Effectiveness of the ARISCAT Risk Score for Predicting Postoperative Pulmonary Complications in Major Urological Surgery

Ali Akgul, Ali Akdogan, Ahmet Besir, Ersagun Tugcugil and Sedat Saylan

Department of Anaesthesiology and Critical Care, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkiye

ABSTRACT

Objective: To evaluate the predictive power of the ARISCAT (assess respiratory risk in surgical patients in Catalonia) score for postoperative pulmonary complications (PPCs) following major urological procedures.

Study Design: A descriptive study.

Place and Duration of the Study: Department of Anaesthesiology and Critical Care, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkiye, from January to December 2023.

Methodology: A total of 140 ASA I–IV patients aged 18–85 years who had elective major urological surgery were included. Records were kept including patient demographics, surgical technique, comorbidities, length of postoperative hospital stay, ASA scores, preoperative pulmonary risk scores (ARISCAT), and any PPCs occurring during hospitalisation. Appropriate statistical analyses were performed using Chi-square or Fisher's exact tests for categorical variables, Mann-Whitney U and Student's t-tests for numerical variables, and ROC analysis to evaluate the predictive power of the ARISCAT score for PPC incidence.

Results: Of the 140 patients who had major urological surgery, 24 (17.1%) experienced postoperative pulmonary problems. The findings showed that the development of PPC was significantly correlated with the ASA and the ARISCAT scores, the amount of intraoperative fluids administered, the length of the operation, and a body mass index of 25 or above.

Conclusion: The ARISCAT risk score system was shown to be a simple, repeatable, economical, and effective method for forecasting the occurrence of PPC in major urological procedures. In terms of forecasting the growth of PPC, it was found that the ARISCAT score outperforms the ASA score. It was believed that implementing effective preventative measures, morbidity and mortality rates could be decreased when high-risk individuals were identified.

Key Words: *ASA score, ARISCAT score, Postoperative pulmonary complications, Major urological surgery*.

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INTRODUCTION

A major worry about surgical outcomes is postoperative pulmonary complications (PPCs), which frequently result in increased morbidity and mortality. With an incidence ranging from 2% to 19% in non-cardiac surgeries, these complications, which affect the respiratory system after anaesthesia and surgery, occur at different rates depending on the procedure type.[1,2] Due to their impact on patient recovery, extended hospital stay, and healthcare cost, it is critical to identify those factors that contribute to PPCs. A higher risk of developing PPCs has been linked to several patient-related characteristics, including age, obesity, smoking, and pre-existing pulmonary disease.[3]

Correspondence to: Dr. Ali Akdogan, Department of Anaesthesiology and Critical Care, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkiye
E-mail: draliakdogan@yahoo.com

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The formation of PPCs is complex and impacted by procedural factors such as the type of surgical approach and anaesthetic method, as well as patient-specific circumstances. Preoperative risk factors linked to PPCs have been thoroughly examined in prior studies, with a focus on the significance of early detection to minimise surgical treatment and reduce complications.[4,5]

Assess respiratory risk in surgical patients in Catalonia (ARISCAT) risk score is a validated and practical tool that incorporates both patient-specific and procedure-related variables to estimate the likelihood of PPCs (Table I).[4] These include age, oxygen saturation, recent respiratory infection, anaemia, type and duration of surgery, and surgical site.

Although the American Society of Anesthesiologists (ASA) physical status classification is widely used as a general preoperative risk stratification system, it lacks procedure-specific and respiratory-focused parameters.[6] In clinical practice, ASA is often used in parallel with other tools such as ARISCAT, especially when assessing pulmonary risk.[7] The primary aim of this study was to evaluate the predictive capacity of the ARISCAT score in identifying patients at risk for PPCs following major

urological surgeries. ASA classification was included as a secondary point of reference to reflect current clinical assessment practices.

Table I: The ARISCAT risk score and the complication rates.

