

Research Article

A Systematic Review of Cardio-Pulmonary Exercise Testing as a Preoperative Assessment Tool

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Received: 07-21-2015

Accepted: 08-10-2015

Published: 08-18-2015

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Abstract

Introduction

Assessing patient fitness is central to patient care, especially for individuals at risk for intra- and post-operative complications. Despite the development of robotic surgery and minimally invasive procedures major surgical interventions remain a mainstay of treatment. Precise pre-operative assessment is required to minimize risk and for medical optimisation before and after surgical interventions.

Method

We conduct a systematic review of the literature related to major surgery and cardiopulmonary exercise testing. Search terms used included: (Cardiopulmonary exercise testing) AND (major surgery) OR AND (outcomes). The following databases were screened from 1984 to September 2014: CINAHL and MEDLINE (NHS Evidence), Cochrane, AMed, BNI, EMBASE, Health Business Elite, HMIC, PschINFO.

Results

Sixty-seven papers were identified but only 7 mapped to the identified search terms.

Conclusions

There is a dearth of literature related to cardio-pulmonary exercise testing as a pre-operative assessment tool. From the limited data available, evidence is inconclusive, and more work is needed to determine the role of cardio-pulmonary exercise testing in pre-operative assessment.

Keywords: Patient Fitness; Pre-Operative Assessment; Major Surgery

Introduction

The worldwide increase in elderly is having a significant impact on healthcare systems globally [1]. Between 2009 and 2010, more than 7.4 million individuals aged 60 years and older required some form of hospital in-patient treatment in the UK. This is a rise of 37% since 1999–2000 [1]. Modern surgery has advanced much, both technologically and in its delivery; with developments such as robotic surgery and enhanced recovery. However, despite this appropriate patient selection and assessment of fitness for surgery are paramount. This systematic review will explore the role of cardiopulmonary exercise testing in assessment of patient fitness for surgery and improvement of patient outcomes.

Cardio-pulmonary exercise testing (CPEX) is an accurate means of pre-operative assessment as it gives a standardised measure of a patients' function capacity and reserve [1]. It has been used to investigate whether the ability to increase cardiac output and oxygen saturation to compensate for the stress response during surgery is directly related to outcome [2]. It is essentially an exercise test with baseline measurement throughout including ECG, blood pressure and oxygen saturations. This should be central to assessment of a patient, where there is a risk of high operative (or post-operative) mortality.

Functional capacity assesses the difference between baseline and greatest function; health status correlates more closely with measures of functional capacity than any resting measurement. CPEX allows measurement of the stress response during surgery, by mimicking it with increasing exercise. This allows assessment of the patient's functional capacity [1]. It also allows monitoring of levels of aerobic work involving the cardiovascular, respiratory and skeletal muscle systems, which form part of the stress response to surgery [3]. Patients who can meet this increased oxygen demand through increased cardiac output, will usually do well after surgery [4]. However, patients who do not have this are unlikely to cope with the operative stress and are more likely to suffer complications [5].

Other methods of assessment

There are others methods of assessing exercise tolerance in these patients. The Duke Activity Status Index allows assessment of physical activity via metabolic equivalents (METs) [6]. Ability to perform levels of exertion are standardised and graded [7]. Also, assessment of patient fitness may be based on mobility. A patient who is unable to climb two flights of stairs has an 89 per cent chance of postoperative cardiorespiratory complications [8].

The Acute Physiology and Chronic Health Evaluation (APACHE) score, allows assessment of physiological components and comorbidities [9]. The Physiological and Operative Severity Score for enumeration of mortality and morbidity (POSSUM) was de-

signed with surgical patients in mind [10]. Lung function tests and stress tests such as dobutamine stress echocardiography, exercise electrocardiography (ECG) and dipyridamole thallium scintigraphy (DTS) have also been used for risk assessment [11]. However, the positive predictive value for postoperative ischaemic events is poor (20–30 per cent), the negative predictive value is 95–100 percent [11]. As a result, respiratory and cardiac function can no longer be reliably predicted.

Advantages of CPEX

CPEX allows assessment of oxygen usage under dynamic stress conditions. This reflects the ability of the patient to meet the physiological challenges of the perioperative period [3]. These challenges include major fluid shifts, acute inflammation and acute catabolism [4]. This also gives us the chance to detect cardiac failure and myocardial ischemia at subclinical levels [5]. CPEX is an elegant tool to assess overall cardiopulmonary function and may provide crucial insight into outcomes of major surgery. However, CPEX is not often used as a preoperative assessment tool. The purpose of this paper is to provide a state-of-the-science review of the role of CPEX as a preoperative assessment tool.

Search Strategy

A systematic review relating to literature on CPEX testing and major surgery was conducted. The search strategy aimed to identify all references related to CPEX testing AND major surgery. The selection criteria specified papers could be related to all levels of research. This was due to paucity of literature available. Search terms used were as follows: (Cardiopulmonary exercise testing) AND (major surgery) OR AND (outcomes). The following databases were screened from 1984 to September 2014: CINAHL and MEDLINE (NHS Evidence), Cochrane, AMed, BNI, EMBASE, Health Business Elite, HMIC, PschINFO. In addition, searches using Medical Subject Headings (MeSH) and keywords were conducted using Cochrane databases. 67 papers were identified (Please see Table 1). Yet only 7 papers mapped to search terms present. We examine literature outcomes and conclusions for and against CPEX testing pre major surgery.

