Drugs for Local and General Anesthesia
Anesthesia

- Local—affecting a limited part of the body
- General—resulting in loss of consciousness
Local Anesthetics

• Five techniques for applying local anesthesia
  – Topical
  – Infiltration
  – Nerve block
  – Spinal
  – Epidural
Topical (Surface) Anesthesia

- Creams, sprays, suppositories
- Drops and lozenges
- Applied to mucous membranes
- Safe, unless absorbed in the systemic system
Infiltration (Field Block) Anesthesia

• Direct injection into tissue immediate to surgical site

• Blocks specific groups of nerves near site
Nerve Block Anesthesia

• Direct injection into tissues that may be distant from surgical site
• Affects nerve bundles supplying surgical area
• Used to block sensation in a limb or large area of face
Spinal Anesthesia

-Injected into CSF
-Affects large, regional areas such as lower abdomen and legs
Epidural Anesthesia

• Injected into epidural space of spinal canal
• Used most often in labor and delivery
Figure 19.1 Techniques for applying local anesthesia: (a) topical; (b) infiltration; (c) nerve block; (d) spinal; and (e) epidural
<table>
<thead>
<tr>
<th>Route</th>
<th>Formulation/Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topical (surface) anesthesia</td>
<td>Creams, sprays, suppositories, drops, and lozenges</td>
<td>Applied to mucous membranes including the eyes, lips, gums, nasal membranes, and throat</td>
</tr>
<tr>
<td>Infiltration (field block) anesthesia</td>
<td>Direct injection into tissue immediate to the surgical site</td>
<td>Drug diffuses into tissue to block a specific group of nerves in a small area close to the surgical site</td>
</tr>
<tr>
<td>Nerve block anesthesia</td>
<td>Direct injection into tissue that may be distant from the operation site</td>
<td>Drug affects nerve bundles serving the surgical area; used to block sensation in a limb or large area of the face</td>
</tr>
<tr>
<td>Spinal anesthesia</td>
<td>Injection into the cerebral spinal fluid (CSF)</td>
<td>Drug affects a large, regional area such as the lower abdomen and legs</td>
</tr>
<tr>
<td>Epidural anesthesia</td>
<td>Injection into the epidural space of the spinal cord</td>
<td>Most commonly used in obstetrics during labor and delivery</td>
</tr>
</tbody>
</table>
Local Anesthetics

• Work by blocking sodium channels
  – Temporarily suspending nerve conduction and preventing pain signals from reaching the CNS
Pharmacotherapy Illustrated

19.1  Mechanism of Action of Local Anesthetics

1. **Nerve conduction is normal**
   - Sodium channels are open, allowing Na⁺ to enter the neuron.
   - Sensory neuron

2. **Local anesthetic is administered**
   - Amide examples:
     - Lidocaine (Xylocaine) — short acting
     - Bupivacaine (Marcaine) — longer acting

3. **Sodium channels are blocked**
   - Nerve conduction is temporarily suspended, preventing pain signal from reaching the CNS.
Classification of Local Anesthetics

- Classified by their chemical structures
  - Two major classes
    - Esters
    - Amides
  - Some miscellaneous anesthetics are not esters or amides
Figure 19.2 Chemical structures of ester and amide local anesthetics

<table>
<thead>
<tr>
<th>Type</th>
<th>General formula</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ester</td>
<td>R–C–O–R</td>
<td>Procaine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H₂N–C–O–C₂H₂–N(C₂H₅)₂</td>
</tr>
<tr>
<td>Amide</td>
<td>R–NH–C–R</td>
<td>Lidocaine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C₆H₄–NH–C–CH₂–N(C₂H₅)₂</td>
</tr>
</tbody>
</table>
### Table 19.2 Selected Local Anesthetics