Score components		Risk scores
Age (years)		
≤50		0
51-80		3
>80		16
Preoperative oxygen saturation		
≥96		0
91-95		8
≤90		24
Respiratory infection in past 1 month		17
Preoperative haemoglobin <10g/dl		11
Incision		
Peripheral incision		0
Upper abdominal incision		15
Intrathoracic incision		23
Surgery duration (hours)		
≤2 hours		0
2-3 hours		16
>3 hours		23
Emergency procedures		
Elective		0
Emergency		8
	ARISCAT scores	**Pulmonary complication rates**
Risks		
Low	<26	1.6%
Medium/intermediate	26-44	13.3%
High	≥45	42.1%

ARISCAT: Evaluate catalan surgical patients' respiratory risk.

METHODOLOGY

After receiving clearance from the local ethics committee, this prospective observational study was conducted at the Department of Anaesthesiology and Critical Care, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkiye (Protocol No. 2022/199; Dated: 26.10.2022). The study population consisted of ASA grade I–IV patients, aged 18-90 years, scheduled for elective major urological procedures, including nephrectomy, prostatectomy, cystectomy, and percutaneous nephrolithotomy. To account for anticipated data problems, a total of 140 patients were enrolled, although the initial power analysis indicated a minimum required sample size of 104.

Patients with pre-existing chronic respiratory diseases or active lower respiratory tract infections were excluded, whereas those with resolved respiratory infections within the previous month were included, in line with ARISCAT risk score criteria. Additionally, patients undergoing emergency surgery, pregnant women, with significant intraoperative blood loss and elevated body mass index (BMI), individuals receiving immunosuppressive therapy, and those who declined participation were excluded from the study. BMI was calculated for all patients using preoperative weight and height data and analysed both as a continuous and categorical variable (BMI ≥25 kg/m^2).

Intraoperative fluid administration, including both crystalloids and colloids, was recorded in millilitres. Fluids were administered according to standard clinical judgment, considering patient weight, estimated surgical loss, and maintenance requirements. A combination of the 4-2-1 rule for maintenance and estimated intraoperative deficit/loss was used.

In the post-anaesthesia care unit (PACU), patients were closely monitored for postoperative mortality, respiratory issues, and the need for intensive care unit (ICU) admission. The duration of hospitalisation was noted. The European Perioperative Clinical Outcome (EPCO) definitions served as the basis for diagnosing PPCs.[8] The following complications were documented: pleural effusion, atelectasis, pulmonary embolism, aspiration pneumonia, pulmonary oedema, pneumonia, respiratory failure, bronchoconstriction, and pneumothorax.

The statistical software programme SPSS version 23.0 (spss.ktu.edu.tr) was used to analyse the data. Continuous variables were defined by their mean, minimum, and maximum values, while categorical data were summarised using frequency and percentage distributions. The normality of the data was evaluated using the Kolmogorov-Smirnov test. While Chi-square and Fisher's exact tests were used for categorical data comparisons, the Mann-Whitney U test and the Student t test were used for numerical variables. For multiple comparisons of categorical variables, post-hoc analysis was performed, following a significant Chi-square or Fisher's exact test result. Additionally, using the receiver operating characteristics (ROC) analysis, the predictive power of the ARISCAT score for the incidence of PPCs was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for the predetermined cut-off value. For every test, a p-value of less than 0.05 was deemed statistically significant.

RESULTS

Initial consideration for the research included 155 patients undergoing major urological surgeries, including percutaneous nephrolithotomy, prostatectomy, cystectomy, and nephrectomy. One hundred and fourty patients were selected in the final analysis, after seven patients were eliminated for failing to give informed permission, five for missing data, and three for significant intraoperative blood loss.

Of these patients, 24 (17.1%) patients had PPCs, while 116 (82.9%) patients did not show any PPCs. Atelectasis was the most common complication in 17 (12.1%) patients, followed by respiratory infections in 2 (1.4%) patients, and respiratory failure in 4 (2.9%) patients (Table II).

