SPECIAL ARTICLE

Preoperative Evaluation of Patients Undergoing Lung Resection Surgery: Defining the Role of the Anesthesiologist on a Multidisciplinary Team

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IN THE FIELD of thoracic surgery, one of the key problems in lung resection is the management and function of the residual lung, which has the potential to interfere with both the pulmonary and cardiovascular systems, and, therefore, influence surgical outcome in terms of morbidity and mortality. Between 2007 and 2013, 5 papers addressing preoperative evaluation and risk stratification were published.[1-5] However, the members of the task forces responsible for these documents did not include all the professionals involved in the preoperative surgical evaluation, and the documents mainly addressed the stratification of respiratory risk. In 2014, new guidelines[6,7] addressing cardiac risk assessment in the perioperative period were published and proposed new and distinct approaches, rendering the literature on the assessment and risk stratification of thoracic surgery patients even more confusing. Guidelines are important because they have the potential to improve outcomes and quality of care, especially in high-risk surgical patients (HRSPs), and also improve the management of healthcare resources.

The most appropriate person to serve as the "perioperativist"—overseeing the involvement of all other stakeholders in the preoperative, intraoperative, and postoperative phases of the care of thoracic patients—is the anesthesiologist because of the nature of this professional's training and practice, which already require the assessment, evaluation, and preparation of patients with a multitude of complex comorbidities for surgery.[8]

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Around the world, the role of the anesthesiologist is being expanded thanks to the introduction of innovative delivery care models, such as enhanced recovery after surgery[9] and the perioperative surgical home,[10,11] which are aimed at improving patient outcome while increasing efficiency. Indeed, the 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery recognized the anesthesiologist as the ideal "perioperative physician" to coordinate the preoperative evaluation due to the anesthesiologists' unique and intensive training on the specific demands of the proposed surgical procedures.[8]

In this article, the authors discuss the key items relevant to preoperative evaluation, paying particular attention to the multidisciplinary approach, as depicted in Figure 1. The authors' goal was to establish a simple algorithm that is easy to apply in the clinical setting, an algorithm that takes into consideration the assessments made by the pulmonologist, medical and radiation oncologists, cardiologist, anesthesiologist, and, of course, the thoracic surgeon. The authors reviewed other recently published algorithms and considered the similarities and differences between them to identify the key steps that a preoperative functional evaluation should contain.

THE PULMUNOLOGIST'S PERSPECTIVE

In most cases, it is the pulmonologist who makes the diagnosis of lung cancer, and the patient then is referred to a surgeon. The evaluation of lung function status is one of the most important steps in estimating the risk of postoperative respiratory failure and outcome. Functional status is a reliable predictor of perioperative and long-term cardiac events, and patients with preoperative reduced functional status have a higher risk of developing complications,[12,13] whereas those with a good preoperative functional status are at lower risk. The majority of reports base the preoperative evaluation of respiratory function on spirometry parameters—in particular, forced expiratory volume in the first second (FEV_1) and carbon monoxide diffusing capacity (DLCO). These parameters are evaluated together and assessed as percentages of predicted values (pp), thereby taking into consideration differences related to patient age, height, weight, and sex. However, spirometry requires patient cooperation and its results must be interpreted cautiously before validation.[14-16] There is a general consensus that further tests are unnecessary when FEV_1 and DLCO are normal (ie, $>80\%$ of predicted values) and the patients are evaluated as low risk. For $ppFEV_1$ and

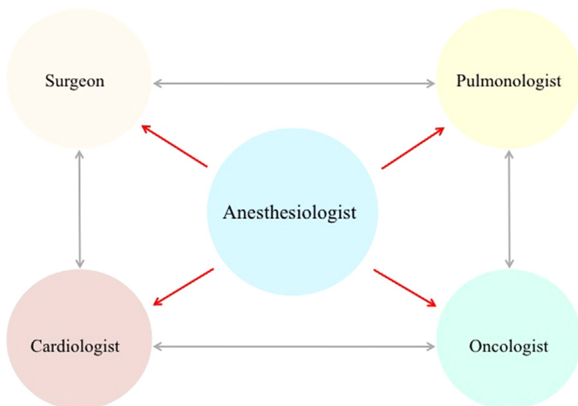

Fig 1. The "true" multidisciplinary approach requires a physician team leader, and anesthesiologists are uniquely positioned to serve as "perioperativists," actively involving all others healthcare participants.

ppDLCO >40% but <80%, the surgical risk is considered as intermediate, but this result should be subjected to interpretation, taking into account the patient's cardiovascular reserve (see the sections describing the anesthesiologist's and the cardiologist's perspective).

