Necessity of the heart, for lung resection

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Cardiac complications are the second most common cause of perioperative morbidity and mortality in patients undergoing non-cardiac thoracic surgery. The estimated risk of major postoperative cardiac complications within the first 30 days after surgery is 2–3% and account for at least one-third of perioperative deaths (1,2). Aside from mortality, perioperative cardiac complications result in substantial morbidity, prolonged hospitalization, and increased cost. Furthermore, such events can negatively impact both the intermediate and long-term prognosis of the thoracic malignancies being treated operatively. Therefore, preoperative cardiovascular risk evaluation should be considered mandatory and essential in the assessment of patients undergoing non-cardiac thoracic surgery. Frequently debated is the nature of the cardiac testing that should be performed given the lack of uniform guidelines.

In this issue of the Journal, Liu and colleagues investigated the impact of preoperative cardiovascular evaluation on the perioperative cardiovascular risk of patients undergoing surgery for lung cancer. The main aspects of the study incorporated cardiovascular-related assessments on the safety and outcomes of lung cancer surgery. Recommended preoperative cardiac function tests for patients undergoing lobectomy included: (I) 12 lead electrocardiogram (irrespective of known cardiovascular disease), (II) echocardiography for unexplained dyspnea, cardiomyopathy, suspected heart failure, or stable heart failure with echocardiographic assessment greater than 12 months, (III) exercise stress testing in patients with risk factors for myocardial ischemia with poor functional capacity (<4 metabolic equivalents) or lack of functional capacity, (IV) 6 minute walk test or stair climb test in asymptomatic patients with risk factors, and (V) coronary angiography in patients with known coronary heart disease. Beyond these recommendations, additional preoperative cardiac function tests are individualized and involve multidisciplinary management in order to identify the best preoperative clinical strategy, and cardiology consultation should be obtained preoperatively in all patients with known cardiac disease.

Accurate preoperative risk stratification is paramount to mitigate the risk of perioperative cardiac complications. Valid estimates of the risks and benefits of surgery can facilitate informed decision-making about the appropriateness of surgery. Accurate cardiac risk estimation can also guide intraoperative surgical management decisions and inform decisions around monitoring during and after surgery. Together these factors can allow for appropriate preoperative medical optimization, timely cardiac-specific interventions, and guidance regarding perioperative management. Most importantly, preoperative cardiac risk assessment provides patients the opportunity to make a truly informed decision regarding surgical treatment.

Three important factors primarily affect the risk of perioperative cardiac complications associated with non-cardiac thoracic surgery include surgery-related factors, patient-related factors and the urgency of the surgical procedure. Surgery itself is an established risk for cardiovascular complications, and only no surgery or intervention is associated with no perioperative risk. Unrecognized or unappreciated cardiac disease significantly increases the risk of major adverse cardiac event of death or myocardial infarction. Aside from these two factors, other

risk factors are on a cardiovascular disease continuum which may be modifiable to alter perioperative risk.

Clinical risk indices, such as the Revised Cardiac Risk Index (RCRI), the National Surgical Quality Improvement Program (NSQIP) Myocardial Infarction and Cardiac Arrest calculator or the American College of Surgeons—NSQIP surgical risk calculator, and clinical practice guidelines have been developed to help make informed decision-making (3). These strategies typically group procedures into broadly defined anatomical categories for the sake of simplicity and to facilitate ease of use. However, these broad categories can potentially underestimate the true risk of the operation. Alternatively, risk assessments, such as the RCRI, consider patient factors more than the risk of the operation. This approach may overestimate risk and result in unnecessary consultations, unnecessary costs, delays in surgery, and even harm from further investigations.

The European Respiratory Society, the European Society of Cardiology, the European Society of Thoracic Surgery, the American College of Chest Physicians, and the American College of Thoracic Surgeons recommend cardiac evaluation prior to lung resection based on the American Heart Association/American College of Cardiology (AHA/ACC) guidelines (4,5). Three general groups are identified based on their estimated 30-day cardiac event rates: low risk (<1%), intermediate risk (1–5%) and high risk (>5%). Because these modifiable risk factors function on a continuum, simple classification into these three categories may have limited clinical usefulness. Routine "screening", which refers to testing for a disease or condition in an asymptomatic low-risk patient, is not warranted secondary to questionable benefit. Such testing can lead to invasive follow-up tests, such as angiography, and procedures, such as percutaneous revascularization with their attendant costs and harms and low clinical benefit. At the other end of the spectrum, as exemplified in this expert consensus, symptomatic or high-risk patients warrant further testing to further elucidate risk of perioperative cardiac complications.

