NEUROMUSCULAR BLOCKING AGENTS
(nondepolarizing)

**Atracurium**
(a-tra-kyoor-ee-um)

**Cisatracurium**
(iss-a-tra-kyoor-ee-um)

**Pancuronium**
(pun-cure-oh-nee-yum)

**Vecuronium**
(vay-cure-oh-nee-yum)

**Rocuronium**
(roe-kyoor-own-ee-um)

**Atracurium**

Terne.

**Cisatracurium**

Terne.

**Pancuronium**

Terne.

**Vecuronium**

Terne.

**Rocuronium**

Terne.

**Classification**

Therapeutic: neuromuscular blocking agents-nondepolarizing

**Pregnancy Category B** (cisatracurium only), C

**Indications**

Indications of skeletal muscle paralysis and facilitation of intubation after induction of anesthesia in surgical procedures. Facilitation of compliance during mechanical ventilation.

**Action**

Prevent neuromuscular transmission by blocking the effect of acetylcholine at the myoneural junction. Have no analgesic or anxiolytic properties.

**Therapeutic Effects:**

Skeletal muscle paralysis.

**Pharmacokinetics**

Absorption:

Following IV administration, absorption is essentially complete.

Distribution:

- **Atracurium**: Distributions into extracellular space; crosses the placenta.
- **Cisatracurium**: Rapidly distributes into extracellular space. Pancuronium—Rapidly distributes into extracellular fluid; small amounts cross the placenta.
- **Rocuronium**: Rapidly distributes into extracellular fluid; minimal penetration of the CNS.
- **Vecuronium**: Rapidly distributes in extracellular fluid; minimal penetration of the CNS.

**Metabolism and Excretion:**

- **Atracurium**: Metabolized in plasma; 5% excreted unchanged in urine.
- **Cisatracurium**: Undergoes pH-dependent breakdown, which is responsible for 80% of metabolism; remainder eliminated by liver and kidneys.
- **Pancuronium**: Excreted mostly unchanged by the kidneys; small amounts are eliminated in bile. Vecuronium—Mostly metabolized and eliminated in the bile. Vecuronium—Some metabolized in the liver (3%), with conversion to at least one active metabolite; 35% excreted unchanged by the kidneys.

Half-life:

- **Atracurium**: Infants: 20 min; Children: 17 min; Adults: 16 min
- **Cisatracurium**: 22–31 min
- **Pancuronium**: 2 hr
- **Rocuronium**: Infants 3–12 months: 0.8–1.8 hr; Children 1–3 yr: 0.4–1.8 hr; Children 3–5–11 yr: 0.5–3 hr; Adults: 1–6–2 hr (1 to 3 hr in hepatic impairment and 1.5 to 2 hr in renal impairment).
- **Vecuronium**: Infants: 65 min; Children: 41 min; Adults: 65–75 min (1), near term in pregnant patients, 1.4 hr in hepatic impairment.

**TIME/ACTION PROFILE (neuromuscular blockade)**

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>ONSET</th>
<th>PEAK</th>
<th>DURATION</th>
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<tbody>
<tr>
<td>IV</td>
<td>1–4 min</td>
<td>3–5 min</td>
<td>20–35 min</td>
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<tr>
<td>Cisatracurium</td>
<td>2–3 min</td>
<td>2–3 min</td>
<td>28–50 min</td>
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<tr>
<td>Pancuronium</td>
<td>5–10 min</td>
<td>2–3 min</td>
<td>40–60 min</td>
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<tr>
<td>Vecuronium</td>
<td>1 min</td>
<td>0.5–1 min (adult)</td>
<td>20–60 min (adult)</td>
</tr>
<tr>
<td>Rocuronium</td>
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</tr>
</tbody>
</table>

**Contraindications/Precautions**

**Contraindications:**

Hypersensitivity; Hypersensitivity to bromides (pancuronium, vecuronium only); Pedi: Products containing benzyl alcohol should be avoided in neonates.

**Precautions:**

- Underlying cardiovascular disease (risk of arrhythmias; less with atracurium or vecuronium); Dehydration or electrolyte abnormalities.

**Use Cautiously in:**

- Dehydration or electrolyte abnormalities; Hypersensitivity.

**Monitoring:**

- MAC: Minimal alveolar concentration.

