Original Article

Thoracoscore: Does it predict mortality in the Indian scenario? - A retrospective study

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ABSTRACT

Background and Aims: Preoperative risk stratification helps in better prognostication and allocation of resources. However, risk scoring models are less often used in thoracic surgery. Thoracoscore, a risk score model for thoracic surgery was originally developed on a French population and was later validated in many countries. As there is no literature on its ability to predict mortality in the Indian population, we aimed to validate Thoracoscore in Indian thoracic surgical patients. **Methods:** This retrospective study was carried out in a tertiary care centre after obtaining institutional ethics committee clearance. Patients who were operated for lung pathologies via a posterolateral thoracotomy incision between January 2014 and December 2018 were included in the study. Data on Thoracoscore variables and few additional factors (pulmonary arterial hypertension (PAH), redo surgery, blood loss, blood transfusion, duration of anaesthesia, one lung ventilation and surgery) was collected along with observed mortality statistics. Mortality was predicted using online calculator from the site https://sfar.org/scores2/thoracoscore2.php. Significant continuous and categorical variables in causation of mortality were identified using unpaired t-test and Chi-square tests, respectively. These variables were subjected to multivariate logistic regression to find independent risk factors for mortality. The calibration and discrimination of the Thoracoscore model was analysed by using Hosmer–Lemeshow test and area under the curve of receiver operating characteristic curves. **Results:** Overall observed mortality in the study was 3.2% while predicted mortality was 0.44%. The Thoracoscore had poor calibration and fair discrimination ability. PAH and re-operative surgery along with Thoracoscore were found to be independent risk factors of mortality in thoracic surgery. **Conclusion:** Thoracoscore fails to predict mortality in the Indian population.

Key words: Mortality, pulmonary arterial hypertension, thoracotomy

INTRODUCTION

Risk stratification helps to find out the risks associated with a specific patient for a particular procedure. Stratifying risk in the preoperative period helps in better prognostication of individual patients thus enabling better counselling. It can also help organisations to plan proper allocation of resources. There is a lot of literature and emphasis on preoperative risk stratification scores in cardiac surgery even in the Indian population.[1] However, risk scoring models in thoracic surgery are relatively new and are less often used. Some available scoring systems for thoracic surgery are Thoracoscore, European Society Objective Score risk model and the Society of Thoracic Surgeons risk model.[2-4] The new British Thoracic Society guidelines now insist on preoperative risk assessment by incorporation of scoring system for proper patient selection and providing risk adjusted in-hospital

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mortality for individual patients undergoing thoracic surgery.[5]

Generally, risk stratification systems are developed in a large cohort of population in one country and then validated in other countries. The ethnicity of population, nature of disease, treatment modalities and surgical skills are varied in different countries. Thus, risk stratification models need validation in a particular country before being put into clinical use. The original Thoracoscore was derived from data of 15183 patients who underwent thoracic surgery in 59 French hospitals.[2]As per our knowledge, there is no literature available on its ability to predict mortality in the Indian population. Thus, we planned the present study with the primary objective of validating Thoracoscore in the Indian population. The secondary objective was to look for additional perioperative variables that may be contributing to mortality in Indian thoracic surgical patients.

METHODS

We conducted the present retrospective study after obtaining institutional ethics committee approval (EC/NIMS/2295/2019) and in accordance with the principles of the declaration of Helsinki. All adult patients who had open lung surgery[pneumonectomy, lobectomy, decortications, others (wedge resection, cyst excision, bronchopleural fistula closure)] via thoracotomy between the period of 1 January 2014 to 31 December 2018 were included in the study. Using the electronically stored data from the department of cardiothoracic surgery and anaesthesia department, the case records and intraoperative anaesthesia charts of patients were retrieved. Data was collected as per risk factors identified in Thoracoscore. Thoracoscore has nine variables like age, sex, American Society of Anesthesiologists (ASA) score, performance status, dyspnoea score, priority of surgery (elective/emergency), procedure class (pneumonectomy/other), diagnosis group (benign/malignant) and comorbidity score [Appendix 1]. Data was also collected on additional preoperative variables like presence of moderate to severe pulmonary arterial hypertension (PAH)(defined as moderate if pulmonary artery systolic pressure was 35-55 mmHg and severe if >55mmHg), any redo surgery and intraoperative variables like duration of anaesthesia, one lung ventilation, and surgery, amount of blood loss and number of blood transfusions. Patients having missing information on any of the above mentioned variables were excluded from the study. In-hospital mortality was also noted. Predicted mortality was calculated from the online Thoracoscore calculator (https://sfar.org/scores2/thoracoscore2.php). Surgical category wise predicted and observed mortality was noted.

