Major morbidity after lung resection: a comparison between the European Society of Thoracic Surgeons Database system and the Thoracic Morbidity and Mortality system

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ABSTRACT

Objective: The Thoracic Morbidity and Mortality (TM&M) classification system is a method for univocally coding the postoperative adverse events by their complexity of management. The aim of the present study was to compare the distribution of the severity of complications according to the TM&M system versus the distribution according to the classification proposed by European Society of Thoracic Surgeons (ESTS) Database in a population of patients submitted to lung resection in our unit.

Methods: 457 patients with any type of complications (326 lobectomy, 60 pneumonectomy, 71 wedge/segmentectomy) out of 1,518 patients submitted to pulmonary resections (January 2000-April 2011) were analyzed. Each complication was graded from I to V (TM&M system), reflecting an increasing severity of management. We verified the distribution of the different grades of complications and analyzed their frequency among those defined as "major cardio-pulmonary complications" by the ESTS Database.

Results: According to the TM&M system, 0.6% of complications were regarded as grade I, 66.3% as grade II, 9.5% as grade IIIa, 4.4% as grade IIIb, 6.8% as grade IVa, 3.3% as grade IVb and 9.1% as grade V. According to the ESTS definitions, 290 complications were regarded as "major". Sixty two percent of them were reclassified as minor complications (grade I or II) by the TM&M classification system.

Conclusions: The application of the TM&M grading system questions the traditional classification of complications following lung resection. This grading system may be used as an additional endpoint for outcome analyses.

KEY WORDS Lung cancer surgery-outcomes-surgery; complications

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Introduction

The rate of postoperative complications is often used in our specialty as a parameter for evaluating both the effectiveness of treatment and the quality of care (1,2). However, a standardized grading of complication is lacking.

The Thoracic Morbidity and Mortality (TM&M) classification system of surgical complications has been proposed as a method for classifying the postoperative adverse events, based on the complexity of the therapeutic procedure necessary to treat them (3).

The aim of the present study was to compare the distribution of the severity of complications according to the TM&M system versus the distribution according to the classification proposed by European Society of Thoracic Surgeons (ESTS) Database (4) in a population of patients submitted to lung resection in our unit.

Materials and methods

This is a retrospective study performed on data prospectively collected in an electronic clinical database, approved by the local Institutional Review Board. Informed consent was obtained from all patients to use their personal information and data for clinical and scientific purposes.

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The local data manager prospectively performed the data collection. The demographic and clinical information of all patients submitted to pulmonary resection in the previous 30 days were entered into an electronic database on a monthly basis. Table 1 lists the database variables used for the present study and how they were codified. All the included variables had a level of completeness greater than 95%.

We included in the present analysis all patients consecutively submitted to pulmonary resection in our Institution from January 2000 to April 2011. Within this cohort, those patients experiencing at least one postoperative complication were analyzed.

Definition of different types of complications and TM&M classification system

Postoperative adverse events were classified according to the definitions proposed by the ESTS Database Committee (2,4,5). According to these definitions the "major cardiopulmonary morbidity" included any of the followings, regardless the complexity of treatment used to manage them: pneumonia, atelectasis requiring bronchoscopy, adult respiratory distress syndrome, mechanical ventilation longer than 24 h, pulmonary edema, pulmonary embolism, myocardial ischemia, cardiac failure, arrhythmia, stroke, acute renal insufficiency.

The TM&M classification system (3,6) is a method for classifying the complications after thoracic surgery based on the Clavien-Dindo classification schema (7,8). Following this method, each complication is graded from I to V, reflecting an increasing severity and complexity of management regardless the type of complication. Table 2 shows the different grades of complications as defined by the TM&M classification.

For the purpose of this study, we recoded all postoperative complications registered in our database using the TM&M classification system. For patients with multiple complications, we considered only the most severe one, as suggested by Seely and colleagues (3). Two staff surgeons independently reviewed each complicated patient and assigned the correspondent TM&M grade for the reported complication. Disagreements between reviewers were resolved by consensus.