Some authors recently have extended this range to less than 40%, considering values as low as 30% as presenting an intermediate risk;[3,4,17-19] although the patient populations evaluated in such studies with very low levels of lung function were heterogeneous and the results were not compared with patient outcomes.[17,18] Nevertheless, this cut-off has been introduced into clinical practice on the basis of indirect evidence and expert consensus opinion.[4]

In a recent report on video-assisted thoracoscopic surgical (VATS) lobectomy, a preoperative FEV_1 or DLCO <30% of predicted values was shown to be a contraindication for surgery, and no other tests for the risk stratification of lung function were recommended at this point.[20] On the other hand, a number of other studies have suggested leaving the limit at 40%.[5,21,22] In summary, the scientific data published to date are inconsistent, making it difficult to formulate an official guideline. Because the lower proposed thresholds can be applied safely, with strong support from the literature, it seems reasonable to maintain a "safety margin" by considering the 40% cut-off and evaluating patients with values between 30% and 40% in more depth before pulmonary resection.

Arterial blood gas analysis should be performed in all patients scheduled for an elective pulmonary resection as part of the basic pulmonary function tests.[22] There is no consensus regarding a value of arterial oxygen tension that clearly indicates an increased risk for pulmonary resection. A $PaCO_2$ >45 mmHg has been associated with an increased risk of postoperative complications, but it is not considered to preclude pulmonary resection.[23] The presence of 1 of the 3 following conditions generally is associated with an increased risk of postoperative complication and/or respiratory failure: FEV_1 <30% of the predicted value, PaO_2 <60 mmHg, or $PaCO_2$ >50 mmHg.[24,25] The cardiopulmonary exercise test (CPET) commonly is used to provide information about the real cardiorespiratory reserve, and it can be performed by means of either a "high-technology" test (ie, measurement of peak oxygen consumption [VO_2 max]) or a "low-technology" test (eg, the shuttle test, stair climbing, or the 6-minute walk test with or without the measurement of oxygen saturation).[3-5] The various published guidelines recommend different tests; for example, one recommends the shuttle test over the stair climbing test,[5] and another suggests a VO_2 cut-off of 10 mL/kg/min,[4] rather than the standard value of 15 mL/kg/min.[26]

CPET generally is recommended in all patients with abnormal lung function (ie, in patients with FEV_1 and DLCO <80%). On the basis of indirect evidence and the consensus opinion of experts, but not objective clinical evidence, the DLCO cut-off value recently was changed from 80% to 60%.[4] Some guidelines suggest that exercise tests should be performed in all patients with FEV_1 and DLCO <80% as the first step in risk stratification, whereas other authors recommend that split-lung function tests are performed first and then only followed by CPET in patients with ppDLCO and/or $ppFEV_1$ <30%.[3,5]

Many different opinions have been published over recent years, generating an ambiguous situation that does not help clinicians resolve their doubts or advise them about the most suitable choices.[1-5] For concrete conclusions to be drawn, conclusive data are required, generated from large studies that compare parameters to outcome, type of surgery, and preoperative patient selection and that summarize all the different practitioner points of view.

A clear and simple guideline for clinicians is needed. The authors' response to this need is the following: high-technology testing in patients with ppDLCO and/or $ppFEV_1$ <40% followed by the stratification of patients with values ranging from 40% to 80% with "low-technology" tests (eg, stair climbing or the 6-minute walk test). If performance in these tests is less than <22 m or <400 m, respectively, these patients should be evaluated using a "high-technology" test (measurement peak oxygen consumption [VO_2 max]).