There was no statistically significant association between PPCs incidence and factors including gender, age, comorbidities, smoking status, type of surgery, use of epidural analgesia, or blood product administration, according to the examination of patients' characteristics (Table II). ARISCAT risk levels and ASA categories, however, were shown to be significantly correlated with the incidence of PPCs (Table III). The ARISCAT score, BMI, duration of the surgery and anaesthesia, length of hospital stay, intraoperative fluid administration, and other parameters were also substantially linked to PPCs (Table III).

Table II: Patient characteristics and the distribution of PPC types.

Variables	Postoperative complications		p-values
	No n (%)	Yes n (%)	
Gender			
Male	95 (82.6)	20 (17.4)	>0.99
Female	21 (84.0)	4 (16.0)	
Age			
<60 years	55 (88.7)	7 (11.3)	0.101
≥60 years	61 (78.2)	17 (21.8)	
BMI			
<25 kg/m^2	41 (95.3)	2 (4.7)	0.009*
≥25 kg/m^2	75 (77.3)	22 (22.7)	
Comorbidity			
No	49 (90.7)	5 (9,3)	0.050
Yes	67 (77.9)	19 (22,1)	
Smoking			
No	85 (83.3)	17 (16.7)	0.807
Yes	31 (81.6)	7 (18.4)	
Types of surgery			
Nephrectomy	44 (81.5)	10 (18.5)	
Prostatectomy	46 (80.7)	11 (19.3)	0.137
Cystectomy	3 (60.0)	2 (40.0)	
PNL	23 (95.8)	1 (4.2)	
Epidural analgesia			
No	85 (82.5)	18 (17.5)	0.862
Yes	31 (83.8)	6 (16.2)	
Blood product administration			
No	101 (84.9)	18 (15.1)	0.204
Yes	15 (71.4)	6 (28.6)	
Types of PPCs observed			
Atelectasis		17 (12.1%)	
Respiratory failure		4 (2.9%)	
Pneumonia		2 (1.4%)	
Pleural effusion		2 (1.4%)	
Pulmonary embolism		2 (1.4%)	
Bronchospasm		1 (0.7%)	

*p-values were calculated using the Chi-square test for gender, age, BMI, comorbidity, smoking, epidural analgesia, and blood product administration, and the Fisher's exact test for types of surgery. *The acceptable level of statistical significance was p <0.05. BMI: Body mass index; PNL: Percutaneous nephrolithotomy.*

Table III: The associations of PPCs with the risk scores and perioperative variables.

Variables	Postoperative complications		p-values
	No n (%)	Yes n (%)	
ARISCAT risk grade			
Low	39 (100.0)	0 (0.0)	
Medium	65 (86.7)	10 (13.3)	
High	12 (46.2)	14 (53.8)	<0.001*
ASA			
1	29 (87.9)	4 (12.1)	
2	52 (86.7)	8 (13.3)	
3	33 (80.5)	8 (19.5)	0.024*
4	2 (33.3)	4 (66.7)	
ARISCAT score	34.0 (18.0-41.0)	47.0 (41.0-53.5)	<0.001**
BMI	27.1 ± 4.3	30.2 ± 4.6	0.002**
Intraoperative fluid volume	2500.0 (1700.0-3000.0)	3000.0 (2500.0-4500.0)	0.001**
Operation time	147.5 (110.0-180.0)	200.0 (166.25-240.0)	<0.001**
Anaesthetic time	170.0 (135.0-205.0)	222.5 (191.25-281.25)	<0.001**
Hospitalisation time	5.0 (4.0-7.0)	8.0 (7.0-12.25)	<0.001**

**p-values were calculated using the chi-square test for the ARISCAT risk grade and the Fisher's exact test for ASA classification. The acceptable level of statistical significance was p <0.05. ARISCAT: Assess respiratory risk in Catalan surgical patients; ASA: American Society of Anesthesiologists Classification **p-values were calculated using the Student's t-test for BMI and the Mann-Whitney U test for the ARISCAT score, amount of fluid administered, and operation, anaesthetic, and hospitalisation time.*

With a sensitivity of 83.3%, a specificity of 64.7%, a PPV of 67.2%, and a NPV of 94.9%, ROC analysis showed that the ARISCAT score accurately predicted the development of PPCs. Strong predictive accuracy was indicated by the computed area under the ROC curve (AUC), which was 0.825 (Figure 1).

