

Original Research Article

Study of risk, incidence and mortality associated with postoperative pulmonary complications using assess respiratory risk in surgical patients in catalonia score

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ABSTRACT

Background: Postoperative pulmonary complications (PPCs) are one of the major complications that are seen in patients undergoing surgeries and are also a significant cause of increased duration of hospital stay and mortality. Owing to their high incidence the present study was done to assess the risk and incidence of PPCs using the assess respiratory risk in surgical patients in catalonia (ARISCAT) score and to observe the mortality related to PPCs.

Methods: The study was done at a tertiary care center over a period of three month and 150 patients were involved. The patients were the categorized into three risk groups and were observed for development of any PPCs.

Results: Out of the 150 patients that were studied, 29 developed some form of PPC. 21 out of these 29 (72.41%) patients were from the high-risk category. 11 out of the 29 patients died in a span of 30 days. Pneumonia was seen to be the most common PPC.

Conclusions: ARISCAT score can be useful as a preoperative evaluation tool to classify patients into risk groups and predict the development of PPC in the high-risk groups and to take measures to reduce the risk of PPCs. We conclude from our study that anemia, emergency surgery and surgery with duration of more than 3 hours were significant factors contributing to both the incidence and mortality of PPCs irrespective of the risk group.

Keywords: ARISCAT, Postoperative pulmonary complications, Risk, Incidence, Mortality

INTRODUCTION

Postoperative pulmonary complications (PPCs) are one of the major risks associated with surgeries and are also associated with increased morbidity, mortality and subsequently longer hospital stays and also lead to increased cost of hospital care.^{1,2} After reviewing the literature, it was found that the incidence of PPCs varies from 2 to 70%.³ In one of the studies it was found that Pneumonia is the second most common type of nosocomial infection after urinary tract infections, with

50% cases of pneumonia being postoperative.^{4,5} Efforts to identify the risk factors that may be associated with these PPCs have been done since the 1930s.⁶ The preoperative evaluation of a patient's pulmonary status becomes necessary in view of high incidence of PPCs.^{3,7} As of today, there have been very few studies that have been done to develop a predictive model for PPCs, which affects the clinician's ability to predict and plan strategies to prevent PPCs in high-risk groups. The recent assess respiratory risk in surgical patients in catalonia (ARISCAT) study addressed the problem of differences

across surgical contexts with the use of a population-based approach that represented many different procedures and patients in a variety of demographic settings.^{8,9} ARISCAT score is a clinically relevant scoring system using seven factors to assess the risk of developing PPCs.^{8,9} As the impact of pulmonary complications after surgery has become increasingly apparent, their risk estimation should be done as a standard protocol as a part of preoperative medical evaluations.

Aim

To assess the risk of developing postoperative pulmonary complications, their incidence and mortality in patients undergoing major surgeries using ARISCAT score.

METHODS

Study design

This study was a prospective study done at a tertiary care hospital in the city of Pune, India. The study involved a random sample cohort of 150 patients admitted to our hospital who were undergoing some form of major surgery. The study was conducted over a period of 3 months and was started after obtaining proper ethical committee approval.

Inclusion and exclusion criteria

Patients who were selected to be a part of the study were properly explained about the type of study and only after taking their consent, the questionnaire was filled out. Only a patient who was admitted for some surgical procedure was a candidate eligible for the study. All the OPD (outpatient) based patients were excluded.

Data collection

The data collection was done using a questionnaire which initially had the patients demographic information like age, sex, BMI and hospital registration number. After this there was a series of questions to elicit the patient's clinical history which were pertaining to any respiratory infection in the last one month, any history of cerebrovascular accident, malignancy, weight loss of >10%, long term use of steroids, previous prolonged hospital stay, diabetes, COPD, hypertension, asthma, congestive heart failure, liver disease, renal failure and ascites. Patient was also asked regarding any habits like smoking, alcohol or tobacco chewing.

The next set of questions were related to the surgical procedure like site of incision, type of surgery, whether the surgery was emergency or elective, duration of surgery, re-operation, multiple times use of general anesthesia during admission and if patient had a Ryle's tube inserted.

Following this along with a respiratory system clinical exam, a quick clinical examination of the cardiovascular system, nervous system and abdomen was performed.

Using the table (Table 1), the ARISCAT score was calculated for each patient.

Table 1: ARISCAT score.

