Contents

General principles

- high mortality surgery (ElAAA 7%, EmAAA >50%)

Preoperative Management

- often elderly with marked cardiovascular disease
- co-morbid conditions; DM, HTN, lipids, MI, IHD, CVA, renal impairment, COPD, smoking, CCF

Table 2 ACC/AHA clinical predictors of preoperative risk

Major
Unstable coronary syndromes (unstable angina/MI within 30 days)
Decompensated congestive cardiac failure
Significant arrhythmias
Severe valvular disease
Intermediate
Mild angina pectoris
Previous MI (>30 days earlier)
Compensated or previous congestive cardiac failure
Diabetes mellitus
Renal insufficiency
Minor
Advanced age (>70 yr)
Abnormal ECG
Non-sinus rhythm
History of stroke
Uncontrolled systemic hypertension

- Lee's criteria for periop CVS risk in non-cardiac surgery (3 day MACE risk):
  - high risk surgery (abdo, thoracic or suprainguinal vasc surgery)
  - Hx IHD
  - Hx stroke/TIA
  - Hx of heart failure
  - chronic renal impairment = creat >177
  - DM on insulin

  ↳ Risk of cardiac events periop based on number of factors:
    - 0 = 0.4%
    - 1 = 1%
    - 2 = 6%
    - ≥3 = 11%
- NB MACE = death, MI, cardiac arrest
- medications; beta-blockers, ACE I, diuretics, warfarin, aspirin, anti-platelet agents, hypoglycaemic agents, insulin

  ↳ should be on anti-platelet agent (clopidogrel better than aspirin)
- quantify exercise capacity
- measure BP in both arms (use higher of two) - target <140/90 (130/80 if PVD & DM)
- look for signs of CCF
- if just had coronary revascularisation ⟹ should defer surgery for at least 4-6weeks (depends on balloon, stent)
- stop smoking 4-6wks
- investigations;
  - bloods, x-match, -
    - target Hb >13 in both
    - if DM HbA1C <70mmol/L (<45 = normal)
  - ECHO, CXR, ECG, lung function, ABG,
  - dynamic tests of cardiac function - mandatory for elective all AAA patients

    - include CPET (gold standard), ETT, dobutamine stress echo, radionucleotide thallium scan,
  - angiography
- good communication important between surgeon and anaesthetist
- continue beta-blockers (don't start c/o POISE trial)
- r/v prev anaesthetic charts

Regional Anaesthesia Advantages

- improved patient monitoring (awake CEA)
- ↓ed hospital stay & cost (CEA)
- improved blood flow
- reduced DVT risk
- reduced re-operation (peripheral revascularisation)
- ↑ed post operative analgesia
- reduced pulmonary complications (AAA)
- pre-emptive analgesia for amputation (reduction in phantom limb pain)
- treatment of proximal hypertension during x-clamping (AAA)

Neuraxial & Heparin/LMWH

- pre-conditions:
  - normal renal function
  - weight >55kg
  - INR <1.5
  - platelets >100
- Enoxaparin prophylactic (40mg):
  - 12 hours after last dose before technique
  - 6 hours after technique before next dose
    - ↳ 2 hours if v high risk of thrombosis
    - ↳ wait 24hrs if difficult insertion or epidural vein known breach
- enoxparin Rx dose (1mg/kg bd or 1.5mg/kg od or <55kg)
  - 24hours after last dose before technique
  - 6 hours after technique before next dose
    - ↳ adjust as above for other probs
- unfractionated heparin IV infusion:
  - 4hours after stopping infusion & normal APTT
  - 6hours after technique before next dose
    - ↳ 1 hr if v high thrombosis risk
    - ↳ wait min 6 hours if difficult insertion or vein breach

By Surgery

Elective AAA Repair

= excision of aortic aneurysmal sac and replacement with synthetic graft (tube or trouser graft)
- mortality 15%
- aneurysm = >30mm. Operated >55mm
- annual risk of rupture 55mm = 18% female, 12% male which rises exponentially with size

Preoperative Management

- elderly, smokers
- vascular co-morbidities - all should start statins & anti-platelets
  ↳ aspirin can continue through surgery; d/w surgeon other anti-platelets
- dynamic cardiac assessment where possible
- go after IHD, valves disease and renal dysfunction
- check sites for invasive monitoring and epidural
- x-match 6 U
- continue all cardiac medication
- book with ICU

Intraoperative Management

- have vasoconstrictors ready (phenylephrine, metaraminol, ephedrine, noradrenaline)
- have vasodilators ready (GTN, remi, labetalol, SNP)
- large bore access
- rapid access IV lines
- level 1 & cell saver
  ↳ can use isovolaemic haemodilution - but no evidence
- epidural (T6-T11) [or RSC] :
  - against epidural:
    - high failure rate
    - Coagulopathy - 1:1000 haematoma
    - other alternatives
    - diff to know what to do if bloody tap:
      - defer surgery or continue
  - for epidural:
    - best protection against resp complications
- artline pre-induction
- don't use epidural until aorta repair complete (or else dose with opioid)
  ↳ easier to Rx hypotension of unclamping with functional SNS
- 5 lead ECG (II and V5 -> increases sensitivity of myocardial ischaemia)
- careful induction - remi 0.1-0.2mcg/kg/min or fentanyl 5-10mcg/kg
- GA (ETT + IPPV)
- CVL post induction

