SHORT COMMUNICATIONS

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Thoracoscore: Predicting risk of in-hospital mortality for patients undergoing pulmonary resection

Thoracoscore: Procena rizika intrahospitalnog mortaliteta bolesnika nakon resekcije pluća

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Abstract

Background/Aim. Thoracic surgery is in need of a widely recognized and dependable risk model which could prospectively make objective conclusions and retrospectively allow comparison of outcomes. Thoracoscore is the first model with multiple variables developed for predicting in-hospital mortality following pulmonary resections. It is integrated in the British Thoracic Society and National Institute of Health and Clinical Excellence guidelines. However, additional evaluation of Thoracoscore is considerably advised in order to demonstrate its validity and potentially make it a dependable tool for thoracic surgeons across the world. Our study assesses the accuracy of Thoracoscore scoring system in estimating in-hospital mortality in patients undergoing pulmonary resections. **Methods.** Between September 2013 and October 2014 data were retrospectively collected on 196 patients operated on at the Thoracic Surgery Clinic, Institute of Pulmonary Diseases of Vojvodina. The procedures performed were: pneumonectomies, lobectomies and modified lobectomies (including bilobectomy and sleeve-lobectomy), Wedge resections and atypical resections. The Thoracoscore was calculated based on these nine variables: age, sex, American Society of Anaesthesiologists' (ASA) class, performance status classification, dyspnea score, priority of surgery, procedure class, diagnosis group and co-morbidities score. **Results.** Study included one hundred and ninety-six patients, average age of 62 ± 9 years, and 61% were males. Predicted mean in-hospital mortality was 3.6 ± 3.2% 95% confidence interval (CI) 3.16–4.06, and mean actual in-hospital mortality was 6/196 (3.1%) (95% CI 1.78–4.42). Patients who were > 65 years old contributed to 3/6 (50%) of in-hospital mortality, and 4/6 (67%)were males. Four of 6 (67%) patients underwent pneumonectomy due to malignant pathology. Thoracoscore was divided into 4 risk groups: low (0–3), moderate (3.1–5), high (5.1–8) and very high (> 8). The correlation between observed and expected mortality was 0.99, by category of risk. Old age, male gender and malignancy showed to be strong indicators of in-hospital mortality. **Conclusion.** At our department Thoracoscore presented with good performance and as a practical tool for predicting in-hospital mortality among patients undergoing lung resections. However, any risk scoring system needs further validation before implementation and outcomes must be compared to those of other programs.

Key words:
thoracic surgical procedures; lung diseases; hospital mortality; risk factors; prognosis; treatment outcome.

Apstrakt

Uvod/Cilj. U oblasti grudne hirurgije prisutna je potreba za široko priznatim i pouzdanim modelom rizika na osnovu kojeg bi se mogli prospektivno donositi objektivni zaključci i koji bi omogućio retrospektivno poređenje ishoda. *Thoracoscore* je prvi model koji se sastoji od nekoliko parametara za procenu intrahospitalnog mortaliteta nakon resekcije pluća. Ovaj model je usvojen od strane udruženja kao što su *British Thoracic Society* i *National Institute of Health and Clinical Excellence*. Ipak, savetuje se dodatna evaluacija *Thoracoscore* bodovnog sistema kako bi se ustanovila njegova validnost i pouzdanost u oblasti grudne hirurge širom sveta. U našoj studiji smo pokušali ustanoviti tačnost *Thoracoscore* bodovnog sistema u proceni intrahospitalnog mortaliteta bolesnika nakon resekcije pluća. **Metode.** U periodu od septembra 2013. do oktobra 2014. godine podaci su retrospektivno prikupljeni za 196 bolesnika operisanih na Klinici za grudnu hirurgiju Instituta za plućne bolesti Vojvodine. Izvršene hirurške procedure bile su pneumonektomije, lobektomije i modifikovane lobektomije (bilobektomije i *sleeve*-lobektomije). *Thoracoscore* je izračunavan na osnovu devet parametara: starost, pol, *American Society of Anesthesiologists* (ASA) skor, dispneja skor, procena opšteg stanja bolesnika, komorbiditeti, dijagnostička grupa, hitnost operacije i hirurška procedura.

