General Anesthesia Agents & Procedures
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Learning Objectives:
➢ Explain the actions, effects and precautions associated with agents used in general anesthesia.
➢ Describe anesthesia procedures and delivery systems.

Introduction To Anesthesia

Goal of surgical anesthesia
➢ Achieve lack of sensation with:
  ◆ Safety
  ◆ Comfort
  ◆ Economy
  ◆ Convenience

Pre-anesthesia procedure
➢ Preoperative assessment
➢ Initial cleansing
➢ Pre-anesthetic medications

Preoperative assessment
➢ History
  ◆ cardiopulmonary disease
  ◆ malignant hyperthermia
➢ Current conditions
  ◆ sleep apnea - postoperative risk
  ◆ coagulopathy
  ◆ cardiopulmonary disease
  ◆ infections
  ◆ renal, hepatic disease
  ◆ diabetes
Preoperative assessment

- Current medications
  - cardiac medications
  - anticoagulants
  - herbals & nutritional supplements
- Social history - alcohol, tobacco
- Physical exam
  - cardiopulmonary assessment
  - evaluate for difficult intubation

FYI - Click for difficult airway evaluation
http://www.anesth.uiowa.edu/Uploads/LEMONAIRWAYEVAL.htm

Preoperative assessment

- Laboratory tests - as indicated
- Electrocardiogram (>40 YO)
- Cardiac testing; e.g., stress test
- Pulmonary function tests??
- Radiographs

FYI - Click for anesthesia risk assessment
http://www.anesthesiarisk.net/Awaretext.html

Anesthesia Procedure

- Induction- initial entry to surgical anesthesia
- Maintenance- continuous monitoring and medication
- Emergence- resumption of normal CNS function

Desired effects of general anesthesia

- Rapid induction
- Hypnosis - sleep
- Analgesia - lack of pain
- Secretion control
- Muscle relaxation
- Rapid reversal

Anesthesia stages

I. Amnesia
  - induction to loss of consciousness
  - pain sensation intact
II. Excitement
  - uninhibited response to stimuli
  - desirable to shorten, bypass this stage

Anesthesia stages

III. Surgical anesthesia- planes 1-4
  - Gaze central, pupils constricted
  - Absent somatic & physiologic responses
IV. Medullary paralysis (overdose)
  - Pupils dilated
  - Hypotension, circulatory failure
Monitoring during anesthesia

- Vital signs documented every five minutes
- Physical monitoring
  - pulse
  - color
  - chest excursion, breath sounds
  - reflexes
  - neuromuscular blockade

Click for information on neuromuscular blockade monitoring
http://www.globalrph.com/neuromuscular.html#Train_of_four

Monitoring during anesthesia

- Electronic monitoring
  - Exhaled tidal volume
  - FIO2
  - SPO2
  - ETCO2
  - ECG
  - Temperature

Click to see anesthesia monitoring (then, click 'Play')
http://www.capnography.com/ASA/ASAM.htm

Monitoring during anesthesia

- Electronic monitoring
  - Bispectral index (BIS) monitoring - EEG-based monitor for level of consciousness
    - reduce operative awareness
    - titrate anesthetic agents

FYI - click for information on BIS monitoring
http://en.wikipedia.org/wiki/Bispectral_index

General Anesthetic Agents

Types of agents for anesthesia

- Pre-anesthetic agents
- Intravenous anesthetics
- Anesthetic gases
- Neuromuscular blockers
- Anticholinesterase agents

Premedications for anesthesia

- Anticholinergics- atropine, rubinol
  - Reduce vagal response
  - Reduce pulmonary secretions
  - Reduce gastric motility
- Analgesics- reduce pain, anxiety
- Tranquilizer (benzodiazepines)- to reduce anxiety
- H2 antihistamine- to avert emesis
Barbiturate IV Anesthetics
- Rapid-acting
- Short duration
- Agents
  - Thiopental (pentothol)- previously almost universally used
  - Suritol NA
  - Brevital Na

FYI - click for more information on IV anesthetics
http://anesthesiologyinfo.com/articles/01072002.php

