CEPHALOSPORINS (Veterinary—Systemic)

This monograph includes information on the following: Cefaclor; Cefadroxil; Cefazolin; Cefixime; Cefotaxime; Cefetetan; Cefpodoxime; Ceftazidime; Ceftriaxone; Cefotetan; Cephalothin; Cephamandole; Cefoxitin; Cefuroxime; Cefprozil; Cephalixin; Cephalexin; Cephapirin; and Cephradine.

First-generation cephalosporins have the highest activity of the cephalosporins against gram-positive bacteria, including most Corynebacteria, Streptococci, and Staphylococci, particularly Staphylococcus aureus and Staphylococcus intermedius. Cephalothin and cephapirin generally have the greatest activity against staphylococci. Staphylococcus epidermidis is only variably susceptible to cephalaxin and cefadroxil. Rhodococcus equi, methicillin-resistant S. aureus, and Enterococcus species are usually resistant. The first-generation cephalosporins have activity against gram-negative bacteria, including some Actinobacillus, Escherichia coli, Haemophilus influenzae, Klebsiella pneumoniae, Pasteurella, Proteus mirabilis, and Salmonella; however, Actinobacter, Citrobacter, Enterobacter, indole-positive Proteus, and Pseudomonas are resistant. Many anaerobic bacteria are susceptible to these antibiotics, with the exception of beta-lactamase-producing Bacteroides and Clostridium difficile.

Second-generation cephalosporins include cefaclor, cefamandole, cefmetazole, cefonicid, cefotetan, cefoxitin, ceftazidime, ceftriaxone, cefepime, ceftazidime, ceftizoxime, and cefotaxime. Second-generation cephalosporins have the same efficacy as or perhaps slightly less efficacy than first-generation cephalosporins against gram-positive pathogens; however, this lack of efficacy is primarily against S. aureus and S. intermedius. Second-generation cephalosporins are more effective than first-generation cephalosporins in the treatment of infections caused by gram-negative bacteria such as Enterobacter, E. coli, Klebsiella, and Proteus. Many anaerobic bacteria are susceptible to second-generation cephalosporins; cefoxitin and cefotetan can also be effective against Bacteroides fragilis. However, Enterococcus and Pseudomonas species are resistant to second-generation cephalosporins. Use of these antimicrobials is generally reserved for infections that are resistant to first-generation cephalosporins.

Third-generation cephalosporins include cefixime, cefoperazone, cefotaxime, cefpodoxime, ceftazidime, ceftriaxone, and cefpodoxime. Third-generation cephalosporins are the most effective of the cephalosporins against antibiotic-resistant gram-negative bacteria. Cefazidime and ceftazidime are active against Pseudomonas, but the majority of the third-generation cephalosporins commonly used in veterinary practice are not.

Ceftriaxone, cefotaxime, ceftriaxone, and cefpodoxime are the only cephalosporins that consistently reach effective antibacterial concentrations in the central nervous system in people with inflamed meninges. Cefpodoxime remains stable in the presence of many beta-lactamase enzymes, thereby increasing its effectiveness in the treatment of beta-lactamase-producing bacteria; however, it is not active against most obligate anaerobes, Pseudomonas species, or enterococci.

Cefotaxime is a cephalosporin that does not clearly fit into the third-generation cephalosporins. It is a second-generation cephalosporin that is more active against gram-negative bacteria than most second-generation cephalosporins.

Evidence Quality

A Good evidence to support a recommendation for use
B Moderate evidence to support a recommendation for use
C Insufficient evidence to support a recommendation for use
D Moderate evidence to support a recommendation against use
E Good evidence to support a recommendation against use

Evidence Type

1 Species-specific evidence from at least one large randomized and controlled trial (RCT) or multiple small RCTs
2 Species-specific evidence from a small RCT, disease models, large case studies, pharmacokinetic studies using surrogate endpoints, or evidence from well-designed trials in a different species that is considered appropriate for comparison
3 Dramatic results from either well-designed, species-specific trials without controls or small case studies
4 Pharmacokinetic studies without surrogate endpoints
5 In vitro studies
6 Opinions of respected authorities on the basis of clinical experience or reports of expert committees

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generation category and has been called a "new-generation" cephalosporin. It has broader gram-positive activity, including good activity against Streptococcus, and less activity against Pseudomonas than other third-generation cephalosporins. It is active against beta-lactamase–producing strains as well as anaerobes, such as Fusobacterium necrophorum and Bacteroides melaninogenicus. Cefotiofur is rapidly metabolized to desfuroylcefotiofur in vivo and S. aureus is four- to eightfold less sensitive to desfuroylcefotiofur than to the parent cefotiofur. Protein mirabilis has a widely variable susceptibility to some metabolites of cefotiofur.