THE ANESTHESIOLOGIST'S PERSPECTIVE

Over the past decades, anesthesiologists have expanded their focus outside the operating room. This development is not unique to the United States; many countries in Europe have developed strategies to increase the role of the anesthesiologist in the perioperative setting.[8,9,27,28] None of the most recent studies on preoperative evaluation in thoracic surgery has taken into consideration the role of the anesthesiologist or the intensivist[1-5]; thus, these studies have not embraced the real advantages that a truly multidisciplinary team can offer. According to the 2014 ESC/ESA guidelines on noncardiac surgery, the anesthesiologist, who is expert on the specific domain of the proposed surgical procedure, usually should coordinate the preoperative evaluation.[7]

The aim of the anesthesiologist is to improve the surgical outcome by identifying potential anesthetic difficulties and any existing medical conditions and improving safety by assessing and quantifying risk, thereby allowing perioperative care to be planned. In this way, cardiac risk assessment plays an important role. Although the American Society of Anesthesiologists' classification of "physical status" for describing common clinical problems is used widely, multiple variations have been observed among the assessments of individual anesthesiologists.[29] The revised cardiac risk index (RCRI) should be taken into account to estimate cardiovascular risk, with its intrinsic limitations (see the section on the cardiologist's prospective) as either "moderately good or moderately bad."[30]

In thoracic surgery, a new scoring system known as thoracic-RCRI (ThRCRI) recently was introduced by Brunelli et al.[31] The ThRCRI is calculated according to the following system: pneumonectomy 1.5 points, previous ischemic heart disease 1.5 points, previous stroke or transient ischemic attacks 1.5 points, creatinine >2 mg/dL 1 point. It stratifies patients into the following 4 risk categories: group A, low risk, 0 points; group B, intermediate risk, ≥ 1.5 points; groups C and D, high risk, ≥ 2 points.[32] A ThRCRI score of at least 2 points, any cardiac condition requiring medication, newly suspected cardiac condition, or an inability to climb 2 flights of stairs should prompt cardiology consultation.[4,32] Surprisingly, only a few studies have evaluated this scoring system; moreover, its clinical application in daily clinical practice was found to be poor. One recent article found that the scoring system failed to predict the risk of cardiac complications accurately.[30]

However, in accordance with the ESC/ESA guidelines, the assessment of functional capacity status by means of daily living activities in terms of metabolic equivalents (METS) are used widely by anesthesiologists and cardiologists, and only patients with METS ≤ 4 are referred to the cardiologist for consultation.[6,7] Nevertheless, several studies recently examined the hypothesis that preoperative natriuretic peptides could help identify patients at risk of adverse cardiac events after major noncardiac surgery.[34,35] However, the power of these tests with their high negative predictive value (NPV) is particularly helpful in "opposite-direction" patients with low levels of natriuretic peptides (<100 pg/dL) who exhibit fewer complications.[36] These tests should be reserved for patients with METS <4.[7]

A preoperative cardiology consultation is only necessary for patients with METS ≤ 4 and clinical risk factors.[7,8] When the outcome of the cardiac examination is positive (assessed using clinical evaluation and noninvasive tests), the patient needs to be assessed using the CPET, which provides information about the real cardiopulmonary reserve by evaluating VO_2 max (Fig 2). A patient who attains and exceeds a VO_2 max >20 mL/kg/min is considered to be low risk; a patient with a VO_2 max between 15 to 20 mL/kg/min is considered to be intermediate risk; and a patient with a VO_2 max <15 mL/kg/min is considered to be high risk. When the results of the cardiac examination are negative (assessed using clinical evaluation and noninvasive tests), the patient's case is moved to the right side of the flowchart (Fig 2). If the values of $ppFEV_1$ and ppDLCO are less than 40%, the patient's case is returned to the left side of the flowchart and the patient is required to undergo the CPET. If the value of VO_2 max is >20 mL/kg/min, between 15 to 20 mL/kg/min, or <15 mL/kg/min, the patient is classified as low, medium, or high risk, respectively. If a patient with negative cardiac examination results and METS >4 exhibits a $ppFEV_1$ and ppDLCO between 40% to 80%, it then becomes advisable to measure the real cardiorespiratory reserve using "low-technology" tests (eg, the stair climbing test and the 6-minute walk test in the presence or absence of exercise-induced oxygen desaturation measurements). A patient who achieves the cut-off of >22 m for the stair climbing test or >400 m for the 6-minute walk test is considered to have passed the test and, as such, is classified as low risk. On the other hand, if a patient does not achieve these cut-offs, then further assessment using the VO_2 max is performed; VO_2 max values >20 mL/kg/min, between 15 to 20 mL/kg/min, or <15 mL/kg/min are considered low, medium, or high risk, respectively. If the outcome of a cardiac examination is negative with METS >4 and $ppFEV_1$ and ppDLCO $>80\%$, the patient is classified as low risk.