Sr no.	ARISCAT score component	Score
1	Age (in years)	
	≤50	0
	51–80	3
	>80	16
2	Preoperative SpO ₂ (in %)	
	≥96	0
	91–95	8
	≤90	24
3	Respiratory infection in the last month	17
4	Preoperative anemia (≤10 g/dl)	11
5	Surgical incision	
	Peripheral	0
	Upper abdominal	15
	Intra-thoracic	24
6	Duration of surgery (in hours)	
	≤2	0
	>2 to 3	16
	>3	23
7	Emergency procedure	8
	Total score	

Table 2: Risk stratification of ARISCAT score.

Risk	ARISCAT score
Low	<26
Medium/ Intermediate	26-44
High	≥45

After obtaining the total score patients were categorized into three classes based on the risk of development of Postoperative pulmonary complications as per Table 2.

After the score and risk was calculated, each patient was followed up after surgery to look for development of respiratory complications. The patient's total hospital stay was also recorded. The respiratory complications were classified based on the EPCO guidelines in Table 3.^{10,11}

The patients were also monitored for their final outcome after surgery. If there was death of a patient then it was classified as whether the death was due to the PPC or due to some other cause.

Table 3: EPCO definitions and respiratory outcomes in patients.^{11,12}

Outcome	EPCO definition
Respiratory infection	Antibiotics for suspected infection with one or more of the following: new or changed sputum, new or changed lung opacities, fever, white blood cell count $>12 \times 10^9$ litre ⁻¹
Respiratory failure	Postoperative PaO ₂ <8 kPa (60 mm Hg) on room air A PaO ₂ : FIO ₂ ratio <40 kPa (300 mm Hg), or arterial oxyhaemoglobin saturation measured with pulse oximetry $<90\%$ and requiring oxygen therapy
Pleural effusion	CXR with blunting of costophrenic angle, loss of sharp silhouette of the ipsilateral hemidiaphragm in upright position, displacement of adjacent anatomical structures, or (in supine position) hazy opacity in one hemithorax with preserved vascular shadows
Atelectasis	Lung opacification with mediastinal shift, hilum or hemidiaphragm shift towards the affected area, with compensatory hyperinflation in adjacent non-atelectatic lung
Pneumothorax	Air in the pleural space with no vascular bed surrounding the visceral pleura
Bronchospasm	Newly detected expiratory wheeze treated with bronchodilators
Aspiration pneumonia	Acute lung injury after inhalation of regurgitated gastric contents
Pneumonia	CXR with at least one of the following: infiltrate, consolidation, cavitation; plus at least one of the following: fever >38 °C with no other cause, white cell count <4 or $>12 \times 10^9$ litre ⁻¹ , >70 yr of age with altered mental status with no other cause; plus at least two of the following: new purulent/changed sputum, increased secretions/suctioning, new/worse cough/ dyspnoea/ tachypnoea, rales/bronchial breath sounds, worsening gas exchange
ARDS	
Tracheo-bronchitis	
Pulmonary edema	
Exacerbation of pre-existing lung disease	
Pulmonary embolism	
Death	

Statistical analysis

The data that was obtained from the study was analyzed using simple statistical measures of rate and percentage.

RESULTS

Our study was conducted on a total of 150 patients. The demographic details of the patients have been described in Table 4. It was found that when the patients were categorized into risks using ARISCAT score, there were

57 (38%) patients in high risk, 65 (43.33%) patients in medium risk and 28 (18.67%) patients in the low risk. Our results showed that a total of 29 patients (19.33%) out of 150 developed some PPC. Out of these 21 cases were from high-risk category, 4 from the medium risk and only 1 was from the low risk category. The type of pulmonary complication was defined as per the EPCO guidelines.^{10,11} Out of the total 29 patients who developed PPCs it was found that 11 (37.9%) patients died due to the PPC. Out of these 10 deaths were from the high-risk group and one from the medium risk group. No deaths were seen in the low risk group.

Table 4: Demographic characteristics of patients.