All the statistical analysis was done using Statistical Package for Social Sciences version 20 software (2011, International Business Machines, Armonk, New York, United States of America).The continuous variables in the present study were expressed as mean ± standard deviation and were analysed with unpaired t-test. The categorical variables were stated as frequencies (percentages) and evaluated using Chi-square test. Results were considered statistically significant if *P* value was less than 0.05. Thoracoscore is a risk prediction model based on preoperative risk factors. Thus, only the statistically significant preoperative variables were subjected to multiple logistic regression and the independent risk factors for mortality were identified. This was done to enable identification of additional factors not incorporated in Thoracoscore but implicated in mortality. The calibration and discrimination of Thoracoscore was analysed in our sample. Hosmer–Lemeshow test was used for assessment of calibration of Thoracoscore. It compares predicted versus actual mortality. If the test is non-significant then the calibration is good and vice versa. A risk model's ability to differentiate high risk patients from low-risk ones is termed Discrimination. It is tested by calculating the area under curve (AUC) of the receiver operating characteristic (ROC) curve. AUC value of <0.5 shows a very poor model. A value of 0.5 means that the model is no better than predicting an outcome other than random chance. Values above 0.7 and 0.8 indicate good and strong model, respectively. A value of 1 suggests perfect model.

RESULTS

A total of 441 patients were operated during the study period. Out of these, 47 were excluded due to incomplete data [Figure 1]. Thus, the final analysis included 394 patients. Thirteen (3.2%) patients had postoperative mortality while the predicted mortality was 0.44%. Mean age for the study population was 41.63 ± 14.34 years. There were 70% males and 30% females in our population [Table 1]. Lobectomy was the most common type of surgery performed [Table 2]. In the subgroup analysis, mortality was found to be maximum for pneumonectomies followed by decortications. Predicted and observed mortality in the total population and various surgical subgroups were also noted [Table 2].

The Hosmer–Lemeshow Chi-square goodness of fit test showed a (χ^2) value of 13.49 and corresponding significance of 0.03, thus revealing a poor calibration of the model. The AUC of ROC was 0.698 with confidence interval of 0.50-0.88 indicating a fair but not good discrimination ability of the model [Figure 2].

Table 1: Comparison of Thoracoscore variables in the present study population and in the original Thoracoscore

	Original Thoracoscore dataset	Our set of population
Number of patients	10122	394
In-hospital death (%)	218 (2.1%)	13 (3.2%)
Mean age in years	54.6	41.6±13.74
Male	6932 (68.5%)	276 (70%)
American Society of Anesthesiologists physical class ≥III	2738 (28.5%)	7 (1.8%)
Performance status ≥3	1722 (18.1%)	14 (1%)
Dyspnoea score ≥3	1068 (10.5%)	17 (4.3%)
Urgent surgery	1582 (15.6%)	5 (1.3%)
Pneumonectomy	607 (6%)	10.2%
Malignancy	5783 (57.1%)	66 (16.8%)
Number of comorbidities		
≤2	8185 (80.8%)	332 (84.3%)
≥3	1937 (19.2%)	62 (15.7%)

Data presented as number (percentage)

Table 2: Observed and predicted mortality in various surgical subgroups

Surgical subgroups	Number of patients (% of total)	In-hospital death (number)	Predicted mortality (%)	Observed mortality (%)
Lobectomy	213 (54.1)	6	0.43	2.8
Pneumonectomy	38 (9.6)	3	0.77	7.8
Decortication	95 (24.1)	3	0.38	3.15
Others	48 (12.2)	1	0.41	2.08
Total	394 (100)	13	0.44	3.29