Non-barbiturate IV Anesthetics
- Etomidate- intubation
  - rapid-acting
  - short duration
- Ketamine- intubation
  - strong analgesia
  - bronchodilator

Non-barbiturate IV Anesthetics
- Midazolam (Versed)
  - benzodiazepine
  - rapid-acting sedative
  - reversible with flumazenil (Romazicon)

Non-barbiturate IV Anesthetics
- Propofol (Diprivan)- largely replaced thiopental
  - Hypnotic
  - Antiemetic
  - No analgesia
  - Cardiovascular depression - hypotension
  - Painful to inject

Anesthetic Gas Kinetics
- Action - probably modify the electrical activity of neurons at a molecular level by modifying functions of ion channels.
- Magnitude of effects are proportional to:
  - lipid solubility of drug
  - partial pressure in the brain

Anesthetic Gas Kinetics
- Factors affecting partial pressure
  - Inspired concentration
  - Flow rate of anesthetic
  - Minute volume
    - increased VE with anesthetic turned on increases uptake
    - increased VE with anesthetic turned off increases excretion
### Anesthetic Gas Kinetics
- Factors affecting partial pressure
  - Blood gas partition coefficient - rate of exchange of gases between compartments:
    - alveoli
    - blood
    - brain
  - Tissue perfusion

### Inhaled Anesthetics
- Nitrous oxide (N2O)
  - weak - used with other medications, gases
  - safe - does not cause hypotension
  - adverse effects:
    - pulmonary hypertension
    - inhibits hypoxic vasoconstriction
    - diffuses into ETT cuffs

FYI - link to history of anesthesia
http://www.mnwelldir.org/docs/history/anesthesia.htm

### Inhaled Anesthetics
- Halogenated volatile liquids
  - halogen (F, Br) included in molecule
  - nonflammable
  - potent - low concentrations as 2nd gas

### Malignant hyperthermia
- A rare life-threatening condition that is triggered by exposure to certain drugs used for general anesthesia
- It also is associated with succinylcholine
- It is genetically predisposed - there is a hyperthermia susceptibility trait

### Malignant hyperthermia
- Manifestations
  - temperature elevation
  - hypercapnia
  - tachycardia
  - tachypnea
  - hypertension
  - cardiac dysrhythmias
### Malignant hyperthermia

- **Manifestations (cont’d)**
  - Acidosis
  - Hypoxemia
  - Hyperkalemia
  - Skeletal muscle rigidity
  - Myoglobinuria

- **Management** - operating rooms have malignant hyperthermia boxes
  - Stop administration of triggering agent
  - Dantrolene - muscle relaxant
  - Cooling blanket
  - Fluids

FYI - click to download article on malignant hyperthermia

### Adverse effects of general anesthetics

- **Depress all components of CNS**
- Respiratory depression
- Negative inotropic effects
- Decreased threshold for premature ventricular contractions (PVCs)
- Peripheral vasodilation (except nitrous oxide)
- Decreased uterine contractions
- Depressed fetal activity => hypotonic newborn

### Inhaled Anesthetics

- **Halogenated volatile liquids**
  - Halothane (Fluothane)
  - Enflurane (Ethrane)
  - Isoflurane (Forane)
  - Desflurane (Suprane)
  - Sevoflurane (Ultane)
  - Methoxyflorane (Penthrane)

### Anesthesia machine

- Ventilator, anesthesia bag
- Gas cylinders - O2, N2O
- Precision flowmeters
- Calibrated vaporizer - for liquid anesthetics
- CO2 absorber
- Rebreathing bag
- Tubing
- Gas scavenging system
Click for virtual anesthesia machine; next, click educational animations; then, click deliver a virtual anesthetic. Follow menu from there. http://www.simanest.org/vfgs3.html

Anesthesia machine

Drager
Narkomed 6000

Neuromuscular Blocking Agents

Neuromuscular junction
Nerve stimulation ==> ACh secretion ==> binds to ACh receptor ==> contraction

