General Anesthesia

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This Presentation is Approved for
1 CRCE Credit Hour

Learning Objectives

- Explain the actions, effects, & precautions associated with agents used in general anesthesia
- Describe anesthesia procedures & 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

Pre-Operative Assessment

- History
  - Cardiopulmonary disease
  - Malignant hyperthermia
- Current conditions
  - Sleep apnea: post-operative risk
  - Coagulopathy
  - Cardiopulmonary disease
  - Infections
  - Renal, hepatic disease
  - Diabetes

Pre-Operative Assessment

- Current medications
  - Cardiac medications
  - Anticoagulants
  - Herbals & nutritional supplements
- Social history: alcohol, tobacco
- Physical exam
  - Cardiopulmonary assessment
  - Evaluate for difficult intubation

FYI see links below for article on difficult airway evaluation

Pre-Operative Assessment

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

FYI see links below for anesthesia risk assessment

Anesthesia Procedure

- Induction: initial entry to surgical anesthesia
- Maintenance: continuous monitoring & 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

See links below for neuromuscular blockade monitoring

Monitoring During Anesthesia

- Electronic monitoring
  - Exhaled tidal volume
  - FiO_2
  - SPO_2
  - $ETCO_2$
  - ECG
  - Temperature

See links below anesthesia monitoring (click 'Play')

Monitoring During Anesthesia

- Electronic monitoring
  - Bispectral index (BIS) monitoring: EEG-based monitor for level of consciousness
    - Reduce operative awareness
    - Titrate anesthetic agents

FYI see links below for info on BIS monitoring

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 (benzodiazipines): 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

Non-Barbiturate IV Anesthetics

- Etomidate: intubation
  - Rapid-acting
  - Short duration
- Ketamine: intubation
  - Strong analgesia
  - Bronchodilator

Non-Barbiturate IV Anesthetics

- Midazolam (Versed)
  - Benzodiazipine
  - 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 (N_2O)
  - Weak: used with other medications, gases
  - Safe: does not cause hypotension
  - Adverse effects
    - Pulmonary hypertension
    - Inhibits hypoxemic vasoconstriction
    - Diffuses into ETT cuffs

FYI see links below for history of anesthesia

Inhaled Anesthetics

- Halogenated volatile liquids
  - Halogen (F, Br) included in molecule
  - Nonflammable
  - Potent: low concentrations as 2nd gas

Inhaled Anesthetics

- Halogenated volatile liquids
  - Adverse effects
    - Hepatotoxicity
    - Nephrotoxicity
    - CO poisoning: degradation product
    - Congenital anomalies & spontaneous abortions in OR personnel
    - Malignant hyperthermia

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

Malignant Hyperthermia

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

FYI see links below for article on malignant hyperthermia

Adverse Effects of General Anesthesia

- Depress all components of CNS
- Respiratory depression
- Negative inotropic effects
- Decreased threshold for premature ventricular contractions (PVCs)

Adverse Effects of General Anesthesia

- 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)

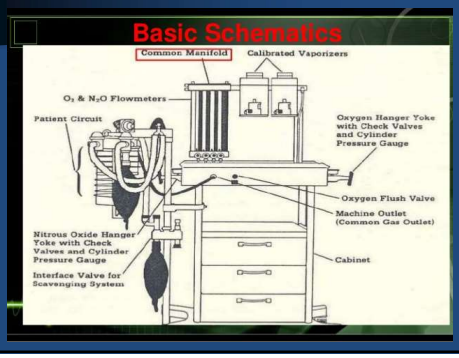
Anesthesia Machine

- Ventilator, anesthesia bag
- Gas cylinders: O_2, N_2O
- Precision flowmeters
- Calibrated vaporizer: for liquid anesthetics
- CO_2 absorber
- Rebreathing bag
- Tubing
- Gas scavenging system

