >210 min.	-0.4622	0.1667	7.69	0.005*	1.58 (1.15-2.18)
Comorbidity	-0.3987	0.1526	6.89	0.009*	1.48 (1.10-1.97)

CPD: Chronic pulmonary disease; DS: Duration of surgery; OR: Odds ratio; CI: Confidence interval

associated with acute respiratory symptoms.

- Acute respiratory failure: clinical picture resulting from acutely deficient exchange of gases in the lung, making mechanical ventilation necessary for treatment.
- Prolonged orotracheal tubing: need for orotracheal tubing for more than 48 hours, due to maintaining mechanical ventilation for the treatment of acute respiratory failure or the aspiration of tracheobronchial secretion in those unable to eliminate it spontaneously.
- Prolonged mechanical ventilation: need for mechanical ventilation for more than 48 hours for the treatment of acute respiratory failure.
- Bronchoconstriction: presence of wheezing associated with acute respiratory symptoms and use of bronchodilator medication. In order to dismiss a diagnosis of pulmonary embolism and pulmonary edema the lung pulmonary scan, pulmonary arteriography, measurements of cardiac debit and pulmonary capillary pressure were obtained for all the patients who did not present a previous history of asthma or chronic obstructive pulmonary disease. Bronchoconstriction related to intubing and extubing of patients was not considered as a pulmonary complication.

Table 4 - The distribution of 408 patients according to the presence or absence of three risk factors (respiratory disease, comorbidity and surgical duration > 210 min) in relation to postoperative respiratory complications

Risk factor	PPC		Total
	present	absent	
positive	13	16	29
negative	1	62	63
Total	**14**	**78**	**92**

sensitivity = 93% (95% CI 73% to 91%)

specificity = 79% (95% CI 80% to 100%)

positive predictive value = 45% (95% CI 29% to 67%)

negative predictive value = 98% (95% CI 95% to 100%)

prevalence of PPC = 15% (95% CI 8% to 24%)

positive likelihood ratio 5.05 (95% CI 0.76 to 33.49)

negative likelihood ratio 0.09 (95% CI 0.01 to 0.6)

When patients died, the main and secondary causes of the fatal evolution were determined. The data from the post-mortem were considered and in the absence of this, clinical and laboratory data were used.

Statistical Methods.

Initially, a univariate analysis using a chi-square test was performed to compare each risk factor (independent variable) to PPCs, as well as the odds ratio with a 95 percent confidence interval. The stepwise logistic regression method was used for identifying the risk factors. In the stepwise procedure, the best (most significant F statistic) single risk factor was selected for entry into the model first. Then it was determined whether the addition of the remaining risk factors increased the ability of the model to predict the risk of an occurrence of PPC. If the added risk factor improved the prediction, it remained part of the model; if not, it was rejected. The algorithm was complete when no further important risk factors could be added to the model. Next, the predictive model coefficients and the possible risk factor combinations were computed. These predictions were then compared with the observed adverse outcome rates by using various discrepancy measurements.[23-25]

RESULTS

Of the 408 patients studied, 206 (50.4%) were men and 202 (49.5%) were women. The average age of the group was 55 years (SD 15). The average age for men was 56 years (SD 14), ranging from 17 to 90 years, while the average age for women was 55 years (SD 16), ranging from 17 to 84 years.

The average duration of surgery was 252 minutes (SD 105). In 140 patients (34%) the surgery length was less than 210 minutes, while for 268 (66%) it lasted more than 210 minutes. Table 1 shows patients classified according to the type of surgical procedure carried out.

Among the cases studied, 183 (45%) were patients with respiratory symptoms, the most common symptom being a cough, followed by

expectoration and wheezing.

Chronic pulmonary disease was diagnosed in 120 patients (29%), the most common being chronic obstructive pulmonary disease and asthma. There were 136 current smokers (33%) with an average of 27 packet-years (SD 17). The average body mass index was 24.82 (SD 5.90) and in accordance with this, 220 eutrophic patients (54%), 78 obese (19%) and 110 undernourished (27%) were observed.