- catheter
- may need PAC
- pain +++
- supine with arms out

CLAMP ON

- heparin prior to clamp 3000-5000units
- see sudden HTN:
  - ↑↑ in SVR ⟹ ↑myocardial wall stress & O2 consumption
    - see ~40% ↑ in systolic pressures above clamp & 85%↓ MAP below clamp
    - reflex brady cardia, ↓contractility & periph vasodilation
  - distal to clamp:

        - ↓O2 consumption
        - anaerobic metabolism
        - hepatic & renal hypoperfusion ⟹ accumulation of lactic acid
    - ↑ed SVC flow, ↓blood flow to all lower limb organs
    - SNS response
  ↳ manage with deepen volatile/TIVA, ßblocker, GTN, or epidural LA
  ↳ check if clamp below sup mesenteric artery - supply to small bowel & R hemicolon
- cell salvage
- hypothermia cares (don't place on legs as worsens ischaemic damage when clamp on)
- may get a body respiratory alkalosis (but met acidosis in clamped LLs)
      ↳ if maintain MV then alkalosis will help with met acidosis during unclamping
- risk of atheromatous emboli to LLs
- X clamp generally 30-60mins
- fluid load (aim for CVP 5cmH2O higher than baseline) - good for stability, post clamp ↓bp & renal function

CLAMP OFF

- may help if one leg let off @ a time
- stop anti-HTN prior to unclamping
- ↑ventilation ready for acid load
- hypotension multifactorial
    - causes: hypovolaemia, reflex hyperaemia, myocardial stunning, vasodilation
    - Rx:
        - lighten - ↓volatiles, opioids, vasodilators
        - fluid
        - boluses of adrenaline 10mcg, calcium gluconate 10%, inotropes/pressors
        - temporarily reapply clamp
        - monitor end organ function - urine output, bowel function
- ↑K
- Correct deficiencies:
    - platelets <100
    - ACT - normal = <140s
- Use TEG

Postoperative Management

- extubate if safe to do so
- ICU management
- mortality (5% -> multi-organ failure and MI)
- PCA if required
- WWWE

Special Points

- renal failure:
    - 1-2% of cases
    - multifactorial - but more likely if suprarenal
    - assoc with 50% mortality
    - mannitol (0.5g/kg) – used by some as free radical scavenger and osmotic diuretic
    - avoid hypovolaemia

Emergency AAA Repair

= excision of ruptured aortic aneurismal sac and replacement with synthetic graft (tube or trouser graft)
- overall mortality 65%
- 50% die on scene
- 25% die in hospital
- true anaesthetic & surgical emergency
- may be rupture or dissection

Preoperative Management
- elderly
- vascular co-morbidies
- go after IHD, valves disease and renal dysfunction
- confirm diagnosis with U/S or CT if stable
- resuscitate to SBP 90mmHg - limited IVF boluses 250ml max
- small increments of morphine IV to pain
- avoid coughing, straining or excessive movement
- insert 2 large bore IV +/- art line
- central access can be obtained post induction - CVL vs Swan Sheath
- x-match 6 U
- urinary catheter
- book with ICU
- get blood to floor

Intraoperative Management
- have vasoconstrictors ready (phenylephrine, metaraminol, ephedrine, noradrenaline)
- have vasodilators ready (GTN, remi, labetalol, SNP)
- hot line
- level 1
- ?!?artline pre-induction
- 5 lead ECG (II and V5 -> increases sensitivity of myocardial ischaemia)
- careful induction pre-draping & surgeon scrubbed
- GA (ETT + IPPV) - CVS stable eg ketamine & high dose roc
- as soon as intubated surgeon can cut
- no volatile until clamp on
- one IV should be kept running with volume and products
- catheter
- may need PAC
- pain +++
- supine with arms out

CLAMP ON/OFF
- as elective

Postoperative Management
- ICU management
- PCA if required
- WWWE
- complications = hypothermia, renal impairment, blood loss, coagulopathy

Special Points

- **Intra-op TOE vs ECG to monitor for ischaemia**:
  - TOE:
    - adv:
      - RWMA
      - quantification on effect on systolic function
      - can help diagnose cause of ischaemia eg massive PE
    - disadv:
      - RWMA may not result from ischaemia. myocardial stunning diff to differentiate from ischaemia
      - expensive
      - training, accrediatation & maintenance
  - ECG:
    - disadv:
      - ST changes can be non specific
      - diathermy