**Pharmacologic Effects:**

- **Cardiac**:
  - Bradycardia
  - Tachycardia

- **CNS**:
  - Sedation
  - Nerve stimulation

**Overdosage:**

- Symptoms: Bradycardia, hypotension, respiratory depression, apnea, cardiac arrest.

**Treatment:**

- Tobramycin

**Missed Dose:**

- As much as possible at next scheduled dose.

** Pregnancy Category**: B, C (cisatracurium only), C

**Lactation**: Use cautiously.

**Adverse Reactions**

See monograph for complete adverse reactions information.

**Contraindications**: Hypersensitivity to this or other nondepolarizing neuromuscular blocking agents or to any component of the formulation.

**Warnings/Precautions**: 

- Use with caution in the presence of acidosis or alkalosis, hypokalemia, or hypomagnesemia.

**Adverse Reactions**: 

- Cardiovascular: Bradycardia, hypotension, cardiac arrest

- CNS: Nerve stimulation

- Gastrointestinal: Nausea, vomiting

- Respiratory: Apnea, respiratory depression, cardiac arrest

**Overdosage**: 

- Symptoms: Bradycardia, hypotension, respiratory depression, apnea, cardiac arrest

**Treatment**: 

- Tobramycin

**Missed Dose**: 

- As much as possible at next scheduled dose.
long-term rates may be required and duration of action may be shortened in patients receiving
val prolongation when administered with
blocking agents
other local anesthetics
carbenicillin
ministered after steady-state anesthesia with enflurane or isoflurane or 0.3–0.4 mg/
function (slower onset to complete paralysis with cisatracurium;
Geriatric patients or patients with impaired renal
ase inhibitors/insecticides, severe liver disease, pregnancy, or hereditary predisposi-
nesterase levels (may be seen in association with anemia, dehydration, cholinester-
burns (may be more resistant to effects of cisatracurium); Low plasma pseudocholi-
IV (Adults and Children 2–12 yr): Initial intubating dose—0.08–0.1 mg/kg (initially; or 0.06–0.1 mg/kg if given after steady-state anesthesia achieved or 0.06–0.085
mg/kg if given after rapid-sequence intubation and anesthesia, wait for disappearance of succinylcholine effects; or 0.05–0.09 mg/kg during balanced anesthesia); Maintenance
dose—0.01–0.015 mg/kg 25–40 min after initial dose; then q 12–15 min as needed; Continuous infusion—0.08–1.2 mcg/kg/min. Rocuronium
IV (Adults and Children 3–13 yr): Intubation dose—0.08–0.1 mg/kg; Additional doses of 0.03 mg/kg may be used q 25–40 min to maintain paralysis;
Maintenance infusion—1–2 mcg/kg/min. Vecuronium
IV (Adults and Children 1 mo–6yr): Initial intubating dose—0.05–0.1 mg/kg (0.04–0.085
mg/kg if given after rapid-sequence intubation and anesthesia, wait for disappearance of succinylcholine effects, or 0.05–0.09 mg/kg during balanced anesthesia); Maintenance
dose—0.01–0.015 mg/kg 25–40 min after initial dose; then q 12–15 min as needed; Continuous infusion—0.8–1.2 mcg/kg/min. Pancuronium
IV (Adults and Children 6 mo–6 yr): Initial intubating dose—0.08–0.1 mg/kg, then repeat doses as needed; Continuous infusion—1–2 mcg/kg/min. Cisatracurium
Continuous infusion—0.1–0.2 mg/kg/min.
Atracurium
Route/Dosage
Atracurium
IV (Adults and Children >2 yr): 0.4–0.5 mg/kg initially (0.25–0.35 mg/kg if ad-
injected after rapid-sequence intubation with edrophonium or succinylcholine); may then repeat with 0.08–0.1 mg/kg 20–45 min af-
for intubation and anesthesia; or 0.05–0.085 mg/kg during balanced anesthesia); Maintenance
dose—0.01–0.015 mg/kg 25–40 min after initial dose; then q 12–15 min as needed; Continuous infusion—0.075–0.125 mg/kg; Continuous infusion—12 mcg/kg/min. Rocuronium
IV (Adults and Children 3–10 yr): Dose—0.06–0.1 mg/kg (initial dose 0.04–0.085
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IV (Adults and Children 6 mo–6 yr): Initial intubating dose—0.08–0.1 mg/kg, then repeat doses as needed; Continuous infusion—1–2 mcg/kg/min. Vecuronium
IV (Adults and Children 1 mo–6 yr): Initial intubating dose—0.08–0.1 mg/kg, then repeat doses as needed; Continuous infusion—1–2 mcg/kg/min. Cisatracurium
Continuous infusion—0.1–0.2 mg/kg/min.
Neuromuscular response should be monitored with a peripheral nerve stimulator intraoperatively. Paralysis is initially selective and usually occurs sequentially in the following muscles: levator muscles of eyelids, muscles of mastication, limb muscles, abdominal muscles, muscles of the glottis, intercostal muscles, and the diaphragm. Recovery of muscle function usually occurs in reverse order.