Comorbidity associated with the basic surgical illness was observed in 173 patients (42%). Only three patients (2%) presented three associated clinical diagnoses (systemic arterial hypertension, diabetes mellitus and cardiopathology), while 42 patients (24%) had two clinical illness and the most common association in this case was systemic arterial hypertension with cardiopathology (11%), followed by systemic arterial hypertension with diabetes mellitus (9%) and by cardiopathology with diabetes mellitus (4%). However, the majority of patients just presented a single illness (74%).

Among the 247 patients who had spirometry, 177 had normal pulmonary function tests (72%) and 70 patients (28%) had abnormal spirometry, and the obstructive pattern was the most common abnormality observed.

Of the 408 patients who underwent upper abdominal surgery, 58 (14%) developed PPCs. The time spent in the intensive care unit was 6.8 ± 6 days for patients who developed PPCs compared with the significantly shorter stay of 2.6 ± 2 days for patients without PPCs ($p < 0.05$). Patients who developed PPCs also had a prolonged postoperative hospital stay: 16 days (SD 7) for patients with PPCs against 8.9 ± 6 days for patients without PPCs ($p < 0.05$).

Thirty-three patients (8%) died and in 22 of these a postoperative pulmonary complication was the direct cause.

The univariate analysis of the various variables studied identified the following risk factors that were statistically significant for PPCs (Table 2): chronic pneumopathy (OR = 3.6; 95% CI = 0.55 to 5.90), presence of respiratory symptoms at the time of evaluation (OR = 2.9; 95% CI = 1.74 to 5.04), surgery lasting more than 210 minutes (OR = 1.8; 95% CI = 1.05 to 3.12), comorbidity (OR = 1.9; 95% CI = 1.18 to 3.12), age >50 (OR = 1.8; 95% CI = 1.03 to 3.45), smoking (OR = 1.7; CI = 1.00 to 2.89) and current smoking (OR = 1.6; CI 1.01 to 2.61).

Table 5 - Multivariate analysis of risk factors for postoperative pulmonary complications, in the population who underwent spirometry

Effect	Estimate	Standard error	χ^2	p	OR (CI)
Intercept	-1.5618	0.2038	58.73	<0.0001*	
CPD	-0.6835	0.1935	12.48	0.0004*	1.97 (1.36-2.86)
DS >210 min.	-0.3866	0.1793	4.65	0.03*	1.50 (1.04-2.18)
Comorbidity	-0.4187	0.1906	4.83	0.02*	1.46 (1.05-2.04)
FEV_1/FVC <70%	0.2698	0.1910	1.99	0.15	1.29 (0.89-1.88)

* Statistically significant ($p < 0.05$); CPD: Chronic pulmonary disease; DS: Duration of surgery

Table 6 - Multivariate analysis of risk factors for postoperative pulmonary complications, in the population who underwent spirometry, without taking into consideration chronic pulmonary disease

Effect	Estimate	Standard error	χ^2	p	OR (CI)
Intercept	-1.4551	0.1872	60.40	<0.0001*	
FEV_1/FVC <70%	0.5133	0.1753	8.57	0.003*	1.66 (1.19-2.31)
Comorbidity	-0.3554	0.1728	8.23	0.03*	1.41 (1.02-2.06)
DS >210 min.	-0.3766	0.1847	4.16	0.04*	1.44 (1.02-2.06)

* Statistically significant ($p < 0.05$); DS: Duration of surgery; OR: Odds ratio; CI: Confidence interval

Nonetheless, the multivariate logistic regression analysis identified the following factors as independent predictors of PPCs: presence of chronic pulmonary disease, surgery lasting >210 minutes and comorbidity (Table 3). The concomitant occurrence of all the three risk factors led to an even higher chance of developing PPCs (Table 4).

Amongst the 247 patients who performed spirometry the incidence of PPCs was 19% (45/247). In this group the univariate analysis indicated that the occurrence of PPCs was associated with the presence in the preoperative period of chronic pulmonary disease ($p < 0.0001$), respiratory symptoms ($p = 0.0005$), comorbidity ($p = 0.04$) and current smokers ($p = 0.04$). Of the spirometric variables analyzed, only an FEV_1/FVC lower than 70% indicated a significantly increase risk for PPCs ($p = 0.004$). The multiple logistic regression identified the same risk factors in these populations (Table 5).

When the FEV_1/FVC was controlled within a multiple logistic regression model, it was not found to be an independent predictor for PPCs. However, further analysis revealed that if the variable "chronic pulmonary disease" was withdrawn from the model, then the spirometric value became statistically significant (Table 6).

