



Additional information to accompany presentations

PACU Learning and Teaching Resource
CIRCULATION : ANAESTHESIA & SURGERY

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Presentation : Anaesthesia & Surgery

Introduction

- The combination of drugs, anaesthetic agents and techniques, together with the surgical impact may profoundly interfere with normal cardiovascular homeostasis in the fit adult. If the adult has a history of cardiac or respiratory disease, is elderly or overweight, the risk of cardiovascular dysfunction increases.
- The following table lists risk factors for cardio-vascular function:

Factors	Risk intra/post operative cardiovascular dysfunction
Anaesthetic drugs	Myocardial depression, vasodilation, arrhythmias : hypotension
Anaesthetic techniques [spinal/epidural]	Vasodilation, hypotension
Surgical : fluid loss	Hypovolaemia – risk of hypotension
Pain	Stress, rise in HR and BP : hypertension risk
Obesity	Heart works harder
Previous history of cardiac disease	Vulnerable to all of above : risk of cardiac events

Considering all of the above, the anaesthetist will prepare an individual patient plan in order to safeguard cardiovascular function intra and post operatively.

Planning anaesthesia to protect the CVS system

- Choice of technique must be appropriate for patient, surgery. For high risk, complex surgery, general anaesthesia together with ventilation may be the choice. For these patients invasive monitoring will be used.

- For those patients with a history of cardiac disease, avoidance of any factors which stress the heart must be taken. Meticulous fluid management, careful choice of cardiac friendly drugs and techniques is the order of the day. 'No hidden surprises' for these patients.
- For elderly patients who can tolerate awake procedures it is sometimes safer to avoid general anaesthesia and operate under spinal. GA can stress the cardiac workload. The elderly cannot quickly compensate to factors which disturb cardiovascular homeostasis due to blunted autonomic responses.
- For routine surgery : laryngeal mask airway combined with spontaneous ventilation avoiding drugs known to cause CVS or respiratory side effects is routinely used.
- Monitoring must always be appropriate for the individual case : for prolonged and or complex surgery or for the high risk patient [one with cardiac disease] invasive arterial and central venous monitoring may be deemed essential in order to fine tune fluid and drug administration.
- Fluid management with consideration to likely fluid loss and patient's cardiac status. Important not to overload a weakened heart. A urinary catheter will be inserted if fluid management critical.
- Thermoregulation a warming blanket to keep patient warm and well perfused throughout will be used. Induction of anaesthesia causes widespread vasodilation, hypotension and drop in core temperature. Patients need constant warming and filling during surgery to ensure they remain normotensive.
- Pain control - balanced analgesia to ensure that nerve blocks, regional techniques and opioids are given to ensure patient well analgesed when he enters PACU. If he is a cardiac patient this is very important to keep stress levels down and avoid cardiac incidents.

- Pre-operative investigations: those with cardiac problems must be properly investigated : 12 lead ECG : Bloods : Cardiac stress studies : Echocardiography : Exercise tolerance tests. The results will inform the anaesthetist about the complexity of his condition in order to plan safe anaesthesia.

Induction and Maintenance of general anaesthesia

- On induction loss of consciousness leads to loss of airway & respiratory impairment. The airway is secured and patient hand ventilated until set up in theatre. The anaesthetist will use a combination of the following drugs to maintain the patient during the procedure.

General anaesthesia drugs and agents

- Induction and maintenance agents used in GA impact on the CVS either by their effect on CO or SVR or both. Myocardial depression impairs the contractility of the heart muscle, cardiac output falls, and in turn BP. Vasodilation reduces SVR – if the patient is not well filled, BP will fall. We will now examine the common agents used here:

Anaesthetic drugs : [hypnotics]

- **Thiopentone [induction]** : Causes myocardial depression and reduced system vascular resistance. May lead to hypotension if patient hypovolaemic or with cardiac disease. Reflex tachycardia may be seen.
- **Diprivan [propofol] : [induction and maintenance]** : Unless the drug is given slowly, can cause hypotension in hypovolaemic or cardiac patient. Slow infusion rate is safest where CVS depression is modest.
- **Ketamine** : boosts cardiac output [increase HR]. Myocardial oxygen requirements increase.
- **Benzodiazepines [i.e. midazolam]** a sedative. Large doses decrease CO and systemic arterial pressure particularly if given with opioids, often a reflex tachycardia occurs.