	GTN	Sodium Nitroprusside
Dose	0.15-0.8 mcg/kg/min	0.3-4 mcg/kg/min
Pharmaceuticals	Doesn't require protection from light Can be administered SL, IV, PO or transdermally (used in outpatient setting) Needs to be diluted	Protection from light Only IV and required arterial monitoring (limited to theatre and ICU use) Needs to be diluted
PD	Onset – 3-5min Offset – 3-5min Ease of titration – moderately easy Acts on (1) venous capacitance vessels (2) large coronaries (3) decrease cardiac wall tension (4) arterial vessels -> all to decrease myocardial O2 demand - venous dilation > arterial dilation CVS – decrease wall cardiac wall tension (used in cardiogenic shock and acute pulmonary oedema) RESP – bronchodilation, inhibition of HPV CNS – headache and flushing GI – decrease in LOS tone Haem – inhibition of platelet aggregation Toxicity – metabolism producers methaemoglobinaemia	Onset – 1-2min Offset – 1-2min Ease of titration – very easy Acts on capacitance and resistance vessels - less selective for veins than GTN - useful in arterial hypertensive crises' (aortic dissection) CVS – no change in contractility RESP – nil effect on bronchodilation, inhibition of HPV CNS – cerebral vasodilation -> increase in ICP GI – decrease in LOS tone Toxicity – cyanide toxicity major issue (related to infusion rate) -> produces a histotoxic hypoxia – advised for only 24 hours of use.
PK	Absorption - substaintial first pass metabolism Distribution – large Vd Metabolism – via glutathione-S-tranferase Elimination – t1/2 = 1.5 min	Distribution – small Vd (ECF) Metabolism – chemical reaction with aminoacids and enzymes in RBC's in plasma Elimination – thiocyanate = 3 days
Situations where I would use each agent	- cardiac surgery - AAA cross-clamp time to offset dramatic increase in SVR - acute pulmonary oedema - hypertension in the neurosurgical patient - IHD (treatment and control of angina, acute MI)	- hypertensive crises for 24 hrs while I was titrating up longer acting anti-hypertensives (type II aortic dissection) -

        - hard to interprit if ↑HR
        - subtle changes can be hard to see
    - adv:
        - more immediate changes compared to TOE
        - cheap, quick, min invasive
- **Advantages of PAC**:
    - CVP - IVF optimisation
    - PAP - ?pHTN - need optimisation ie normal O2, Co2, pH, GTN, milrinone, NO
    - SvO2 - aim for normal = 65% -70%:
        - optimise via IVF, Hb, ↑FiO2, PEEP, inotropes
    - CO - how is heart coping with ↑SVR. Optimise with inotropes
- **TOE vs PAC** - should consider under
    - preload Ax - TOE (RVEDV) & PAC (CVP)
    - pulmon vasculature assessment - PAC (pressures) & TOE (derived pressure if TR)
    - cardiac output - TOE (EF, LVEDV) & PAC (PCWP as estimate of LVEDP)

- SVR - PAC (SVR, SVRI derived values)
- valve function - TOE (visual & pressure gradients)
- ischaemia - TOE (RWMA)
- O2 extraction & delivery - PAC (SvO2)

- **management of HTN** when clamping on: GTN & SNP both donate NO to vasculature endothelium:
- **Renal protection**:
  - optimise renal blood flow:
  - minimise nephrotoxic agents
  - ensure emptying of renal collecting system
  - preop:
    - adequate hydration - avoid dehydration, stop diuretics
    - stop nephrotoxic agents eg ACEI, diuretics
    - limit exposure to scans & contrast - use N-acetyl cysteine
    - stop smoking 4 week prior
    - BSl control
    - note normal bp
  - intraop:
    - bp target & IVF
    - mannitol prior to aorta clamp - antioxidant effect on renal parenchyma
    - infra-renal clamping (still see turbulent flow into renals)
    - minimise X clamp time
    - optimise O2 delivery
    - urinary catheter
    - monitor intrap-op acid base - avoid acidaemia
  - Postop:
    - monitor UO
    - careful ICU housekeeping & Rx of complications eg sepsis, rhabdo, haemorrhage
- **Acute heart failure** after clamping:
  - = abnormal response to aortic cross clamping – normally there should be ↓CVP because of ↓VR
  - Differential
    - cross clamping has produced an increase in SVR -> transmitted to left heart which has failed and now is causing right heart failure.
    - PE
    - fluid overloaded
    - CVP transducer dropped on floor
  - Priorities
    1. maintain haemodynamic control
    2. diagnose and treat cause
    3. treat myocardial ischaemia and failure
    4. Inform surgeon
    5. Declare emergency
    6. Get help
  - Treatment:

    A – patency and position

    B – turn FiO2 1.0 and ensure adequate ventilation, apply PEEP (increase O2 and will prevent pulmonary oedema), assess AWP and chest expansion

    C - assess blood pressure (invasive and non-invasive -> if arterial blood pressure low this is a bad sign), pulse and ECG (ST segments), TOE or PAC -> evidence of failing left or right ventricle, myocardial ischaemia, look @ PA rule out pulmonary embolism and pericardium to rule out tamponade (both unlikely)

