EDITORIAL I

Not fit for a haircut . . . how should we assess fitness and stratify risk for surgery?

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Owing to increases in life expectancy, the patients presenting for surgery are older, and have more co-morbidities. Worldwide, 3–4% of patients die within 2 months of major surgery, with increased mortality and morbidity in high-risk surgical candidates, including the elderly and medically unwell. In Australia and New Zealand, older patients having non-cardiac surgery have a 20% risk of serious complication and a 5% risk of dying within 30 days of surgery. The cost to patients and the community is enormous. In a cohort of 806 534 Medicare beneficiaries having surgery in America, 51.5% of patients discharged after a surgical procedure had either died or been readmitted to hospital within a year, and 70.5% of readmissions were for a medical problem.

Predicting surgical risk is relevant to physicians, patients, and health economists alike. Better predictive ability may allow us to allocate resources, streamline specialist tertiary centres, plan postoperative care, and better inform patients so they can make appropriate life decisions and potentially reconsider going ahead with surgery. With these and other targeted perioperative interventions, it may be possible to decrease morbidity and mortality for patients and the associated healthcare costs to the community.

The ability to predict which patients are ‘fit for surgery’ has long been discussed in the literature. International practice guidelines recommend that any patient who is undergoing elective major non-cardiac surgery and does not have an unstable cardiac condition should proceed directly to surgery, provided that they can perform four metabolic equivalents of activity without symptoms. Historically, clinicians have made a subjective assessment of whether patients could exercise to this level based on patient history, physical examination, and sound clinical judgement. However, this mode of assessment has been shown to be poorly predictive of postoperative morbidity and mortality.

More recently, preoperative assessment has included questionnaires such as the Duke Activity Status Index, risk prediction tools, and biomarkers including B-type natriuretic peptide. Basic objective tests of functional capacity such as the 6 min walk test have also been used to predict perioperative risk and to plan wait-listing for cardiorespiratory transplant. In addition, specific variables are used to predict risk for certain types of surgery. For example, carbon monoxide gas transfer factor, pulmonary artery pressures, and ventilation–perfusion ratios may be used to predict morbidity and mortality in patients undergoing thoracotomy for lung cancer resection.

Cardio-pulmonary exercise testing (CPET) is an objective measure of functional capacity that seems to have an expanding role in the assessment of patients with cardio-pulmonary disease and has received much attention in the anaesthetic literature for its ability to identify ‘unfit’ patients. Two articles previously published in the BJA consider different aspects of CPET. Laughney and colleagues consider arm ergometry as an alternative for patients who cannot complete CPET because of an inability to effectively pedal a bicycle, while James and colleagues report a pilot study comparing the predictive
ability of CPET to plasma biomarkers and two risk scoring systems.

Major surgery is accompanied by tissue injury, systemic inflammation, and a neurohumoral stress response that challenges the body in a manner thought to be similar to the cardio-pulmonary, metabolic, and muscular stress produced by CPET. The strength of CPET is that it tests the ability of the whole cardio-pulmonary, circulatory, and metabolic systems to work maximally. Two recent systematic reviews provide evidence that CPET is able to predict morbidity and mortality after major non-cardiac surgery.

CPET is administered by trained professionals in a laboratory environment according to guidelines produced by The American Thoracic Society and The American College of Chest Physicians. The central measure for preoperative risk obtained from CPET is the VO2 peak. Previous studies have suggested that a VO2 peak of more than 20 ml min⁻¹ kg⁻¹ is associated with a low risk of complications after lung resection, whereas a VO2 peak of <15 ml min⁻¹ kg⁻¹ confers a high risk. Of note, this cut-off in VO2 peak is based on cycle CPET, where large muscle groups with a high metabolic requirement (i.e. increased VO2) are used. As such, the benefit of CPET may be limited in patients who are unable to reach their VO2 peak.

One such group comprises those patients with lower limb dysfunction resulting from arthritis or peripheral vascular disease. Philbin and colleagues demonstrated that roughly 40% of patients presenting for lower limb arthroplasty were unable to complete cycle ergometry. Unfortunately, this comorbidity is a frequent occurrence in many of the high-risk patients in whom CPET is likely to be performed. Although the inability to perform CPET or reach an anaerobic threshold may itself be predictive of poor outcome, it would be preferable to generate objective data for risk prediction in this group.