Accepted

*Escherichia coli* infections (treatment)—*Chicks* and *turkey poults*, day-old: Cefotiofur for injection is indicated in the control of early mortality associated with susceptible *E. coli*. [R-11; 15]

**Metritis** (treatment)—*Cattle*: Cefotiofur injectable suspension is indicated in the treatment of bovine respiratory disease complex (shipping fever), caused by susceptible organisms, including *Histophilus somni* (formerly *Haemophilus somnus*), *Mannheimia* (Pasterella) *haemolytica*, and *Pasteurella multocida*. [R-11; 12; 81; 99; 196] Cefotiofur injectable oil suspension is also indicated in the control of these infections in animals at high risk of developing them. [R-11; 196]

**Pneumonia**, bacterial (treatment)—

*Cattle*: Cefotiofur injectable suspension and cefotiofur for injection are indicated in the treatment of swine respiratory disease complex (manginal fever), caused by susceptible organisms, including *Actinobacillus pleuropneumoniae*, *P. multocida*, *Salmonella choleraesuis*, and *Streptococcus suis* type 2. [R-11; 81; 96] Cefotiofur injectable oil suspension is indicated in the treatment of respiratory tract infections caused by susceptible organisms, including *Actinobacillus pleuropneumoniae*, *Haemophilus parasuis*, *P. multocida*, and *Streptococcus suis*. [R-147]

*Sheep*: Cefotiofur for injection is indicated in the treatment of ovine respiratory disease caused by susceptible *M. haemolytica* and *P. multocida*. [R-11; 12; 97] In Canada, cefotiofur for injection is indicated in the treatment of respiratory infection caused by *Mannheimia species* in lambs. [R-12]

**Pododermatitis**, acute (treatment)—*Cattle*: Cefotiofur for injection and cefotiofur injectable suspension are indicated in the treatment of acute bovine interdigital necrobacillosis associated with *F. necrophorum* and *B. melaninogenicus*. [R-11; 12; 81; 99]

**Respiratory tract infections** (treatment)—*Horses*: Cefotiofur for injection is indicated in the treatment of respiratory tract infections caused by susceptible organisms, including *Haemophilus somnus* and *Streptococcus* species. [R-11; 12; 97]

**Skin and soft tissue infections** (treatment)—

*Cats*: Cefadroxil and *E. coli*, *P. multocida*, *Proteus mirabilis*, *S. aureus*, *S. intermedius*, and *Streptococcus canis* (group G, beta-hemolytic). [R-118]

**Urinary tract infections** (treatment)—*Dogs*: Cefadroxil and cefotiofur for injection are indicated in the treatment of urinary tract infections caused by susceptible organisms, including *E. coli*, *P. multocida*, *P. mirabilis*, and *S. aureus*. [R-11; 12]

Perioperative infections (prophylaxis)—*Dogs*: Cefazolin is used in the prevention of infections associated with surgery, including bone surgery, and caused by susceptible organisms when the risk of infection is high or potentially severely damaging. [R-1; 2; 85; 83]

Potentially effective

**Infections, bacterial (treatment)—*Birds***:

There are insufficient data to establish the efficacy and safety of cefalexin and cefalothin in the treatment of bacterial infections in birds, such as cranes, ducks, emu, pigeons, and quail; however, based on pharmacokinetic studies and the apparent wide margin of safety, they have been used in the treatment of susceptible bacterial infections. [R-14]

*Cats*—There are insufficient data to establish the efficacy and safety of cefotaxime, cefoxitin, and ceftriaxone in the treatment of bacterial infections in cats; however, based on pharmacokinetics, pathogen sensitivities, and the apparent wide margin of safety, these medications are used to treat a variety of susceptible infections, including certain *bone*, respiratory, skin, soft tissue, and urinary tract infections. [R-1]

*Dogs*—There are insufficient data to establish the efficacy and safety of cefacloxac, cefazolin, cefotaxime, cefotetan, and cephradine for non–urinary tract infections, cefalexin, cefalothin, cephalothin, cephalixin, cefoxitin, and cefpodoxime proxetil tablets are indicated in the treatment of swine respiratory disease. [R-106]

