Anaesthesia for Pneumonectomy

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Outline

- Previous examples
- Pre-operative Assessment
- Anaesthetic considerations
- One-lung ventilation
- Post-operative complications

Previous examples from SAQ

March 2013: Question 2 (+ May 2006)

- What are the indications for OLV? (30%)
- How can the risks associated with lung resection be quantified pre-operatively? (30%)
- How would you manage the development of hypoxaemia during OLV? (40%)

September 2009: Question 10

- List the indications for the placement of a DLT in anaesthesia and critical care? (25%)
- List, giving the appropriate threshold values for each, the methods of pre-operative assessment you would use to decide whether a patient could tolerate lung resection? (25%)
- How would you manage the development of hypoxaemia during OLV? (40%)

October 2005: Question 2

- What tests of lung function can be used to predict whether a patient will tolerate a pulmonary resection? (60%)
- Indicate minimum values for lobectomy and pneumonectomy? (40%)

Previous examples from VIVA

December 2014: Lung cancer patient undergoing lung resection

- 60 female with SCC for RLL resection
- Shown spirometry test results - obstructive picture, low TLCO DLCO 50%, FEV1 1.48
- What is FEV25-75? What is its significance?
- What is TLCO? How do you perform the test? Conditions where it is affected?
- What is the criteria for lobectomy and lung resection? FEV1, ppo TLCO/FEV1, vo2 max etc
- How do you work out ppo FEV1?
- How many segments are there?
- Lung function criteria for lobectomy/pneumonectomy
- Other pre-op investigations
- Other factors to consider in patients with cancer
- Exercise testing/CPE

Pre-operative Assessment

- Mortality from lobectomy is 2.3% and for pneumonectomy 5.8% in 2010.
- Purpose of preoperative assessment is to stratify risk of:

1) **Perioperative cardiac event;**
2) **Perioperative death;**
3) **Postoperative dyspnoea;**

