Induction of anaesthesia

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Abstract

General anaesthesia is a temporary state of unconsciousness which is induced to facilitate a therapeutic procedure. Induction is the first stage of a sequential process. It commences with patient preparation and assessment away from theatre then continues in the safe and monitored environment of the anaesthetic room or operating theatre where the administration of drugs and airway interventions take place. The anaesthetic then transits through maintenance, emergence and recovery phases. The exact mechanism of induction, whether it be intravenous, inhalational or rapid sequence induction, depends on the needs of the patient and the procedure planned. As general anaesthesia is seldom a therapeutic intervention in itself, it is essential that inherent risks to the patient be minimized.

Keywords Complications of induction; inhalational induction; intravenous induction agents; mind the gap; pre-oxygenation; rapid sequence induction

Royal College of Anaesthetists CPD Matrix: 1A02, 1E06, 2A03

Learning objectives

After reading this article, you should be able to:

- demonstrate the preparation required prior to induction of anaesthesia
- compare the different methods of induction
- identify the appropriate induction for each individual patient
- recognize and manage the complications associated with induction of anaesthesia

Introduction

Induction of anaesthesia is the initiation of a temporary state of unconsciousness, amnesia, analgesia and muscle relaxation. Rarely is it performed as a therapeutic procedure in itself, but rather as a means to make a therapeutic procedure more tolerable. It is therefore imperative it is performed in the safest way possible. It is the duty of every anaesthetist to pick the most suitable agent, via the most suitable route, to ensure these endpoints are met while making every effort to minimize the inherent risks to the patient.

Before induction

A preoperative assessment should include an anaesthetic history (Box 1) with a focused systemic examination and an airway examination, along with a review of the hospital notes. This will identify high-risk patients and allow the anaesthetist to design a comprehensive perioperative strategy, which should be explained and agreed with the patient, thereby gaining informed consent.

In the anaesthetic room the anaesthetic machines and equipment should be checked as recommended by the AAGBI guidelines. An ODP or anaesthetic nurse should accompany the anaesthetist. The theatre team must have access to the difficult airway equipment, defibrillator and emergency drugs (dantrolene, intralipid and sugammadex). The team brief and WHO safer surgery checklist should be completed, and monitoring must be applied as per AAGBI guidelines (Box 2).

There are several scenarios in which such preparation prior to induction is not feasible. Emergency surgical procedures such as ruptured abdominal aortic aneurysms and category 1 caesarean sections will bypass the anaesthetic room altogether. In these circumstances, or when called to the emergency department for emergency induction of anaesthesia, an AMPLE history (**A**llergies, **M**edication, **P**ast medical history, **L**ast meal intake, **E**vents leading to illness) may be more appropriate.

Pre-oxygenation

Prior to the administration of an induction agent, patient's will frequently require pre-oxygenation. The aim of pre-oxygenation is to replace nitrogen in the functional residual capacity (FRC) with oxygen; this process is also referred to as denitrogenation and creates an oxygen reservoir within the FRC. It is a simple safety feature as the greater the oxygen reserve within FRC, the longer apnoea can be tolerated before critical hypoxia develops.[1] Pre-oxygenation is achieved by delivering 100% high-flow oxygen via a breathing circuit to a spontaneously breathing patient until the end tidal oxygen reaches over 90%. Classically, this is done by breathing normal tidal volumes for 3 minutes, although it is now accepted that 8 vital capacity breaths over 60 seconds are equally as effective. It must be remembered that the time to desaturation is considerably reduced in those with respiratory disease, hypermetabolic states and those with reduced FRC.

An increasingly popular technique is the use of high-flow nasal cannulae to provide continued oxygenation throughout intubation by passive apnoeic oxygenation. A meta-analysis by the American College of Emergency Physicians has shown that the use of nasal cannulae for passive apnoeic oxygenation during laryngoscopy can prolong the time to desaturation in high-risk patients during airway management. Apnoeic oxygenation was associated with increased peri-intubation oxygen saturation, decreased rates of hypoxaemia and increased first-pass intubation success.[2] Several devices (Optiflow™ and SuperNO_2VA™) can deliver humidified high-flow nasal oxygen during airway management. If high-flow nasal cannulae are not available, standard nasal specs can be used giving 100% oxygen at 15 L/min.

Induction techniques

Intravenous (IV) induction

Induction using intravenous agents is the most commonly used method for induction of anaesthesia. Administered either as a

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Anaesthetic history

- Personal or family history of problems with anaesthetics
- Comorbidities and the impact these have on functional capacity
- Allergies
- Medications, including alternative remedies, and which have been taken or omitted
- Any smoking, alcohol or illicit drug use
- Last food and drink
- Dentition; establish any lose teeth, dental work or dentures (partial or complete)

Box 1

AAGBI recommendations for standards of monitoring during anaesthesia and recovery 2015 (https://www.aagbi.org/sites/default/files/Standards_of_monitoring_2015_0.pdf).