Volatile agents : [hypnotics]

- **Halothane** : a potent myocardial depressant and causes bradycardia both of which affects CO and can lower BP. Has little effect on SVR
- **Enflurane** : dose dependent depression of contractility, small reduction in SVR both of which can contribute to hypotension. Less arrhythmogenic than halothane
- **Isoflurane** : less myocardial depression than enflurane and halothane. Lowers SVR so can cause fall in BP. Arrhythmias uncommon
- **Sevoflurane** : similar properties to isoflurane with smaller effects on HR.
- **Desflurane** : similar to sevoflurane

Opioids : [narcotics]

- **Morphine** : little effect on BP normally, but in hypovolaemic patients, or those who have received vasodilator drugs, it may lead to hypotension due to release of histamine which vasodilates. Bradycardia can occur as a result of stimulation of vagal centre.
- **Fentanyl** : has little effect on CVS. A small reduction in BP may occur and HR may decrease due to vagal stimulation.
- **Remifentanyl : Alfentanyl** Depresses the CVS more than fentanyl, especially in elderly and ASA3/4 high risk patients.

Muscle relaxants :

- As a rule have little effect on CVS, however pancuronium may cause tachycardia and hypertensio
- **Suxamethonium** : sinus bradycardia may ensue administration.
- **Neostigmine** : **[Reversal agent]** cholinergic effect produces bradycardia – usually given with glycopyrrolate or atropine.

Anaesthetic Gases

- **Nitrous Oxide** : a direct myocardial depressant but sympathetic activity normally antagonizes this. Healthy patient is little affected by N₂O. In those with cardiac disease N₂O may cause reduction in CO and BP
- **Oxygen** : essential for myocardial cell function. Lack of it leads to ischaemia, weakens the heart muscle with maybe serious results.
- **Carbon dioxide** : used sometime if patient overventilated. Carbon dioxide vasodilates the blood vessels.

Maintaining CVS stability during surgery

- Using monitoring devices [as physical assessment is limited due to theatre drapes] the anaesthetist assesses ECG, HR, BP, CVP, SaO₂, ETCO₂, urine output throughout the procedure. He adjusts fluids, drugs, ventilator settings according to this hard data.

- He also continuously responds to intra-operative events [sudden bleed] by considered intervention. HR, rhythm and BP will be assessed and fluids increased. If the patients HR and BP elevate he will consider if the patient is in pain, and needs more analgesia –a bolus dose of opioid will be given. If his level of consciousness is lighter, and he appears to be unsettled on the ventilator, he may needs more anaesthetic hypnotic agents. Throughout the procedure, bolus doses are given to ensure haemodynamic stability.
- Invasive arterial monitoring will allow real time information on blood pressure and enable Arterial Blood Gas samples for analysis of respiratory function.

Reversal of anaesthesia

- This can be a challenging time as consciousness is regained and the cardio-vascular system responds to the assault it has received from surgery and anaesthesia. It will take some time before normal homeostasis is achieved and in the meantime arrhythmias, sudden fluid shifts, hypo and hypertensive episodes can occur fast.

Patient handover to PACU staff :

- The nurse should be given a complete history of the patients cardio-vascular pre, intraoperative and current status with specific guidelines regarding fluid infusion, analgesia and so on. Often parameters will be given for blood pressure, central venous pressure.

Residual cardio-vascular problems in the PACU

- **Hypovolaemia** : This is a common reason for hypotension intra and post operatively. Clear fluid lost from evaporation in exposure of the gut in abdominal surgery impacts on intravascular volume in time causing hypotension. Active bleeding from the wound site is the other major risk. Particularly at risk are major joint surgery ; dental, ENT, and gynae specialities. If the patient has been starved overlong prior to surgery this effect is exacerbated.

- **Pain** : if an effective balanced analgesia plan has not been carried out, sudden return of severe pain may destabilise the patient. HR and BP will rise with sympathetic stimulation.
- **Spinal, epidural anaesthesia** cause vasodilation with hypotension.
- **Hypotension** due to mixture of volatiles, opioids, anaesthetic drugs, all of which depress the myocardium and lead to loss contractility with vasodilation.
- **Thermoregulation** : induction of anaesthesia – causes massive vasodilation – opening up peripheries and causing hypothermia – patient must be warmed and filled to avoid sudden swings in BP as peripheries open up – and fluid flows to extremities.



Trainer's notes on power point presentations

Circulation : Anaesthesia & Surgery

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Anaesthesia & Surgery Presentation

This presentation is designed to focus on how anaesthesia and surgery impacts on cardio-vascular function both intra operatively and into the post anaesthesia phase. By understanding how the anaesthetist risk assesses to ensure cardiovascular stability during anaesthesia, the PACU practitioner learns how to continue that process into the end stage of anaesthesia – recovery. This presentation now refers the information learned in basic sciences to clinical practice.

