c) For adult liver flukes in sheep: 7.6 mg/kg (Paul 1986)
d) For treatment of nematodes in sheep: 3 mL of suspension per 100 lbs of body weight PO (Bulgin 2003)

- **BIRDS:**
  a) Ratites: Using the suspension: 1 mL/22 kg of body weight twice daily for 3 days; repeat in 2 weeks. Has efficacy against flagellate parasites and tapeworms. (Jenson 1998)

Monitoring
- Efficacy
- Adverse effects if used in non-approved species or at dosages higher than recommended
- Consider monitoring CBC's and liver enzymes (q4–6 weeks) if treating long-term (>1 month)

Client Information
- Shake well before administering
- Contact veterinarian if adverse effects occur (*e.g.*, vomiting, diarrhea, yellowish sclera/mucous membranes or skin)

Chemistry/Synonyms
A benzimidazole anthelmintic structurally related to mebendazole, albendazole has a molecular weight of 265. It is insoluble in water and soluble in alcohol.

Albendazole may also be known as. Albendazole may also be known by these synonyms: albendazolum, SKF-62979, *Valbazen®* or *Albenza®*; many other trade names are available.

Storage/Stability
Albendazole suspension should be stored at room temperature (15–30°C); protect from freezing. Shake well before using. Albendazole paste should be stored at controlled room temperature (15–30°C); protect from freezing.

Dosage Forms/ Regulatory Status
VETERINARY-LABELED PRODUCTS:

Albendazole Suspension: 113.6 mg/mL (11.36%) in 500 mL, 1 liter, 5 liters; *Valbazen® Suspension* (Pfizer); (OTC). Approved for use in cattle (not female cattle during first 45 days of pregnancy or for 45 days after removal of bulls, or of breeding age) and sheep (do not administer to ewes during the first 30 days of pregnancy or for 30 days after removal of rams). Slaughter withdrawal for cattle = 27 days at labeled doses. Slaughter withdrawal for sheep = 7 days at labeled dose. Since milk withdrawal time has not been established, do not use in female dairy cattle of breeding age.)

Albendazole Paste: 30% in 205 g (7.2 oz); *Valbazen®* (Pfizer); (OTC). Approved for use in cattle (not female cattle during first 45 days of pregnancy or for 45 days after removal of bulls or of breeding age). Slaughter withdrawal = 27 days at labeled doses. Since withdrawal time in milk has not been established, do not use in female dairy cattle of breeding age.

HUMAN-LABELED PRODUCTS:

Albendazole Tablets: 200 mg; *Albenza®* (SmithKline Beecham); (Rx)

ALBUTEROL SULFATE

(al-*byoo*-ter-ole) Salbutamol, Proventil®, Ventolin®

BETA-ADRENERGIC AGONIST

Prescriber Highlights
- Used primarily as a bronchodilator after PO or inhaled dosing
- Use with caution in patients with cardiac dysrhythmias or dysfunction, seizure disorders, hypertension or hyperthyroidism
- May be teratogenic (high doses) or delay labor

Uses/Indications
Albuterol is used principally in dogs and cats for its effects on bronchial smooth muscle to alleviate bronchospasm or cough. It is also used in horses as a bronchodilator.

Pharmacology/Actions
Like other beta-agonists, albuterol is believed to act by stimulating production of cyclic AMP through activation of adenyl cyclase. Albuterol is considered to be predominantly a $beta_2$ agonist (relaxation of bronchial, uterine, and vascular smooth muscles). At usual doses, albuterol possesses minimal $beta_1$ agonist (heart) activity. Beta-adrenergics can promote a shift of potassium away from the serum and into the cell, perhaps via stimulation of Na^+-K^+-ATPase. Temporary decreases in either normal or high serum potassium levels are possible.

Pharmacokinetics
The specific pharmacokinetics of this agent have apparently not been thoroughly studied in domestic animals. In general, albuterol is absorbed rapidly and well after oral administration. Effects occur within 5 minutes after oral inhalation; 30 minutes after oral administration (*e.g.*, tablets). It does not cross the blood-brain barrier but does cross the placenta. Duration of effect generally persists for 3–6 hours after inhalation and up to 12 hours (depending on dosage form) after oral administration. The drug is extensively metabolized in the liver principally to the inactive metabolite, albuterol 4'-O-sulfate. After oral administration the serum half-life in humans has been reported as 2.7–5 hours.