Neuromuscular junction
Ach-ase secreted ==> ACh hydrolyzed ==> muscular relaxation
Action of non-depolarizing agents (curariform)  
Occupy Ach receptor sites ==> prevent depolarization

Reversal of non-depolarizing agents  
Anticholinesterase hydrolyzes cholinesterase ==> increase acetylcholine ==> depolarization

Indications for neuromuscular blockers  
- Muscular relaxation for:  
  - intubation  
  - surgical procedures  
- Controlled ventilation; e.g.,  
  - oscillators  
  - inverse ratio ventilation  
  - independent lung ventilation  
  - increased intracranial pressure

Neuromuscular blockers - history  
- Amazon natives  
  - curare, Tubocurarine  
  - poison for blowgun darts  
  - potency - trees monkeys could climb

Non-depolarizing agents  
- Adverse effects  
  - histamine release ==>  
    - flushing  
    - bronchospasm  
    - anaphylaxis

Non-depolarizing agents  
- Side effects  
  - histamine release ==>  
    - flushing  
    - bronchospasm  
    - anaphylaxis  
  - vagolysis ==> tachycardia, hypertension  
  - hypoventilation, apnea  
  - aspiration

FYI - click for video of flushing  
http://www.youtube.com/watch?v=WofFb_eOxxA
Non-depolarizing agents

- **Contraindications**
  - myasthenia gravis
  - asthma
  - electrolyte disturbance
- **Interaction** - potentiated by
  - aminoglycosides; e.g., gentamycin
  - tetracyclines

Specific NDP agents

- Tubocurarine Cl - prototype agent
- Pancuronium Br (Pavulon) - long acting
- Atracurium besylate (Tracrium)
- Vecuronium Br (Norcuron)
- Doxacurium (Nuromax)
- Cisatracium (Nimbex)
- Rocuronium (Zemuron)

FYI - Link to properties of specific NDP agents
http://en.wikipedia.org/wiki/Neuromuscular-blocking_drugs

Depolarizing agent (succinylcholine)

Drug attaches to Ach receptor $\rightarrow$ depolarizes muscle $\rightarrow$ inhibits repolarization

Succinylcholine

- **Side effects**
  - fasciculation $\rightarrow$ muscle soreness
  - hyperkalemia
  - increased ocular pressure
  - increased intracranial pressure
  - malignant hyperthermia

Succinylcholine (Anectine, Sucostrin)

- **Onset** $\rightarrow$ 1 min
- **Duration** $\rightarrow$ 4-6 min
- Perfect for intubations
Anticholinesterase Agents

- **Action**: Inhibit ACh-ase $\implies$ increase ACh at NM junction $\implies$ permit depolarization
- **Indications**
  - Reverse curariform paralysis
  - Diagnose and treat myasthenia gravis

**Reversal of non-depolarizing agents**

- Cholinesterase hydrolyzes cholinesterase $\implies$ increase acetylcholine $\implies$ depolarization

**Anticholinesterase agents**

- **Side effects**: Increase acetylcholine at muscarinic receptors $\implies$ cholinergic crisis
  - Bradycardia
  - Secretion
  - Bronchospasm
- **Cholinergic crisis**: Treated with atropine

**Anticholinesterase agents**

- **Edrophonium Cl (Tensilon)**
  - Onset: $< 1 \text{ min}$
  - Duration: 2-10 min
  - Routes: IV, IM
  - Indications: Reverse NDPS, diagnose MG (Tensilon test)

**Anticholinesterase agents**

- **Agents for myasthenia gravis**:
  - Pyridostigmine (Mestinon)
  - Ambenonium Cl (Mytelase)
  - Neostigmine (Prostigmin)

Click for video of positive Tensilon test
http://www.youtube.com/watch?v=k7YX9kuWrxA
Summary & Review

- Preoperative evaluation
- Balanced anesthesia- for safety, comfort and convenience.
- Four stages of anesthesia
- Intraoperative monitoring

Summary & Review

- Pre-anesthetic medications
- Intravenous general anesthetics
- Inhaled general anesthetics
- Anesthesia machine
- Neuromuscular blockers- NDP & DP
- Anticholinesterase agents

References


References


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