Managements of complications were prospectively collected in the medical records and in the clinical database, which were reviewed for retrieving that information and assigning the score.

We then verified the frequency of distribution of the different grades of complications in our series and in particular among those patients who had been classified as having major cardiopulmonary complications according to ESTS definitions.

A descriptive statistics was used. Results are reported as means and standard deviation for numeric variables or frequency of occurrence for categorical variables. The statistical analysis was performed on Stata 9.0 statistical software (Stata Corp. College Station, TX).

Results

From January 2000 to April 2011, 1,518 consecutive patients were submitted to pulmonary resection in our Unit. Among them, 457 patients experienced at least one complication. The following 290 complications were classified as major cardiopulmonary complications according to the ESTS criteria: 112 arrhythmia, 84 pneumonia, 40 atelectasis requiring bronchoscopy, 16 adult respiratory distress syndrome, 16 pulmonary edema, 14 myocardial ischemia, 4 cardiac failure, 3 stroke, 1 acute renal insufficiency.

Table 3 shows the baseline and surgical characteristics of the entire population and of those patients with and without complications. The majority of patients were submitted to pulmonary lobectomy for primary malignant neoplastic disease. Compared to non-complicated patients, those with complications were older (P<0.001), were more frequently male (P<0.001), underwent more frequently to major anatomic resections for lung cancer (P<0.001). Moreover, the complicated patients had significantly lower values of Forced Expiratory Volume in one second (FEV1) (P<0.001) and Carbon Monoxide Lung Diffusion Capacity (DLCO) (P<0.001) and higher American Society Anesthesiologists (ASA) (P<0.001) and Eastern Cooperative Oncology Group (ECOG) scores (P<0.001).

Table 4 shows the distribution of postoperative complications by their complexity of management according to the TM&M classification system. More than 65% of complications were graded as minor complication (72% after lobectomy and 30% after pneumonectomy).

Twenty three percent of total complications were defined as major according to the TM&M classification (including mortality). These complications occurred in approximately 7% of the total population of operated patients.

According to the ESTS definitions, major cardiopulmonary complications occurred in 63% of complicated patients corresponding to 19% of the total population.

As reported in Table 5, ESTS-defined major cardiopulmonary complications required a major treatment or lead to death (grade III to V according to the TM&M system) in only 38% of cases. Sixty-two percent of major cardiopulmonary complications according to ESTS definitions were therefore recoded as minor complications according to TM&M. On the other hand, 38 complications not defined as major according to the ESTS were recoded as major complications (III or IV) according to the TM&M system due to their complex management. None of them however lead to death-grade V.

Discussion

The definition of quality in a health care system is very difficult

Table 1. Variables used for the analysis.

Variable	Description
Patient ID	Code
Gender	- Male - Female
Age	Number
Date of operation	Date
Type of operation	- Wedge/segmentectomy - Lobectomy - Pneumonectomy
Diagnosis/Morphology	- Primary neoplastic malignant - Secondary neoplastic malignant - Other
Postoperative complications - Pneumonia - Pulmonary embolism - Pulmonary edema - Mechanical ventilation (>24 h) - Atelectasis - ARDS - Respiratory failure - Prolonged air leak (>5 days) - Bronchopleural fistula - Atrial arrhythmia - Ventricular arrhythmia - Myocardial infarct - Heart failure - Renal failure - Empiema - Chylothorax - Emothorax - Neurological complication - Other	Y/N
Grouping of complication - Pulmonary complication - Cardiac complication - Major cardio-pulmonary complication	Y/N
Treatment for complication	- Reoperation - Other (description free text)
ICU	Y/N
Outcome at discharge	- Alive - Died
Outcome at 30th day	- Alive - Died
FEV1%	Number
DLCO%	Number
BMI	Number
ASA	Value
ECOG	Value

Acronyms: ARDS, Adult Respiratory Distress Syndrome; ICU, Intensive Care Unit; FEV1, Forced Expiratory Volume in one second; DLCO, Carbon Monoxide Lung Diffusion Capacity; BMI, Body Mass Index; ASA, American Society Anesthesiologists score; ECOG, Eastern Cooperative Oncology Group score.