Contraindications/Precautions/Warnings
Albuterol is contraindicated in patients hypersensitive to it. It should be used with caution in patients with diabetes, hyperthyroidism, hypertension, seizure disorders, or cardiac disease (especially with concurrent arrhythmias).

Use during the late stages of pregnancy may inhibit uterine contractions.

Adverse Effects
Most adverse effects are dose-related and those that would be expected with sympathomimetic agents including increased heart rate, tremors, CNS excitement (nervousness) and dizziness. These effects are generally transient and mild and usually do not require discontinuation of therapy. Decreased serum potassium values may be noted; rarely is potassium supplementation required.

Some cats don't like the "hiss" occurring during actuation of the metered-dose inhaler or the taste of the drug/vehicle.

Reproductive/Nursing Safety

In very large doses, albuterol is teratogenic in rodents. It should be used (particularly the oral dosage forms) during pregnancy only when the potential benefits outweigh the risks. Like some other beta agonists, it may delay pre-term labor after oral administration. In humans, the FDA categorizes this drug as category ***C*** for use during pregnancy (*Animal studies have shown an adverse effect on the fetus, but there are no adequate studies in humans; or there are no animal reproduction studies and no adequate studies in humans.*)

Overdosage/Acute Toxicity

Clinical signs of significant overdose after systemic administration (including when dogs bite an aerosol canister) may include: arrhythmias (bradycardia, tachycardia, heart block, extrasystoles), hypertension, fever, vomiting, mydriasis, and CNS stimulation. Hypokalemia may also be noted. If recently orally ingested, and if the animal does not have significant cardiac or CNS effects, it should be handled like other overdoses (empty gut, give activated charcoal and a cathartic). If cardiac arrhythmias require treatment, a beta-blocking agent (*e.g.*, atenolol, metoprolol) can be used. The oral LD_{50} of albuterol in rats is reported to be greater than 2 g/kg. Contact an animal poison control center for further information.

Drug Interactions

The following drug interactions have either been reported or are theoretical in humans or animals receiving albuterol (primarily when albuterol is given orally and not via inhalation) and may be of significance in veterinary patients:

- **BETA-ADRENERGIC BLOCKING AGENTS** (*e.g.*, **propranolol**): May antagonize the actions of albuterol
- **DIGOXIN**: Albuterol may increase the risk of cardiac arrhythmias
- **INHALATION ANESTHETICS** (*e.g.*, **halothane, isoflurane, methoxyflurane**): Albuterol may predispose the patient to ventricular arrhythmias, particularly in patients with preexisting cardiac disease—use cautiously
- **OTHER SYMPATHOMIMETIC AMINES**: Used with albuterol may increase the risk of developing adverse cardiovascular effects
- **TRICYCLIC ANTIDEPRESSANTS OR MONOAMINE OXIDASE INHIBITORS**: May potentiate the vascular effects of albuterol

Doses

- **DOGS:**

  WARNING: There are several older references that state that the oral dose is 50 mg/kg q8h. **This is an obvious overdose and should not be followed.** A more reasonable dose orally in dogs is: 0.05 mg/kg (50 *micrograms*/kg) PO q8–12h.

  a) 0.05 mg/kg (50 *micrograms*/kg) PO q8h (Johnson 2000)

  b) 0.02 mg/kg PO q12h for 5 days; if no improvement and no adverse effects may increase to 0.05 mg/kg PO q8–12h. If patient responds, reduce to lowest effective dose. (Church 2003)

  c) For inhalation, based on a 60 lb dog: 0.5 mL of the 0.5% solution for nebulization in 4 mL of saline nebulized every 6 hours (McConnell and Hughey 1992)

- **CATS:**

  a) For bronchodilation in feline asthma using the 90 mcg/puff aerosol albuterol inhaler and an appropriate spacer and mask:

  For mild symptoms give one puff albuterol as needed with one puff of 110 mcg fluticasone twice daily.

  Moderate symptoms may be treated with albuterol one puff as needed with a 5 day course of prednisone at 1 mg/kg PO daily, and 220 mcg of fluticasone twice daily.

  Severely affected cats should be treated on an emergency basis with oxygen, an intravenous dose of a glucocorticoid, 90 mcg (one puff) albuterol every 30 minutes as needed.