Postoperative recovery in the intensive care unit (ICU) should be planned before surgery for all patients requiring postoperative organ support (eg, cardiac, respiratory, renal support) and for lung transplantation patients. In some cases, the individual risk of mortality is $>5\%$ and the patients are described as HRSP due to the type of surgery.[37] A patient with an assigned risk score of more than 2 standard deviations greater than the mean value for the entire population undergoing this kind of surgery[37] is considered to be an HRSP. ICU admittance requires postoperative care "tailored" with consideration of the patient's reserve as a "pro-active" approach in terms of hemodynamic optimization[38,39] (ie, values of arterial pressure, heart rate, cardiac index, oxygen delivery, lactate levels, and central venous saturation should be maintained within acceptable ranges). In selected patients, respiratory optimization also could be "tailored",[40,41] although others have disputed this proposal.[42] This would entail improving post-extubation oxygenation with continuous positive airway pressure or noninvasive ventilation. As described by Boyd and Jackson,[37] this approach rarely is applied due to a lack of knowledge about the patient's baseline risk, a general lack of understanding about this type of analysis, and limited ICU resources. This concept reinforces the need for an "effectiveness" approach to high-risk patients in thoracic surgery. Thus, HRSPs should be scheduled for ICU admittance as part of the preoperative plan. If, for any reason, a bed in the ICU is not available, the planned surgery should not proceed.[28] If intraoperative complications occur, it goes without saying that recovery in the ICU constitutes a "reactive" response to the problem. In support of the authors' hypothesis outlined here, a recent multicenter 5-year observational study conducted in 80 general ICUs reported that the most frequent cancer types admitted to the ICU after elective surgery were colorectal carcinoma and lung carcinoma; both pathologic conditions were associated with a short length of stay and low mortality.[43]

THE CARDIOLOGIST'S PERSPECTIVE

In relation to the incidence of perioperative major adverse cardiac events (MACE) (ie, deaths and myocardial infarction within 30 days of surgical intervention), intrathoracic (non-major) surgery was considered to present an intermediate level of risk (1%-5%), whereas pneumonectomy and lung transplant surgery were considered to present high risk ($>5\%$) by the 2014 ESC/ESA guideline for patients undergoing noncardiac surgery.[6] On the other hand, in the 2014 ACC/AHA Guideline