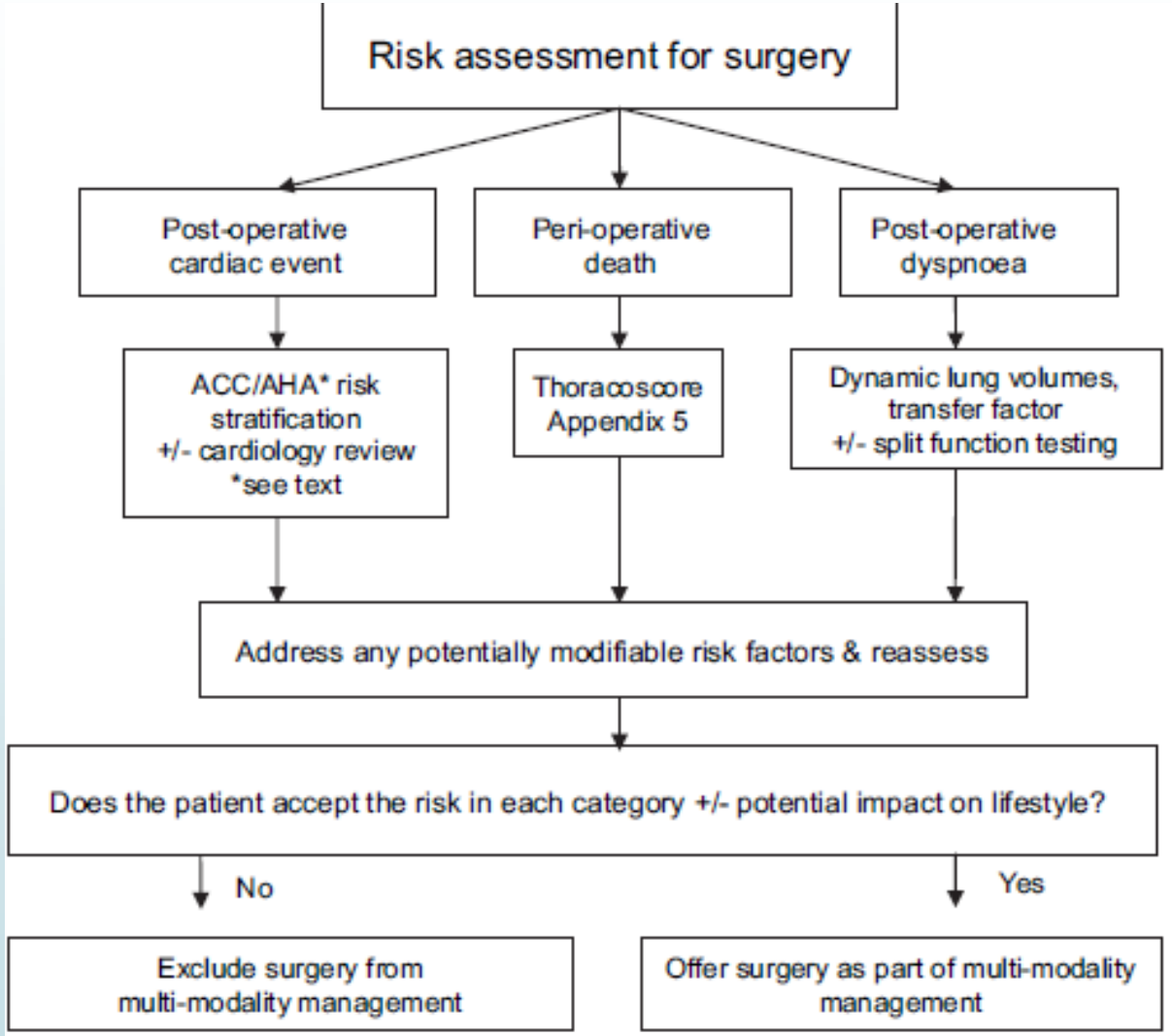


Figure 2 Tripartite risk assessment. ACC, American College of Cardiology; AHA, American Heart Association.

Pre-operative Assessment - CVS

- Cardiac risk should be stratified;
- All patient require preop ECG.
- Preop ECHO in patients with audible heart murmur or dyspnoea.
- Postpone surgery if within 30 days of acute MI.
- Cardiology review if suffered acute MI within last 6 months
- Cardiology treatment of active cardiac conditions before thoracic surgery ➔

Table 3 Active cardiac conditions

Condition	Examples
Unstable coronary syndromes	Unstable or severe angina—CCS class III or IV*
	Recent MI†
Decompensated heart failure	NYHA functional class IV
	Worsening heart failure
	New onset heart failure
Significant arrhythmias	High-grade atrioventricular block
	Mobitz II atrioventricular block
	Third degree atrioventricular heart block
	Symptomatic ventricular arrhythmias
	Supraventricular arrhythmias including atrial fibrillation with uncontrolled ventricular rate: HR >100 beats/min at rest
	Symptomatic bradycardia
	Newly recognised ventricular tachycardia
Severe heart valve disease	Severe aortic stenosis: mean pressure gradient >40 mm Hg, aortic valve area <1.0 cm^2 or symptomatic
	Symptomatic mitral stenosis: progressive dyspnoea on exertion, exertional presyncope or heart failure

*May include 'stable' angina in patients who are unusually sedentary.
†The American College of Cardiology National Database Library defines recent MI as >7 days but ≤1 month within 30 days.
CCS, Canadian Cardiovascular Society grading for angina pectoris; HR, heart rate; MI, myocardial infarction; NYHA, New York Heart Association.