<table>
<thead>
<tr>
<th>Chemical Classification</th>
<th>Drug</th>
<th>General Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Esters</strong></td>
<td>benzocaine (Americaine, Anbesol, Solarcaine, others)</td>
<td>CNS depression and burning, stinging and redness at topical application sites</td>
</tr>
<tr>
<td></td>
<td>chloroprocaine (Nesacaine)</td>
<td>Respiratory arrest, circulatory failure, anaphylactoid reaction</td>
</tr>
<tr>
<td></td>
<td>procaine (Novocain)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>proparacaine (Alcaine, Ophthetic)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tetracaine (Pontocaine)</td>
<td></td>
</tr>
<tr>
<td><strong>Amides</strong></td>
<td>articaine (Septocaine, Zorcaine)</td>
<td>Burning, stinging and redness at topical application sites</td>
</tr>
<tr>
<td></td>
<td>bupivacaine (Exparel, Marcaine, Sensorcaine)</td>
<td>Difficulty breathing or swallowing, respiratory depression and arrest, convulsions, anaphylactoid reaction, burning, contact dermatitis</td>
</tr>
<tr>
<td></td>
<td>dibucaine (Nupercainal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lidocaine (Anestacon, Dilocaine, Xylocaine, others)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mepivacaine (Carbocaine, Isocaine, Polocaine)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>prilocaine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ropivacaine (Naropin)</td>
<td></td>
</tr>
<tr>
<td><strong>Miscellaneous drugs</strong></td>
<td>dyclonine (Dyclone)</td>
<td>Burning, stinging, sensation at application site</td>
</tr>
<tr>
<td></td>
<td>ethyl chloride or chloroethane</td>
<td>Respiratory or cardiac arrest</td>
</tr>
<tr>
<td></td>
<td>pramoxine (Tronothane)</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Italics* indicate common adverse effects; *underlining* indicates serious adverse effects.
Esters

• Contains an ester chemical linkage

• Incidence of allergic reaction is low
  – Cocaine natural ester
    ▪ First widely used anesthetic
  – Benzocaine
    ▪ Topical OTC agent
Esters

- Procaine (Novocain)
- Benzocaine (Solarcaine, others)
- Tetracaine (Cetacaine)
- Proparacaine (Alcaine, Ophthmetic)
Esters

• The mechanism of action and primary use are as stated with the amides
• Amides have largely replaced the esters
Amides

- Contain amide chemical linkage
- Longer duration of action and fewer side effects than esters
Amides

- Lidocaine (Anestacon, Dilocaine, Xylocaine)
- Articaine (Septocaine, Zorcaine)
- Bupivacaine (Exparel, Marcaine, Sensorcaine)
Amides

- **Prototype drug**: lidocaine (Xylocaine)
- **Mechanism of action**: to stop axonal conduction by blocking sodium channels
- **Primary use**: for brief medical or dental procedures
Prototype Drug | Lidocaine (Xylocaine)

**Therapeutic Class:** Anesthetic (local/topical); antidyssrhythmic (class IB)  
**Pharmacologic Class:** Sodium channel blocker; amide

<table>
<thead>
<tr>
<th>Actions and Uses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine, the most frequently used injectable local anesthetic, acts by blocking neuronal pain impulses. It may be injected as a nerve block for spinal and epidural anesthesia. Lidocaine patches may be administered to relieve pain related to postherpetic neuralgia (Lidoderm) or dental procedures (DentiPatch). Zingo (lidocaine hydrochloride monohydrate) is a needle-free intradermal injection system that is indicated for rapid local anesthesia. It works by providing 0.5 mg lidocaine topically. This method is useful for pretreatment in instances such as IV insertions or blood draws. Like other amides, lidocaine acts by blocking sodium channels located within neuronal membranes. Lidocaine may be given intravenously (IV), intramuscularly (IM), or subcutaneously to treat dysrhythmias, as discussed in chapter 30. Topical forms are also available. Mouthwashes and rinses can be compounded to help ease pain associated with mouth and throat ulcerations. Lidocaine is commonly compounded with antacids, antibiotics, antifungals, antihistamines, and coating agents.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adverse Effects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>When lidocaine is used for anesthesia, side effects are uncommon. An early symptom of toxicity is CNS excitement, leading to irritability and confusion. Serious adverse effects include convulsions, respiratory depression, and cardiac arrest. Until the effect of the anesthetic diminishes, patients may injure themselves by biting or chewing areas of the mouth that have no sensation following a dental procedure.</td>
<td></td>
</tr>
</tbody>
</table>