Table 2. Grading of complication following the TM&M classification system.

Grading		Definition/treatment performed
Minor complications	Grade I	Adverse event which alters the standard postoperative course without requiring a specific treatment
	Grade II	Pharmacologic treatment or minor intervention required
Major complications	Grade IIIa	Surgical, radiologic, endoscopic treatment, or multitherapy required without general anethesia
	Grade IIIb	Surgical, radiologic, endoscopic treatment, or multitherapy required with general anethesia
	Grade IVa	Intensive care unit treatment for single organ dysfunction required
	Grade IVb	Intensive care unit treatment for multiple organ dysfunction required
Mortality	Grade V	Adverse event which leads to death

Table 3. Baseline and surgical characteristics of all patients and comparison between not complicated and complicated patients.

Variable		All patients [1,518]	Not complicated patients [1,061]	Complicated patients [457]	P value
Age		66.3 [10.9]	65.1 [11.5]	68.9 [8.8]	<0.001*
Gender	Male	1,167 [77%]	771 [72%]	396 [87%]	<0.001†
	Female	351 [23%]	290 [28%]	61 [13%]	
Type of operation	Wedge/segmentectomy	421 [28%]	350 [33%]	71 [16%]	<0.001†
	Lobectomy	960 [63%]	634 [60%]	326 [71%]	
	Pneumonectomy	137 [9%]	77 [7%]	60 [13%]	
Diagnosis/Morphology	Primary neoplastic malignant	1,126 [74%]	735 [69%]	391 [85%]	<0.001†
	Secondary neoplastic malignant	195 [13%]	170 [16%]	25 [5%]	
	Other	197 [13%]	156 [15%]	41 [10%]	
FEV1 %		85 [20]	87 [20]	79 [18.5]	<0.001*
DLCO %		77 [20]	80 [20]	72 [19]	<0.001*
BMI		27 [13]	27 [15]	26 [4]	0.2*
ASA		2.1 [0.6]	2.1 [0.6]	2.3 [0.6]	<0.001*
ECOG		0.8 [0.8]	0.7 [0.8]	1 [0.9]	<0.001*

Results are expressed as means [standard deviation] unless otherwise indicated; *Mann, Whitney Test; †χ^2 Test. Acronyms: FEV1, Forced Expiratory Volume in one second; DLCO, Carbon Monoxide Lung Diffusion Capacity; BMI, Body Mass Index; ASA, American Society Anesthesiologists score; ECOG, Eastern Cooperative Oncology Group score.

to obtain. This is because the quality of care could be measured at different levels and from different point of view (9,10).

In our specialty the complication rate following a surgical operation is a parameter very often used to verify the level of quality delivered by health care providers (11,12). Nevertheless a universally accepted definition of what we intend for complication after a surgical procedure is lacking. Moreover different types of complications are weighted the same, even though they may imply different complexities of management and put different burdens on the postoperative course.

The TM&M system is a method for classifying the postoperative adverse events in thoracic surgery developed by Seely and coll. (3,6). This system is based on the complications classification model proposed by Dindo and coll. in 2004 (7), which grades the complications according to the effort to treat them. Following this method, each postoperative adverse event is univocally graded assigning a score that reflects an increasing severity and complexity of management.

The objective of the present investigation was to assess whether there was any discrepancy between the incidence of major complications as defined by the TM&M classification and the ESTS criteria.

We found that more than 70% of the complications registered in patients submitted to lobectomy or to wedge-segmentectomy were graded as minor complication according to the TM&M. This means that the majority of the complications experienced

Table 4. Distribution of postoperative complications by their complexity of management according to the TM&M classification system.