  - If cause from acute cardiac failure
    - start vasodilators (GTN, labetalol, hyralazine)
    - limit IV fluid input
    - optimise Hb
    - may need inotropes (adrenaline, milrinone, dobutamine, noradrenaline)
    - cautious use of vasopressors
    - 12 lead ECG when appropriate
    - inform ICU
    - assess for requirement of a Intra-aortic Balloon Pump and invasive cardiac output monitor
    - may require cardiology opinion +/- urgent coronary catherisation if having a STEMI (more likely to be a NON-

STEMI)

Endovascular Stenting of AAA

= deployment of bifurcated stent by interventional radiologist into aneurismal sac via femoral arteries
- lower operative morbidity but unproven whether risk of rupture decreased -> needs surveillance.
- is patient EVAR-able:
  - standard EVAR required 1.5cm distance from renal arteries to aneurysmal sac
    ↳ risk of endoleak or renal art occlusion
  - new specialised grafts with fenestrations & custom made mean ↑able to EVAR people

Preoperative Management

- elderly
- vascular co-morbidities
- go after IHD, valves disease and renal dysfunction -> may be patients who have been decline an open repair because of bad cardio-respiratory function (may not need ICU)
- check sites for invasive monitoring and epidural
- x-match 6 U
- continue all cardiac medication
- remote anaesthesia issues
- need to be ready for rupture (2%)

Intraoperative Management

- supine
- epidural + sedation OR GA
- invasive monitoring

Postoperative Management

- HDU
- complications =
  - AKI - 10-20% risk
  - aneurysm rupture in ~2% ⟹ 50% mortality
  - post-implantation syndrome:
    - 30-40% incidence
    - = pyrexia, ↑WCC, ↑CRP but no sepsis
    - suggested inflam response to graft material
    - self limiting 2-10d
  - stent migration and endoleak:
    - type 1 = graft seal failure at graft ends
      ↳ complete EVAR - consider open surgery later
    - type 2 = aneurysm sac filling via branch vessel
      ↳ 10-25% common after EVAR but significance unsure
    - type 3 = leak through graft fabric
    - type 4 = porosity of graft (often intentional)

Thoraco-Abdo AA Repair

= excision of aortic aneurysmal sac extending above the origin of the renal arteries and replacement with synthetic graft
- Modified TAA classification:
  - 1 = distal to L subclav artery to above renals
  - 2 = distal to L subclav to aoritic bifurcation
  - 3 = 6th intercostal space to aortic bifurcation
  - 4 = diaphragm to aortic bifurcation
  - 5 = 6th intercostal space to above renals

Preoperative Management

- as AAA

- NB aneurysm may compress trachea and distort the anatomy of upper vasculature

Intraoperative Management

- may required thoracotomy/sternotomy + laparotomy
- DLT with OLV -
  - collapse L lung ⟹ ↓s X clamp time
  - allow access to aorta
  - aneurysm may distort the L main stem bronchus - may have difficulty placing L sided DLT
- problems:
  - hypertension more pronounced (GTN, esmolol, SNP)
  - clamp takes out splanchnic, renal and renal arteries
  - spinal cord ischaemia
    - from clamping of Artery of Adamkiewicz
    - prevention (lumbar drain, cool spinal cord via epidural, intrathecal magnesium, distal perfusion techniques, bypass, deep hypothermic arrest)
      ↳ use surgeons preferred technique as none EBM
    - SCPP = MAP - (CSF + CVP)
      ↳ ∴ CSF drain ⟹ ↓CSF ⟹ ↑SCPP for same given MAP
    - Prevention:
      - MAP target 80-100
      - drain inserted & set to overflow at 10cmH2O for 48-72hrs
        ↳ place night before
      - others = distal aortic perfusion, hypothermia via epi catheter, drugs (CCBs, steroids, naloxone)
    - Monitoring:
      - SSEPs not reliable during X clamping as only assess posterior columns (ant motor column most at risk
      - MEPs - shown some success
    -
  - acidosis:
    - metabolic acidosis on cross clamp
    - resp acidosis from OLV
    - Rx by post op ventilation +/- bicarb
  - post clamp hypotension severe
  - ↑blood loss compared to AAA

Postoperative Management

- ICU
- renal failure in 25% of cases ->
  - proportional to length of X clamp
  - mannitol prior to X clamp
  - normovolaemia

Proximal & distal aortic perfusion management

- methods:
  - simple X clamping:
    - ↑ing ischaemia distally esp. >30mins
    - but ↓ed morbidity than other options give speed of surgery is quick
  - passive shunts:
    - shunt blood across clamping ∴ ↓LV afterload
    - has to carry >60% of baseline aortic flow
    - Gott shunt is most common
    - technically difficult, bleeding, dislodgement, stroke, death
  - atrio-femoral bypass:
    - = most common method used