Goats—Cefotiofur injectable suspension and cefotiofur for injection are indicated in the treatment of urinary tract infections caused by susceptible organisms, including *Histophilus somni*, *H. somni*, *Mannheimia* (Pasterella) *haemolytica*, and *Pasturella multocida*. [R-11; 12; 81; 99; 196] Cefotiofur injectable oil suspension is also indicated in the control of these infections in animals at high risk of developing them. [R-11; 196]

Sheep—Cefotiofur for injection is indicated in the treatment of ovine respiratory disease caused by susceptible *M. haemolytica* and *P. multocida*. [R-11; 12; 97] In Canada, cefotiofur for injection is indicated in the treatment of respiratory infection caused by *Mannheimia species* in lambs. [R-12]

**Piglets**, acute (treatment)—*Cattle*: Cefotiofur for injection and cefotiofur injectable suspension are indicated in the treatment of acute bovine interdigital necrobacillosis associated with *F. necrophorum* and *B. melaninogenicus*. [R-11; 12; 81; 99]

**Respiratory tract infections** (treatment)—*Horses*: Cefotiofur for injection is indicated in the treatment of respiratory tract infections caused by susceptible organisms, including *Haemophilus somnus* and an obligate anaerobe) in

There are insufficient data to establish the clinical efficacy and safety of cefalexin and cefalothin in the treatment of gram-negative or polymicrobial infections such as *Enterobacteriaceae* species and an obligate anaerobe) in dogs; however, pharmacokinetics and a determination of minimum inhibitory concentrations against common pathogens show that cefotetan and cefoxitin are likely to be effective in the treatment of these types of infections. [R-14]

In addition, although safety and efficacy have not been established, there are pharmacokinetic and minimum inhibitory concentration data that suggest ceftriaxone is likely to be effective in the treatment of infections caused by gram-negative *bacteria*, including *Pseudomonas* species (Evidence rating: B-2). [R-147]

**Foals***:

There are insufficient data to establish the safety and efficacy of cefadroxil and cefradine in foals for the treatment of bacterial infections; however, based on the pharmacokinetics known, pathogen sensitivities, and the apparent wide margin of safety, these medications are used to treat a variety of susceptible infections, including certain *bone*, joint, respiratory, skin, soft tissue, and urinary tract infections. [R-106]

There are insufficient data to establish the safety and efficacy of cefalexin and cefradine in foals for the treatment of non–urinary tract infections, cefalexin, cefalothin, cephalothin, cephalixin, cefoxitin, and cefpodoxime proxetil tablets are indicated in the treatment of swine respiratory disease. [R-106]

*Actinobacillus pleuropneumoniae*, *P. multocida*, *Salmonella choleraesuis*, and *Streptococcus suis* type 2. [R-11; 81; 96] Cefotiofur injectable oil suspension is indicated in the treatment of respiratory tract infections caused by susceptible organisms, including *Actinobacillus pleuropneumoniae*, *Haemophilus parasuis*, *P. multocida*, and *Streptococcus suis*. [R-147]

Sheep—Cefotiofur for injection is indicated in the treatment of ovine respiratory disease caused by susceptible *M. haemolytica* and *P. multocida*. [R-11; 12; 97] In Canada, cefotiofur for injection is indicated in the treatment of respiratory infection caused by *Mannheimia species* in lambs. [R-12]

**Pododermatitis**, acute (treatment)—*Cattle*: Cefotiofur for injection and cefotiofur injectable suspension are indicated in the treatment of acute bovine interdigital necrobacillosis associated with *F. necrophorum* and *B. melaninogenicus*. [R-11; 12; 81; 99]

**Respiratory tract infections** (treatment)—*Horses*: Cefotiofur for injection is indicated in the treatment of respiratory tract infections caused by susceptible organisms, including *Haemophilus somnus* and an obligate anaerobe) in dogs; however, pharmacokinetics and a determination of minimum inhibitory concentrations against common pathogens show that cefotetan and cefoxitin are likely to be effective in the treatment of these types of infections. [R-14]

In addition, although safety and efficacy have not been established, there are pharmacokinetic and minimum inhibitory concentration data that suggest ceftriaxone is likely to be effective in the treatment of infections caused by gram-negative *bacteria*, including *Pseudomonas* species (Evidence rating: B-2). [R-147]
responsive to other antimicrobials.\textsuperscript{21}\textsuperscript{[R-42; 67]}