Grade of complication	Surgical procedure			Total	
	Wedge-segmentectomy (complicated 71 pts) [total 421 pts]	Lobectomy (complicated 326 pts) [total 959 pts]	Pneumonectomy (complicated 60 pts) [total 138]	Complicated patients (457 pts)	Entire population (1,518 pts)
Minor					
Grade I	1 (1.4%) [0.2%]	2 (0.6%) [0.2%]		0.6%	0.2%
Grade II	53 (74.7%) [12.6%]	234 (71.8%) [24.4%]	18 (30%) [13%]	66.3%	20%
Major					
Grade IIIa	3 (4.2%) [0.7%]	32 (9.8%) [3.3%]	6 (10%) [4.4%]	9.5%	2.7%
Grade IIIb	1 (1.4%) [0.2%]	10 (3.1%) [1%]	9 (15%) [6.5%]	4.4%	1.3%
Grade IVa	6 (8.4%) [1.4%]	16 (4.9%) [1.7%]	9 (15%) [6.5%]	6.8%	2%
Grade IVb	1 (1.4%) [0.2%]	8 (2.5%) [0.8%]	6 (10%) [4.3%]	3.3%	1%
Mortality					
Grade V	6 (8.4%) [1.4%]	24 (7.4%) [2.5%]	12 (20%) [8.6%]	9.1%	2.8%

( ), % on the totality of complicated patients for each type of operation; [ ], % on the totality of patients for each type of operation.

Table 5. Distribution of the major cardio-pulmonary ESTS complications following the TM&M system.

Grade of complication	Patients	%
Minor		
Grade I -II	179	61.7
Major		
Grade IIIa	27	9.3
Grade IIIb	5	1.7
Grade IVa	24	8.3
Grade IVb	14	4.8
Mortality		
Grade V	41	14.2
Total	290	100

by our patients had a minimal impact on their postoperative course and required no treatment or only pharmacologic or minor interventions. These results seem in line with the data reported by Seely and coll. in 2010 (3). Conversely, 70% of complicated patients submitted to pneumonectomy experienced major complications, reflecting a higher severity of morbidity and the consequent need of more complex treatments.

Subsequently, we pointed our attention on a specific group of adverse events, which were considered major cardio-respiratory complications according to the classification proposed by the ESTS. In our specialty this group of postoperative complications is often selected as a primary endpoint for outcome analyses or as an instrument to measure the quality of care (13).

In particular, the risk-adjusted cardiopulmonary morbidity was recently adopted as one of the parameters used to measure the outcome domain of the Composite Performance Score (CPS), a quality indicator proposed by ESTS to evaluate all aspects (preoperative, intraoperative and postoperative domains) of the surgical practice. The CPS is currently used as a pivotal evaluation instrument in the ESTS Quality Certification Program (2,5).

According to the TM&M system, only 38% of those cardiopulmonary complications defined as major by the ESTS criteria were graded III or higher. This finding may question the systematic use of un-weighted cardiopulmonary complications for outcome analyses.

A potential limitation of the present study is represented by its retrospective nature. This implies a lesser accuracy in the definition of the treatment used, especially for those complications that required just a medical treatment.

Moreover the effectiveness of the treatment for an adverse event is dependent both from the characteristics of the patient and from the type of care offered. The standardization of the therapy proposed for each complication is mandatory to obtain reliable information about its results. In relation to this aspect, we should underline that, despite in our unit the postoperative course was managed following specific pathways of care, standardized treatment protocols for postoperative complications were implemented only after January 2008.

In conclusion, we found that only one third of those complications defined as "major" according to the ESTS

Database required complex management and were graded as major complications by the TM&M system. For this reason, we think that the TM&M classification system may complement more traditional classification methods in order to reliably weigh morbidity and refine outcome analyses.

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