Slides 3-4 : Risk assessment with regard to CVS and development of plan for anaesthesia. Get the group to ‘think like an anaesthetist’ and consider his patient’s cardio-vascular status. How old is he? Does he have a history of circulatory disease? What is the nature of surgery, will it be prolonged? What is the potential for fluid loss?

It is useful to have a few patient scenarios on hand for the group to discuss the risk factors, and to plan how to pre-empt the risks.

5: The familiar diagram of stages of GA as a reminder of the stages involved here.

6: Preparation for induction – setting up the patient –monitoring [basic monitoring and extra devices if patient is high risk eg arterial monitoring, urinary catheter. Note the importance also of base line observations. Do not forget the patient and the importance of reassurance.

8: Induction to maintenance of anaesthesia. Sequence : a good reminder here of the order of intervention. Remind students that the airway is lost, post induction.

9: Introduce gases, anaesthetic agents. These will be covered more fully in next slide and later slides.

10: Introducing the role of the anaesthetist in maintaining patient safety. Helps to allow students to get into the mindset of the anaesthetist.

11-16: Slides to show different groups of drugs and their effects on the cardio-vascular system. Reference to their specific effect on contractility, systemic vascular resistance which have been studied already in Basic Sciences. So too the drugs and their groups have been studied in detail in previous modules [airway, breathing]. They should by now be very familiar. This is a good chance to revise the constituents of BP and to make it relevant by relating to clinical practice.

17: Now we examine the use of anaesthetic techniques [spinal, epidural with or without GA which can cause vasodilatation as both techniques block the autonomic nerve outflow [sympathetic chain] along with the voluntary spinal nerves. Loss of pain may be accompanied by fall in blood pressure as systemic vascular resistance is lost. These patients must always have an intravenous infusion in progress. Discuss the care of patients with regional anaesthesia in practice here.

18: Surgical factors are important. Fluid loss [blood or clear fluid] will cause hypovolaemia and hypotension. Pain leads to sympathetic nerve stimulation with raised HR and BP. So too does the release of sympathetic nerve stimulation via the surgical stress response. Rapid vasodilation brought about by induction of general anaesthesia leads fall in temperature, and peripheral vasoconstriction if patient not actively warmed and filled. This can destabilise the BP. Again, relate this to clinical practice experience of students.

19: This diagram gives an overview of the risks to the circulation caused by anaesthesia and surgery. Take time to go over it again – it repeats information given in diagrammatic flow mode.

20-21 : These slides focus on how the anaesthetist monitors the patient [as most of the patient is covered up!].

22-23 : refers to what adjustments to patient care the anaesthetist makes from the information gained from the monitors. Slide 23 reminds the student that additional monitoring is needed with high risk patients.

25-26 : Fluid management is a key priority for the anaesthetist. Fluid lost must be replaced by crystalloid, plasma expanders, blood products. Remind students that fluid depletion is a classic reason for hypotension. Good point to discuss the differences between the colloids and crystalloids.

27: Thermoregulation management is a key part of modern anaesthesia. The anaesthetist will work to ensure that the patient is peripherally warm and well perfused thus avoiding sudden changes in fluid distribution as the patient 'opens up' vasoconstricted vessels.

28: Emergence from anaesthesia : this can be an unstable time for the patient as he wakes up : emphasise the impact that shivering has on homeostasis causing increased demand for oxygen and putting the CVS under pressure. As the volatile agents are switched off the degree of vasoconstriction / dilation will change. Sympathetic nerve stimulation may elevate BP if the patient is in pain. Homeostasis of the circulatory system may take time. Interpreting these factors relies on the skill of the anaesthetist and the PACU practitioner who takes over care.

29: Handover should include any relevant information about patient history, and progress intra-operatively. Clear parameters should be given for blood pressure, CVP. Note here that the anaesthetist should not leave the patient until the PACU practitioner is satisfied with his or her condition and ongoing plan of care. Do this happen in practice – could introduce a discussion on ethics [duty of care] and legal responsibility for the patient. To what extent does the PACU practitioner act autonomously?

30: As in other modules, the residual effects of anaesthesia often result in or contribute to, cardiovascular complications. Remember it is often a combination of factors that cause problems. Understanding all the risk factors associated with anaesthesia and surgery enables the PACU practitioner to assess them on patient arrival in PACU and prevent them from becoming complications.

31: If in doubt : get help early. CVS events happen fast. Mantra to 'get help' early should be stressed throughout these presentations.