- LA to L com femoral artery with interposed centrifugal pump
- function to ↓LV preload ⟹ ↓CO ∴ LV stroke work
- need ACT 150-200
- don't need vasodilators
- set bypass flow to maintain distal mean aortic pressure of 60-70mmHg (2-3l/min)
- can be useful in pts with poor LV function, renal disease or predicted long X clamp time

▸ partial CPB:
- full heparin
- fem vein/RA to fem artery bypass
- distal aortic mean pressure 50-60mmHg

▸ DHCA
- used if probems applying prox X clamp
- CmRO2 at 37degC = x2.2 higher than at 27deg
- must be limited to 30-40min
- adv: no X clamp, bloodless field, ↑ed ischaemic time
- 2 options:
  - 27deg
  - 15deg - ↓spinal cord injury & renal failure BUT ↑bleeding

Carotid Endarectomy

= removal of atheromatous plaque from the ICA.

- Artery clamped, open, plaque stripped and then closed directly or with a Gore-Tex vein patch

▸ Endarectomy vs stenting:
- IMPROVE trial:
  - ↑stroke peri-op stent
  - ↑MI peri op surgery
  - CEA had less death

- 2 major options with controversy:

▸ Awake Local:
- adv: immediate detection of neuro deficits ⟹ shunt procedure or ↑bp

▸ General:
- ↑ed monitoring eg measurement of carotid stump pressure, EEG, SSEPs, doppler of MCA, NIRS

↳ GALA trial showed
- no difference in stroke, MI, death in 30days between LA vs GA ∴ no reason to do LA
- low conversion rate
- ↓shunting but no endpoint diff
- no benefit from deep Cx plexus block

↳ many criticisms of trial: poor standardisation or surgery & medications, stopped early due to lack of funding

General CEA

Preoperative Assessment and Management

- Risk definitions:

▸ risk of disabling stroke after TIA is 10-20% within a month
▸ greatest benefit of CEA shown if perform within 2weeks of TIA
▸ benefit of op shown if >70% stenosis post TIA or stroke patients
▸ incidence of death or major CVA peri-op = 2-5%
▸ operation also carries risk ∴ only offered if peri-op risks are low & survival >2yrs is good

- dynamic cardiac assessment not usually done
- preop planning:

▸ control hypertension to 160/100
▸ should be medically optimised if time:
- elderly with all the co-morbid conditions associated with vascular disease (HT, hyperlipidaemia, IHD, PVD, previous CVA's or TIA, DM (50% have silent ischaemia), smoking, COPD)

▸ if bilateral carotid disease discussion with surgeon whether
- carotid shunt required intraoperatively or

  - is sufficient co-lateral flow from the other carotid artery to provide cerebral perfusion
  - whether stump pressure is required (extra attachment for the arterial line)
- document pre-existing neurological deficits so new ones can be easily assessed
- note preoperative BP as this and above will be intra-operative target
- appropriate preoperative investigations – bloods, ECHO for associated valve disease and LV function, ECG – signs of LVH or arrhythmias, Group and Hold – in case significant bleeding take place

Intraoperative Management

Induction

- supine, head up
- arterial access for invasive monitoring before induction - contralateral side to operation
- large bore IV access for rapid infusion of vasopressors and fluid if required
- may site a superficial +/- deep cervical field block to ↓intraoperative anaesthetic requirement
- have vasopressors drawn up and lines primed (phenylephrine, metariminol, ephedrine) and vasodilators (GTN, labetalol)
- monitoring; 5 lead ECG, arterial line, NIBP, SpO2, ETCO2
- balanced induction maintaining normal haemodynamics ->
  - ↓↓blood pressure drops may produce watershed infarct,
  - ↑↑bp can causing a haemorrhagic CVA

- ETT (ablate hypertensive response to intubation using short acting opioid, LA to cords or vasodilators such as GTN or SNP)

Maintenance

- ventilate with IPPV to maintain a normal PaO2 and PaCO2 -> optimise cerebral blood flow
- remifentanil infusion is a good agent for rapid waking post-operatively
- bp control around time of clamping of carotid
  - risk of brady-arrhythmias with hypotension
  - maintain BP @ 20% within base line
- options to measure cerebral ischaemia:
  - transcranial doppler - monitors flow & emboli. Operator dependant & can be difficult to get views
  - EEG - only reflects localised cortical structures. cannot see emboli
  - SSEPs. Thought more sensitive & specific than EEG. Ga can alter signal
  - NIRS - frontal lob sensors, poor +ve predictive value
  - Stump pressure - Specific measure of ischaemia but not sensitive. Cannot see emboli
    ↳= Most used
    if pressure within range of MAP then shunt not needed
- Placing shunt:
  - place shunt to straddle cross clamps
  - risks assoc incl embolisation, wall dissection, thrombosis
- once graft in and closing monitor for bleeding
- minimal analgesia required if field block used as surgery is superficial

Extubation

- smooth emergence and extubation with no coughing as this can increased pressure inside carotid and blow graft -> expanding haematoma
- monitor operative site for haematoma
- transfer to recover with arterial line in situ