- Monitor ECG, heart rate, and BP throughout administration.
- Observe the patient for residual muscle weakness and respiratory distress during the recovery period.
- Monitor infusion site frequently. If signs of tissue irritation or extravasation occur, discontinue and restart in another vein.
- Toxicity and Overdose: If overdose occurs, use peripheral nerve stimulator to determine the degree of neuromuscular blockade. Maintain airway patency and ventilation until recovery of normal respirations occurs.
- Administration of anticholinesterase agents (neostigmine, pyridostigmine) may be used to antagonize the action of neuromuscular blocking agents once the patient has demonstrated some spontaneous recovery from neuromuscular block. Atropine is usually administered prior to or concurrently with anticholinesterase agents to counteract the muscarinic effects.
- Administration of fluids and vasopressors may be necessary to treat severe hypotension or shock.

Potential Nursing Diagnoses
- Ineffective breathing pattern (indications)
- Impaired verbal communication (Side Effects)

Implementation
- High Alert: Unplanned administration of a neuromuscular blocking agent instead of administration of the intended medications or administration of a neuromuscular blocking agent in the absence of ventilatory support has resulted in serious harm and death. Confusing similarities in packaging and insufficiently controlled access to these medications are often implicated in these medication errors.
- Dose is titrated to patient response.
- Neuromuscular blocking agents have no effect on consciousness or pain threshold. Adequate anesthetic analgesia should always be used when neuromuscular blocking agents are used as an adjunct to surgical procedures or when painful procedures are performed. Neuromuscular block and/or analgesics should be administered concurrently when prolonged neuromuscular blockade therapy is used for ventilator patients, because patient is awake and able to feel all sensations.
- If eyes remain open throughout prolonged administration, protect corneas with artificial tears.
- Store atracurium, cisatracurium, pancuronium, rocuronium, and vecuronium in refrigerator. To prevent absorption by plastic, pancuronium should not be stored in plastic syringes. May be administered in plastic syringes.
- Most neuromuscular blocking agents are incompatible with barbiturates and sodium bicarbonate. Do not admix.

Atracurium
- Direct IV: May be administered undiluted. Rate: Administer initial IV dose as a bolus over 1 min.
- Intermitted Infusion: Maintenance dose is usually required 20–45 min following initial dose.
- Diluent: SW, 0.9% NaCl or 0.9/0.9% NaCl. Administer every 15–25 min or by continuous infusion.
- Continuous Infusion: Maintenance dose is administered by infusion. Concentration: 0.5 mg/ml for continuous infusion. Rate: Titrate according to patient response.
- Y-Site Compatibility: acyclovir, albuterol, allopurinol, alprostadil, amifostine, amphotericin B lipid, anidulafungin, argatroban, ascorbic acid, atropine, azathioprine, aztreonam, bevacizumab, bleomycin, bumetanide, buprenorphine, butorphanol, calcium chloride, calcium gluconate, carboplatin, carboplatin, epoetin, cyclophosphamide, cyclosporine, cytarabine, dactinomycin, dapsone, docetaxel, docetaxel, dexamethasone, dexamethasone, dexamethasone, dacarbazine, dacarbazine, dalteparin, dantrolene, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, daratumumab, darat
Intermittent Infusion:

Y-Site Incompatibility:

Pancuronium

Direct IV: May be administered undiluted.