**Black Box Warning:** Use of 2% oral viscous lidocaine products especially among infants, may lead to ingestion that cannot be predicted or controlled. When excessive amounts of lidocaine are administered to infants and young children, or they accidentally swallow too much, it can induce seizures, brain injury, cardiac abnormalities, and/or death.

**Contraindications:** Lidocaine should be avoided in cases of sensitivity to amide-type local anesthetics. Application or injection of lidocaine anesthetic is also contraindicated in the presence of severe trauma or sepsis, blood dyscrasias, dysrhythmias, sinus bradycardia, and severe degrees of heart block.
Prototype Drug | Lidocaine (Xylocaine)

**Therapeutic Class:** Anesthetic (local/topical); antidysrhythmic (class IB)  
**Pharmacologic Class:** Sodium channel blocker; amide

---

**Administration Alerts**
- Solutions of lidocaine containing preservatives or epinephrine are intended for local anesthesia only and must never be given parenterally for dysrhythmias.
- Do not apply topical lidocaine to large skin areas or to broken or abraded areas, because significant absorption may occur. Do not allow it to come into contact with the eyes.
- For spinal or epidural block, use only preparations specifically labeled for IV use.
- Pregnancy category B.

---

**Interactions**

**Drug–Drug:** Barbiturates may decrease the activity of lidocaine. Increased effects of lidocaine occur if taken concurrently with cimetidine, quinidine, and beta blockers. If lidocaine is used on a regular basis, its effectiveness may diminish when used with other medications.

**Lab Tests:** Increased creatine phosphokinase (CPK).

**Herbal/Food:** Unknown.

**Treatment of Overdose:** Emergency medical attention is needed because of the many associated substantive symptoms such as breathing difficulty, swelling of the lips, chest pain, irregular heartbeat, nausea, vomiting, tremors, and seizure activity. **Lipid infusion therapy (LipidRescue)** is the use of an intravascular infusion of a lipid emulsion to treat severe, systemic drug toxicity or poisoning. This method was originally developed to treat local anesthetic toxicity, a potentially fatal complication of regional anesthesia that can also occur in other situations where patients receive local anesthetic injections. Lipid infusion therapy can also effectively treat a wide variety of nonlocal anesthetic overdoses. These include reversing CNS and cardiovascular signs and symptoms of drug toxicity.

---

**PHARMACOKINETICS**

<table>
<thead>
<tr>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>45–90 sec IV;</td>
<td>Less than 30</td>
<td>10–20 min IV; 10–90 min IM; 30–60 min topical; more than 100 min injected for anesthesia</td>
</tr>
<tr>
<td>5–15 min IM;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2–5 min topical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Local Anesthetics

• Other agents sometimes added to increase duration or effectiveness
  – Epinephrine
  – Sodium bicarbonate
Epinephrine

- Constricts blood vessels
- Increases duration of anesthetic
Sodium Bicarbonate

• Alkaline solution

• Neutralizes infected area, allowing anesthetic to work better
Adverse Effects of Local Anesthetics

- Adverse effects uncommon
- Reaction to
  - Sulfites
  - Methylparaben
Adverse Effects of Local Anesthetics

• Signs of adverse effects
  – CNS stimulation with early adverse effects
  – CNS depression with later adverse effects
  – Cardiovascular effects
General Anesthetics

• Block flow of sodium into neurons
• Delay nerve impulses and reduce neural activity
• Exact mechanism not known, but likely that GABA receptors in the brain are activated
General Anesthetics