  Chronic therapy should include fluticasone 220 mcg twice daily, 90 mcg albuterol as needed and 1 mg/kg prednisone every other day. (Dowling 2003b)

  b) For intermittent (not daily) signs (*e.g.*, wheeze, increased cough or respiratory rate and effort at rest) of feline asthma: two puffs into an appropriate spacer (*e.g.*, Aerokat) twice daily; cat should breathe through the mask and spacer for 7–10 seconds. Positive clinical effect should be seen within 5–10 minutes. Can be used every ½ hour for 2–4 hours in crisis. (Padrid 2006)

- **HORSES:** (**Note:** ARCI UCGFS Class 3 Drug)

  a) 8 micrograms/kg PO q12h (Enos 1993)

  b) 2–3 mcg/kg via inhalation using a specially designed mask and spacer (*Aeromask*® and *Aerovent*®) (Foreman 1999)

  c) For heaves: 0.8–2 mcg/kg in a metered dose inhaler (Lavoie 2003)

  d) For short-acting bronchodilation: 450–900 mcg (5–10 puffs) as needed, not to exceed 4 times per week unless in conjunction with a corticosteroid (Mazan 2003)

  e) For heaves: 360 mcg (4 puffs) inhaled as needed. Tolerance develops rapidly if used as a sole therapy. (Rush 2006a)

Monitoring

- Clinical symptom improvement; auscultation, blood gases (if indicated)
- Cardiac rate, rhythm (if warranted)
- Serum potassium, early in therapy if animal is susceptible to hypokalemia

Client Information

- Contact veterinarian if animal's condition deteriorates or it becomes acutely ill.
- If using the aerosol, shake well before using. Be certain how to appropriately administer the product to maximize effectiveness. Do not puncture or use near an open flame; do not allow exposure to temperatures greater than 120°F. Keep out of reach of children and pets.

Chemistry/Synonyms

A synthetic sympathomimetic amine, albuterol sulfate occurs as a white, almost tasteless crystalline powder. It is soluble in water and slightly soluble in alcohol. One mg of albuterol is equivalent to 1.2 mg of albuterol sulfate.

Albuterol sulfate may also be known as: salbutamol hemisulphate, salbutamol sulphate, or salbutamoli sulfas; many trade names are available.

Storage/Stability

Oral albuterol sulfate products should be stored at 2–30°C. The inhaled aerosol should be stored at room temperature; do not allow exposure to temperatures above 120°F or the canister may burst. The 0.5% nebs should be stored at room temperature; the 0.083% nebs should be stored in the refrigerator. Discard solutions if they become colored.

Dosage Forms/Regulatory Status

- **VETERINARY-LABELED PRODUCTS:** None

The ARCI (Racing Commissioners International) has designated this drug as a class 3 substance. See the appendix for more information.

HUMAN-LABELED PRODUCTS:

Albuterol Tablets: 2 mg & 4 mg; *Proventil®* (Schering); generic; (Rx)

Albuterol Extended Release Tablets: 4 mg & 8 mg; *VoSpire® ER* (Odyssey); (Rx)

Albuterol Syrup: 2 mg (as sulfate) per 5 mL in 473 mL & 480 mL; *Proventil®* (Schering); generic; (Rx)

Albuterol Aerosol: Each actualization delivers 90 mcg albuterol in 6.7g, 6.8g, 8.5g, 17g and 18g; *Proventil®* (Schering); *Albuterol HFA®* & *ProAir HFA®* (Ivax); *Proventil HFA®* (Key); *Ventolin HFA®* (GlaxoSmithKline); generic; (Rx). **Note:** At the time or writing (2007), manufacturers of albuterol aerosols are transitioning their products from CFC propellants to ozone-friendly HFA propellants. While these new dosage forms have been shown to be effective, they are not considered generically equivalent to the CFC-containing products. Dosage adjustments may be required.