Demographic characteristic	Value (%)	Demographic characteristic	Value (%)
Age (years)	Mean age 46.82 \pm 1 SD (31.37-62.3)	BMI, range	9.37-57.46
Age (years), range	2 to 100	BMI <18	14 (9.33)
<50	81 (54)	BMI (18-25)	93 (62)
51-80	65 (43.33)	BMI (25.1-30)	36 (38.7)
>80	4 (2.66)	BMI (>30.1)	7 (4.66)
Sex (Male)	91 (60.66)	Nasogastric tube (preoperative)	18 (12)
Sex (Female)	59 (39.34)	Anesthesia	
Preoperative SpO2		General	83 (55.33)
<90	16 (10.67)	Regional	67 (44.67)
91-95	15 (10)	Smoking status	
>96	119 (79.33)	Never smoked	133 (88.66)
Surgery (emergency)	64 (42.66)	Former smoker	10 (6.67)

Continued.

Demographic characteristic	Value (%)	Demographic characteristic	Value (%)
Surgery (elective)	86 (57.34)	Current smoker	7 (4.67)
Surgical specialty		Alcohol use	
Orthopedic	5 (3.33)	Never	103 (68.67)
General and GI	45 (30)	Former user	7 (4.67)
Urology	16 (10.67)	Current user	40 (26.67)
Gynecology	27 (18)	Functional status	
Breast	3 (2)	Independent	132 (88)
Cardiothoracic and vascular	16 (10.66)	Partially/totally dependent	18 (12)
Neurosurgery	24 (16)	Hypertension	42 (28)
Other	8 (5.33)	Diabetes mellitus	35 (23.33)
Surgical incision		Heart failure	3 (2)
Peripheral	55 (36.66)	Cerebrovascular disease	1 (0.66)
Upper abdominal	86 (57.34)	Renal disease	3 (2)
Intrathoracic	9 (6)	Liver disease	3 (2)
Duration of surgery (hours)		Respiratory infection in the last month	15 (10)
>3	58 (38.66)	Malignancy	3 (2)
2 to 3	59 (39.34)	Ascites	3 (2)
<2	33 (22)	Asthma	5 (3.33)
Anemia	44 (29.33)	Prolonged hospitalization	6 (4)
Postoperative pulmonary complications	29 (19.33)	Long term steroid use	2 (1.33)
ARISCAT score, range	8 to 114	Weight loss (>10)	11 (7.33)
Mortality	36 (24)	COPD	10 (6.67)
Death due to pulmonary cause	11 (30.55)	Death due to other cause	25 (69.44)

Table 5: Type of PPC developed in the patients in our study.

Type of PPCs	Number of cases (%)
Pneumonia	6 (31.57)
Respiratory infection	4 (21.05)
Respiratory failure	3 (15.78)
Pleural effusion	3 (15.78)
Respiratory infection with respiratory failure	3 (15.78)
Atelectasis	2 (10.52)
Pulmonary embolism	2 (10.52)
Pulmonary edema	2 (10.52)
Ards	1 (5.26)
Aspiration pneumonia	1 (5.26)
Pneumothorax	1 (5.26)
Exacerbation of preexisting disease	1 (5.26)
Total	29 (100)

Table 6: Mortality according to risk as per ARISCAT score.

Risk	Total patients at risk	PPCs	% of patients developing PPC	Death due to PPCs	% Mortality due to PPCs
High	57	21	36.84	10	47.61
Medium	65	5	7.69	1	20
Low	28	3	10.71	0	0
Total	150	29	-	11	-

Table 7: Risk versus PPC incidence.

	PPC	No PPC	
High risk	21 (a)	36 (b)	PPV= $a/(a+b) \times 100$ =36.84
Medium and low risk	8 (c)	85 (d)	NPV= $d/(d+c) \times 100$ =91.39
	Sensitivity = $a/(a+c) \times 100 = 72.41$	Specificity = $d/(d+b) \times 100 = 70.24$	

The type of complications that developed in patients has been summarized in Table 5. Pneumonia was found to be the most common type of PPC in our study. Table 6 demonstrates the mortality in different risk groups. It is evident that there were a total of 11 deaths out of the 29 patients who developed some form of PPC. Of these 11 deaths, 10 deaths were in the high risk group and one death was in the medium risk group. There was no death in the low risk group.

We can estimate the usefulness of the ARISCAT score based on the parameters described in Table 7. The positive predictive value for the score was 36.84 and the negative predictive value was 91.39. Also, the sensitivity was 72.41 and the specificity was 70.24.