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Rezultati. U studiju je bilo uključeno 196 bolesnika, prosečne starosti 62 ± 9 godina, od kojih je 61% bilo muškog pola. Prosečna stopa intrahospitalnog mortaliteta na osnovu *Thoracoscore* modela bila je 3.6 ± 3.2%, interval pouzdanosti (IP) 3.16–4.06, dok je prosečna vrednost stvarnog intrahospitalnog mortalita iznosila 6/196 (3.1%) (95% IP 1.78–4.42%). Najveća stopa mortalita, 3/6 (50%), bila je kod bolesnika starijih od 65 godina. Od ukupnog broja intrahospitalno preminulih bolesnika, 4/6 (67%) bili su muškog pola. Pneumonektomija je urađena kod 4/6 (76%) bolesnika zbog malignog patološkog nalaza. *Thoracoscore* je bio podeljen u 4 grupe rizika: nizak rizik (0–3), umeren rizik (3.1–5), visok rizik (5.1–8) i veoma visok rizik (> 8). Korelacija između stvarnog i očekivanog mortaliteta iznosila je 0.99, na osnovu kategorije rizika. Starija dob, muški pol i malignitet su se pokazali kao najznačajniji indikatori intrahospitalnog mortaliteta. **Zaključak.** Na našoj klinici *Thoracoscore* se pokazao kao praktičan model za procenu intrahospitalnog mortaliteta bolesnika nakon resekcije pluća. Ipak, ovaj bodovni sistem mora biti dodatno ispitan pre zvanične upotrebe, dok se ishodi moraju uporediti sa ishodima drugih klinika.

Ključne reči:
hirurgija, torakalna, procedure; pluća, bolesti; mortalitet, bolnički; faktori rizika; prognoza; lečenje, ishod.

Introduction

Over the past twenty years, scoring systems have become a useful methods for patient assessment, especially because the patients who require pulmonary resection have become more complex, with more comorbidities. The risk of mortality is one of the crucial elements when trying to decide if surgery is the best option for the patient. Usefulness of an objective risk stratification model were acknowledged by cardiac surgeons more than two decades ago. Today, they substantially rely on several models of risk assessment for patients facing cardiac surgery. However, as of now, broadly accepted risk model for thoracic surgery has yet to be established. Thus far, only two risk scoring systems have been evaluated, but neither become a standard. Thoracoscore is the first model with multiple variables developed for predicting in-hospital mortality following pulmonary resections [1]. This model was acquired from data of 15,183 patients who underwent thoracic surgery in 59 French hospitals [1, 2]. It was integrated in the British Thoracic Society and National Institute of Health and Clinical Excellence guidelines [1–3]. Thoracoscore was verified internally and externally by some groups which is not sufficient and the results were diverse. The observed versus predicted mortality rates showed notable differences among European countries. This fact indicates a necessity for creating an objective risk stratification model [1, 4, 7]. Thoracoscore opened up new horizons in thoracic surgery and its beginnings would hopefully lead to development of an objective and reliable risk stratification model that would help in providing patients with better quality of treatment.

This study assesses the accuracy of Thoracoscore scoring system in a major Serbian university-based thoracic surgery centre with a population of patients undergoing variety of pulmonary resections.

Methods

Patient population

Between September 2013 and October 2014, data were retrospectively collected on 196 patients operated on at the Thoracic Surgery Clinic, Institute of Pulmonary Diseases of Vojvodina. The procedures performed were: 50 pneumonectomies, 109 lobectomies and modified lobectomies (including bilobectomy and sleeve-lobectomy), 9 Wedge resections and 28 atypical resections. The Thoracoscore was calculated using these nine variables: age, sex, American Society of Anaesthesiologists (ASA) class, performance status classification, dyspnea score, priority of surgery, procedure class, diagnosis group and comorbidities score. Data were collected from the patients' charts and were entered into the hospital information system by thoracic surgeons. Thoracoscore was calculated for all patients undergoing elective, urgent or emergency pulmonary resections at the Institute for Pulmonary Diseases of Vojvodina.

Data analysis and statistical methods

Variables were noted as percentages and continuous variables as mean value ± 1 standard deviation. Descriptive statistics were used for all applicable variables. Mortality rate for all patients undergoing lung resection was calculated using Thoracoscore, and presented as the ratio of observed deaths to expected deaths. The formula used for calculating mortality in the original work of Falcoz et al. [1] was as follows: Odds = exp[−7.3737 + (0.7679 if code of age is 1 or 1.0073 if code of age is 2) + (0.4505 × sex score) + (0.6057 × ASA score) + (0.6890 × performance status classification) + (0.9075 × dyspnea score) + (0.8443 × code for priority of surgery) + (1.2176 × procedure class) + (1.2423 × diagnosis group) + (0.7447 if code of comorbidity is 1 or 0.9065 if code of comorbidity is 2)] [1]. Procedures were stratified into 4 groups: pneumonectomy, lobectomy and modified lobectomy (including bilobectomy and sleeve-lobectomy), Wedge resection and atypical resection. The groups presented as follows: Group 1 – low risk group (≤ 3%); Group 2 – moderate risk (3.1–5%); Group 3: high risk group (5.1–8%); Group 4: very high risk group (> 8%). Because the original model underestimated mortality in the moderate risk group and overestimated mortality in the high risk group, our risk groups have been modified to have different values from those in the original study by Falcoz et al. [1] In-hospital mortality for each group was observed, predicted and assessed. Calculation of the area under the reciever operating characteristic (ROC) curve was used to interpret Thoracoscore's