Pre-operative Assessment - CVS

Table 4 Revised cardiac risk index

Number of factors	Risk of major cardiac complication*
0	0.4%
1	1%
2	7%
≥3	11%

- High risk surgery (All thoracic);
- History of IHD;
- History of CCF;
- History of cerebrovascular disease;
- Diabetes treated with Insulin therapy;
- Preop serum creatinine > 177 µmols/L;

Pre-operative Assessment - CVS

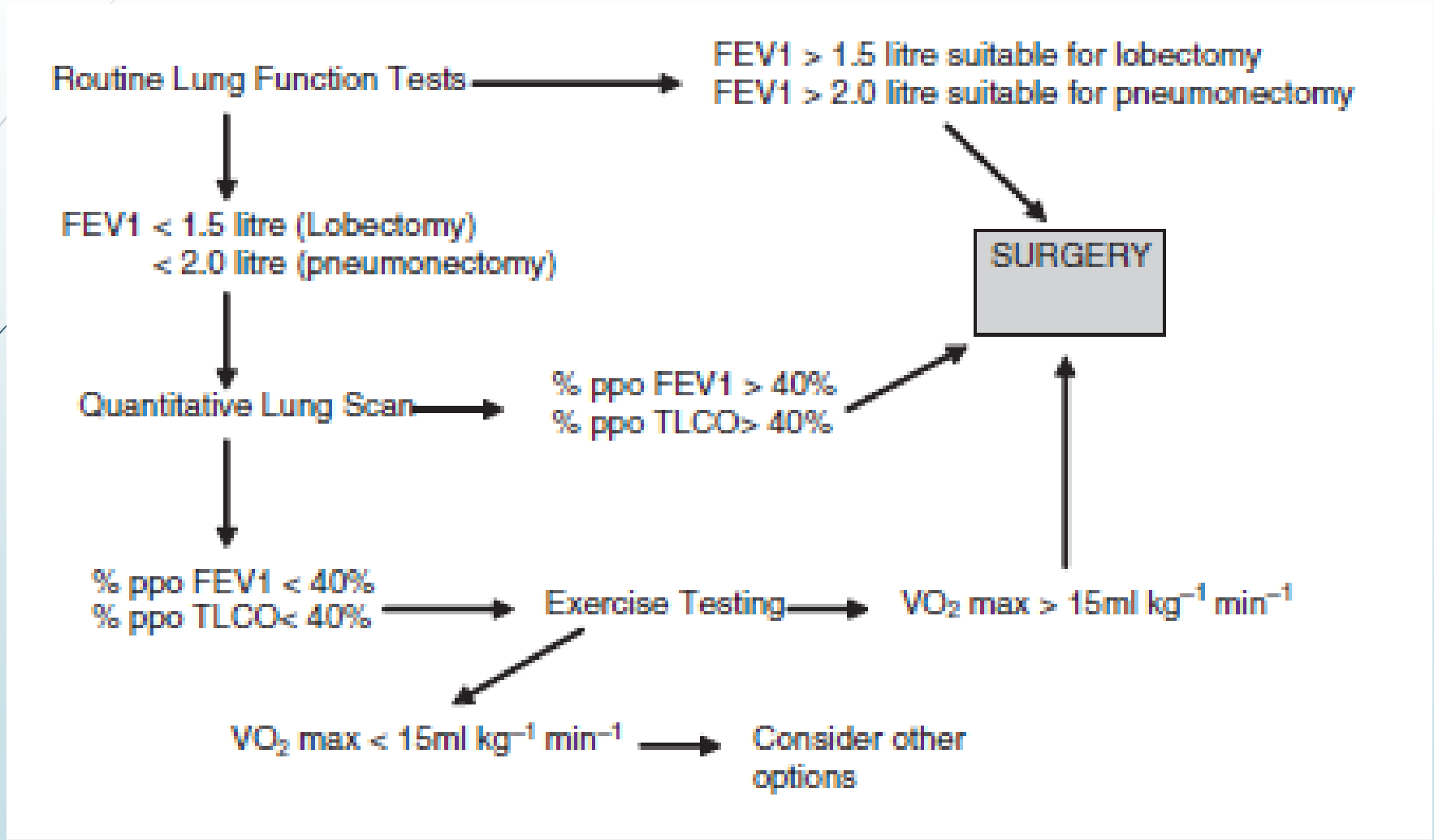
- Optimise medical therapy.
- Continue nitrates, aspirin, statin and β – blockers in perioperative period.
- Avoid dual anti-platelet therapy at time of lung resection.
- Smoking cessation