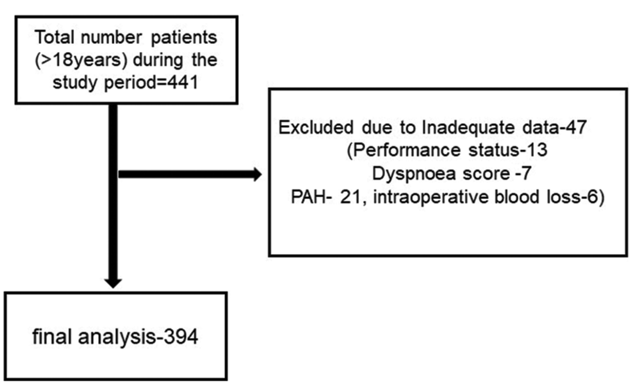

Figure 1: Flow chart of patient recruitment. PAH: Pulmonary arterial hypertension

In the univariate analysis, presence of moderate to severe PAH and redo surgery were the significant preoperative variables implicated in mortality along with Thoracoscore. Duration of anaesthesia, duration of surgery, duration of one lung ventilation, blood loss, and number of transfusions were found to be significant intraoperative factors associated with mortality [Table 3].

Preoperative presence of PAH, redo surgery and Thoracoscore emerged as the independent risk factors of mortality in logistic regression analysis [Table 4].

DISCUSSION

Risk prediction scores are increasingly used across all surgical subspecialities to predict mortality in the preoperative period. As per current British guidelines, use of risk model system is mandatory for lung surgery.[5] The notable risk models available for lung resection are Thoracoscore, European society objective score (ESOS.01), National lung cancer audit score (NLCA), and SABCIP score [°**S**ex, **A**ge, **B**MI, **C**linical stage, **I**nterstitial lung disease and **P**rocedure type] from Japanese database.[3,6,7] However, apart from Thoracoscore, all other scoring models were built to predict death, predominantly in lung cancer patients. Thus, we chose to validate Thoracoscore in our study sample which has a greater number of non-malignant cases as compared to malignant ones.

In the present study, Thoracoscore was found to underestimate mortality. The scoring system was

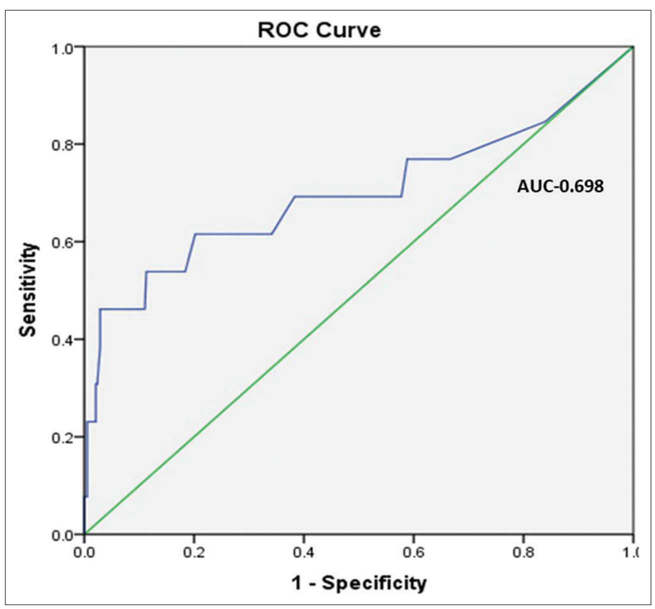

Figure 2: Receiver operating characteristic (ROC) curve with area under curve (AUC) showing discrimination of Thoracoscore

found to have poor calibration and fair discrimination ability.

The mortality after thoracic surgery ranges between 1.38 and 5.2% in various studies[8-13] and was 3.2% in the present study. Although the Thoracoscore values were statistically higher in patients who died (1.39 ± 1.52) as compared to those alive (0.41 ± 0.47), the overall score values were very low. The Thoracoscore also underestimated mortality in all surgical categories.