Using just the clinical variables it may be possible to identify the critical population. We could calculate the probability of PPCs for a given set of prognostic variables using the regression coefficient and the equation presented in Diagram 1.

The presence of chronic pulmonary disease or FEV_1/FVC below 70% identifies the same population that is going to develop PPCs. This is why FEV_1/FVC became an important predictor of PPCs (Table 7) when the same population was analyzed without taking into account the presence of chronic pulmonary disease.

The probability of PPCs occurring can be calculated from the factors comorbidity and surgery lasting more than 210 minutes, in association with $FEV_1/FVC < 70\%$, using equation 3 (Diagram 1)

With this data it was possible to identify eight risk classes with different chances of developing PPCs in accordance with the prevalence of the independent variable (Table 8).

DISCUSSION

Preoperative assessment of patients scheduled to undergo upper abdominal surgery assists the physician in determining preoperative risk. Physiological changes that occur after laparotomy, including alterations in lung volume, ventilatory gas exchange and respiratory defense mechanisms, impose an increased risk of pulmonary complications for susceptible patients.

In this study we observed a PPC incidence of 14% (58/408). However, other studies have shown a wide variation, between 10 and 80% in the incidence of PPCs following abdominal surgery.[7-10,26,27] This variation occurs because in the literature there is no standard definition of PPCs and so the discrepancy between these findings is understandable.

In this study the relatively low incidence of pulmonary complications was due to the fact that patients was undergoing prophylactic measures

Table 7 - Multivariate analysis of clinical risk factors for postoperative pulmonary complications in the population who underwent spirometry

Effect	Estimate	Standard error	χ^2	p	OR (95% CI)
Intercept	-1.6518	0.1970	70.29	< 0.0001*	
CPD	-0.7733	0.1828	17.90	<0.0001*	2.16 (1.52-3.06)
Comorbidity	-0.4115	0.1780	5.34	0.020*	1.50 (1.08-2.10)
DS >210 min.	-0.4184	0.1901	4.84	0.027*	1.50 (1.04-2.18)

* Statistically significant ($p < 0.05$); CPD: Chronic pulmonary disease; DS: Duration of surgery; OR: Odds ratio; CI: Confidence interval

to avoid such complications, as recommended by the ethical committee.

Bronchoconstriction was the most frequent complication observed (50% = 29/58). It was not associated with intubation or extubation and usually occurred alone. More than one complication is frequently observed in the same patient at the same time.

Pulmonary infection (pneumonia or tracheobronchitis) accounted for 40 percent (23/58) of the patients with PPCs. Sixty-five percent of these patients (15/23) developed acute respiratory failure with prolonged intensive care treatment and hospitalization. The high hospital costs imposed by this additional medical care have been described in the literature.[28]

This study was designed to evaluate patients undergoing elective upper abdominal surgery, using clinical and spirometric parameters as suggested by previous studies, so as to estimate the probability of PPCs. Before doing this study, we used to assess the prognostic index on the basis of prognostic scores developed in other populations with different backgrounds. As well as engendering a significant improvement in prognosis, risk factors could be calculated based on stratified risk groups that we developed in this work, unlike in most other studies (Table 8).

The main factors traditionally associated with PPCs are chronic airways disease, advanced age, upper abdominal surgery, prolonged duration of surgery, history of smoking, and obesity.[1,7,8,10,13,28,29]

To select the risk factors to be included in logistic regression for PPC we chose the variables based on p value of the chi square test in a step-down significance procedure. The variables were included in the following sequence: pneumopathy ($p = 0.0001$), respiratory symptoms ($p = 0.0001$), comorbidity ($p = 0.007$), age over 50 years old ($p = 0.03$), surgery duration over 210 minutes ($p = 0.03$), habitual smoking ($p = 0.04$), current smoking ($p = 0.04$) and dystrophy ($p=0.10$) (Table 2).

The logistic regression in our study showed the same risk factors as found in the literature. We found that the presence of chronic pulmonary disease is also strongly associated with PPCs, particularly if the patient's surgery lasted longer than 210 minutes and comorbidity was present.