Pre-operative Assessment - Respiratory

- Pulmonary Function Tests:
  - Spirometry (Post-bronchodilator):
  - FEV1, FVC (litres)
  - FEF_{25-75}: mean forced exp flow between FVC_{25} – FVC_{75}
  - Gas transfer:
    - **TLCO** (Transfer capacity)/**DLCO** (Diffusion capacity)(mmol/kPa/min)
    - Transfer coefficient: **KCO** (mmol/Kpa/min/litre)

- Spirometry and Gas transfer measure different functions of the lung

Pre-operative Assessment - Respiratory



Bronchopulmonary segments

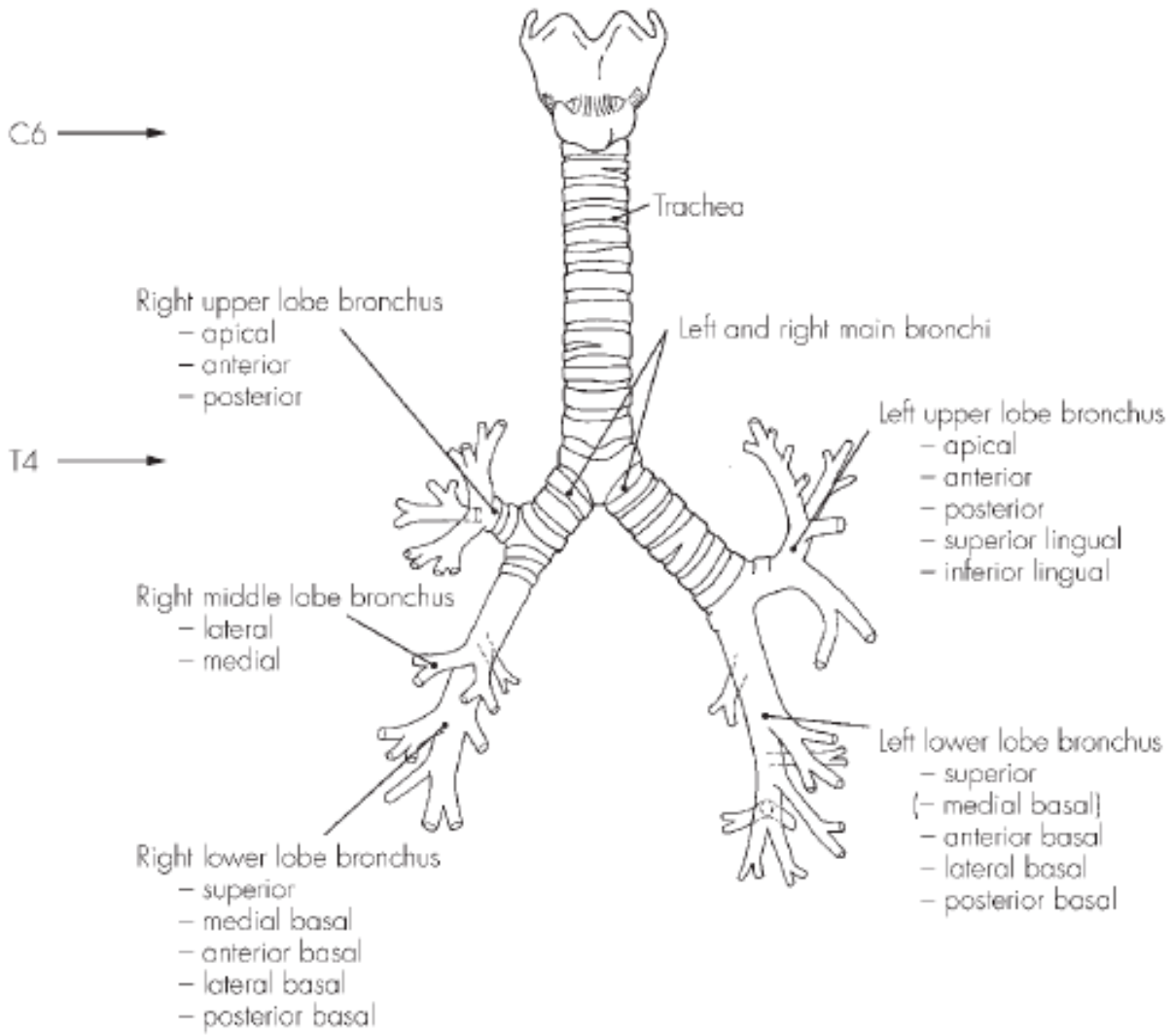


Fig 6.1
The bronchial tree

Predicted post-operative function

$$T = 19 - O$$

$$R = T - \text{functioning segments to be resected}$$

The number of segments to be resected is: right upper lobe=3, middle lobe=2, right lower lobe=5, left upper lobe=5 (3 upper division, 2 lingula) and left lower lobe=4.

The predicted postoperative (ppo) lung function is then estimated by:

$$\text{ppoValue} = \frac{\text{Preoperative value}}{T} \times R$$

- Calculate the **Remaining** segments (**R**).
- Use preoperative FEV1/FVC/DLCO/KCO values and divide by T (19) and multiply by **R**.
- As a guide a ppo FEV1 < 0.7 - 0.8 is not recommended.

Example 1

Height:	175.00 Cms	**Weight:**	99.00 Kgs
Sex:	Male	**BMI:**	32.3 kg/m2
Diagnosis:	Aortic aneurysm - Pre op	**Smoking history:**	Cigarette 49.0 Pack yrs
Medication:			
Date of Test:	13/12/2019	**Physiologist:**	Mata, Iuri

