ORIGINAL RESEARCH

Predictibility of post operative pulmonary complications in the subjects residing in upper assam using the ariscat score

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ABSTRACT

Background: Studies on post operative pulmonary complications are few and far for our country and our region in spite of them conferring significant morbidity and mortality to our patients as well as imposing a significant burden on our already fragile healthcare systems. **Aim**: This study was undertaken with the aim of determining the incidence risk and mortality associated with post operative pulmonary complications in our region using the ARISCAT score. **Methods**: Over the course of one year, ARISCAT score was calculated for 400 patients posted for surgery. Preoperative clinical parameters and postoperative complications were recorded. Following data collection, a thorough clinical examination of the respiratory system, cardiovascular system, nervous system, and abdomen was performed. Data was analysed using SPSS V21. Binary logistic regression was used to calculate odds ratio. ROC Curve and diagnostic accuracy test was used for calculation of sensitivity and specificity, PPV, NPV and accuracy. **Results**: 12.3% of the patients developed post operative pulmonary complications. The PPV of the ARISCAT score was found to be 45.21%, the NPV 95.11%, sensitivity 67.35% and specificity 88.60%. There was a statistically significant 9.117 times higher chance ($p<0.001$) of developing PPC in those at belonging to intermediate risk group and 48.262 times higher chance ($p<0.001$) in those belonging to high-risk group as compared to low-risk group. For the ARISCAT score, in our study, a score of 33.5 was the optimal cut-off to detect post operative pulmonary complications with a sensitivity of 85.71% and specificity of 76.07%. 26.5% of patients developing a PPC died. 113 times higher risk ($p<0.001$) of death was observed for those who were with PPC as compared to without PPC patients. Most common type of post operative pulmonary complication developed was respiratory infection (30.6%), followed by pulmonary oedema (20.4%). **Conclusion**: Patients who were found to be at a higher risk of developing post operative pulmonary complications as per the ARISCAT score developed them more frequently as compared to the ones who were found to be at a lower risk.

Keywords: ARISCAT Score, European Perioperative Clinical Outcome (EPCO), Morbidity, Mortality, Pulmonary Complications [PPC].

INTRODUCTION

Pulmonary complications are the second most common type of post operative complications after wound infection and contribute significantly to perioperative morbidity and mortality. In addition, they affect negatively how the already limited health care resources are utilised in a developing country like ours that aims to provide free health to all.[1] It has been seen that the development of a post-operative pulmonary complication increases hospital stay by an extra 13-17 days which then increases the overall health care costs by 41-47%. In addition, studies have found that one out of five patients who develop a post operative pulmonary complication will die within 30 days of major surgery compared to only 0.2- 3% who will die in the absence of a post operative pulmonary complication.[2,3]

In 2015, a European joint taskforce, comprising of the European Society of Anaesthesiologists and the European Society of Intensive Care Medicine, the ESA-ESICM, published standards for the definitions of clinical outcome measures for perioperative conditions, the European Perioperative Clinical Outcome (EPCO) definitions.[4] They considered respiratory infection, respiratory failure, pleural effusion, atelectasis, pneumothorax, bronchospasm,

and aspiration pneumonitis to be composite outcome measures and defined pneumonia, acute respiratory distress syndrome, and pulmonary embolus as individual adverse outcomes.[5]

Other published definitions for post operative pulmonary complications by different internationally recognised societies also exist that demonstrate the wide variability in literature and therefore, an expected variability in studies conducted on them. For the purposes of this study, we have considered all complications that affect the respiratory system post operatively, according to the European Perioperative Clinical Outcome (EPCO) definitions, to be a post operative pulmonary complication and have used the ESA-ESICM standard definitions to categorise individual complications.[6]

The Assess Respiratory Risk In Surgical patients in Catalonia (ARISCAT) score, was first developed in 2010, and is a simple tool that uses seven objective, easily assessable and straightforward variables to assess the risk of developing post operative pulmonary complications. Subsequent to its creation, the score was validated in multiple large multicentric cohorts and was found to be a sensitive and specific predictor of post operative pulmonary complications.[7]

If risk assessment for pulmonary outcomes is done routinely, then we would be able to identify patients at a high risk of developing post operative pulmonary complications, and in an elective setting, we would be able to modify the risk factors, optimise the patient and aid surgical timing. This would also have far reaching consequences including a significant reduction in mortality and morbidity as well as the cost of health care.[8]

Therefore, we have undertaken this present study with the aim of determining the risk of developing post operative pulmonary complications, their incidence and mortality in patients undergoing major surgeries in the various surgical departments of Assam Medical College and Hospital and to assess the predictive value of the ARISCAT score for post-operative pulmonary complications in our population as the primary objective and to determine ARISCAT score preoperatively and stratify the population into risk groups for development of post operative pulmonary complications.