• Produce unconsciousness
• Produce lack of responsiveness to painful stimuli
• Given as inhalation agents or intravenous agents
Stages of General Anesthesia

• **Stage I**: Loss of pain
• **Stage II**: Excitement and hyperactivity
• **Stage III**: Surgical anesthesia
• **Stage IV**: Respiratory and cardiovascular paralysis
## Table 19.3 Stages of General Anesthesia

<table>
<thead>
<tr>
<th>Stage</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loss of pain: The patient loses general sensation but may be awake. This stage proceeds until the patient loses consciousness.</td>
</tr>
<tr>
<td>2</td>
<td>Excitement and hyperactivity: The patient may be delirious and try to resist treatment. Heart rate and breathing may become irregular and blood pressure can increase. IV agents are administered here to calm the patient.</td>
</tr>
<tr>
<td>3</td>
<td>Surgical anesthesia: Skeletal muscles become paralyzed. Cardiovascular and breathing activities stabilize. Eye movements slow and the patient becomes still.</td>
</tr>
<tr>
<td>4</td>
<td>Paralysis of the medulla region in the brain (responsible for controlling respiratory and cardiovascular activity): If breathing or the heart stops, death could result. This stage is usually avoided during general anesthesia.</td>
</tr>
</tbody>
</table>
### Table 19.4 Examples of Intravenous General Anesthetics

<table>
<thead>
<tr>
<th>Chemical Classification</th>
<th>Drug</th>
<th>General Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzodiazepines</td>
<td>diazepam (Valium)</td>
<td><em>Dizziness, decreased alertness, diminished concentration</em></td>
</tr>
<tr>
<td></td>
<td>lorazepam (Ativan)</td>
<td>Cardiovascular collapse, laryngospasm</td>
</tr>
<tr>
<td></td>
<td>midazolam (Versed)</td>
<td></td>
</tr>
<tr>
<td>Opioids</td>
<td>alfentanil (Alfenta)</td>
<td><em>Nausea, gastrointestinal (GI) disturbances</em></td>
</tr>
<tr>
<td></td>
<td>fentanyl (Sublimaze, others)</td>
<td>Marked CNS depression</td>
</tr>
<tr>
<td></td>
<td>remifentanil (Ultiva)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sufentanil (Sufenta)</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous IV drugs</td>
<td>etomidate (Amidate)</td>
<td><em>Dizziness, unsteadiness, dissociation, increased blood pressure and pulse rate, confusion, excitement</em></td>
</tr>
<tr>
<td></td>
<td>ketamine (Ketalar)</td>
<td>Circulatory or respiratory depression with apnea, laryngospasm, anaphylaxis</td>
</tr>
<tr>
<td></td>
<td>propofol (Diprivan)</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Italics* indicate common adverse effects; *underlining* indicates serious adverse effects.
General Anesthetics: Intravenous

- Opioids, benzodiazepines, and miscellaneous agents
- Rapidly induce unconsciousness
General Anesthetics: Intravenous

- Used in combination with inhalation agents
  - Provide greater analgesia and muscle relaxation
  - Balanced anesthesia
Opioids

- Alfentanil (Alfenta), remifentanil (Ultiva), sufentanil (Sufenta)
Opioids

• Fentanyl (Sublimaze, others) given with antipsychotic agent to produce neuroleptanalgesia
  – Patients are conscious, but insensitive to pain and unconnected with surroundings
  – Premixed combination of the two agents called Innovar
Benzodiazepines

• Diazepam (Valium)
• Lorazepam (Ativan)
• Midazolam (Versed)
Miscellaneous IV General Anesthetics

- etomidate (Amidate)
- ketamine (Ketalar)
- propofol (Diprivan)
General Anesthetics: Inhaled Drugs

• Gaseous agents or volatile liquids

• Prevent flow of sodium into neurons in CNS, delay nerve impulses, produce reduction in neural activity