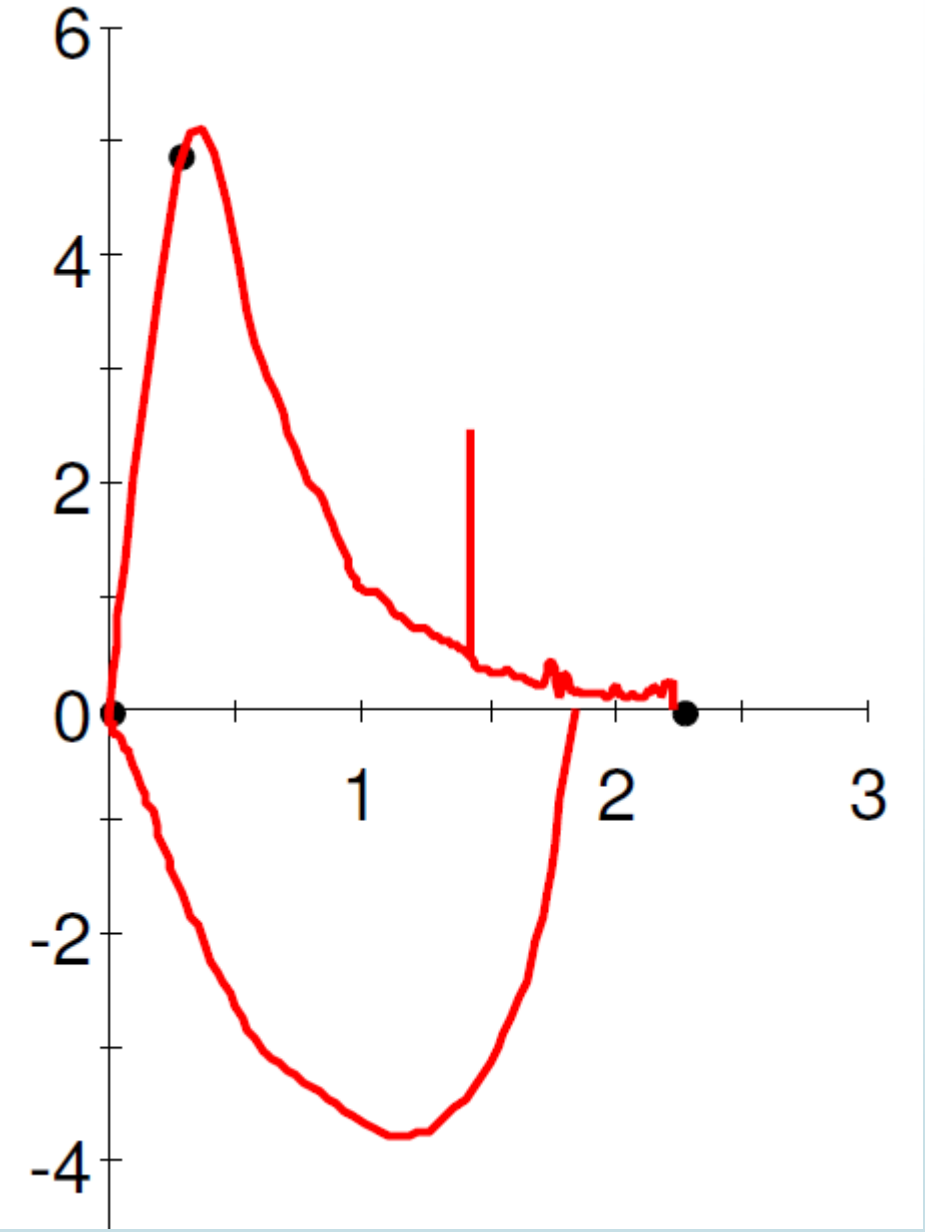
Spirometry

	FEV1	FVC	EV1/FVC
Predicted	3.29	4.29	76.95
Pre	3.55	4.99	71.14
% Predicted	107	116	92

Example 2

	Pred	Actual	%Pred	LLN	ULN	Z Score
---- SPIROMETRY ----						
FEV1 (L)	1.76	1.44	81	1.25	2.24	-1.06
FVC (L)	2.26	2.23	98	1.64	2.91	-0.07
FEV1/FVC (%)	78.50	64.36	81	64.40	90.62	-1.65
FEF Max (L/sec)	4.89	5.10	104	3.41	6.37	0.24
FEF 25-75% (L/sec)	1.56	0.64	41	0.70	2.82	-1.78
FEV1/SVC (%)	77.88					

Example 2



Ventilation-Perfusion scanning

- This is a quantitative assessment of lung function.
- Performed with inhalation of Xenon and IV Technetium.
- A gamma camera and computer calculate the uptake of radioactive ions by the lungs via inhalation and perfusion.
- Illustrates whether or not the diseased lung contributes to overall lung function.
- Especially useful for pneumonectomy.

- **Post-op FEV1** = **Pre-op FEV1** x **% radioactivity of non-operated lung**

Pre-operative Assessment: Exercise testing

- There are 2 standardised tests:
  - 6 minute walk test (Distance in 6 minutes).
  - Shuttle walk test (10m course, number of cones achieved with increasing intensity, lasts for 12 minutes).
  - > 400 metres → Surgery. < 400 metres → CPET.