Post-operative Care

- examine for neurological deficits for 3 hrs
- monitor for complications:
  - intra/postop stroke
  - ACS
  - cervical haematoma 5-10%
  - airway compromise - due to dissection around airway
    ↳ immediate remove sutures in recovery to allow drainage before intubation
    THEN re-exploration if airway obstruction developing
  - CVS instability:
    - intra-op - labile bp post stroke

    - post op: hyperperfusion syndrome (1%):
        - headaches +/- ⟹ haemorrhagic stroke
        - area previously protected by tight stenosis now exposed to ↑bp ∴ reperfusion injury
        - ∴ should get bp clear targets and Rx plan from surgeons eg labetalol, fluid bolus
- HDU optimal

Awake CEA

- disadv of awake CEA:
    - block risks - failure, intravascular injection, haemotoma, phrenic nerve palsy
    - pt discomfort eg claustrophobia, full bladder
    - poor access to airway
    - pt cooperation

Intraoperative

- block:
    - deep Cx plexus block (C2-C4) (not advocated now 2nd to GALA)
        - Cx transverse process palpated as bony ridge under post border of SCM
        - 0.5% bupiv injection 3x5ml at C2, 3, 4 or single injection 10-15ml at C3
        - complications: neuraxial injection, haematoma, phrenic nerve palsy, Ln palse, Horners syndrome
    - superficial block - reinforces deep block:
        - 10ml 0.5% bupiv placed along post border of SCM
    - local by surgeon around carotid sheath - needed in 50% despite 'perfect' above blocks
- supine, head up
- Continuous neuro testing off UL on contralat side to CEA
- can use remi or propofol sedation for incision and dissection -> turn off when carotid clamped
- monitor patients speech, contralateral arm strength and cerebration ->
- if neuro deterioration then:
    - unclamp if at all possible
    - shunt placement
    - ↑BP
    - convert to GA with LMA -
        - difficult as may be combative
        - ↑EtCO2 = cerebral vasoD ⟹ need early intubation
        - need airway plan to start
- once graft in and closing monitor for bleeding

Post-operative Care

- as GA

Peripheral Re-vascularisation Procedures

- femoro-popliteal bypass
- femoro-distal bypass (femoral artery -> anterior/posterior tibial artery)
- femoro-femoral crossover bypass

= bypass operations using long saphenous vein or Gore-Tex graft
- see ↑ing trend towards angio & stenting

Preoperative Management

- only 8% pts with PVD have normal carotids (60% have severe CAD)
- >5% risk of death or ACS
- duration surgery unpredictable
- should continue ßblockers esp in high risk pts
- if one or more major risk factors (see general considerations) ⟹ dynamic assessment of cardio-respiratory system
    - non-exercise testing is preferrable eg stress ECHO
    - CPET v limited value
    - BNP - although variability with renal function
- x-match 2U

Intraoperative Management
- nil specific apart from good balance anaesthetic:
  - Anaesthetic plan:
    - GA (ETT/LMA):
      - adv: theortical benefit in high risk 2nd to volatile & opioid preconditionning myocardial protection
    - RA (CSE)
      - CIs = anticoagulation & pt refusal
      - adv: ↓resp morbidity, ↓POCD, ↓bleeding, impaired perfusion
  - MAP target within 20% baseline
  - supine
  - pain +++
  - large bore IV access
  - art line
  - heparin before clamping

Postoperative Management
- O2
- silent myocardial ischaemia is common - serial ECGs
- routine

Special Points
- acute limb ischaemia:
  - usually from thromboembolism ⟹ occlusion of graft/artery
    - others = trauma, iatrogenic, dissection, small vessel disease
  - high mortality >25% at 30days
  - if acute ischaemia with loss of sensation/muscle power must restore perfusion <6hrs
  - option for embolectomy under LA with anaesthetist support
  - reperfusion injury:
    - ↑K
    - myocardial depression
    - arrhythmias +/- cardiac arrest
    - myoglobinaemia & AKI

Axillobifemoral Bypass

= extraperitoneal bypass (trouser graft) from axillary artery -> femoral arteries
↳ ∴ much less invasive & better tolerated although is v long operation
- ↑ingly less common due to advanced stenting techniques

Preoperative Management
- often last chance operation for those with occluded aortic or iliac arteries (often very high risk)
- are current aortic grafts infected - may be only chance at life
- standard preoperative assessment

Intraoperative Management
- supine
- GA + IPPV
- art line
- CVP
- creation of tract to femorals = very stimulating (remi good for this)
- heparin/protamine required at clamping/unclamping

Postoperative Management
- HDU
- PCA

Amputations

- BKA
- through knee
- AKA
- Symes - through ankle joint with heel preserved
- Digits