There could be many possible reasons for the failure of Thoracoscore to predict mortality accurately. Of notable importance is the fact that the patient characteristics of our study population were different from the original dataset. The mean age of the population in the study was 41.6 years which is almost a decade younger than the original dataset. Longer life expectancy in the western population may be the reason behind the higher age in the original Thoracoscore study derived from the French population. As compared to Thoracoscore original dataset, there were lesser number of patients in ASA class ≥3 (28.5% versus 1.8%), Performance status ≥3 (18.1% versus 1%) and dyspnoea grade ≥3 (10.5% versus 4.3%) in our study population. Our study population had more pneumonectomy patients as compared to the original database. Earlier studies by Qadri *et al*.[11] concluded that Thoracoscore overpredicted mortality in patients undergoing pneumonectomy.[12] However, the present study is not in agreement with these results. Most of the previous studies including the original Thoracoscore validated the score in study set predominantly consisting of patients with malignancy.[10-15] Our study population had only 16.8% (57.1% in original Thoracoscore data) patients with cancer, which could be a possible explanation for disagreement of predictive ability of the scoring system. However, against the general perception that malignancy leans towards increased mortality and non-malignant patients are likely to have a better outcome, Thoracoscore underpredicted mortality in our population. Thus, it is explicit that other factors, important in causation of mortality in the Indian setting, are missing in Thoracoscore. Various other factors could possibly be contributing to the disparity in outcome and these key factors deserve mention.India is a country where tuberculosis is endemic. Tuberculous lung disease when untreated can complicate and present in the form of pyothorax, pleural thickening, bronchopleural fistula, cavitary lesions with or without fungal balls, fibrosis and/or destruction of one lobe or the whole lung. Most of the thoracic surgeries in India are done to ameliorate the complications of tuberculosis and can range from simple window thoracotomy to decortication, lobe resections or pneumonectomy.[16] In a study by Lee *et al*.,[17] tuberculous patients were found to have a higher involvement of non-bronchial systemic arteries (NBSAs) and a significantly greater number of feeding vessels. It is possible that these patients have a higher amount of surgical bleeding during dissection of the affected lobe due to greater number of NSBAs and collateral feeding vessels. In the present study, amount of blood loss intraoperatively was a significant factor associated with mortality in univariate analysis. Further, higher bleeding might also have resulted in longer duration of surgery eventually leading to longer one lung ventilation and anaesthesia duration. As we did not collect data on history of tuberculosis, we cannot establish a definite association. Further studies are warranted to explore this relation. Western literature rarely describes pulmonary tuberculosis (PTB) as a cause for development of PAH. PTB can lead to development of PAH due to damage caused to vasculature, endarteritis and parenchymal architectural changes. Thus, in a country like India, with a high burden of PTB, it is not unusual to find PAH in patients coming for surgery of PTB sequelae.[18,19]

Table 3: Comparison of variables between those who survived and those who did not

Variables	Alive (*n* –381)	Death (*n* –13)	*P*
Moderate to severe PAH (*n*)	24	5	0.001
Redo surgery (*n*)	19	4	0.004
Thoracoscore	0.41±0.47	1.39±1.52	0.03
Blood loss (ml)	404.15±201.25	700±254.95	0.001
Transfusion (units)	0.44±0.75	1.69±1.3	0.005
Duration of anaesthesia (minutes)	204.04±69.83	284.31±112.36	0.02
Duration of surgery (minutes)	167.22±64.62	245.77±96.97	0.013
Duration of OLV (minutes)	132.76±57.86	197.38±107.11	0.05

n – number; OLV – one lung ventilation; PAH – Pulmonary arterial hypertension. Data are presented as mean±standard deviation

Table 4: Logistic regression analysis showing independent risk factors for mortality following thoracotomy

Variables	B	SE	Wald	Odds ratio	Confidence interval	*P*
Moderate to severe pulmonary arterial hypertension preoperatively	1.82	0.74	6.06	6.2	1.4-26.65	0.014
Redo surgery	2.8	0.77	13.9	17.9	3.94-81.59	<0.001
Thoracoscore	1.41	0.42	11.25	4.1	1.79-9.35	<0.001

B –Unstandardised β. SE – standard error of unstandardised β

PAH is a known risk factor associated with postoperative mortality in non-cardiac surgery. In a study by Ramakrishna *et al*.,[20] early mortality following non-cardiac surgery in patients with PAH was as high as 7%. Another retrospective study by Minai and colleagues revealed a high death rate of 18% in patients with moderate to severe PAH following major surgery.[21]The present study also found moderate to severe PAH to be an independent predictor of mortality. Non-inclusion of PAH as a variable in Thoracoscore could well be a reason for underprediction of mortality in the Indian scenario.