MATERIALS AND METHODS

This hospital based observational study was performed at Assam Medical College and Hospital, a tertiary care hospital in rural India. Institutional ethics committee approval was obtained prior to conducting the study and informed written consents were obtained from all participants. Patients aged more than 18 years undergoing any major surgical procedure under general or neuraxial anaesthesia in our hospital, with the surgery planned as a non-ambulatory procedure were included for the purposes of the study. Patients in whom certain information demographics like age, sex etc were missing or those who had repeat surgical procedures separated by less than 10 days or those receiving primary care outside Assam Medical College and Hospital were excluded from the purposes of the study.

Over the course of one-year (June 2021 to May 2022) patients fulfilling the inclusion and exclusion criteria were selected for the purposes of the study after obtaining written informed consent and subjected to detailed history taking, thorough clinical examination and relevant laboratory investigations were noted

Preoperative data collection was done during the time of pre anaesthetic assessment using a questionnaire which had patient demographics like age, sex, BMI and hospital registration number. Then the patient's clinical history was elicited pertaining to any respiratory infection in the last one month, any history of cerebrovascular accident, malignancy, weight loss >10%, long term use of steroids, previous prolonged hospital stays, any comorbid conditions like diabetes, COPD, hypertension, asthma, congestive heart failure, liver disease, renal failure, ascites etc. Patient was asked regarding any personal habits like smoking or alcohol use. Patient was graded according to the ASA physical status. Then queries related to the surgical procedure like the operation being planned, the primary diagnosis, the need for a preoperative Ryles tube were noted.

Following data collection, a thorough clinical examination of the respiratory system, cardiovascular system, nervous system, and abdomen was performed. The patient's preoperative investigations like hemoglobin were noted. NPO status was noted according to the ASA NPO guidelines i.e., fatty food or meats 8 hours prior surgery, non-human milk or light meal 6 hours prior surgery, and clear liquids including water, pulp free juice and tea or coffee without milk for 2 hours prior surgery. Data regarding the duration of surgery, the type of surgery, the site of incision, whether it was an emergency procedure or an elective procedure, the type of anaesthesia being administered etc. was recorded.

ARISCAT SCORE

Based on the data collected above, the ARISCAT score[7,9] for the patient was calculated according to the Table 1 as shown below:

Table 1: ARISCAT Score

1	**Age (in years)**	
	<=50	0
	51-80	3

	>80	16
2	Preoperative SpO2	
	>=96	0
	91-95	8
	<=90	24
3	Respiratory infection in the last month	17
4	Preoperative anaemia (<=10 g/Dl)	11
5	Surgical Incision	
	Peripheral	0
	Upper abdominal	15
	Intrathoracic	24
6	Duration of the surgery (in hours)	
	<=2	1
	>2 to 3	16
	>3	23
7	Emergency procedure	8

After calculation of the ARISCAT score, the patients were categorized as at high risk, intermediate risk, or low risk of developing post operative pulmonary complications[7] depending upon Table 2 as shown below:

The patients were followed up after surgery daily to look for development of any respiratory complications till discharge or death once daily.

The respiratory complications were classified based on European Perioperative Clinical Outcome (EPCO) definitions for post operative pulmonary complications.[4]

According to the EPCO guidelines,[9,10] the postoperative pulmonary complications were classified as:

Respiratory infection, Pleural effusion, Atelectasis, Pneumothorax, Bronchospasm, Aspiration Pneumonitis, Pneumonia, Infiltrate, consolidation, cavitation, Fever, white cell count <4 or >12x 10^9 /litre, New purulent/changed sputum, Increased secretions/ suctioning, New/ worse cough/ dyspnoea/ tachypnoea, Rale/ bronchial breath sounds, Worsening gas exchange, ARDS, Trachea-bronchitis, Pulmonary oedema, Exacerbation of pre-existing lung disease, Pulmonary embolism and Death.