validity. The area under the ROC was calculated as *C* statistic. The discriminative power of the model was excellent if the area under the ROC was > 0.80, very good if > 0.75 and good if > 0.70 [6]. All data were evaluated using Statistics Package for the Social Sciences (SPSS) version 2.0 (SPSS, Inc, Chicago, IL, USA).

Results

The study included 196 patients, average age of 62 ± 9 years where 61% were males. (Table 1). Mean predicted probability of in-hospital mortality was 3.6 ± 3.2%, 95% confidence interval (CI) 3.16–4.06%, while mean actual in-hospital mortality was 3.1% (6/196) (95% CI 1.78–4.42%). Patients who were > 65 years old contributed to 3/6 (50%) of in-hospital mortality, and 4/6 (67%) of patients who died in hospital were males. Four of 6 (67%) patients underwent pneumonectomy due to malignant pathology. Each of the 4 incremental risk groups was analyzed for predictive and observed mortality (Table 2). The correlation between observed and expected mortality was 0.99, by a category of risk. Thoracoscore showed outstanding discriminatory ability with *C* statistic (0.78, 95% CI).

Discussion

Out of 9 variables in the Thoracoscore model, age,

Table 1

Patient preoperative characteristics

Characteristics	Cohort	Alive	Died perioperatively
Patients, n (%)	196	190 (96.9)	6 (3.1)
Age (years), mean ± SD			
median	62 ± 9		
range	22–80		
< 55, n (%)	33 (16.9)	32 (97.0)	1 (3.0)
55–65, n (%)	102 (2.0)	100 (98.0)	2 (2.0)
> 65, n (%)	61 (31.1)	58 (95.0)	3 (5.0)
Gender, n (%)			
male	119 (60.7)	115 (96.6)	4 (3.4)
female	77 (39.3)	75 (97.4)	2 (2.6)
Diagnosis group, n (%)			
benign	19 (9.7)	19 (100)	0 (0)
malignant, n (%)	177 (90.3)	171 (96.6)	6 (3.4)
Procedure clases			
pneumonectomy	50 (25.5)	46 (92)	4 (8)
lobectomy and modified lobectomy	109 (55.6)	107 (98.2)	2 (1.8)
wedge resection	9 (4.6)	9 (100)	0 (0)
atypical resection	28 (14.3)	28 (100)	0 (0)
ASA class, n (%)			
≤ 2	16 (8.2)	16 (100)	0 (0)
≥ 3	180 (91.8)	174 (96.7)	6 (3.3)
Performance status classification, n (%)			
≤ 2	188 (96)	184 (97.9)	4 (2.1)
≥ 3	8 (4)	6 (75)	2 (25)
Dyspnea score, n (%)			
≤ 2	147 (75)	144 (98)	3 (2)
≥ 3	49 (25)	46 (93.9)	3 (6.1)
Priority of procedure, n (%)			
elective	196 (100)	190 (96.9)	6 (3.1)
urgent	0 (0)		
Comorbidities, n (%)			
0	32 (16.3)	32 (100)	0 (0)
≤ 2	126 (64.3)	123 (97.6)	3 (2.4)
≥ 3	38 (19.4)	37 (97.4)	1 (2.6)

SD – standard deviation; n (%) – number percentage of patients.