- **CPET**
  - VO_2 max can be used to correlate complications and mortality:

VO_2 max	Complication and Mortality
> 20 ml/kg/min	None
< 15 ml/kg/min	↑ Complications
< 10 ml/kg/min	↑ Complications and ↑Mortality

Example 1

---- O2 CONSUMPTION ----							
VO2 (mL/kg/min)	6.0	12.5	15.9	15.0	22.4	79	71
VO2 (mL/min)	590	1240	1575	1488	2216	79	71
VCO2 (mL/min)	527	1185	1706	1613	2681	69	64
RER	0.89	0.96	1.08	1.08		88	
METS	1.7	3.6	4.5	4.3	6.4	79	71
---- CARDIAC ----							

Anaesthetic considerations – Patient factors

- Smoking – associated problems
  - COPD/Emphysema
  - Vascular disease: IHD, Cerebrovascular disease, PVD
  - Reactive airways for intubation/extubation + coughing
  - Poor dentition – Awkward placing DLT
- Poor nutritional status – Smoking/Lung cancer/COPD cachexia
- Consider pulmonary rehabilitation: pre-operative steroids and nebulisers

Anaesthetic considerations – Surgical factors

- Staged surgery:
  - 1st stage: Induction of anaesthesia + Rigid bronchoscopy;
  - 2nd stage: Placement of DLT and proceed to pneumonectomy;
- TIVA allows for a single anaesthetic;
- Volatiles are bronchodilators;
- Requires OLV for 2nd stage
  - Right lung has more segments and larger surface area; right pneumonectomy increases risk of hypoxaemia under OLV.
  - Increased pulmonary blood flow through smaller left pulmonary vessels.
- Lateral positioning of patient:
  - Pressure areas;
  - Supports: Neck and Arms;
  - Nerve compression;

Anaesthetic considerations – Anaesthetic factors

- **Airway:**
  - Rigid bronchoscopy performed first.
  - DLT ideally – need airway assessment (Potentially single ETT with bronchial blocker).
- **Monitoring:**
  - Standard +
  - Arterial pressure monitoring: ABG's for hypoxaemia, Potential for blood loss – pulmonary vessels, Allows optimisation of perfusion pressure;
  - CVC: Ideally on side of pneumonectomy – for vasoactive drugs/Blood transfusion
  - Temperature + Warming: Thorax is totally open
  - Urinary bladder catheterisation

Anaesthetic considerations – Anaesthetic factors

- **Cardiovascular instability:**
  - 2 units Xmatched blood;
  - Vasopressors;
  - Avoid excessive IV fluids due to post-op pulmonary oedema/ALI
- **Analgesia:**
  - Thoracic epidural gold standard.
  - Paravertebral or erector spinae if failure in siting epidural.
- **One Lung ventilation:**
  - Managing hypoxaemia under OLV.
  - Can consider pulmonary artery ligation early as this is pneumonectomy.
- Post-operative HDU/Level II Bed required.

One Lung Ventilation

The following are the suggested targets during OLV:

- Tidal volume: **5 - 6 ml kg** (ideal body weight);
- Peak airway pressure: **< 35 cmH_20**
- Plateau airway pressure: **< 25 cmH_20**
- Aiming for: **Normal $PaCO_2$**
- PEEP: **5cm H_2O**
- Avoid hyperoxia, titrating FiO_2 to maintain oxygen saturations of **94 – 98%.**

Post-op Complications

- Cardiac Arrhythmias (Occurs in upto 40%):
  - Post-op AF most common;
  - Elderly male patients with pre-existing cardiac disease are at risk;
- Postoperative Pulmonary oedema (>50% mortality);
  - Right pneumonectomy is a risk factor
  - Occurs within first 72 hours post-op
- Bronchopleural Fistula:
  - Right pneumonectomy is a risk factor.
  - Other risk factors: Prolonged ventilation, residual tumour in stump, large diameter stumps.
- Cardiac Herniation: Rare complication (Mortality >50%)
  - Associated with right pneumonectomy with stripping of pericardial sac;
  - Or Left intrapericardial pneumonectomy
  - Heart herniates into post-pneumonectomy space.

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