One way to get around this problem is to perform a maximum exercise test using an arm ergometer. However, there are theoretical and documented reasons why such a method has not been widely adopted. These mainly centre on the difference in VO2 peak obtained being lower in an individual who performs the test using an arm ergometer compared with a cycle ergometer. The hypothesized reason is that when performing a cycle exercise test, larger muscle groups are used compared with an arm exercise, which will therefore increase the metabolic requirement. However, all the literature refers to studies that have been done in healthy volunteers rather than in patients with lower limb dysfunction or patients with other significant comorbidities—the group in which an arm CPET is likely to be the most useful.

Loughney and colleagues present a small but well-conducted and detailed study in which they perform both arm and cycle exercise tests in healthy volunteers and patients being assessed for elective abdominal aortic surgery. Methodologically, the study is sound and data conclusive. As expected, both patients and healthy controls achieved a lower VO2 peak as a group when performing an arm CPET compared with a cycle CPET. Despite good correlation between arm and cycle VO2, the ability of an arm CPET to predict the VO2 that was obtained by the cycle CPET is poor, the main reason being the large variability in the VO2 values obtained. This is a good example of why correlation is a poor method for comparing the agreement between two tests.

These data clearly show that arm CPET cannot be used to predict the VO2 from a cycle test in patients or healthy volunteers and therefore cannot be used as a substitute. However, this does not invalidate the use of arm CPET in its own right. Further analysis demonstrated that arm CPET was able to discriminate between patients obtaining anaerobic thresholds above or below 10.2 ml kg⁻¹ min⁻¹ by the cycle CPET. Although the data for this statement could only be described as preliminary, it does provide a good case for further work in this area.

Another interesting result was that 1 patient experienced chest pain and electrocardiogram (ECG) changes and another experienced significant arterial oxygen desaturation during the cycle CPET but not during the arm CPET. This result is not entirely surprising given the higher metabolic requirement of the cycle exercise test, and does give some credence (although the data are very preliminary) to the supposition that significant clinical signs may only be illuminated with the higher workloads achieved during a cycle test.

CPET has been shown to predict complications and both short- and long-term mortality after major surgery. There is growing interest in using CPET as part of a preoperative risk stratification algorithm, and this study highlights the importance of standardizing CPET conduct and laboratory protocols to ensure reproducible results that are directly comparable with the results obtained from CPET labs around the world.

The second paper concerning CPET in this journal is a well-conducted pilot study by James and colleagues. This study compares the predictive accuracy of two preoperative scoring systems, plasma biomarkers and CPET, for 28-day complications and major adverse cardiac events (MACE) in elective patients undergoing major elective non-cardiac surgery. CPET had good predictive accuracy for MACE, but not all complications, with an area under receiver operating characteristic curve of 0.83 [95% confidence interval (CI) 0.69–0.96] for anaerobic threshold (AT) and 0.81 [95% CI 0.69–0.96] for VO2 peak. The plasma biomarkers (B-type natriuretic peptide and creatinine) but not the preoperative scoring systems demonstrated a trend towards being able to predict MACE but not all complications. The small sample size and limited duration of the follow-up excluded the ability to assess prediction of mortality.

The authors acknowledge that a limitation of this study was the failure to blind clinicians to CPET results, although they comment that ‘clinical staff made few requests for CPET data’. As discussed by Grocott and colleagues in this journal, the majority of preceding studies investigating CPET for non-cardiac surgery share this methodological compromise. Unblinded cohort studies are inherently biased if clinicians are able to modify perioperative care on the basis of CPET results, a phenomenon known as confounding by indication. Before determining whether clinical decisions based on CPET results can modify postoperative risk, we must be certain that CPET is an accurate and reliable risk prediction tool in high-risk patients having major non-cardiac surgery. We must also define the most predictive CPET variables to measure...
and the ideal cut-points for these measurement variables to stratify risk.

Despite this, the paper provides further evidence for CPET as part of a multivariable risk prediction algorithm, one that potentially includes plasma biomarkers. Further large, clinician-blinded studies, such as the recently commenced Measurement of Exercise Tolerance for Surgery study, are required to confirm the findings of this study.

Authors’ contributions
M.A.S.: contributed to the first draft and manuscript revisions and produced the final manuscript; B.T.: contributed to the first draft and manuscript revisions and produced the final manuscript.

Declaration of interest
M.A.S. is a member of the steering committee for the Measurement of Exercise Tolerance for Surgery (METS) study. B.T. is a collaborator on the METS study.

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