STATISTICAL ANALYSIS

All data was analysed using Microsoft Excel, Graph Pad Prism, and IBM SPSS V21. Tables, pie chart and bar diagram were used to show descriptive statistics. Binary logistic regression was used to calculate odds ratio. ROC Curve and diagnostic accuracy test was used for calculation of sensitivity and specificity, PPV, NPV and accuracy. Chi square test and Fishers Exact test was used to evaluate association between categorical variables. All data was analysed using SPSS version 21. A p value of less than 0.05 was considered as statistically significant at 5% level of significance.

RESULTS

The age range of patients was 19 years to 85 years. The mean age was 40 years. The age group of 21-30 years had the maximum number of participants (n=110). 11 patients were above the age of 71 years.

Out of the total 400 study participants, 47% were females and 53% were males.

79.5% of patients had a Body Mass Index (BMI) between 18.5 to 24.9 as shown in table 2.

In our study, out of the 400 study subjects 92 were dependants and 308 had an independent functional status, 78.8% of participants did not have respiratory infection in the past month,

34.5% of the study population had preoperative anaemia, 65.5 % of the study population did not have preoperative anaemia, overall mean preoperative SPO2 was 98.51± 2.779 in our study.

85.3% underwent elective major and 14.8% had emergency operations, 45% of patients underwent major orthopaedic surgery followed by 25.3% patients of general surgery. Only 2.3% of patients underwent major neurosurgery and 6% of patients underwent major cardiothoracic surgery. Duration of surgery was less than 2 hours in 88.25% of the patients, between 2-3 hours in 8.5 % of the patients and more than 3 hours in 3.25% of the patients. The site of surgical incision was intrathoracic in 5.5% of the patients, upper abdominal in 43.8% and peripheral in 50.7% of patients. 38.3 percent of patients received general anaesthesia whereas 61.8% of received neuraxial or regional anaesthesia. After calculating the ARISCAT

score, we found that 59.5% of our study subjects had low risk, 22.25% of them had intermediate risk and 18.25% of them had a high risk of developing post operative pulmonary complications.

Out of the 49 patients, 33 cases (45.2%) were from the high-risk group, 12 cases (13.5%) were from the intermediate risk group and only 4 cases (1.7%) were from the low-risk group developed post operative pulmonary complications. 33 patients out of total 73 patients belonging to the high-risk group, 16 patients out of the 327 patients in the low and intermediate risk group developed post operative pulmonary complications.

The positive predictive value of the ARISCAT score is found to be 45.21%, the negative predictive value is found to be 95.11%. The sensitivity of the ARISCAT score was found to be 67.35% and the specificity was found to be 88.60%.

From the binary Logistic regression, it was observed that there is a statistically significant 9.117 times higher chance ($p<0.001$) of developing PPC in those at belonging to intermediate risk group and 48.262 times higher chance ($p<0.001$) in those belonging to high-risk group as compared to low-risk group.

We observed that for the ARISCAT score of 33.5 was the optimal cut-off to detect post operative pulmonary complications with a sensitivity of 85.71% and specificity of 76.07%. Out of the 49, 13 patients (26.5%) died. 10 deaths were from the high-risk group, 2 deaths were from the intermediate risk group. 1 death was from the low-risk group. 30.3% of the patients who developed post operative pulmonary complications in the high-risk group died.

From the binary Logistic regression, it is observed that there is as statistically significant 113 times higher risk ($p<0.001$) of death was observed for those who were with PPC as compared to without PPC patients.

Most common type of post operative pulmonary complication developed was respiratory infection (30.6%), followed by pulmonary oedema (20.4%).