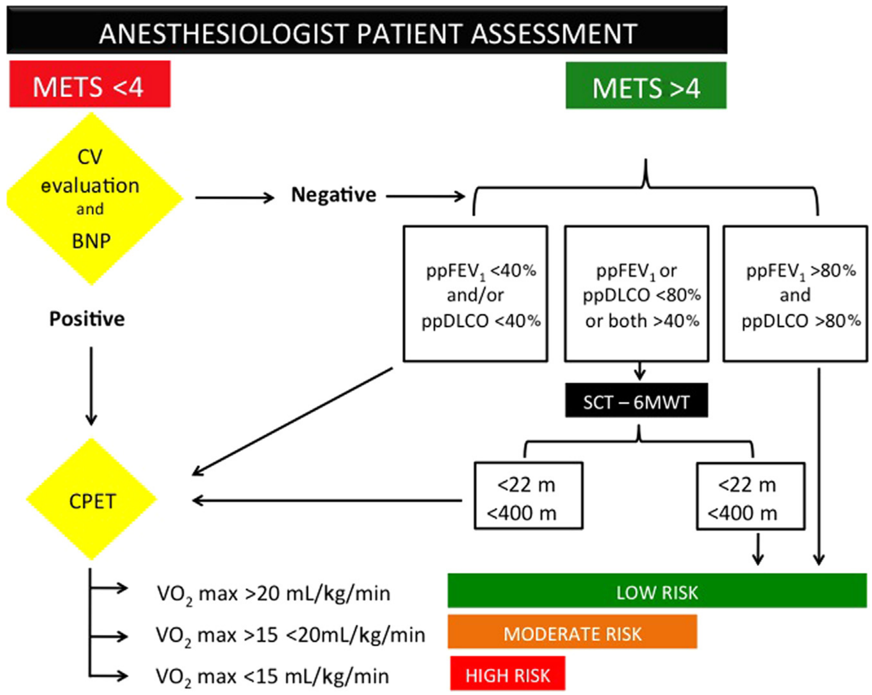

Fig 2. Algorithm flowchart for the evaluation of cardiopulmonary reserve before lung resection in lung cancer patients. Forced expiratory volume in the first second (FEV_1) and carbon monoxide diffusing capacity (DLCO) evaluated together and assessed not as absolute values but as postoperative percentages of predicted values (pp). Abbreviations: CV, cardiovascular; BNP, brain natriuretic peptide; CPET, cardiopulmonary exercise test; VO_2 max, peak oxygen consumption; SCT-6MWT, stair climbing test and 6-minute walk test.

on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery, only 2 levels of risk are considered: "low-risk" procedures, in which the combined surgical and patient characteristics predict a risk of MACE $<1\%$ (eg, cataract and plastic surgery procedures), and "elevated-risk" procedures, which include all other major procedures with a risk of MACE $\geq 1\%$.[7]

However, it also is important to note that morbidity and mortality related to the untreated underlying conditions may change the surgical outcome. Consequently, the cardiology evaluation may influence the perioperative course by attempting to reduce the cardiac risk without influencing the decision to perform the intervention. It is standard practice today to refer cardiac patients with active cardiac conditions (unstable coronary syndrome, decompesated heart failure [NYHA functional class IV; worsening or new-onset heart failure], significant arrhythmias, severe valvular disease) for cardiology evaluation; on the other hand, cardiac patients who do not present with active symptoms are stratified poorly because of the apparent reduction of indication for a cardiology visit.

Both the ESC/ESA and ACC/AHA guidelines recommend the RCRI as the preferred scoring tool to assess cardiac risk in patients undergoing noncardiac surgical procedures.[6,7] Six independent predictors of complications were identified and included in the RCRI: high-risk type of surgery, history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dL. The index classifies patients into 5 different groups and assigns risk as follows: group 0 = low risk; groups 1 and 2 = intermediate risk; and groups 3, 4, and 5 = high risk.[44] However, the ability of the RCRI to estimate the risk of cardiac complications after surgery has been reported as limited; for example, its capacity to discriminate between patients who were at low versus high risk for perioperative cardiac complications after mixed noncardiac surgery was considered moderate.[30] Moreover, the RCRI was unable to discriminate between low- and high-risk patients undergoing vascular noncardiac surgery who generally exhibited increased perioperative cardiac risk,[45-47] and other results available in the literature do not support its use for predicting all-cause mortality after major noncardiac surgery.[30]

The thoracic surgery algorithms proposed by Brunelli et al[4] and Licker et al[48] focus on the evaluations provided by the cardiologist in terms of the ThRCRI or RCRI score, but the ESC/ESA[6] recommends that if patients scheduled for thoracic surgery present in good physical status, then they should proceed to surgery without the need for a cardiologist's evaluation. It has been considered unethical and unnecessary to waste resources on these patients in the absence of any specific evidence.[33] In the authors' opinion, in cases of poor or moderate functional vital capacity, the anesthesiologist should refer patients to a cardiologist as soon as possible for the optimization of their medical therapy (eg, statins, beta-blockers). Two weeks before surgery usually is an adequate time interval to establish the benefits of the new pharmacologic treatment. Noninvasive testing only should be considered for selected cases, such as in patients with coronary artery revascularization.