= removal of necrotic or infected tissue due to vascular ischaemia

Preoperative Management

- sick, bed-bound diabetics with significant cardiovascular disease in which revascularisation has failed
- often on large doses of analgesics (chronic pain)
- may be septic - no point in deferring as operation is for source control
- Should Ax:
  - Full routine incl: CVS examination, blds, ECG, CXR
  - ECHO - if murmur or suggestion of cardiac failure
  - Resp: <70% FEV1 or ratio <0.65 ≈ high peri-op risk
- stop anticoags for appropriate time prior to neuraxials:
  - LMWH: 24hrs for full dose; 12hrs for prophylactic dosing
  - clopidogrel for 7 days prior

Intraoperative Management

- supine
- Regional preferred: spinal, epidural, sciatic or femoral nerve blocks
  ↳ ↓ed POCD within first week
- If GA then some regional is advisable eg sciatic/fem nerve block
- pain ++++
- surgically sited sciatic nerve catheter good for post-operative pain relief

Postoperative Management

- regional analgesia best (otherwise PCA)
- phantom limb pain (60-70%) ->
  - gaba - thought not to help
  - NSAIDs avoided
  - chronic pain input,
  - preoperative RA may reduce incidence
  - sciatic/fem nerve block alternative to epidural if anticoagulated

Pain phenomena after amputation

1. phantom sensation
2. stump pain
3. phantom pain

Phantom Sensation

- any sensation experienced where the amputation limb use to be
- paresthesia in missing limb
- sensation that it is present
- usually immediately straight after amputation sometime can be delayed

Stump pain

- associated with surgery and usually resolves once wound heals
- can persist and may be secondary to a neuropathic process
- can be difficult to treat
- refer them on to limb centres to optimise prothesis
- may required surgical revision if pathology found (bone spurs, infection, osteomyeliitis)

Phantom limb pain

- experienced by around 70%
- **symptoms;** pain in first week, may induced by spinal or epidural for an unrelated procedure, shooting, burning, cramping, aching in distal area of phantom limb, pain can be constant with varying intensity, variable spontaneous resolution rates, can affect the breast post mastectomy
- **risk factors;** pre-amputation pain, presence of persistent stump pain, bilateral limb amputations, lower limb amputation
- **mechanism;** ? central re-organisation in brain in spinal cord from peripheral afferent input:
  - peripheral mechanisms – ectopic discharge from nerves or dorsal root ganglia, increased sensitivity of neuromas, sympathetically mediated afferent input
  - spinal cord mechanisms – reorganisation from degeneration of unmyelinated C fibers, central sensitisation of dorsal horns -> hyperalgesia
  - supraspinal mechanisms – errors occurring in the cortical remapping process -> overamplifiication

- treatment; should be MDT and multimodally based:

1. opioids (good for acute pain)
2. gabapentin (good in neuropathetic pain but not proven in phantom limb pain)
3. carbamazepine (good in neuropathetic pain but not proven in phantom limb pain)
4. NMDA antagonists (not good efficacy)
5. calcitonin (not good efficacy)
6. betablockers (not good efficacy)
7. pre-emptive analgesia with epidural -> doesn't work
8. perineural LA techniques -> has not been shown to be effective
9. physical treatments – acupuncture, heat, cold, U/S, TENS, massage, adjustment of prostheses, manipulation of stump (all have reported some success)
10. mirror box – used to treat unrelenting spasms (effective)
11. explanation, reassurance, psychotherapy, hypnosis, CBT – all have reported some success

First Rib Resection

= resection for first/cervical rib in patients with thoracic outlet syndrome (compression of brachial plexus or subclavian vessels)

- thoracic outlet =
  - borders= post: T1 body; lat: medial 1st rib; ant: sup border of manubrium
  - contains: oesophagus, trachea, thoracic duct, phrenic & vagus & RLN nerves, SNS trunks, common carotid & subclavian a & IJ & brachiocephalic v & subclavian v
  - brachial plexus emerges superior to outlet: between scalene ant & medius
- symptoms of syndrome:
  - Nerve:
    - 90% = C8 T1 nerve root:
    - ulnar nerve distribution ⟹ wasting AbPB & hypothenar eminence & interoseii
  - Artery:
    - subclavian a compression
    - prev occupation of arm overuse eg painter
  - Venous:
    - swelling & congestion of arm
    - cyanosis, paresthesia

Preoperative Management

- usually young and fit

Intraoperative Management

- GA + ETT + IPPV
- superficial cervical plexus block (great)
- avoid muscle relaxants (surgeon needs to be able to ID plexus)
- supine with arm of board
- at conclusion:
  - pressure test lungs (>40cmH2O) with saline instilled to check for pneumonthorax

Postoperative Management
CXR

Varicose Vein Surgery
= removal of tortuous veins of LL

- high tie and strip (long saphenous)
- tie of short saphenous
- multiple strips

Preoperative Management
- usually young and fit
- may be redo procedure -> long

Intraoperative Management
- LMA + SV or ETT + IPPV (prone)
- bleeding can be deceptive
- elevate legs
- may require turning during operation