Table 1: demographic data

Demographics	Subgroup	**Actual number of study subjects**	**%**
Age group (in years)	≤20	28	7
	21-30	110	27.5
	31-40	82	20.5
	41-50	83	20.8
	51-60	63	15.8
	61-70	23	5.8
	71-80	8	2
	81-90	3	0.8
Gender	Male	214	53.5
	Female	186	46.5
BMI group	Below 18.5	29	7.2
	18.5 to 24.9	318	79.5
	25-29.9	49	12.3
	30 and above	4	1
ASA Grade	1	213	53.25
	2	144	36
	3	26	6.5
	4	7	1.75
	5	10	2.5
Functional status	Dependent	92	23
	Independent	308	77
Respiratory infection in last month	No	315	78.8
	Yes	85	21.3
Preoperative anemia	Yes (Hb <=10g/dL)	138	34.5
	No	262	65.5
Preoperative SpO2	≥96	356	89
	91-95	31	7.8
	≤90	13	3.3
	Total	400	100

Table 2: surgical and anaesthesia variables

Variables	**Subgroup**	**Frequency**	**%**
Nature of surgery	Emergency	59	14.8
	Elective	341	85.3
	General	101	25.3

	Orthopaedics	180	45
	Gynaecological	85	21.3
	Cardiothoracic	24	6
	Neurosurgery	9	2.3
	Urology	1	0.3
Surgical specialty site	Peripheral	203	50.7
	Upper abdominal	175	43.8
	Intrathoracic	22	5.5
Duration OF SURGICAL	<2 hrs	353	88.25
	2-3 hrs	34	8.5
	>3 hrs	13	3.25
Type of anesthesia	General	153	38.3
	Regional and neuraxial	247	61.8

Table 3: calculation of ariscat score and risk stratification of the population

ARISCAT Score	Risk of developing PPCs	Frequency	%
<26	Low	238	59.5
26-44	Intermediate	89	22.25
≥44	High	73	18.25

Table 4: actual number of patients developing post operative pulmonary complications

Post operative pulmonary complications	Frequency	%
Yes	49	12.3
No	351	87.8

Table 5: occurrence of post operative pulmonary complications in those with high-risk vs those with intermediate and low risk

	Postop pulmonary complications		
Risk of PPC	**Yes**	**No**	**Total**
High Risk	33	40	73
Intermediate & Low Risk	16	311	327

Table 6: PPV, NPV, sensitivity and accuracy of the ARISCAT score

Statistic	Value%	95% CI
Sensitivity	67.35	52.46 to 80.05
Specificity	88.60	84.81 to 91.73
PPV	45.21	36.74 to 53.95
NPV	95.11	92.85 to 96.68
Accuracy	86.00	82.21 to 89.25

Table 7: ODDs of developing PPC in intermediate and high-risk vs in low-risk group

	Postop pulmonary complications			OR	Lower	Upper	p value
Risk	**No**	**Yes**	**Total**				
Low	234	4	238	Ref			
Intermediate	77	12	89	9.117	2.857	29.097	<0.001

High	40	33	73	48.262	16.218	143.620	<0.001

Table 8: mean ARISCAT score of those with PPC vs those without

PPC	N	Mean ARISCAT Score	SD	p value
No	351	21.23	19.527	<0.001
Yes	49	50.94	20.787	

Table 9: PPC Vs no PPC in patients with ARISCAT score of more than 33.4 Vs those in score less than 33.4

ARISCAT Score	PPC	No PPC	Total
>33.4	42	84	126
<33.4	7	267	274
Total	49	351	400

Table 10: occurrence of death in patients with post operative pulmonary complications Vs those without post operative pulmonary complications

	Occurrence of death			95% CI		P value
Postop pulmonary complications	**No (Death)**	**Yes (Death)**	**OR**	**Lower**	**Upper**	
No	350 (99.7)	1 (0.3)	Ref			
Yes	37 (75.5)	12 (24.5)	113.5135	14.35332	897.724	<0.001
Total	387 (96.8)	13 (3.3)				

DISCUSSION

PPC increases the cost of healthcare and decrease the quality of life in both the long run as well as the short run. However, very few studies have been done on post operative pulmonary complications in this part of the country.

12.3% of our study population developed post operative pulmonary conclusions. A study by Stones J et al[10] found the incidence of post operative pulmonary complications to be 21.7% after thoracic surgery. Another study by Tilak KM et al[11] found the incidence of post operative pulmonary complications in patients undergoing thoracic and abdominal surgeries to be 11.5%(13). Overall, the incidence of post operative pulmonary complications is said to range from less than 1% to 23% after major surgeries.