In patients at increased risk of postoperative morbidity, noninvasive stress testing is expensive and has been shown to have a low predictive positive value (ie, it has a high false positive rate), which might cause more harm than good.[49,50] Functional capacity often is expressed in terms of METS, in which 1 MET is the basal oxygen consumption of a 40-year-old man weighing 70 kg. In the literature addressing perioperative management, functional capacity is classified as excellent (>10 METS), good (7-10 METS), moderate (4-6 METS), poor (<4 METS), or unknown. Perioperative cardiac and long-term risks are increased in patients unable to perform 4 METS of work during daily activities. Guidelines only recommend a preoperative consultation with a cardiologist for patients with METS ≤ 4 and clinical risk factors.[51,52]

For the first time, the 2014 ESC/ESA guidelines clearly mentions use of the biomarker brain natriuretic peptide (BNP).[6] The measurement of plasma levels of BNP or its N-terminal fragment is being used increasingly in the perioperative setting.[53,54] A number of studies recently examined the hypothesis that elevated preoperative plasma concentrations of natriuretic peptides can be used to identify patients at risk for adverse cardiac events.[55,56] However, considering the data published to date, the assessment of serum biomarkers for patients undergoing noncardiac surgery cannot be proposed for routine use, although it may be considered in high-risk patients (METS ≤ 4 or with a RCRI >1 for vascular surgery and >2 for nonvascular surgery).

Supraventricular arrhythmias and, in particular, atrial fibrillation (AF) are important complications in thoracic surgery, occurring in up to 44% of patients after pulmonary and esophageal surgery.[40] The incidence of AF is associated with an increased risk of pulmonary complications, increased length of hospital stay, and increased mortality. The 2014 AHA guidelines for the management of patients with AF suggest treating patients who develop AF after cardiac and thoracic surgery with a beta-blocker unless contraindicated; the guidelines also mention the preoperative administration of amiodarone in patients at high risk of developing AF while undergoing cardiac and thoracic surgery.[57]

SURGICAL PERSPECTIVE

In the early stage of non–small cell lung cancer, surgery continues to present the best option.[58-61] However, due to increases in life expectancy; pollution; and cigarette use, abuse, and misuse, lung resection also often is required in patients with decreased pulmonary function and increased cardiovascular risk—in other words, in HRSPs.[37] The extent of lobar resection (ie, lobectomy, bilobectomy, sleeve-lobectomy up to pneumonectomy, and sublobar resections [ie, segmentectomy and wedge resection]) depends on oncologic staging and the clinical impact on the patient's functional status.[59,60] Mediastinal lymph node dissection is essential to achieve accurate staging, and together with lung resection improves the survival rate. The use of video-assisted and robotic-assisted thoracic surgery (VATS and RATS) are becoming increasingly popular, such that they constitute 2 of the most common forms of surgery practiced in many institutions today.[61-64] These approaches often are associated with quicker recovery times, shorter lengths of hospital stay, and lower complication rates.[65,66] When feasible, from both the technical and oncologic perspectives, VATS (and often RATS) provides an optimal strategy for patients with marginal function and early stage I or II lung cancer and for patients with pulmonary metastatic lesions (Fig 3).[5,20,58-61] The level of cardiac risk that a patient presents also can guide the type of surgery selected and may favor less invasive interventions, such as VATS and RATS, that generally are correlated with lower rates of overall perioperative morbidity in terms of pneumonia and atrial arrhythmia.[64-66] Thanks to these advances in surgical care, morbidity and mortality rates after lung resection have decreased significantly over time. The current rates of mortality, as reported by the Society of Thoracic Surgeons and the European Association of Cardio-Thoracic Surgery, are between 1.6% to 2.3% after lobectomy and 3.7% to 6.7% after pneumonectomy.[4,67,68] Indeed, a growing body of evidence demonstrates improved surgical outcomes and better long-term survival rates in patients treated by surgeons specializing in lung cancer in high-volume cancer centers.[69,70] Another important medical advancement has come in the form of stereotactic ablative radiotherapy (SABR). SABR can be chosen as an alternative to surgery, especially in high-risk patients, for the treatment of early stage non–small cell lung cancer. Clear benefits of SABR have been reported; however, although overall survival rates at 1 year were comparable between SABR and sublobar resection (81%-85.7% *v* 92%, respectively), overall 3-year survival was significantly higher after sublobar resection (87.1% *v* 45.1%-57.1%).[71]