• **Primary use:** with IV agents to maintain loss of consciousness; used alone for dental procedures
### Table 19.5 Inhaled General Anesthetics

<table>
<thead>
<tr>
<th>Type</th>
<th>Drug</th>
<th>General Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>nitrous oxide</td>
<td><em>Dizziness, drowsiness, nausea, euphoria, vomiting</em> Apnea, cyanosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> Italics indicate common adverse effects; underlining indicates serious adverse effects.</td>
</tr>
<tr>
<td>Volatile liquid</td>
<td>desflurane (Suprane)</td>
<td><em>Drowsiness, nausea, vomiting</em> Myocardial depression, marked hypotension, pulmonary vasoconstriction, hepatotoxicity, malignant hyperthermia</td>
</tr>
<tr>
<td></td>
<td>enfurane (Ethrane)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>isoflurane (Forane)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sevoflurane (Sevo, Ultane)</td>
<td></td>
</tr>
</tbody>
</table>
Inhalation Agents: Gaseous Agent

• Nitrous oxide, “laughing gas”
• Only gas routinely used for general anesthesia
Prototype Drug | Nitrous Oxide

Therapeutic Class: General anesthetic  Pharmacologic Class: Inhalation gaseous drug

**Actions and Uses**
The main action of nitrous oxide is analgesia caused by suppression of pain mechanisms in the CNS. This agent has a low potency and does not produce complete loss of consciousness or profound relaxation of skeletal muscle. Because nitrous oxide does not induce surgical anesthesia (stage 3), it is commonly combined with other surgical anesthetic agents. Nitrous oxide is ideal for short surgical or dental procedures because the patient remains conscious and can follow instructions while experiencing full analgesia.

Nitrous oxide is always combined with oxygen (25% to 30%) and is administered in a semiclosed method through a tube or by mask. Nitrous oxide is also used for dental procedures in which the mask is placed over the nose.

**Administration Alerts**
Establish an IV if one is not already in place in case emergency medications are needed.

**PHARMACOKINETICS**

<table>
<thead>
<tr>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>−5 min</td>
<td>Less than 10 min</td>
<td>Patients recover from anesthesia rapidly after nitrous oxide is discontinued.</td>
</tr>
</tbody>
</table>

**Adverse Effects**
When used in low to moderate doses, nitrous oxide produces few adverse effects. At higher doses, patients exhibit some adverse signs of stage 2 anesthesia (see Table 19.3) such as anxiety, excitement, and combativeness. Lowering the inhaled dose will quickly reverse these adverse effects. As nitrous oxide is exhaled, the patient may temporarily have some difficulty breathing at the end of a procedure. Nausea and vomiting following the procedure are more common with nitrous oxide than with other inhalation anesthetics.

Some general anesthetics infrequently produce liver damage. Nitrous oxide has the potential to be abused by users (sometimes medical personnel) who enjoy the relaxed, sedated state that the drug produces.

**Contraindications:** This drug is contraindicated in patients with an impaired level of consciousness, head injury, inability to comply with instructions, decompression sickness (nitrogen narcosis, air embolism, undiagnosed abdominal pain or marked distention, bowel obstruction, hypotension, shock, chronic obstructive pulmonary disease, cyanosis, chest trauma with pneumothorax, or who are being air transported.

**Interactions**
**Drug-Drug:** Sympathomimetics and phosphodiesterase inhibitors may exacerbate dysrhythmias.

**Lab Tests:** Unknown.

**Herbal/Food:** Milk thistle taken before and after anesthesia may lower the potential risk of liver damage. Herbal products such as ginger may also provide therapeutic benefit.