Chronic pulmonary disease is one of the most common risk factors found in the literature.[8,26,29,30-32] Once chronic pulmonary disease has been taken into account, the presence of respiratory symptoms and smoking habits ceases to be strongly associated with a high incidence of PPCs. Mitchell et al,[11] in a study of 200 patients who underwent general surgery, observed that the contribution of cigarette smoking to PPCs is more likely to occur via its association with hypersecretion of mucus.

Williams-Russo et al,[9] in a study of the predictive value of comorbidity for PPCs, concluded that predicting and preventing postoperative cardiac morbidity may be the best approach for reducing post-operative pulmonary morbidity. The duration of surgery is also an important risk factor for PPCs.[9,11,14]

Thus, when one patient presents the three concomitant risk factors (chronic pulmonary disease, surgery lasting over 210 minutes and comorbidity), the probability of his developing a postoperative pulmonary complication increase to 47%. The sensitivity and specificity for this

Table 8 - Relationship between presence of risk factors and predictability of postoperative respiratory complication (Equation 1 for previous respiratory disease and Equation 3 for FEV_1/FVC)

			Risk %	
CPD or FEV_1/FVC <70%	DS > 210	Comorbidity	Equation 1	3
No	No	No	14	19
No	No	Yes	20	25
No	Yes	No	21	25
Yes	No	No	27	28
No	Yes	Yes	28	32
Yes	No	Yes	36	35
Yes	Yes	No	37	36
Yes	Yes	Yes	47	44

CPD: Chronic pulmonary disease; DS: Duration of surgery > 210 minutes

test were 92.8 and 79.4 respectively (Table 4), and the positive predictive value was 44.8%. This allowed us to identify the critical population that needed intensive preoperative treatment.

These findings have many clinical implications, because all high-risk patients can be identified by the presence of previous respiratory disease, comorbidity and surgery duration of more than 210 minutes. When possible these factors should be modified in order to reduce the incidence of PPCs.

Routine preoperative spirometry for patients who are to have upper abdominal surgery is recommended to identify and begin preventive care for those with abnormal findings.[8,33,34]

Spirometry could not be performed on all the individuals in this study. However, it was indicated for patients in accordance with the criteria of Houston et al,[8] which take into account not only patients with pulmonary problems and respiratory symptoms, but also all patients with ages equal or superior to 65 years old, and all patients exposed to smoking independent of respiratory symptoms or age. This is different from the criteria established by Zibrak et al[35] for pre-operative evaluation, which only include those patients with abnormal pulmonary history for doing spirometry. The Houston criteria allowed us to guarantee having a representative population similar to the entire group of patients by admitting into the subpopulation some patients with a normal pulmonary function test. On the other hand, the confirmation that the subpopulation had the same characteristics as the entire group provided us with a result that should put in doubt the real validity of the indication for spirometry recommended by Houston et al.

Thus, the sample was representative of the group and included patients with normal and abnormal functioning. Furthermore, in order to ensure that we were working with a subpopulation (247 patients) representative of the whole group, we once again carried out a logistic regression analysis of the risk factors identified by univariate analysis on this subpopulation and we obtained the same result in relation to the total of patients (Equation 2).

In our population, pulmonary function tests do appear to have been of some benefit in predicting PPCs, especially an FEV_1/FVC lower than 70%. However, when we used multivariate analysis to determine the impact of each independent variable on the outcome, in the context of all other variables, we could see that the presence of altered FEV_1/FVC appeared to be significantly associated with the occurrence of PPCs (Table 6). This occurs because the FEV_1/FVC alteration can not be dissociated from the presence of chronic pulmonary disease. In other words, in patients with chronic pulmonary disease, the measurement of FEV_1/FVC would only be helpful if we were to give up doing a good clinical evaluation.