A final, yet very important, consideration is that the surgeon must take into account the views of the patient and their caregivers and their willingness to accept, or not, the degree of disability that may be endured over the course of the postoperative period. As eloquently discussed in a narrative article about quality of life, the patient's wishes always should be respected.[72]

OTHER RISK FACTORS

The presence of multiple risk factors in thoracic surgery could change preoperative risk stratification and perioperative management. Comorbidities other than cardiac disorders in the lung resection surgical population could lead to increases in

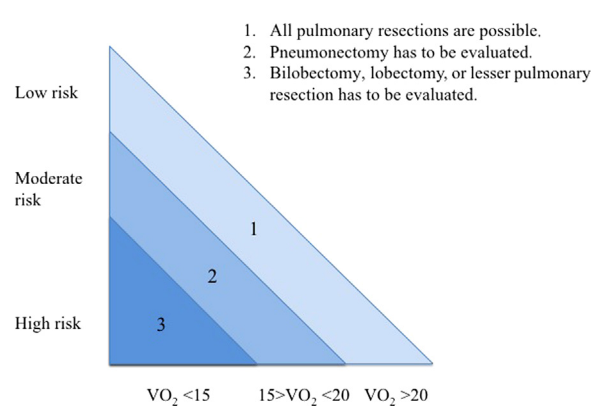

Fig 3. The combination of functional capacity, patient risk, and type of surgery and the need for patient tailoring. Abbreviation: VO_2 max, peak oxygen consumption.

morbidity and mortality and may require more detailed explanation compared with those occurring in other patient populations.

Renal Disease

Preoperative kidney disease is an independent risk factor for adverse postoperative cardiovascular outcomes, including myocardial infarction, stroke, and the progression of heart failure.[6,36] Preoperative end-stage renal disease and hemodialysis increase the mortality rate after pulmonary resection by approximately 4-fold.[73-75] In the Society of Thoracic Surgeons (STS) database, postoperative renal dysfunction after pulmonary resections, defined as the doubling of plasma creatinine levels or the requirement for renal replacement therapy, was reported to occur in 1.4% of surgery patients and has been identified as a strong predictor of mortality and composite major morbidity.[75-77] However, the true incidence of acute kidney injury in lung surgery likely is underestimated due to the use of different definition criteria and the absence of any systematic measurement of creatinine levels.[78,79]

Obesity

The impairment of central responses and sleep-disordered breathing associated with obesity can lead to hypercapnia and hypoxia.[80] However, in lung surgery, a high body mass index is not associated with an increased risk of mortality.[80] In all patients, the use of aggressive pain control, early mobilization, pulmonary hygiene, physical therapy, and VATS procedures contribute to maintaining low morbidity rates.[81] Nevertheless, respiratory complications after standard pneumonectomy for lung cancer are 5-fold more frequent in overweight and obese patients than in subjects with a body mass index <25 kg/m^2.[82]

Age

Age has been identified as an independent predictor of complications arising from lung resection,[5,83,84] the severity of which depends on the grade of surgery. The British Thoracic Society has shown that pneumonectomy is associated with higher mortality risks in the elderly and that age should be a factor in deciding suitability for pneumonectomy.[85,86] However, with careful preoperative selection, patients older than 70 years undergoing wedge resection, segmentectomy, or lobectomy with good exercise tolerance and adequate cardiopulmonary reserves have not shown higher morbidity and mortality risk.[86] For example, 1 study assessing complications and outcomes after pulmonary resection in patients ages 80 to 89 reported no postoperative deaths in 40 patients undergoing lesser resection (16 lobectomies [40%], 12 segmentectomies [30%], and 12 wedge resections [30%]).[87] Nevertheless, surgical risk depends on comorbidities, the probability of which generally increases with age.