DISCUSSION

As per the literature that was reviewed concerning the use of ARISCAT score to predict the development of PPCs, our study has been one of the very few studies to directly involve the use of ARISCAT score to predict the PPCs in patients undergoing major surgeries. There has been one study performed by Kupeli et al, that compares the American Society of Anesthesiologists (ASA) classification versus ARISCAT score to predict PPCs in patients following renal transplant.¹² In the present study it was found that the ARISCAT score was a useful tool to predict the development of PPCs in patients undergoing major surgical procedures. There have been many studies done regarding the risk of developing PPCs in patients after surgery pertaining to the risk factors, type of PPC and Mortality associated with PPCs. In the study conducted by Mazo et al in the year 2014, The ARISCAT score was used for prediction of PPCs in 1627 patients out of which 71 (4.4%) developed some form of PPC.⁹

After carefully reviewing the demographics described in Table 4, we infer that increasing age is one of the important factors for PPCs. It has been found in the studies done by Miskovic and Yang that age >65 is a risk factor for PPCs¹ as older patients tend to be more frail.^{11,13,14} In the study performed by Arozullah et al, it was found that the incidence of pneumonia was more after abdominal and thoracic surgeries as compared to other types of surgeries.¹⁵ It was also seen in studies done by Canet, Brueckman, Smith and Johnson that emergency surgery increased the risk of PPCs from two to six fold as compared to elective surgeries which is similar to what

we have found in our study as well.^{8,16-18} Patients with preoperative anemia are found to have a three-fold increase in the risk of PPCs as per the study done by Canet and this correlates to our study.⁸ In the study done by Canet and colleagues, it was found that the incidence of PPCs was 7.5% and 2% for patients who were with and without administration of a GA respectively.⁸ Duration of surgery for >2 hours and any further increase in the duration of surgery is a risk factor for development of PPCs as per the study done by Canet and this has been found in the present study as well.⁸ Male sex, hypertension, BMI >40 or BMI <18.5, CHF, diabetes mellitus, COPD, prolonged hospitalization, weight loss of >10% (within 6 months), malignancy have all been stated as important risk factors for development of PPCs as per the study performed by Ramchandran et al.¹⁹ Alcohol consumption is also associated with increased risk of PPCs.¹⁵ Chronic liver disease increases risk of PPCs.²⁰ Renal disease and ascites also increase the risk of PPCs.¹¹ Also, smoking is a very important risk factor for PPCs.¹¹ Pneumonia was found to be the most common type of PPC in our study. This correlates with the and done by Gupta et al⁵ where pneumonia was seen in 50% patients who developed PPCs. This finding correlates with our study as Pneumonia was found to be the most common complication in 31.57% of those developing PPCs. As per the study done by Kroell and colleagues, respiratory failure (15.53%) was found to be the most common complication followed by pneumonia (4%) out of the total patients developing PPCs.²¹

After a careful and detailed case-wise analysis of the seven ARISCAT components in the 29 patients who developed PPCs we found the following findings. Preoperative anemia was found to be a significant risk factor and was seen in 23 out of 29 patients. 19 out of the 29 patients had an emergency surgery, while 10 had an elective surgery. Duration of surgery was more than three hours for 18 out of 29 patients, 2-3 hours for 6 patients and less than two hours for 5 patients. 14 out of 29 patients had an upper abdominal incision, 8 had an intra-thoracic incision and seven had a peripheral incision. 11 out of 29 patients had a respiratory infection in the past month. 12 out of 29 patients had a preoperative SpO₂ of less than 90, 8 patients had a preoperative SpO₂ of 91-95. One out of 29 patients was more than 80 years old, 10 were between 51 to 80 years of age and the rest were less than 50 years of age.

The seven factors included in ARISCAT score were individually studied in these 29 cases to assess their impact on the mortality of PPCs. Out of the 29 patients who developed PPCs, 11 succumbed to death. Out of these 11 patients, 10 patients had preoperative anemia; 9

patients had an emergency surgery; 7 patients had duration of surgery of more than 3 hours; 5 patients had an intra-abdominal incision and 4 patients had an intra-thoracic incision; 5 patients had a respiratory infection in the past month.

Table 8: Comparison of present study with previous studies with respect to incidence of PPCs.