1.7% of the patients in the low-risk group developed post operative pulmonary complications. 13.5% of those at intermediate risk developed post operative pulmonary complications and 45.2% of those at high risk developed post operative pulmonary complications. In a similar study done by Tilak et al,[11] they found that 36.84% of the patients at a high risk of developing PPCs according to the ARISCAT score developed them, 7.69% of those at medium risk developed them and 10.71% of those at low risk developed them.

Patients at a low risk of developing post operative pulmonary complications had lower incidence of post operative pulmonary complications and patients at a higher risk of developing post operative pulmonary complications had a higher incidence of them, reflecting the accuracy of the ARISCAT score in predicting them.

The ARISCAT score was found to be a reliable predictor of post operative pulmonary complications in our study, with a negative predictive value (NPV) of 95.11% and a positive predictive value (PPV) of 45.21% with sensitivity 67.35% and specificity 88.60%. A similar study by Ulger G et al[12] found a NPV of 91.39% with a PPV of 36.84%, sensitivity 72.41 and specificity 70.24 in a random sample cohort of 150 patients, the majority of whom had undergone general and GI surgery.

An increasing age was associated with more odds of developing post operative pulmonary complications in the present study. It was seen that only 4 out of the 28 patients below 20 years developed post operative pulmonary complications whereas 5 out of the 11 patients above the age of 70 years developed post operative pulmonary complications in our study. Previous studies on post operative complications also show advancing age as a major determinant of post operative outcomes including post operative pulmonary complications. Patients with BMI>30 or those with BMI <18.5 were found to have higher risk of developing post operative pulmonary complications in the present study. In another study done by Ramachandran et al., they found that a BMI of more than 40 or an increase or decrease in BMI by 10% in the past six months were associated with increased risk for developing post operative pulmonary complications were similar to the findings by Rodgers A et al.[13]

In our study we did not find any significant differences amongst genders for development of post operative pulmonary complications, however, other studies have found that the male gender was at an

increased risk for development of post operative pulmonary complications.

Presence of preoperative anemia was significantly associated with the development of post operative pulmonary complications in our study. This is in concordance with many other studies by Li C et al,[14] Ramachandran SK et al[15] and Arozullah AM et al[16] that have identified the presence of preoperative anaemia as an independent risk factor for the development of post operative pulmonary complications.

The risk of developing post operative pulmonary complications increased with the duration of surgery and patient with a duration of surgery more than 3 hours developed significantly more post operative pulmonary complications than patients with a duration of surgery under 1 hour in the present study. Sherrer M et al,[17] found that a duration of surgery of more than 2 hours or any further increase in the time of surgery was a risk factor for development of post operative pulmonary complications. Other studies by Gupta H et al,[18] and Schultz MJ et al[19] have also consistently found an association between increased duration of surgery and development of post operative pulmonary complications.

In the present study we also found that patients who underwent emergency procedures or those that underwent upper abdominal or intrathoracic procedures or patients who did not have an NPO status preoperatively were at an increased risk of developing post operative pulmonary complications. Another study by Schultz MJ et al[19] have also found similar associations.

In the present study, we found that 24.5% of the patients who developed post operative pulmonary complications died, were at statistically significant risk of dying as compared to patients who did not develop PPCs. Tilak et al[11] found in their study that 37.9% of patients with PPCs dies within 30 days, Other studies by Sherrer M et al,[17] Gupta H et al,[18] and Schultz MJ et al[19] have found similar mortality percentages.

In our study, the ARISCAT score was found to be reliable as a predictor of post operative pulmonary complications in our population and could be used reliably to stratify the population into high risk, intermediate risk, and low risk groups. Patients who were found to be at a higher risk of developing post operative pulmonary complications developed them more frequently as compared to the ones who were found to be at a lower risk.

CONCLUSION

In the present study, 24.5% of the patients who developed a post operative pulmonary complication died. Therefore, from our study we can conclude that the ARISCAT score is a simple, easily assessable tool for the reliable prediction of post operative pulmonary complications and if applied properly, will go a long way in reducing morbidity and mortality as well as decrease health related expenditure and help in proper allocation of health care resources. However, multicentric trials with a larger sample size and longer follow up is essential to arrive at a conclusion.

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