There are insufficient data to establish the safety and efficacy of cephalothin in the treatment of bacterial infections in foals; however, pharmacokinetic data from a three-day dosing study suggest that serum concentrations of cephalothin proxetil necessary to treat certain bacterial infections can be reached (Evidence rating: B-2).\textsuperscript{[R-112]}

**Horses:** There are insufficient data to establish the efficacy and safety of cefoxitin,\textsuperscript{21} cephalothin,\textsuperscript{21} and cephaloridine\textsuperscript{21} in horses for the treatment of bacterial infections; however, based on the pharmacokinetics known, pathogen sensitivities, and the apparent wide margin of safety, these medications are used to treat a variety of susceptible infections, including certain bone, joint, respiratory, skin, soft tissue, and urinary tract infections.

There are insufficient data to establish the safety and efficacy of cephalexin in the treatment of susceptible gram-positive infections in horses; however, pharmacokinetic evidence suggests that plasma concentrations of cephalexin necessary to treat certain bacterial infections can be reached with oral administration (Evidence rating: B-2).\textsuperscript{[R-131]}

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Ceftiofur sodium—Solubility is pH dependent (greater than 400 mg per mL in water at pH > 5.5), although it gels with time. (5–10) No gelling or precipitation occurs at a concentration of 70 mg/mL. (6–108)

Cephalaxin USP—Slightly soluble in alcohol, in chloroform, and in ether.

Cephalexin Hydrochloride USP—Soluble to the extent of 10 mg per mL in water, in acetone, in acetonitrile, in alcohol, in dimethylformamide, and in methanol; practically insoluble in chloroform, in ether, in ethyl acetate, and in isopropyl alcohol.

Cephalothin Sodium USP—Freely soluble in water, in saline TS, and in dextrose solutions; insoluble in most organic solvents.

Cefapirin Sodium USP—Very soluble in water; insoluble in most organic solvents.

Cephadine USP—Sparingly soluble in alcohol and in chloroform; practically insoluble in ether.

Pharmacology/Pharmacokinetics
Note: See also Table 1. Pharmacology/Pharmacokinetics at the end of this monograph.

Mechanism of action/Effect: Cephalosporins are beta-lactam antibiotics that produce their bactericidal effect by inhibition of cell wall synthesis. The site of action for beta-lactam antibiotics is the penicillin-binding proteins (PBPs) on the inner surface of the bacterial cell membrane that are involved in synthesis of the cell wall. (3–6) In actively growing cells, the cephalosporins bind to the PBPs within the cell wall and lead to interference in production of cell wall peptidoglycans and subsequent lysis of the cell in an isosmotic environment. (6–7) Differences in affinity for the types of PBPs by different beta-lactam antibiotics and the bacterial defense mechanisms explain the variations in bactericidal activity among cephalosporins. (6–9)

Distribution: Cephalosporins distribute into most body tissues and fluids. (6–10) They penetrate into pleural fluid, synovial fluid, pericardial fluid, and urine. Cephalosporins can be found in bile fluid if no biliary obstruction is present. (6–10) The cephalosporins penetrate aqueous humor and prostatic fluid less than other body fluids. Most of the cephalosporins have poor penetration of the blood-brain barrier. (6–2, 10) Cefuroxime is the only second-generation cephalosporin known to adequately penetrate into cerebrospinal fluid in people; also, the third-generation antibiotics ceftaxime and cefotaxime have been shown to penetrate inflamed meninges in people. (6–4) Ceftriaxone has been shown to penetrate normal meninges in horses. (6–103)

The high level of protein binding by cefiotrofur in adult animals causes its distribution to differ from that of other cephalosporins. (6–92) Also, the primary metabolite of cefiotrofur, desfuroylceftiofur, has a reactive sulfhydryl group that forms reversible covalent bonds with plasma and tissue proteins. (6–45) Free concentrations of cefiotrofur and its active metabolites tend to be lower than expected when dosages shown to be effective in the treatment of a disease are administered, possibly because of their unique protein binding abilities. (6–40) Concentrations of cefiotrofur and active metabolites in Pasteurella-infected tissue chambers implanted into cattle tend to be higher than concentrations in uninfected chambers. (6–73) Studies of distribution of cefiotrofur into other tissues have also shown it to be unexpectedly soluble in the way in which this affects efficacy in the extra-label treatment of infections is not known. Cefiotrofur is found in endometrial tissue within four to eight hours of subcutaneous administration to postpartum cows. (6–120) When testing tissues potentially used for residue monitoring, the highest concentrations of cefiotrofur are found in kidneys after intramuscular administration to pigs and sheep, followed in pigs by the injection sites, lungs, liver, and muscle. (6–119, 121)