Y-Site Incompatibility: amphotericin B deoxycholate, cyclophosphamide, micafungin, paclitaxel

Cisatracurium
**Neuromuscular Blocking Agents**

(Nondepolarizing)

**Vecuronium**
- **Indications:** Neuromuscular blockade, maintenance of neuromuscular blockade
- **Administration:** Direct IV: Administer undiluted. Rate: Titrate according to patient response.
- **Concentration:** 0.5–1 mg/mL. Rate: Infusion rates of 0.004–0.016 mg/kg/min have been used. Rate of infusion should be limited according to patient's twitch response as monitored with a peripheral nerve stimulator.
- **Y-Site Compatibility:** dobutamine, dopamine, droperidol, lidocaine, mafenide, morphine, propranolol, sodium bicarbonate, sodium chloride, sodium succinate.
- **Y-Site Incompatibility:** atropine, epinephrine, fentanyl, fluidex, heparin, homatropine, lidocaine, nitroglycerin.
- **Y-Site Incompatibility:** (nondepolarizing)
- **Concentration:** 0.05–0.15 mg/mL. Rate: Infusion rates of 0.004–0.016 mg/kg/min have been used. Rate of infusion should be limited according to patient's twitch response as monitored with a peripheral nerve stimulator.
- **Y-Site Compatibility:** dobutamine, dopamine, droperidol, lidocaine, mafenide, morphine, propranolol, sodium bicarbonate, sodium chloride, sodium succinate.
- **Y-Site Incompatibility:** atropine, epinephrine, fentanyl, fluidex, heparin, homatropine, lidocaine, nitroglycerin.
- **Y-Site Incompatibility:** (depolarizing)

**Rocuronium**
- **Indications:** Neuromuscular blockade
- **Administration:** Direct IV: Administer undiluted. Rate: Titrate according to patient response.
- **Concentration:** 0.5–1 mg/mL. Rate: Infusion rates of 0.004–0.016 mg/kg/min have been used. Rate of infusion should be limited according to patient's twitch response as monitored with a peripheral nerve stimulator.
- **Y-Site Compatibility:** dobutamine, dopamine, droperidol, lidocaine, mafenide, morphine, propranolol, sodium bicarbonate, sodium chloride, sodium succinate.
- **Y-Site Incompatibility:** atropine, epinephrine, fentanyl, fluidex, heparin, homatropine, lidocaine, nitroglycerin.
- **Y-Site Incompatibility:** (nondepolarizing)
with bacteriostatic water is stable if refrigerated for 5 days. If other diluents are used, solution is stable for 24 hr if refrigerated. Discard all unused solution.

**Direct IV:**

- **Concentration:** Maximum of 2 mg/ml. Titrate dose according to patient response.
- **Continuous Infusion:** Dilute vecuronium to a concentration of 1 mg/ml in DW, 0.9% NaCl, or LR. Use sterile water for injection instead of manufacturer-provided diluent (contains benzyl alcohol) when reconstituting for use in neonates.

**Note:** Titrate rate of infusion according to patient response.

- **Y-Site Compatibility:** alemtuzumab, alfentanil, alprostadil, amifostine, amikacin, amoxicillin/clavulanate, amphotericin B, amphotericin B colloidal, amphotericin B lipid complex, amphotericin B liposome, aminophylline, amiodarone, ampicillin, ampicillin/sulbactam, anidulafungin, argatroban, azithromycin, aztreonam, bevacizumab, bivalirudin, bleomycin, bumetanide, busulfan, cefazolin, cefotaxim, cefotetan, cefoxitin, ceftazidime, ceftriaxone, cefuroxime, ciprofloxacin, clarithromycin, clioquinol, clioquinol acetate, clindamycin, cyclophosphamide, cytarabine, cyclosporine, dacarbazine, daunorubicin, deferoxamine, dexrazoxane, dexamethasone, dexamethasone sodium phosphate, dexamethasone sodium succinate, dextrose, dextrose 5%, dextrose 5% in water, dextrose 5% in water with epinephrine, dexamethasone, dexmedetomidine, docetaxel, doxorubicin hydrochloride, doxorubicin liposomal, doxycycline, droperidol, enalaprilat, ephedrine, epinephrine, epirubicin, eptifibatide, ertapenem, erythromycin, esmolol, etoposide, etoposide phosphate, famotidine, fenoldopam, fentanyl, fluconazole, fludarabine, fluorouracil, foscarnet, gemcitabine, gentamicin, glycopyrrolate, granisetron, haloperidol, heparin, hydralazine, hydrocortisone sodium succinate, hydromorphone, idarubicin, ifosfamide, insulin, irinotecan, isoproterenol, labetalol, leucovorin calcium, levofloxacin, lidocaine, linezolid, lorazepam, magnesium sulfate, mannitol, mechlorethamine, melphalan, meperidine, meropenem, methotrexate, methyldopate, metoclopramide, metoprolol, metronidazole, midazolam, milrinone, mitoxantrone, morphine, moxifloxacin, mycophenolate, nalbuphine, naloxone, nesiritide, nicardipine, nitroglycerin, nitroprusside, norepinephrine, octreotide, ondansetron, oxaliplatin, pemetrexed, pentazocine, pentobarbital, phenobarbital, phenylephrine, potassium acetate, potassium chloride, potassium phosphates, procainamide, prochlorperazine, promethazine, propranolol, quinupristin/dalfopristin, ranitidine, remifentanil, sodium acetate, sodium bicarbonate, sodium phosphate, streptozocin, sucrose, succinylcholine, sucralfate, sufentanil, succinylcholine, tacrofusine, thiotepa, ticarcillin/clavulanate, tipranate, tirofiban, tobramycin, trimethoprim/sulfamethoxazole, tamoxifen, vancomycin, vaspexpand, ventriculin, vincristine, voriconazole, zidovudine, zolendronic acid