Results

In Table 1 we describe the seven published studies that were used in the analysis.

Vascular Surgery

The role of CPEX has been heavily investigated in vascular surgery [12]. However, there is not conclusive evidence for CPEX to be used as a routine part of pre-operative assessment. This is due to studies having small sample sizes, no randomised control trials with blinding and no standardisation, when re-

Table1. Outcomes of systematic review papers.

Paper	Sample	Outcomes / significantly different?	Support CPEX as Pre-operative tool?
Young et al,2012 [12]	Systematic review of cardio-pulmonary exercise testing (CPET) in the pre-operative evaluation of patients with abdominal aortic aneurysm or peripheral vascular disease requiring surgery.	Systematic review of CPEX testing in vascular surgery – limited by small sample sizes- no significance tests conducted.	Yes CPEX testing improved outcomes on review of several studies in vascular patients .
Duffy et al 2009 [13]	Review of literature for anaesthesia in urological patients	Comparison of CPEX testing to stair climbing and echocardiograms, no significance testing done	Yes Stair climbing similar to, but not as precise as CPEX testing in pre-operative assessments
Smith et al, 2013[14]	Patients pre and post CABG	Analysis of outcomes in post-operative morbidity and mortality in patients undergoing CABG, no significance testing	Yes Worse outcomes with poor pre-operative fitness
Benzo et al, 2007 [15]	Meta-analyses of exercise capacity as a predictor of post-operative cardiopulmonary complications after surgical resection in lung cancer patients	Analysis of exercise capacity and complications post lung resection, no significance testing	Yes Poorer exercise capacity, worse complications post operation
Gerson et al, 1990 [5]	Patients with major cardiac and pulmonary complications associated with abdominal and none- cardiac thoracic surgery	Analysis of exercise tolerance, no significance testing	Yes Poor exercise tolerance pre-operation, resulted in pulmonary/ cardiac complications
Older et al, 1999 [2]	Patients > 60 years of age (or younger with known cardio-pulmonary disease) scheduled for major intraabdominal surgery	Exercise assessment in > 60 years, no significance testing	Yes Poor exercise tolerance, higher risk of complications
Wilson et al 2010 [16]	Impaired functional capacity is associated with all-cause mortality after major elective intra-abdominal surgery	Analysis of exercise pre-operatively, no significance testing	Yes Better outcomes with improved exercise tolerance
Snowden et al 2010[17]	Patients assessed awaiting major surgery	Analysis of outcomes related to exercise tolerance, no significance testing	Improved outcomes when physically fit

porting results [12]. No large trial has yet been conducted however, between echocardiography, pulmonary function tests and dobutamine stress echocardiography and CPEX.

From the available data, only one small, randomised trial attempted to compare echocardiography, stair climbing and CPEX [13]. The results suggested that stair climbing might be as useful as CPEX in risk stratification of patients. Results have failed to demonstrate that echocardiography improves outcomes in major elective non-cardiac surgery.

Cardiothoracic Surgery

An inverse relation was found between cardiorespiratory fitness and complications after coronary artery bypass grafting (CABG). Low preoperative cardiorespiratory fitness is associated with higher operative and 30-day mortality after CABG [14]. If decreased aerobic fitness is present, this is associated with a higher rate of CABG [14]. Reduced aerobic capacity is also associated with higher operative and 30-day mortality after CABG [14]. A recent meta-analysis by Benzo investigated if VO_2 Max differed between patients who develop postoperative cardiopulmonary complications. Fourteen studies representing a total of 955 men and women were included. They concluded that exercise capacity expressed as VO_2 Max is lower in patients who develop clinically relevant complications after curative lung resection [15].

Intra-abdominal Surgery

Gerson performed supine exercise ergometry in 177 patients, aged 65 years and over, undergoing elective major abdominal and non-cardiac thoracic surgery [5]. 69 patients were unable to exercise well with cardiopulmonary complications in 42%, with five deaths [5].

Pre-operative activity of 187 elderly patients undergoing major intra-abdominal surgery was examined by Older et al. Lower activity levels were associated with increased cardiovascular mortality. If patients had preoperative ischaemia, the mortality rate rose from 4% to 42% [2]. This was confirmed by Wilson et al. Survival at 90 days was significantly greater in patients with higher activity levels and in patients without ischaemic heart disease [16]. R. J. T./author><author>Davies, S./author><author>Yates, D./author><author>Redman, J./author><author>Stone, M./author></authors></contributors><language>English</language><added-date format="utc">1396641747</added-date><ref-type name="Journal Article">17</ref-type><auth-address>(Wilson, Davies, Yates, Redman, Stone. The positive relationship between CPEX and postoperative morbidity after major intra-abdominal surgery was further re-enforced, with a sensitivity (88%) and specificity (79%) in predicting post-operative complications [17]. Consistent with previous reports demonstrating that measures of cardiorespiratory fitness are useful in pre-

dicting short-term perioperative outcomes, including extended lengths of hospital stay and 30-day readmission rates, in patients who undergo abdominal aortic aneurysm repair, liver transplantation, bariatric surgery, and other surgical interventions [14].

Conclusions

So the question remains, prior to major surgery, how should we establish or evaluate the role of CPEX testing on patients who are at high risk for surgery? To adequately address the question, clinical trials in which CPEX testing is examined and correlated with physiological and surgical outcomes. It may also have a role perhaps in selection of patients for other taxing treatments prior to surgery such as neoadjuvant chemotherapy prior to cystectomy.

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