No.	Study	Sample size	PPC incidence (%)
1	Present study	150	19.33
2	Li and colleagues ¹⁴	316	18.9
3	Scholes and colleagues ¹⁷	268	13
4	Kupeli and colleagues ²¹	172	12.79
5	Neto and colleagues ²²	6063	10.9
6	Kroell and colleagues ²⁸	9697	10.4
7	Mazo and colleagues ⁷	5099	7.9
8	Smith and colleagues ¹⁶	329	7
9	Canet and colleagues ¹³	5384	4.2

Table 9: Comparison of present study with previous studies with respect to mortality due to PPCs.

No.	Study	Sample size	30-day In-hospital Mortality associated with PPCs (%)
1	Present study	150	37.9
2	Arozullah and colleagues ²⁰	81,719	27
3	Johnson and colleagues ¹⁸	1,80,359	26.5
4	Arozullah and colleagues ¹⁹	1,60,805	21
5	Canet and colleagues ⁶	2464	19.5
6	Smith and colleagues ¹⁶	329	16
7	Brueckmann and colleagues ¹⁵	33,769	16
8	Canet and colleagues ¹³	5384	10.3
9	Mazo and colleagues ⁷	5099	8.3

Table 10: Comparison of PPC incidence in patients according to risk.

Present study (n=150)	Total patients at risk	% of patients developing PPC	PPCs
Risk			
High	57	36.84	21
Medium	65	7.69	5
Low	28	10.71	3
Study of E Kupeli and colleagues (n=172)			
Risk			
High	4	75	3
Medium	86	18.6	16
Low	82	3.61	3

The Table 8 and Table 9, gives a summary of the studies which were comparable to our studies. The incidence of PPCs in the present study was found to be 29 out of 150 patients (19.33%). The findings in our study were comparable to few of the other studies, which had a small sample size. In the study performed by Li and colleagues the incidence of PPCs was found to be 18.9%.¹³ In one of the recent studies done by Kupeli et al the incidence was found to be 10.9%.¹² In the study done by Scholes and colleagues, the incidence of PPCs was 13%. In the present study 11 out of 29 patients (37.9%) who

developed PPCs died within 30 days, and this was found to be similar to the mortality seen in the studies performed by Canet and colleagues, which was 19.5% (30 day); 24.4% (90 days).^{8,22} 16% Mortality was seen in the study performed by Brueckmann and colleagues and Smith and colleagues, while that in the study done by Mazo and colleagues was 8.3%.^{9,16,17} In the previous study done by Arozullah and colleagues mortality was 27% over 30 days, and in the study performed by Arozullah and colleagues later the mortality was 21% over 30 days.^{15,23} In the study done on PPCs by Johnson

and colleagues mortality over 30 days was 26.5%.¹⁸ The present study was compared with the study done by Kupeli and colleagues to look for PPC incidence in the three risk groups.¹² Table 10 compares the two studies.

A new score known as the Las Vegas score which has 13 perioperative components has been recently studied and it was found that it is of moderate use to predict PPCs.^{21,24} This score is still under evaluation. CONUT (controlling nutritional status) score is another score that is used to predict PPCs and mortality in patients with non small cell lung cancer.²⁵ ARISCAT score can be widely applied for risk stratification in a variety of clinical settings. In the study done by Mazo et al they used the seven factor ARISCAT score for the prospective evaluation of a risk score for postoperative pulmonary complications in Europe (PERISCOPE) and they concluded that ARISCAT score was useful to categorize risk of PPCs into low, medium and high.⁹ In our study it was found that patients at high risk of developing PPC had the maximum incidence of PPC and patients at low risk had a low incidence of PPC. Thus, we can say that ARISCAT score that assesses seven factors (age, SpO₂, preoperative anemia, duration of surgery, site of incision, respiratory infection in the last one month, emergency or elective procedure) is a good predictor of risk for developing PPCs in patients undergoing major surgeries.

CONCLUSION

From the results of our study, we can conclude that ARISCAT score can be used as good tool to assess the risk and classify patients accordingly into high, medium or low risk groups. We can also say that the score is a good predictor of development of PPCs as per the risk into which the patient has been categorized. We can conclude from our study that anemia was a significant factor contributing to both the incidence and mortality of PPCs irrespective of risk category. Emergency surgery and surgery with duration of more than 3 hours have also contributed significantly to the incidence and mortality of PPCs. Patients with intra-thoracic incision had 50% mortality. Although, age, preoperative SpO₂ and respiratory infection in the last one month did not seem to have a significant contribution to the incidence and mortality of PPCs.

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