**Treatment of Overdose:** Metoclopramide may help reduce the symptoms of nausea and vomiting associated with inhalation of nitrous oxide.
General Anesthetics: Volatile Liquid

- Volatile anesthetics converted to a vapor to produce anesthetic effects
  - Isoflurane (Forane)
    - Prototype drug
  - Desflurane (Suprane)
  - Sevoflurane (Ultane)
  - Enflurane (Ethrane)
Prototype Drug | Isoflurane (Forane)

**Therapeutic Class:** Inhaled general anesthetic  
**Pharmacologic Class:** GABA and glutamate receptor agonist

**Actions and Uses**
Isoflurane produces a potent level of surgical anesthesia that is rapid in onset. It provides the patient with smooth induction with a low degree of metabolism by the body. This drug provides excellent muscle relaxation and may be used off-label as adjuvant therapy in the treatment of status asthmaticus. Isoflurane with oxygen or with an oxygen/nitrous oxide mixture may be used. Compared to other inhaled general anesthetics, cardiac output is well maintained.

**Administration Alerts**
- Premedication should be selected according to the needs of the patient. Because secretions are weakly stimulated by the use of anticholinergic drugs, premedication is a matter of choice.
- Pregnancy category C.

**PHARMACOKINETICS**

<table>
<thead>
<tr>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>7–10 min</td>
<td>Rapidly absorbed by the lungs; minimum alveolar concentration values vary with age.</td>
<td>Patients recover from anesthesia in less than 1 hour after the drug is discontinued.</td>
</tr>
</tbody>
</table>

**Adverse Effects**
Mild nausea, vomiting, and tremor are common adverse effects. The drug produces a dose-dependent respiratory depression and a reduction in blood pressure. Malignant hyperthermia with elevated temperature has been reported.

**Contraindications:** Patients with a known history of genetic predisposition to malignant hyperthermia should not use isoflurane. Caution should be used when treating patients with head trauma or brain neoplasms due to possible increases in intracranial pressure. Elderly patients are more susceptible to hypotension caused by the drug.

**Interactions**
**Drug-Drug:** When isoflurane is used concurrently with nitrous oxide, coughing, breath holding, and laryngospasms may occur. If isoflurane is administered with systemic pompyrin and aminoglycosides, skeletal muscle weakness, respiratory depression, or apnea may occur. Additive effects may occur with isoflurane if administered with other skeletal muscle relaxants. Additive hypotension may result if used concurrently with antihypertensive medications such as beta blockers. Epinephrine, norepinephrine, dopamine, and other adrenergic agonists should be administered with caution due to the possibility of dysrhythmias. Other drugs may cause dysrhythmias including amiodarone, ibutilide, droperidol, and phenothiazines. Levodopa should be discontinued 6 to 8 hours before isoflurane administration.

**Lab Tests:** Unknown.

**Herbal/Food:** St. John’s wort should be discontinued 2 to 3 weeks prior to administration due to the possible risk of hypotension.

**Treatment of Overdose:** Since isoflurane causes profound respiratory depression, patients are treated symptomatically until effects of the drug diminish.
Adverse Effects of Intravenous Agents for General Anesthesia

• Allergic reactions, dysrhythmias, respiratory depression
  – CNS depression, shivering, headache
  – Nausea and vomiting, vital-sign changes

• During postoperative period: hallucinations, confusion, excitability may occur
Adjuncts to Anesthesia

• Medications given to
  – Complement effects of general anesthesia
  – Treat anticipated side effects of anesthesia
Adjuncts to Anesthesia

- May be given before, during, or after surgery
- Agents are anticholinergic, benzodiazepine, cholinergic, dopamine blocker, neuromuscular blocker, opioids, or phenothiazine
Table 19.6 Selected Adjuncts to General Anesthesia