Postoperative Management
- LA
- simple analgesia

Vascular Surgery on Upper Limb
Anatomy
- L subclavian:
  - from aorta
- R subclavian:
  - from bifurcation of innominate artery (or brachiocephalic artery)
- subclavians⟹
  - verterbals
  - passes 1st rib post to ant scalene mm
  - becomes axillary artery at lateral border of 1st rib ⟹
    - becomes brachial artery at lower margin teres major ⟹
      - in antecubital fossa branches:
        - radial
        - interosseus
        - ulnar arteries

Chronic Upper Limb Ischaemia
- most common cause = atherosclerosis
- good collateral circulation so may be silent
- common to have ischaemia in other locations
- subclavian steal syndrome:
  - symptoms following exercise of that UL
  - prox subclavian stenosed ⟹ exercise ⟹ retrograde flow down vertebral artery to perfuse UL ∴ blood stolen from posterior brain circulation
  - symptoms eg vertigo, double vision, LOC
  - Rx by
    - endovascular ballon angioplasty
    - extrathoracic carotid-subclavian bypass:
      - balanced GA
      - short period of carotid X clamp - generally well tolerated

- GA requires

Acute Limb Ischaemia

- usually 2nd to emboli:
  - AF/mural thrombus
  - paradoxical VTE
  - iatrogenic
- emergency brachial embolectomy under LA
- rarely need GA

Vascular Access for Renal Dialysis

- 3 types of access:
  - indwelling catheters - tunnelled CVL
    - immediate use
    - high infection & thrombosis rates
  - A-V fistulae:
    - generally 1st choice
    - made with end to side vein-artery anastomosis -
      - radial artery to cephalic vein
      - brachial artery to cephalic vein
    - high rate of primary failure but if mature they are superior to grafts
    - low complication rate
  - A-V Grafts:
    - synthetic graft between artery & vein
    - 4-8mm diameter
    - can be used within weeks
      ↳ fistulas can take up to 6 months to mature
    - ↑ed rate of thrombectomy & infection
- Anaesthesia:
  - naive fistula can be constructed under LA
  - grafts may require regional
  - Regional benefits:
    - ↑success rate of procedure via ↑vasoD & ↑fistula blood flow
    - ↓maturation time

Medical Problems

Aortic Dissection

- ascending aortic dissection is x2-3 more common than AAA
- mortality of untreated dissection 1-2%/hr untreated in first 48hrs
- anatomy:
  - ascending = LVOT to innominate
  - Arch - inbetween
  - descending aorta - starts after L subclav artery

Classifications

- time:
  - acute: diagnosis within 2 weeks of onset of symptoms
  - Chronic: >2 weeks since onset
- cause/syndromes:
  - intramural haemorrhage
  - intramural haematoma
  - aortic ulcers
- Debakey:
  - type I = ascending, arch & descending (most common <10cm from AV)
  - type II = ascending only
  - III = descending distal to L subclav artery
    - IIIa up to diaphragm
    - IIIb below diaphragm
- Stanford:
  - type A = ascending (but may extend into arch & descending) ∴ DB I & II
  - type B = descending only ∴ DB III

Causes

- 2 main origins:
  - tear in intima - most common
  - intramural haemorrhage in media ⟹ perforation of intima
- RFs:
  - HTN
  - aortic dilatation
  - Ct disorder eg Marfans

Symptoms/Investigations

- type A - sharp high intensity chest pain
- type B - as above but back & abdo pain more common
- exam:
  - intially with tear = ↑HR, HTN
  - later with rupture = ↑HR, ↓bp
  - other:
    - differential UL pulses (poor sign)
    - syncope
    - stroke/neruological impairement
- Ix:
  - ECG: 20% with dissection will have ischaemic changes
  - Imaging:
    - CXR - prominent aortic knuckle, wide mediastinum, cardiomegaly, haemothorax, apical cap
    - CT-A
    - MRI
    - TTE - only see aortic root; TOE - improved views of arch and descending aorta
    - Aortography - gold standard

Treatment

- T/F to regional centre
- analgesia

- BP control -
  - need to ↓wall shear stress
  - target SBP 110-120 with avoidance of tachycardia
  - labetalol ideal - α & ß blocker
- surgery:
  - type A -
    - urgent surgery asap
    - AVR & root replacement with reimplantation of coronaries common
  - type B - only if
    - persistent or intractable pain
    - aneurysm expansion
    - peripheral ischaemia
    - rupture

    ↳ surgery shown to be no better than medical management

Anaesthesia for Type A Surgery

- avoid over zealous fluid administration
- adequate ß blockade prior to induction
- place L rad A line pressure - in case innominate is involved in dissection
- cardiac induction
- bypass:
  - standard bypass cares
  - may require partial CPB or DHCA while performing distal aortic anastomosis
  - may be long CPB time

Interventional Rx for Type B Surgery

- ↑common to have endovascular repair esp if thoracotomy is high risk for patient
- aim to thrombose false lumen & re-establish true lumen