- **Y-Site Incompatibility:** acyclovir, allopurinol, amphotericin B cholesteryl, amphotericin B colloidal, amphotericin B lipid complex, amphotericin B liposome, bivalirudin, cilostazol, clarithromycin, dasatinib, dopamine, doxorubicin hydrochloride, doxorubicin liposomal, doxycycline, dexamethasone, dexmedetomidine, dexamethasone sodium phosphate, dexamethasone sodium succinate, dicyclomine, dicyclomine hydrochloride, diclofenac, digoxin, diphenhydramine, disopyramide, doxorubicin, doxorubicin hydrochloride, duloxetine, duloxetine hydrochloride, diltiazem, doxycycline, dexamethasone, eptifibatide, erythromycin, etoposide, famotidine, fenoldopam, fentanyl, fluconazole, fludarabine, fluorouracil, foscarnet, gemcitabine, gentamicin, glycopyrrolate, granisetron, haloperidol, heparin, hydralazine, hydrocortisone sodium succinate, hydromorphone, idarubicin, ifosfamide, insulin, irinotecan, isoproterenol, labetalol, leucovorin calcium, levofloxacin, lidocaine, linezolid, lorazepam, magnesium sulfate, mannitol, mechlorethamine, melphalan, meperidine, meropenem, methotrexate, methyldopate, metoclopramide, metoprolol, metronidazole, midazolam, milrinone, mitoxantrone, morphine, moxifloxacin, mycophenolate, nalbuphine, naloxone, nesiritide, nicardipine, nitroglycerin, nitroprusside, norepinephrine, octreotide, ondansetron, oxaliplatin, pemetrexed, pentazocine, pentobarbital, phenobarbital, phenylephrine, potassium acetate, potassium chloride, potassium phosphates, procainamide, prochlorperazine, promethazine, propranolol, quinupristin/dalfopristin, ranitidine, remifentanil, sodium acetate, sodium bicarbonate, sodium phosphate, streptozocin, sucrose, succinylcholine, sucralfate, sufentanil, succinylcholine, tacrofusine, thiotepa, ticarcillin/clavulanate, tipranate, tirofiban, tobramycin, trimethoprim/sulfamethoxazole, tamoxifen, vancomycin, vaspexpand, ventriculin, vincristine, voriconazole, zidovudine, zolendronic acid

**Patient/Family Teaching**

- Explain all procedures to patient receiving neuromuscular blocker therapy without general anesthesia, because consciousness is not affected by neuromuscular blocking agents alone.
- Reassure patient that communication abilities will return as the medication wears off.

**Evaluation/Desired Outcomes**

- Adequate suppression of the twitch response when tested with peripheral nerve stimulation and subsequent muscle paralysis.
- Improved compliance during mechanical ventilation.
- Diagnosis of myasthenia gravis

**Why was this drug prescribed for your patient?**

**Evaluation/Desired Outcomes**

- Adequate suppression of the twitch response when tested with peripheral nerve stimulation and subsequent muscle paralysis.
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