<table>
<thead>
<tr>
<th>Chemical Classification</th>
<th>Drug</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREOPERATIVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticholinergic</td>
<td>atropine</td>
<td>General anesthesia as a premedication, in emergency situations or during surgery to increase heart rate and to reverse the effects of some cholinergic drugs</td>
</tr>
<tr>
<td>Benzodiazepine</td>
<td>midazolam (Versed)</td>
<td>Generally used before other IV agents for induction of anesthesia</td>
</tr>
<tr>
<td>Dopamine blocker</td>
<td>droperidol (Inapsine)</td>
<td>Nausea and vomiting caused by opioids; reduces anxiety and relaxes muscles</td>
</tr>
<tr>
<td>Opioids</td>
<td>alfentanil (Alfenta)</td>
<td>Short duration; for induction of anesthesia when endotracheal or mechanical ventilation is needed; provides analgesia</td>
</tr>
<tr>
<td></td>
<td>fentanyl (Actiq, Duragesic, Sublimaze, others); fentanyl/droperidol (Innovar) morphine remifentanil (Ultiva)</td>
<td>Analgesia during or after anesthesia</td>
</tr>
<tr>
<td></td>
<td>sufentanil (Sufenta)</td>
<td>Analgesia during or after anesthesia; shorter duration of action than fentanyl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Primary anesthesia or to provide analgesia during or after anesthesia</td>
</tr>
</tbody>
</table>
Table 19.6 Selected Adjuncts to General Anesthesia

<table>
<thead>
<tr>
<th>Chemical Classification</th>
<th>Drug</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DURING SURGERY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neuromuscular blockers</td>
<td>mivacurium (Mivacron)</td>
<td>Short duration muscle paralysis; nondepolarizing-type muscle relaxation</td>
</tr>
<tr>
<td></td>
<td>rocuronium (Zemuron)</td>
<td>Intermediate duration muscle paralysis; nondepolarizing-type muscle relaxation</td>
</tr>
<tr>
<td></td>
<td>succinylcholine</td>
<td>Short duration muscle paralysis; depolarizing-type muscle relaxation</td>
</tr>
<tr>
<td></td>
<td>(Anectine, Quelicin)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tubocurarine</td>
<td></td>
</tr>
<tr>
<td><strong>POSTOPERATIVE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholinergic</td>
<td>bethanechol (Urecholine)</td>
<td>Relief of constipation and urinary retention caused by opioids; stimulates GI motility</td>
</tr>
<tr>
<td>Phenothiazine</td>
<td>promethazine (Phenazine, Phenergan, others)</td>
<td>Nausea and vomiting caused by obstetric sedation and anesthesia</td>
</tr>
<tr>
<td>Serotonin blocker</td>
<td>ondansetron (Zofran, Zuplenz)</td>
<td>Nausea and vomiting caused by cancer chemotherapy, radiation therapy, and surgery</td>
</tr>
</tbody>
</table>

Note: *Italics* indicate common adverse effects; *underlining* indicates serious adverse effects.
Neuromuscular Blockers

• Depolarizing
  – Succinylcholine (Anectine, Quelicin)
  – Binds with acetylcholine receptors at neuromuscular joints
Neuromuscular Blockers

• Nondepolarizing
  – Mivacurium (Mivacron)
  – Tubocurarine
  – Compete with acetylcholine for cholinergic receptors at neuromuscular junctions
**Prototype Drug**  |  **Succinylcholine (Anectine, Quelicin)**

**Therapeutic Class:** Skeletal muscle paralytic drug; neuromuscular blocker  
**Pharmacologic Class:** Depolarizing blocker; acetylcholine receptor blocking drug

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**Actions and Uses**
Like the natural neurotransmitter acetylcholine, succinylcholine acts on cholinergic receptor sites at neuromuscular junctions. At first, depolarization occurs, and skeletal muscles contract. After repeated contractions, however, the membrane is unable to repolarize as long as the drug stays attached to the receptor. Effects are first noted as muscle weakness and muscle spasms. Eventually, paralysis occurs. Succinylcholine is rapidly broken down by the enzyme cholinesterase; when the IV infusion is stopped, the duration of action is only a few minutes. Use of succinylcholine reduces the amount of general anesthetic needed for procedures. Dantrolene (Dantrium) is a drug used preoperatively or postoperatively to reduce the signs of malignant hyperthermia in susceptible patients.