Surgery is considered the optimal treatment option for patients with early stage lung cancer, and lung resection has substantial impact on the cardiorespiratory system as a whole (6). Although the impact of lung resections on myocardial function has not been clearly established, patients undergoing major lung resection, are considered intermediate risk by most clinical risk indices (3). Atrial fibrillation is the most reported frequent cardiac complication following lung resection, however, unless present preoperatively, the arrhythmia is generally transient and resolves within days to weeks after surgery (7). By contrast, nonfatal and life-threatening cardiac complications occur in over one-third of patients undergoing lung resection (8). These patients often are smokers, have increased risk factors for atherosclerotic disease and are of older age. The highest risk of cardiac complications occur in patients undergoing a pneumonectomy, with a reported risk of 15% in some series (9). Such effects are thought to derive from the dramatic physiologic alterations associated with pneumonectomy, including alterations in pulmonary artery pressure, increase in dead space to alveolar space ratio, reduction of effective diffusion capacity and increased myocardial strain (9). Similar events can occur with lobectomy but to a lesser extent. Unfortunately, the RCRI has not been shown to accurately predict cardiac events and/or mortality in neither patients undergoing lung resection nor vascular surgery. Therefore, a modified RCRI, referred to as the Thoracic-RCRI (Th-RCRI) was formulated for patients undergoing lung resection (1,2,10-14). The Th-RCRI is comprised of the 4 variables and their corresponding specific weight for the final index: (I) history of coronary artery disease or previous ischemic heart disease, 1.5 points, (II) cerebrovascular disease, previous stroke or transient ischemic attack, 1.5 points, (III) serum creatinine >2 mg/dL, 1 point, and (IV) pneumonectomy, 1.5 points. Four different risk classes which help predict incremental risk of cardiac morbidity are generated by summing the points:

- (I)   Class A (0 points): risk of cardiac complication =1.5%;
- (II) Class B (1–1.5 points): risk of cardiac complication =5.8%;
- (III) Class C (2–2.5 points): risk of cardiac complication =19%;
- (IV) Class D (>2.5 points): risk of cardiac complication =23%.

Although, the Th-RCRI achieved higher discriminative factor than the original RCRI, its effectiveness is variable based on the type of lung resection (segmentectomy, lobectomy, or pneumonectomy). As previously reported, the ThRCRI was developed and validated at major referral centers for pulmonary surgery with experienced, high-volume surgeons (14). Therefore, caution should be exercised when using the ThRCRI. However, the most recent guidelines of the American College of Chest Physicians suggest that patients with a RCRI >2 or ThRCRI >1.5 be referred for a formal cardiology evaluation (5). Furthermore, a general consensus from thoracic surgery societies guidelines recommends a

cardiology evaluation for patients undergoing lung resection with any cardiac condition requiring medication, recent diagnosis of active heart disease or limited exercise capacity (inability to climb 2 flights of stairs) (4,5).

Utilization of algorithms guide risk assessment and help quantify risk probability for an individual patient in the perioperative period. Such algorithms aide surgeons in selecting patients for operations and allow patients to make informed decisions regarding risk and benefits prior to lung resection. However, further research is needed to further improve and optimize preoperative risk stratification to prevent or decrease postoperative cardiac complications.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Brunelli A, Varela G, Salati M, et al. Recalibration of the revised cardiac risk index in lung resection candidates. Ann Thorac Surg 2010;90:199-203.
2. Brunelli A, Cassivi SD, Fibla J, et al. External validation of the recalibrated thoracic revised cardiac risk index for predicting the risk of major cardiac complications after lung resection. Ann Thorac Surg 2011;92:445-8.
3. Cohn SL, Fernandez Ros N. Comparison of 4 Cardiac Risk Calculators in Predicting Postoperative Cardiac Complications After Noncardiac Operations. Am J Cardiol 2018;121:125-30.
4. Kristensen SD, Knuuti J, Saraste A, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). Eur Heart J 2014;35:2383-431.
5. Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;130:e278-333.
6. Ettinger DS, Aisner DL, Wood DE, et al. NCCN Guidelines Insights: Non-Small Cell Lung Cancer, Version 5.2018. J Natl Compr Canc Netw 2018;16:807-21.
7. Fernando HC, Jaklitsch MT, Walsh GL, et al. The Society of Thoracic Surgeons practice guideline on the prophylaxis and management of atrial fibrillation associated with general thoracic surgery: executive summary. Ann Thorac Surg 2011;92:1144-52.
8. Keshava HB, Boffa DJ. Cardiovascular Complications Following Thoracic Surgery. Thorac Surg Clin 2015;25:371-92.
9. Groth SS, Burt BM, Sugarbaker DJ. Management of Complications After Pneumonectomy. Thorac Surg Clin 2015;25:335-48.
10. Ferguson MK, Celauro AD, Vigneswaran WT. Validation of a modified scoring system for cardiovascular risk associated with major lung resection. Eur J Cardiothorac Surg 2012;41:598-602.
11. Ferguson MK, Saha-Chaudhuri P, Mitchell JD, et al. Prediction of major cardiovascular events after lung resection using a modified scoring system. Ann Thorac Surg 2014;97:1135-40.
12. Brunelli A, Ferguson MK, Salati M, et al. Thoracic Revised Cardiac Risk Index Is Associated With Prognosis After Resection for Stage I Lung Cancer. Ann Thorac Surg 2015;100:195-200.
13. Salati M, Brunelli A. Risk Stratification in Lung Resection. Curr Surg Rep 2016;4:37.
14. Wotton R, Marshall A, Kerr A, et al. Does the revised cardiac risk index predict cardiac complications following elective lung resection? J Cardiothorac Surg 2013;8:220.