Anesthesia Machine

See links below for virtual anesthesia machines

Anesthesia Machine

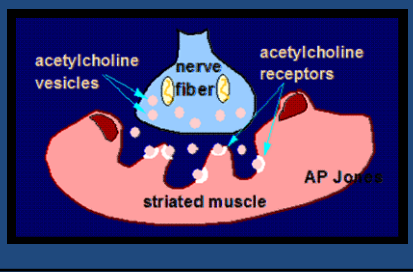


Anesthesia Machine

Neuromuscular Blocking Agents

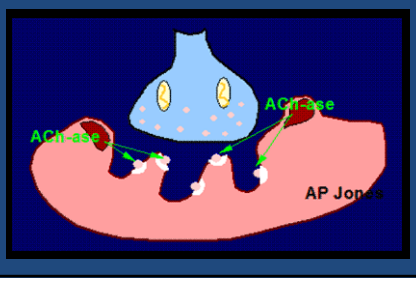
Neuromuscular Junction

Nerve stimulation → ACh secretion → binds to ACh receptor → contraction



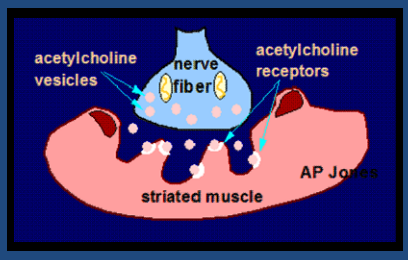
Neuromuscular Junction

ACh-ase secreted → ACh hydrolyzed → muscular relaxation



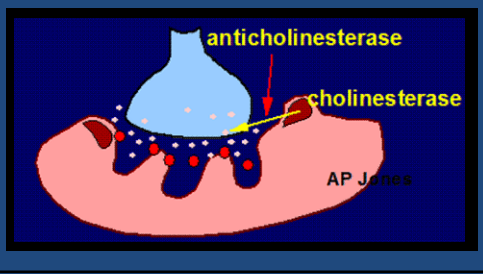
Action of Non-Depolarizing Agents (Curariform)

Occupy ACh receptor sites → prevent depolarization



Reversal of Non-Depolarizing Agents

Anticholinesterase hydrolyzes cholinesterase → increases 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

FYI see links below for video of flushing

Non-Depolarizing Agents

- Adverse effects
  - Histamine release →
    - Flushing
    - Bronchospasm
    - Anaphylaxis
  - Vagolysis → tachycardia, hypertenstion
  - Hypoventilation, apnea
  - Aspiration

Non-Depolarizing Agents

- Contraindications
  - Myasthenia gravis
  - Asthma
  - Electrolyte disturbance
- Interaction: potentiated by
  - Aminoglycosides, e.g. gentamycin
  - Tetracyclines

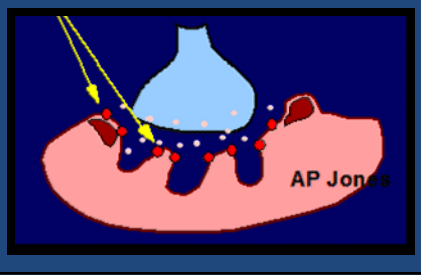
Specific NDP Agents

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

FYI see links below for properties of specific NDP agents

Depolarizing Agents (Succinylcholine)

Drug attaches to ACh receptor → depolarizes muscle → inhibits repolarization



Succinylcholine

- Very short-acting
- Not reversible with drugs
- Pseudocholinsterase deficiency → slow hydrolysis of agent → prolonged action

Succinylcholine

- Side effects
  - Fasciculation → muscle soreness
  - Hyperkalemia
  - Increased ocular pressure
  - Increased intracranial pressure
  - Malignant hyperthermia

Succinylcholine (Anectine, Sucostrin)

- Onset 1 min
- Duration 4 - 6 min
- Perfect for intubations

Anticholinesterase Agents

Anticholinesterase Agents

- Action: inhibit ACh-ase → increase ACh at NM junction → permit depolarization
- Indications
  - Reverse curariform paralysis
  - Diagnose & treat myasthenia gravis

Reversal of Non-Depolarizing Agents

Anticholinesterase hydrolyzes cholinesterase → increases acetylcholine → depolarization

Anticholinesterase Agents

- Side effects: increase acetylcholine at muscarinic receptors → cholinergic crisis
  - Bradycardia
  - Secretion
  - Bronchospasm
- Cholinergic crisis treated with atropine

Anticholinesterase Agents

- Edrophonium Cl (Tensilon)
- Onset < 1 min
- Duration 2 - 10 min
- Routes IV, IM
- Indications
  - Reverse NDPs
  - Diagnose MG (Tensilon test)

See links below for video of positive Tensilon test

Anticholinesterase Agents

- Agents for myasthenia gravis
  - Pyridostigmine (Mestinon)
  - Ambenomium Cl (Mytelase)
  - Neostigmine (Prostigmin)

Summary & Review

- Preoperative evaluation
- Balanced anesthesia: for safety, comfort, & 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

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