Biotransformation: Cefotaxime, (6–20) cephalothin, (6–9) and cephapirin undergo biotransformation in the liver to desacetyl derivatives. (6–1) Cephalosporin proxetil is a prodrug that is converted by de-esterification in the gastrointestinal tract to an active metabolite, cefpodoxime. (6–118) Ceftriaxone is rapidly converted in vivo to desfuroylceftriaxone, which is structurally similar to and, in most instances, equally active microbiologically to, ceftriaxone. (6–30) The significant exceptions are that Staphylococcus aureus is four- to eightfold less sensitive to desfuroylceftriaxone than to ceftriaxone. (6–43, 146) and that Proteus mirabilis has a widely variable susceptibility to some ceftriaxone metabolites. (6–71) The metabolites of other cephalosporins may retain some antibacterial activity.

Elimination: For most cephalosporins, elimination is by renal tubular secretion and/or glomerular filtration. In pigs, 70 to 80% of an intramuscular ceftriaxone dosage was shown to be eliminated in the urine and about 13% in the feces. (6–119) In sheep, 93% of an intramuscular dosage was found to be eliminated in the urine and 7% in the feces. (6–121)

In dogs, 86%, and in rats, 97% of an intravenous 20-mg/kg dose of cefazidime was demonstrated to be eliminated as active drug in the urine within twenty-four hours. (6–149)

Precautions to Consider

Species sensitivity
Rabbits and small rodents—Cephalosporins may disturb the normal intestinal microflora, particularly when administered orally at high doses. (6–21, 80)

Cross-sensitivity
The incidence of cross-sensitivity in animals is unknown. Caution should be used when cephalosporins are administered to patients with a history of an anaphylactic reaction to other beta-lactam antibiotics because cross-reaction may occur. (6–1) however, a history of a delayed allergic reaction to penicillin does not contraindicate use of a cephalosporin. (6–2)

Pregnancy/Reproduction
Pregnancy—Cephalosporins have been shown to cross the placenta in animals. Studies in laboratory animals have not shown the cephalosporins to cause adverse effects in the fetus. (6–22–24) Studies with cefoxitin have found no evidence that the medication is teratogenic or fetotoxic in mice and rats, but a slight decrease in fetal weight has occurred. (6–21)

Lactation
Cephalosporins are distributed into milk. (6–25) however, when administered systemically at accepted doses, therapeutic concentrations are not reached in milk. (6–47, 89)

Drug interactions and/or related problems
The following drug interactions and/or related problems have been selected on the basis of their potential clinical significance (possible mechanism in parentheses where appropriate)—not necessarily inclusive (s = major clinical significance):

Note: Combinations containing any of the following medications, depending on the amount present, may also interact with this.
In addition to the above drug interactions reported in animals, the Human drug interactions\(^{[R-46]}\)

In addition to the above drug interactions reported in animals, the following drug interactions have been reported in humans, and are included in the human monograph Cephalosporins (Systemic) in USP DI Volume I; these drug interactions are intended for informational purposes only and may or may not be applicable to the use of cephapirin in the treatment of animals:

- Antacids or Ranitidine or Histamine H$_2$-receptor antagonists, other (concurrent use of high doses of antacids or H$_2$-receptor antagonists with cefpodoxime decreases absorption of cefpodoxime by 27 to 32%, and decreases peak plasma levels by 24 to 42%) (the extent of absorption of cefaclor is decreased with concurrent use of aluminum hydroxide- or magnesium-containing antacids; cefaclor should not be taken within 1 hour of taking these antacids)
- Anticoagulants, coumarin- or indandione-derivative, or Heparin or Thrombolytic agents (concurrent use of these medications with cefotetan may increase the risk of bleeding because of the N-methylthiotetrazole [NMTT] side chain on these medications; however, critical illness, poor nutritional status, and the presence of liver disease may be more important risk factors for hypoprothrombinemia and bleeding; because all cephalosporins can inhibit vitamin K synthesis by suppressing gut flora, prophylactic vitamin K therapy is recommended when any of these medications is used for prolonged periods in malnourished or seriously ill patients; dosage adjustments of anticoagulants may be necessary during and after therapy with cefotetan; concurrent use with thrombolytic agents may increase the risk of severe hemorrhage and is not recommended) (an increased anticoagulant effect has been reported with concurrent use of cefaclor and oral anticoagulants)
- Nephrotoxic medications (cephalothin has been associated with an increased incidence of nephrotoxicity when used concurrently with aminoglycosides; this effect has rarely been seen with other commercially available cephalosporins used at appropriate doses; the potential for increased nephrotoxicity exists when cephalosporins are used with other nephrotoxic medications, such as loop diuretics, especially in patients with pre-existing renal function impairment; renal function should be monitored carefully in patients receiving cephalosporins and aminoglycosides concurrently)
- Platelet aggregation inhibitors, other (hypoprothrombinemia induced by large doses of salicylates and/or cephalosporins, and the gastrointestinal ulcerative or hemorrhagic potential of nonsteroidal anti-inflammatory drugs [NSAIDs], salicylates, or sulfipyrazone may increase the risk of hemorrhage)