DISCUSSION

In the preoperative evaluation of patients undergoing lung resection, all professionals (surgeon, pulmonologist/oncologist, radiologist, and anesthesiologist) normally should meet 1 day a week to discuss the most complex cases, their timing, and their course as part of a hospital-approved protocol. The need for a multidisciplinary approach that encompasses the different aspects of preoperative patient evaluation should be addressed and discussed by pulmonologists/oncologists, cardiologists, surgeons, and anesthesiologists. After a decision about the patient's management is reached, a report should be sent to the practitioners who attended the meetings. On the other hand, routine cases should be managed as a regular preoperative workup, including the traditional testing, as previously described. Simplification of the available algorithms reported in the literature should lead to easier clinical application.[1-5,48]

As in all management situations, a single practitioner should be responsible for coordinating the preoperative evaluation in terms of risk stratification, assembling and assessing the perspectives, and evaluating the assessments of all the clinicians involved (ie, the surgeon's, pulmonologist's/oncologist's, cardiologist's, and anesthesiologist's). Surprisingly, all previous guidelines have failed to recognize the importance of such a central figure.[1-5] The authors hope that this approach and proposed algorithm correctly interpret the actual processes occurring in everyday clinical practice, bringing clarity to the overall procedure. The pulmonologist's perspective considers the limits related to the residual pulmonary function and the related risk of functional disability. The value of arterial oxygen tension, clearly pivotal for evaluating risk in pulmonary resection, is easy to assess during the entire perioperative period. The cardiologist's perspective is essential for adapting the therapy. The assessment of functional cardiac reserve is mandatory for all patients with a high risk of MACE. The prophylactic use of beta-blockers, statins, and amiodarone during the perioperative period needs to be considered. The surgeon's perspective describes the indications, levels of complexity, and complications associated with the different lung resection procedures and also must be respectful of the informed patient's wishes.

Adopting a multidisciplinary preoperative assessment approach to lung resection will increase hospital efficiency and save resources.[9,10,28] By identifying HRSPs, the most suitable measures to evaluate can be identified to optimize anesthesia management, hemodynamics, and postoperative recovery in the ICU.[37-39] Patients undergoing bilobectomy, pneumonectomy, or other major resections need to be treated in a protective environment by specialized physicians and nurses, in the ICU.[43]

The proposed multidisciplinary approach is not without limitations. Preoperative assessment of functional capacity uses METS as its unit of measure, which indicates energy expenditure as multiples of the baseline metabolic rate, assumed to be 3.5 mL of oxygen per kg of body weight per minute.[88] Some "asymptomatic patients" with unknown AF or serious AV block or a prior asymptomatic myocardial infarction and METS >4, also may require cardiologist consultation. CPET generally is considered to be the "gold standard" for the assessment of exercise capacity; however, patients with severe morbidity (including a history of cardiac ischemic events) may not be able to undergo this or other subjective tests of cardiorespiratory reserve, such as metabolic equivalency tests.[89,90]

CONCLUSIONS

The assessment of risk related to lung resection is a complex process that takes into account the results of a multitude of patient tests (including pulmonary and cardiac evaluation), intervention type, age, and other risk factors. Many specialists should be involved in risk stratification at the preoperative stage and in the perioperative management of the patient, as widely described by the most recent quality models of perioperative medicine. A team consisting of just pulmonologists/oncologists and thoracic surgeons, who play fundamental roles in selecting the best cancer treatments, is not necessarily well-equipped for the comprehensive management and risk stratification of the candidate for surgical treatment. Only a multidisciplinary team that includes the aforementioned specialists and an anesthesiologist, who is involved in the management of the patient, is able to assess the overall risk of the procedure, optimize the perioperative conditions and plan the appropriate treatment regimens to minimize postoperative complications and length of hospital stay. In this way, joint decisions can be made for each patient, even when the literature presents different opinions based on the various individual perspectives. Of the various specialists involved, it is the anesthesiologist, together with the surgeon, who observe the patient throughout the duration of treatment, including the preoperative, intraoperative, and postoperative periods; thus, the anesthesiologist is best equipped to tailor and optimize the treatment strategy.

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