Re-operative surgery is known to be associated with increased incidence of perioperative mortality and morbidity. There is a lack of literature relating redo thoracotomy to mortality. But in our experience, patients who present for multiple surgeries like decortications followed by lobectomy or pneumonectomy often have dense adhesions leading to major blood loss and prolonged postoperative hospital stay.

There is a lot of emphasis on the volume of a centre and surgeon as it has been shown to directly influence patient outcomes. Birkmeyer and colleagues showed that in-hospital mortality for pneumonectomy and lobectomy was significantly lower in high volume centres (>46 cases/year) as compared to low and moderate volume centres.[22] The same authors also concluded that surgeon volume was inversely proportional to mortality in lung resection.[23] As the present study was conducted in a high volume centre, it is unlikely that hospital or surgeon volume would have influenced the outcomes.

There are certain limitations in the present study. The significance of Thoracoscore's individual components was not evaluated in the study and Thoracoscore was considered as an independent continuous variable. The present study has the disadvantages of small sample size, single centre data and retrospective nature. As Thoracoscore is a preoperative risk stratification model, many intraoperative variables which were significant in univariate analysis were not included in logistic regression analysis although they may be significantly contributing to the outcome.

CONCLUSION

Thoracoscore does not reliably predict mortality in the Indian scenario. Large multicentric Indian studies are warranted to make modifications in Thoracoscore to improve its mortality prediction ability in the Indian population.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kar P, Geeta K, Gopinath R, Durga P. Mortality prediction in Indian cardiac surgery patients: Validation of European system for cardiac operative risk evaluation II. Indian J Anaesth 2017;61:157-62.
2. Falcoz PE, Conti M, Brouchet L, Chocron S, Puyraveau M, Mercier M, *et al*. The thoracic surgery scoring system (Thoracoscore): Risk model for in-hospital death in 15,183 patients requiring thoracic surgery. J Thorac Cardiovasc Surg 2007;133:325-32.
3. Berrisford R, Brunelli A, Rocco G, Treasure T, Utley M. The European thoracic surgery database project: Modelling the risk of in-hospital death following lung resection. Eur J Cardiothorac Surg 2005;28:306-11.
4. Kozower BD, Sheng S, O'Brien SM, Liptay MJ, Lau CL, Jones DR, *et al*. STS database risk models: Predictors of mortality and major morbidity for lung cancer resection. Ann Thorac Surg 2010;90:875-81; discussion 81-3.
5. Lim E, Baldwin D, Beckles M, Duffy J, Entwisle J, Faivre-Finn C, *et al*. Guidelines on the radical management of patients with lung cancer. Thorax 2010;65(Suppl 3):iii1-27.
6. Powell HA, Tata LJ, Baldwin DR, Stanley RA, Khakwani A, Hubbard RB. Early mortality after surgical resection for lung cancer: An analysis of the English National Lung cancer audit. Thorax 2013;68:826-34.
7. Tahara M, Ishimaru T, Fujino Y, Fushimi K, Matsuda S, Mukae H, *et al*. A new scoring system for predicting in-hospital death after lung cancer surgery (the SABCIP score) using a Japanese nationwide administrative database. Thorac Cancer 2022;13:870-5.
8. Bradley A, Marshall A, Abdelaziz M, Hussain K, Agostini P, Bishay E, *et al*. Thoracoscore fails to predict complications following elective lung resection. Eur Respir J 2012;40:1496-501.
9. Chamogeorgakis T, Toumpoulis I, Tomos P, Ieromonachos C, Angouras D, Georgiannakis E, *et al*. External validation of the modified Thoracoscore in a new thoracic surgery program: Prediction of in-hospital mortality. Interact Cardiovasc Thorac Surg 2009;9:463-6.
10. Chamogeorgakis TP, Connery CP, Bhora F, Nabong A, Toumpoulis IK. Thoracoscore predicts midterm mortality in patients undergoing thoracic surgery. J Thorac Cardiovasc Surg 2007;134:883-7.
11. Qadri SS, Chaudhry MA, Cale A, Cowen ME, Loubani M. Short- and long-term outcomes of pneumonectomy in a tertiary center. Asian Cardiovasc Thorac Ann 2016;24:250-6.
12. Qadri SS, Jarvis M, Ariyaratnam P, Chaudhry MA, Cale AR, Griffin S, *et al*. Could thoracoscore predict postoperative mortality in patients undergoing pneumonectomy? Eur J Cardiothorac Surg 2014;45:864-9.
13. Sharkey A, Ariyaratnam P, Anikin V, Belcher E, Kendall S, Lim E, *et al*. Thoracoscore and European society objective score fail to predict mortality in the UK. World J Oncol 2015;6:270-5.
14. Barua A, Handagala SD, Socci L, Barua B, Malik M, Johnstone N, *et al*. Accuracy of two scoring systems for risk stratification in thoracic surgery. Interact Cardiovasc Thorac Surg 2012;14:556-9.