DISCUSSION

According to this study, 17.1% of patients having major urological procedures had developed PPCs. Their incidence rate was shown to be significantly correlated with a number of variables, including BMI, intraoperative fluid volume, ASA

classification, ARISCAT risk levels, and operating time. Notably, when it came to determining PPC risk, the ARISCAT score outperformed the ASA categorisation as a predictive method. Furthermore, the postoperative hospital stays were much longer for those who had PPCs.

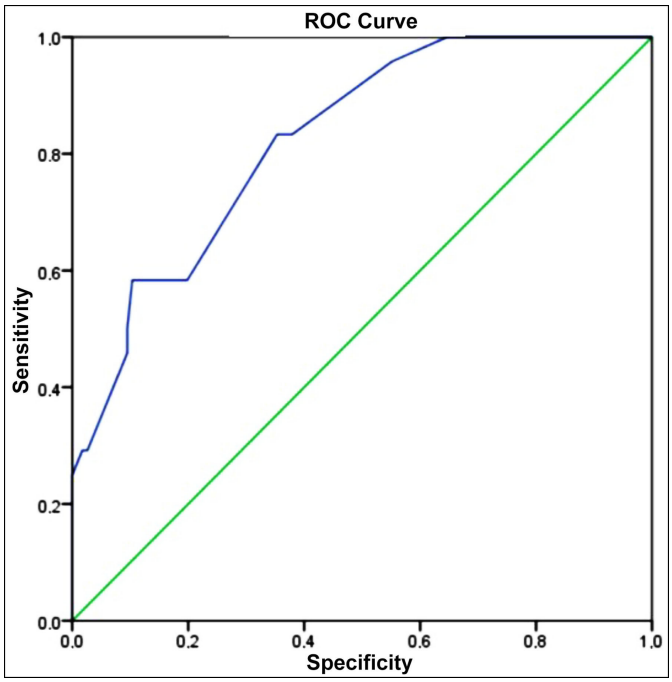

Figure 1: Evaluating the reliability of the ARISCAT score in PPCs with ROC curve.

Due to variations in patient demographics, surgical procedures, anaesthetic techniques, and PPC definitions, the reported incidence of PPCs varies across studies.[8] In a study of 165–169 patients undergoing major abdominal surgery, the incidence of PPCs was 5.8%.[3] In contrast, a study of 286 patients undergoing spinal anaesthesia for percutaneous nephrolithotomy reported a PPC rate of 31.5%.[9] Another study of 1,224 patients undergoing lung resection revealed a PPC incidence of 22%.[10] The present study's PPC rate of 17.1% is consistent with the variability found in the literature.

In this research, atelectasis was the most prevalent PPC, involving 12.1% of patients. Nonetheless, prior studies have demonstrated differences in the distribution of PPC types. In a study of 3,790 patients who had radical cystectomy, pneumonia was the most common PPC.[11] Another study of 1,202 patients who had not undergone thoracic surgery found that respiratory failure was the most common complication, followed by atelectasis.[12] These variations are probably caused by differences in surgical techniques and patient monitoring protocols.

The literature currently in publication offers contradictory results about how gender affects the risk of PPCs. Males had a greater PPC rate than females, according to a retrospective examination of 648 patients undergoing major oral and maxillofacial surgery.[13] The absence of a statistically significant gender-based difference in this study may be attributable to the predominance of male patients undergoing prostatectomy.

One risk factor for PPCs that has been repeatedly established is age. However, age was not a significant predictor of PPCs in this investigation, despite studies showing that individuals aged 80 years and above have a substantially higher PPC risk. The limited number of patients who were 80 years or older may be the cause of this disparity in this study.