Lawrence et al[33] assessed the predictive value of preoperative spirometry through a systematic

Diagram 1 - Equations for estimating the probability of post operative pulmonary complications in patients submitted to elective upper abdominal surgery, using logistic regression. General population: Equation 1. Spirometric population: Equation 2 for clinical variables and Equation 3 for spirometric variables

Equation 1:

$$P(y) = \frac{1}{1 + e^{-(-1.79 + 0.81CPD + 0.46DS + 0.40C)}}$$

Equation 2:

$$P(y) = \frac{1}{1 + e^{-(-1.65 + 0.77CPD + 0.41C + 0.42DS)}}$$

Equation 3:

$$P(y) = \frac{1}{1 + e^{-(-1.46 + 0.51FEV_1/FVC + 0.35C + 0.38DS)}}$$

P(y): Probability of postoperative pulmonary complication; CPD: Chronic pulmonary disease; DS: Duration of surgery > 210 minutes; C: Comorbidity; FEV_1/FVC: FEV_1/FVC <70%

literature search and critical appraisal of the published literature and concluded that it is not clear that spirometry adds much predictive value beyond that of a clinical examination alone, and that the full potential of spirometry for precise, accurate risk assessment may not yet have been realized.

Spirometry can only be recommended when patients being prepared for abdominal surgery are cigarette smokers or have respiratory complaints that have not been previously evaluated.[34]

Our data suggests that when general preoperative evaluation does not reveal any classic history of lung disease, pulmonary function testing may assist in making a specific pulmonary diagnosis and assessing the degree of impairment before operating.

This study confirms the importance of an evaluation of a patient's respiratory condition, especially a clinical evaluation, in order to determine the risk for PPCs in a given population.

Thus it is difficult to avoid the impression that the best predictor of the overall operative risk in the individual patient is still a comprehensive clinical evaluation. Prediction rules and risk stratification should be methodologically sound, clinically validated and hopefully widely accepted.[34]

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Eanes Delgado Barros Pereira - MD, PhD, Associate Professor, Department of Medicine, Pulmonary Division, Federal University of Ceará - Brazil
Ana Luisa Godoy Fernandes - MD, PhD, Associate Professor, Department of Medicine, Pulmonary Division, Federal University of São Paulo - Brazil
Meide da Silva Anção - MD, PhD, Associate Professor, Department of Medicine, Division of Nephrology, Federal University of São Paulo - Brazil
Clóvis de Araújo Peres - PhD, Professor of Statistics of University of São Paulo
Álvaro Nagib Atallah - MD, PhD, Head of Internal Medicine Division of Federal University of São Paulo - Brazil.
Sonia Maria Faresin - MD, PhD, Physician of Department of Medicine, Pulmonary Division, Federal University of São Paulo- Brazil. Chief of Preoperative Respiratory Care of São Paulo Hospital

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Address for correspondence:
Sonia Faresin
Universidade Federal de São Paulo - Disciplina de Pneumologia
Rua Botucatu, 740 - 3º andar
São Paulo/SP - Brasil - CEP 04023-062
E-mail: ???

RESUMO

Objetivo: Avaliar associações entre a presença de variáveis pré-operatórias e a ocorrência de complicações pulmonares no pós-operatório de cirurgia abdominal alta eletiva. **Tipo de Estudo:** Experimentação clínica em perspectiva. **Pacientes:** 408 pacientes foram avaliados prospectivamente no pré-operatório e seguidos no pós-operatório para avaliação de complicações pulmonares. **Variáveis medidas:** Características dos pacientes: historia clínica e exame físico, doenças associadas, tabagismo, e tempo cirúrgico. Foi realizado espirometria no período pré-operatório em 247 pacientes. **Resultados :** A incidência de complicações pulmonares no pós-operatório foi 14%. Na análise univariada comportaram-se como fatores de risco para ocorrência de complicações pulmonares no pós-operatório: idade acima de 50 anos, tabagismo, a presença de doença pulmonar crônica ou sintomas respiratórios no momento da avaliação, tempo cirúrgico maior que 210 minutos e a coexistência de doença clínica ($p \leq 0,04$). Na análise de regressão logística comportaram-se como fatores de risco somente a presença de doença pulmonar crônica, tempo cirúrgico maior que 210 minutos e coexistência de doença clínica associada. ($p < 0,009$). **Conclusão:** Existem três fatores de risco clínicos para complicações pulmonares no pós-operatório de cirurgia abdominal alta: doença pulmonar crônica, tempo cirúrgico maior que 210 minutos e coexistência de doença clínica. Os pacientes que apresentam estes fatores de risco têm três vezes mais chance de complicar do ponto de vista pulmonar no pós-operatório quando comparados aqueles que não apresentam estes fatores de risco ($p < 0,001$). A espirometria está indicada quando não existe certeza quanto ao quadro pulmonar do paciente.