15. Poullis M, McShane J, Shaw M, Woolley S, Shackcloth M, Page R, *et al*. Prediction of in-hospital mortality following pulmonary resections: Improving on current risk models. Eur J Cardiothorac Surg 2013;44:238-42; discussion 42-3.
16. Dewan RK. Surgery for pulmonary tuberculosis-a 15-year experience. Eur J Cardiothorac Surg 2010;37:473-7.
17. Lee JH, Kwon SY, Yoon HI, Yoon CJ, Lee KW, Kang SG, *et al*. Haemoptysis due to chronic tuberculosis vs. bronchiectasis: Comparison of long-term outcome of arterial embolisation. Int J Tuberc Lung Dis 2007;11:781-7.
18. Fishman AP. State of the art: Chronic cor pulmonale. Am Rev Respir Dis 1976;114:775-94.
19. Ferrer MI. Cor pulmonale (pulmonary heart disease): Present-day status. Am Heart J 1975;89:657-64.
20. Ramakrishna G, Sprung J, Ravi BS, Chandrasekaran K, McGoon MD. Impact of pulmonary hypertension on the outcomes of noncardiac surgery: Predictors of perioperative morbidity and mortality. J Am Coll Cardiol 2005;45:1691-9.
21. Minai OA, Venkateshiah SB, Arroliga AC. Surgical intervention in patients with moderate to severe pulmonary arterial hypertension. Conn Med 2006;70:239-43.
22. Birkmeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I, *et al*. Hospital volume and surgical mortality in the United States. N Engl J Med 2002;346:1128-37.
23. Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. N Engl J Med 2003;349:2117-27.

Appendix 1: Variables used in Thoracoscore

Different variables used in thoracoscore	Different groups in calculator	Description
Age	Three groups <55 years 55 to 65 years >65 years	For ease of statistical calculation, divided into three age wise groups
Sex	Male/Female	
ASA physical status	≤2 or ≥3	Healthy patient Mild systemic disease Severe systemic disease Severe systemic disease that is a threat to life. Moribund patient Brain dead
Performance Status	≤2 or ≥3	Zubrod performance index Normal activity symptomatic but fully ambulatory In bed <50% time in day In bed >50% time of day Unable to get out of bed
Dyspnoea Score	≤2 or ≥3	Medical Research Council Scale No dyspnoea Slight dyspnoea Moderate dyspnoea Moderate to severe dyspnoea (stops in between walking) Severe dyspnoea (dyspnoeic while walking few minutes) Very severe dyspnoea while normal activity too.
Priority surgery	Elective Or Urgent or Emergency	
Procedure class	Pneumonectomy or other	Different surgical procedures Pneumonectomy or wedge resection, lobectomy, mediastinoscopy, or other diagnostic procedure.
Diagnosis group	Benign Or Malignant	
Comorbidities	Grouped into 3 categories: No comorbidities ≤2 comorbities ≥3 Comorbid conditions	Following were considered as comorbidities in the Thoracoscore: Addiction to smoking History of cancer COPD Hypertension Heart disease Diabetes Peripheral vascular disease Obesity Alcoholism