Similarly, the association of comorbidities with the development of PPCs offers conflicting information. The present analysis did not identify a significant link between comorbidities and the incidence of PPCs, although several studies showing a considerable correlation between PPCs and chronic respiratory diseases.[9,14] The exclusion of individuals with asthma and chronic obstructive pulmonary disease (COPD), who were more likely to experience respiratory difficulties, may be the cause.

Smoking is a well-known risk factor for PPCs, and previous studies, including those on renal transplant patients, have found a strong correlation between smoking and PPC incidence.[15] This investigation did not find a significant association between smoking and PPC incidence, which may be as a result of limited sample size.

By enhancing pain management, enabling deeper breathing, and encouraging early mobilisation, epidural analgesia has been proposed to lower the risk of PPCs.[16,17] Although prior research has shown that patients who receive epidural analgesia had a lower PPC rate, the results did not support a significant correlation, most likely because of the small number of patients who received this intervention.

The research has also emphasised the role of intraoperative fluid management in PPC risk, with excessive intraoperative fluid administration being linked to a higher frequency of PPCs.[18] This investigation found that patients who developed PPCs had received a considerably larger amount of intraoperative fluids, a finding that consistent with previous findings.

Due to altered lung mechanics, disrupted surfactant production, and impaired mucociliary clearance, prolonged surgical and anaesthetic durations have been associated with an increased risk of PPCs.[19] The present study supported this association, as patients who developed PPCs had significantly longer operative durations than those who did not.

The present study supports previous research, demonstrating a high association between the ARISCAT scores and the incidence of PPCs.[5,20] In this observational study, the

ARISCAT risk score demonstrated promising utility as a simple, cost-effective, and repeatable tool for identifying patients at increased risk of PPCs after major urological surgeries. These findings suggest that higher ARISCAT scores are significantly associated with increased incidence of PPCs and may support early identification and preventive intervention in high-risk individuals. Although the ASA classification was analysed as a comparator, it served primarily as a secondary benchmark and did not provide the same degree of predictive specificity as the ARISCAT score did. These results underscore the potential role of the ARISCAT score in preoperative pulmonary risk stratification within urological surgical populations.

This study indicated that the formation of PPCs considerably lengthened hospital stay, which was consistent with prior research.[21,22] Patients who had PPCs had significantly longer postoperative hospitalisation, highlighting the need for early risk assessment and preventative efforts.

To the best of the authors' knowledge, this study was the first to examine PPC risk factors in major urological procedures using a prospective observational approach. However, it had several limitations. First, as this was a single-centre research study, the results may not be generalisable to larger groups. Furthermore, all patients were categorised within the abdominal surgery category of the ARISCAT system and may have limited heterogeneity. Furthermore, the results could have been affected by the fact that most of the patients were male, because of the nature of urological treatments. Finally, the PPC risk categorisation by surgical treatment type was not possible because of the small sample size.

CONCLUSION

The ARISCAT risk score system was proved to be a simple, repeatable, economical, and effective method for predicting the occurrence of PPCs in major urological procedures. In terms of forecasting the growth of PPCs, it was found that the ARISCAT score outperforms the ASA score. It was believed that by successfully putting preventative measures into practice, morbidity and mortality could be decreased when high-risk individuals were identified.

ETHICAL APPROVAL:
Ethical approval for this study was obtained from the local Ethics Committee of the Karadeniz Technical University, Faculty of Medicine, Trabzon, Turkiye (Protocol No. 2022/199; Dated: 26.10.2022).

PATIENTS' CONSENT:
Written informed consent was taken from all the participants included in this study.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
AA: Conception of the study and critical revision of the manuscript for intellectual substance.
AA: Design of the work, data collection, analysis, interpretation, and manuscript preparation.
AB, SS: Gathering, evaluating, and interpreting the data.
ET: Work planning, analysis, and drafting of the manuscript.
All authors approved the final version of the manuscript to be published.

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