Table 2

Predicted *vs* observed perioperative mortality in incremental risk groups and their confidence intervals (CI)

Risk group	Patients	Mean predicted mortality (%)	CI (%)	Mean observed mortality (%)	CI (%)
Group 1 (≤ 3)	122	1.3	0.93–1.67	0.8	0.62–0.98
Group 2 (3.1–5)	36	3.4	2.92–3.88	2.8	2.47–3.13
Group 3 (5.1–8)	8	3.5	2.83–4.17	2.5	1.81–3.19
Group 4 (> 8)	31	10.1	9.53–10.67	9.7	9.35–10.05
All	196	3.6	3.16–4.06	3.1	2.65–3.55

malignancy, pneumonectomy, ASA class, performance status and dyspnea score had greatest effect on in-hospital mortality risk. Our results correspond with the results presented by Falcoz et al. [1], in their initial study. Alike independent variables for in-hospital mortality after lung resection which were recognized by Berrisford et al. [7] and Harpole et al. [8], Ferguson and Durkin [9] noted performance status as a predictor for postoperative complications. Additionally, Prause et al. [10] and Chamogeorgakis et al. [2,3] noted the ASA score as a strong indicator of perioperative mortality overall. One of the largest pneumonectomy series from the Mayo Clinic showed that pneumonectomy conveys an important risk for in-hospital mortality, contributing to 11% of deaths [11]. On the contrary, Bradley et al. [12] and Sharkey et al. [13] disclosed setbacks of Thoracoscore, highlighting its inability to predict postoperative mortality, and suggested the need for an improved scoring system in the area of thoracic surgery.

It should be mentioned that Thoracoscore model analyzes only in-hospital mortality, eliminating other risks, such as the risk of death regarded to surgery. Also, Thoracoscore consists of only 9 variables, not taking into account other factors that could possibly be as important.

Our study has a few limitations as well. First, long-term survival is not monitored, since this is the first time a scoring system for thoracic surgery was used and validated in Serbia. Second, our study is derived from a single-center database, and patient profiles greatly vary from the population in other countries. Taking into account everything listed, additional evaluation of Thoracoscore is considerably advised.

Conclusion

At our department Thoracoscore presented good performance and came across as a practical tool for predicting in-hospital mortality among patients undergoing lung resections. Older age, male gender and malignant pathology showed to be the strongest indicators of in-hospital mortality in our study. This scoring system is easy to use and, if further validated, could find its practical value in thoracic surgery units.

REFERENCES

1. *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(2): 325−32.
2. *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(3): 463−6.
3. *Chamogeorgakis T, Connery CP, Bhora F, Nabong A, Toumpoulis IK.* Thoracoscore predicts midterm mortality in patients undergoing thoracic surgery. J Thorac Cardiovasc Surg 2007; 134(4): 883−7.
4. *Barua A, Handagala S, 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(5): 556−9.
5. *Pierce RJ, Copland JM, Sharpe K, Barter CE.* Preoperative risk evaluation for lung cancer resection: Predicted postoperative product as a predictor of surgical mortality. Am J Respir Crit Care Med 1994; 150(4): 947−55.
6. *Bernard A, Rivera C, Pages PB, Falcoz PE, Vicaut E, Dahan M.* Risk model of in-hospital mortality after pulmonary resection for cancer: A national database of the French Society of Thoracic and Cardiovascular Surgery (Epithor). J Thorac Cardiovasc Surg 2011; 141(2): 449−58.
7. *Berrisford R, Brunelli A, Rocco G, Treasure T, Utley M.* Audit and guidelines committee of the European Society of Thoracic Surgeons.; European Association of Cardiothoracic Surgeons.The European Thoracic Surgery Database project: modelling the risk of in-hospital death following lung resection. Eur J Cardiothorac Surg 2005; 28(2): 306−11.
8. *Harpole DH Jr, DeCamp MM Jr, Daley J, Hur K, Oprian CA, Henderson WG*, et al. Prognostic models of thirty-day mortality and morbidity after major pulmonary resection. J Thorac Cardiovasc Surg 1999; 117(5): 969−79.
9. *Ferguson MK, Durkin AE.* A comparison of three scoring systems for predicting complications after major lung resection. Eur J Cardiothorac Surg 2003; 23(1): 35−42.
10. *Prause G, Offner A, Ratzenhofer-Komenda B, Vicenzi M, Smolle J, Smolle-Juttner F.* Comparison of two preoperative indices to predict perioperative mortality in non-cardiac thoracic surgery. Eur J Cardiothorac Surg 1997; 11(4): 670−5.
11. *Krowka MJ, Pairolero PC, Trastek VF, Payne WS, Bernatz PE.* Cardiac dysrhythmia following pneumonectomy. Clinical correlates and prognostic significance. Chest 1987; 91(4): 490−5.
12. *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(6): 1496−501.
13. *Sharkey AJ, Ariyaratnam P, Belcher E, Kendall S, Naidu B, Parry W.* Thoracoscore and European society objective score fail to predict mortality in a United Kingdom multicentre study. Interact Cardiovasc Thorac Surg 2013; 17(Suppl 2): S131.

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