Albuterol Solution for Inhalation ("Nebs"): 0.021% preservative-free (0.63 mg (as sulfate)/3mL), 0.042% preservative-free (1.25 mg (as sulfate)/3 mL), 0.083% (2.5 mg (as sulfate)/3 mL) and 0.5% (5 mg (as sulfate)/mL) in 0.5 mL vials, 3 mL UD vials or 20 mL; *Proventil®* (Schering); *AccuNeb®* (Dey); generic; (Rx)

Also available: 14.7 g aerosol metered dose inhaler containing 18 mcg ipratropium bromide (an inhaled anticholinergic) and 103 mcg albuterol sulfate per puff; *Combivent®* (B-I); (Rx) and 3 mL unit dose solution for inhalation (neb) containing 0.5 mg ipratropium bromide and 3 mg albuterol, *DuoNeb®* (Dey); (Rx)

ALENDRONATE SODIUM

(a-*len*-droe-nate) Fosamax®

ORAL BISPHOSPHONATE BONE RESORPTION INHIBITOR

Prescriber Highlights

- Orally dosed bisphosphonate that reduces osteoclastic bone resorption
- Potentially useful for refractory hypercalcemia, FORLs, osteosarcoma
- Very limited clinical experience with use of this drug in animals; adverse effect profile, dosages, etc. may significantly change with more experience & clinical research
- Potentially can cause esophageal erosions; risks are not clear for dogs or cats
- Accurate dosing may be difficult & bioavailability is adversely affected by food, etc.
- Cost may be an issue

Uses/Indications

Alendronate use in small animals has been limited, but it may prove useful for treating refractory hypercalcemia in dogs or cats, feline odontoclastic resorptive lesions (FORLs), and as an osteosarcoma treatment adjuvant.

Pharmacology/Actions

Alendronate, like other bisphosphonates, inhibits osteoclastic bone resorption by inhibiting osteoclast function after binding to bone hydroxyapatite. Secondary actions that may contribute to therapeutic usefulness in osteogenic neoplasms include promoting apoptosis and inhibiting osteoclastogenesis, angiogenesis and cancer cell proliferation.

Pharmacokinetics

Specific pharmacokinetic values are limited for dogs and apparently unavailable for cats. Oral bioavailability in all species studied is less than 2%. In humans, alendronate sodium has very low oral bioavailability (<1%) and the presence of food can reduce bioavailability further to negligible amounts. In women, taking the medication with coffee or orange juice reduced bioavailability by 60% when compared to plain water.

Absorbed drug is rapidly distributed to bone or excreted into the urine. The drug is reportedly not highly plasma protein bound in dogs, but it is in rats. Alendronate apparently accumulates on subgingival tooth surfaces and bordering alveolar bone. Plasma concentrations are virtually undetectable after therapeutic dosing.

Alendronate is not metabolized and drug taken up by bone is very slowly eliminated. It is estimated that the terminal elimination half-life in dogs is approximately 1000 days and, in humans, approximately 10 years, however once incorporated into bone, alendronate is no longer active.

Contraindications/Precautions/Warnings

Alendronate is contraindicated in human patients with esophageal abnormalities (*e.g.,* strictures, achalasia) that cause delayed esophageal emptying and those who cannot stand or sit upright for 30 minutes after administration. At present, it is not believed that small animal patients need to remain upright after administration. Because of a lack of experience, the drug is not recommended for use in human patients with severe renal dysfunction (CrCl <35 mL/min). Alendronate should not be used in patients who have demonstrated hypersensitivity reactions to it.

Alendronate use in small animals should be considered investigational at this point. Limited research and experience, dosing questions, risks of esophageal irritation or ulcers, and medication expense all are potential hindrances to its therapeutic usefulness.

Adverse Effects

Little information on the specific adverse effect profile for dogs or cats is published. In humans, alendronate can cause upper GI irritation and erosions. Anecdotal reports of GI upset, vomiting and inappetance have been reported in dogs receiving the drug. It has been suggested that after administration, walking or playing with the dog for 30 minutes may reduce the incidence of esophageal problems. In cats, buttering the lips after administration to induce salivation and reduce esophageal transit time has been suggested.

Other potential adverse effects of concern include jaw osteonecrosis and musculoskeletal pain.

Reproductive/Nursing Safety

Alendronate at dosages of 2 mg/kg in rats caused decreased postimplantation survival rates and at 1 mg/kg caused decreased weight gain in healthy pups. Higher dosages (10 mg/kg) caused incomplete fetal ossification of several bone types. In humans, the FDA categorizes alendronate as category ***C*** for use during pregnancy (*Animal studies have shown an adverse effect on the fetus, but there are no adequate studies in humans; or there are no animal reproduction studies and no adequate studies in humans.*)

While it is unknown if alendronate enters maternal milk, it would be unexpected that measurable quantities would be found in milk or enough would be absorbed in clinically significant amounts in nursing offspring.