- Pulse oximeter
- NIBP
- ECG
- Inspired and expired oxygen, carbon dioxide, nitrous oxide and volatile agent
- Airway pressure
- Peripheral nerve stimulator if neuromuscular blocking drugs used
- Temperature for any procedure lasting >30 minutes

Box 2

manual bolus or via a syringe driver as part of total intravenous anaesthesia (TIVA) they cause loss of consciousness in approximately one arm–brain circulation time. Since the 1930s there have been many IV induction agents developed but only four are in common use today: propofol, thiopentone, etomidate and ketamine.

Propofol (2,6-di-isopropylphenol) is a lipophilic weak acid, presented as a 0.5%, 1% or 2% aqueous solution in an oil and water emulsion containing soya bean oil, glycerol and purified egg phosphatide. An induction dose of 1–3 mg/kg in adults and 2.5–4 mg/kg in children will produce loss of consciousness. It may also be used for maintenance of anaesthesia during TIVA and for sedation in theatre or ICU. It has a rapid distribution half-life leading to a quick wake up from a bolus dose of around 8–10 minutes. It is metabolized by conjugation in the liver and excreted as water-soluble metabolites in the urine.[3]

Advantages of propofol include suppression of laryngeal reflexes and antiemetic effects. Its main disadvantages are hypotension and pain on injection; this pain can be reduced by pretreatment with lidocaine in conjunction with venous occlusion above the vein.[4]

Thiopentone is a barbiturate presented as a yellow powder that dissolves in water to produce an alkaline solution of pH 10. Its main use is for rapid sequence induction at a dose of 3–7 mg/kg. It is metabolized in the liver and excreted in the urine. Its active metabolites accumulate during infusion due to hepatic enzyme saturation and zero order kinetics. However, after a bolus injection recovery of consciousness is even more rapid than propofol.[3] In the 5th National Audit Project (NAP5), thiopentone was identified as a risk factor for accidental awareness during general anaesthesia (AAGA) owing to this shorter duration of anaesthesia from a single bolus, so it is recommended that additional doses be given if there is any delay in securing the airway due to unanticipated difficulties.[5]

The main advantages of thiopentone are that it both reduces ICP in head injuries and is an effective treatment for status epilepticus. The major complication with its use is inadvertent intra-arterial injection, which may be limb threatening. The use of thiopentone has reduced significantly since the introduction of propofol, largely due to favourable laryngeal conditions provided by propofol for the insertion of laryngeal masks.[5]

Etomidate is an ester imidazole derivative. It is presented as a white emulsion or a clear liquid. The induction dose is 0.3 mg/kg. Its main advantage is its minimal effect on the cardiovascular system so is useful in haemodynamically unstable patients. Unfortunately, in infusion it causes adrenocortical suppression, which has led to its diminished use.[3]

Ketamine is a phencyclidine derivative that antagonizes NMDA receptors. A dose of 1–2 mg/kg will produce a dissociative anaesthesia, analgesia, amnesia and anxiolysis. It has bronchodilating properties, leading to its benefits in status asthmaticus. Unlike other IV induction agents it stimulates the sympathetic nervous system making it suitable for hypotensive patients. This has led to its increasing use in major trauma, but it should be used with caution in those with ischaemic heart disease. In the past, ketamine has been avoided in head injuries due to concerns it would raise intracranial pressure. It is now clear that this is not the case; indeed, it is likely that it has neuroprotective activity.[6] Despite ketamine's attractive profile, its popularity in the developed world has been limited by unpleasant psychogenic side effects and production of excessive secretions.

Future agents: PFO713 has a similar profile to propofol, producing reliable, rapid anaesthesia without pain on injection and with improved cardiovascular stability. Carboetomidate is an etomidate analogue that has reduced ability to inhibit the enzyme 11 β-hydroxylase, and hence reduced adrenocortical suppression. Both agents are awaiting further clinical trials.[3]

Rapid sequence induction

Rapid sequence induction (RSI) is a technique first described in 1970 as a sequence of pre-oxygenation, administration of a predetermined dose of IV induction agent, applying cricoid pressure, followed immediately by a fast-acting neuromuscular blocking agent. It gives rapid loss of consciousness and optimal intubating conditions while minimizing the risk of gastric aspiration. The checked equipment must include working suction, a selection of endotracheal tubes and laryngoscopes, full AAGBI monitoring and a trolley that tips to a head down position easily.[7]

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