**Black Box Warning:** Succinylcholine should be administered in a facility with trained personnel to monitor, assist, and control respiration. Cardiac arrest has been reported resulting from hyperkalemic rhabdomyolysis most frequently in infants or children with undiagnosed skeletal muscle myopathy or Duchenne’s muscular dystrophy. This drug is reserved for use in children in cases of emergency intubation or in instances when immediate securing of airway is necessary.

**Contraindications:** Succinylcholine should be used with extreme caution in patients with severe burns or trauma, neuromuscular diseases, or glaucoma. Succinylcholine is contraindicated in patients with a family history of malignant hyperthermia or conditions of pulmonary, renal, cardiovascular, metabolic, or hepatic dysfunction.
Prototype Drug | Succinylcholine (Anection, Quelicin)

**Therapeutic Class:** Skeletal muscle paralytic drug; neuromuscular blocker  
**Pharmacologic Class:** Depolarizing blocker; acetylcholine receptor blocking drug

### Administration Alerts
- Pregnancy category C.

### Pharmacokinetics

<table>
<thead>
<tr>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5–1 min IV; 2–3 min IM</td>
<td>Variable within minutes</td>
<td>2–3 min IV; 10–30 min IM</td>
</tr>
</tbody>
</table>

### Adverse Effects
Succinylcholine can cause complete paralysis of the diaphragm and intercostal muscles; thus, mechanical ventilation is necessary during surgery. Bradycardia and respiratory depression are expected adverse effects. If doses are high, the ganglia are affected, causing tachycardia, hypotension, and urinary retention.

Patients with certain genetic defects may experience a rapid onset of extremely high fever with muscle rigidity—a serious condition known as malignant hyperthermia. Succinylcholine should be employed with caution in patients with fractures or muscle spasms, because the initial muscle fasciculations may cause additional trauma. Neuromuscular blockade may be prolonged in patients with hypokalemia, hypocalcemia, or low plasma pseudocholinesterase levels.

### Interactions

**Drug-Drug:** Additive skeletal muscle blockade will occur if succinylcholine is given concurrently with clindamycin, aminoglycosides, furosemide, lithium, quinidine, or lidocaine. The effect of succinylcholine may be increased if given concurrently with phenothiazines, oxytocin, promazine, tacrine, or thiazide diuretics. The effect of succinylcholine is decreased if given with diazepam.

If this drug is given concurrently with nitrous oxide, an increased risk of bradycardia, dysrhythmias, sinus arrest, apnea, and malignant hyperthermia exists. If succinylcholine is given concurrently with cardiac glycosides, there is increased risk of cardiac dysrhythmias. If narcotics are given concurrently with succinylcholine, there is increased risk of bradycardia and sinus arrest.

**Lab Tests:** Unknown.

**Herbal/Food:** Unknown.

**Treatment of Overdose:** Treatment may involve drug therapy for the following symptoms: weakness, lack of coordination, watery eyes and mouth, tremors, and seizures. Problems with breathing require emergency medical measures.
# Nursing Practice Application

## Pharmacotherapy With General Anesthetics

### ASSESSMENT

**Baseline assessment prior to administration:**
- Obtain a complete health history including cardiovascular, respiratory, hepatic, renal, or neurologic disease; pregnancy; or breast-feeding. Obtain a drug history including allergies, current prescription and OTC drugs, herbal preparations, caffeine, nicotine, and alcohol use. Be alert to possible drug interactions.
- Assess for a previous history of anesthesia and note any significant reactions. Obtain a family history of anesthesia problems, particularly related to the use of neuromuscular blockers (e.g., succinylcholine), or any unusual temperature effects related to surgery.

### POTENTIAL NURSING DIAGNOSES*

- Anxiety
- Impaired Gas Exchange
- Ineffective Breathing Pattern
- Decreased Cardiac Output
- Nausea, related to adverse drug effects
- Deficient Knowledge (drug therapy)
- Risk for Injury
- Risk for Infection

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