Laboratory value alterations

The following have been selected on the basis of their potential clinical significance (possible effect in parentheses where appropriate)—not necessarily inclusive (\(n\) = major clinical significance):

- **With diagnostic test results**
  - Coombs’ test (positive reactions for the Coombs’ test may be seen in animals receiving cephalosporins;\(^{[R-101]}\) this may be due to changes in the red blood cells, but hemolytic anemia usually is not occurring\(^{[R-3]}\))
  - Glucose, urine (in dogs, cephalaxin has been shown to produce false-positive and false-negative urine glucose results with some commercial tests [Chemstrips and Clinistest were used in the study]; other than being test-dependent, this problem is probably also dosage-dependent and dependent on the timing of collection after drug administration\(^{[R-114]}\) (See also Human laboratory value alterations below in this monograph)
  - With physiology/laboratory test values
    - Ketones, urine (values may be increased)\(^{[R-68]}\)

Human laboratory value alterations\(^{[R-46]}\)

The following laboratory value alterations have been reported in humans, and are included in the human monograph Cephalosporins (Systemic) in USP DI Volume I; these laboratory value alterations are intended for informational purposes only and may or may not be applicable to the use of cephalosporins in the treatment of animals:

- **With diagnostic test results**
  - Coombs’ (antiglobulin) tests (a positive Coombs’ reaction frequently appears in patients who receive large doses of a cephalosporin; hemolysis rarely occurs, but has been reported; test may be positive in neonates whose mothers received cephalosporins before delivery)
  - Creatinine, serum and urine (celofetan, cefoxitin, or cephalothin may falsely elevate test values when the Jaffé’s reaction method is used; serum samples should not be obtained within 2 hours after administration)
  - Glucose, urine (most cephalosporins [cefaclor, cepafolin, cefixime, cefotetan, ceftoxitin, cephalaxin, cephalothin, cephradin] may produce false-positive or falsely elevated test results with copper-reduction tests [Benedict’s, Fehling’s, or Clinitest]; glucose enzymatic tests, such as Clinistix and Tes-Tape, are not affected)
  - Protein, urine (cefaclor may produce false-positive tests for proteinuria with acid and denaturation-precipitation tests)
- **Prothrombin time (PT)** (may be prolonged; cephalosporins may inhibit vitamin K synthesis by suppressing gut flora; also, cefazidime and cephalosporins with the NMTT side chain [cefaclor, cefoperazone, cefotetan] have been associated with an increased incidence of hypoprothrombinemia; patients who are critically ill, malnourished, or have liver function impairment may be at the highest risk of bleeding)

With physiology/laboratory test values
Alanine aminotransferase (ALT [SGPT]), or
Alkaline phosphatase, or
Aspartate aminotransferase (AST [SGOT]), or
Lactate dehydrogenase (LDH)

(seum values may be increased)

Bilirubin, serum, or
Blood urea nitrogen (BUN) or
Creatinine, serum

(concentrations may be increased)

Complete blood count (CBC) or
Platelet count

(transient leukopenia, neutropenia, agranulocytosis, thrombocytopenia, eosinophilia, lymphocytosis, and thrombocytosis have been reported on rare occasions)

Medical considerations/Contraindications

The medical considerations/contraindications included have been selected on the basis of their potential clinical significance (reasons given in parentheses where appropriate)—not necessarily inclusive (= major clinical significance).

Except under special circumstances, this medication should not be used when the following medical problems exist:

Hypersensitivity to cephalosporins

(some reactions may be much more likely to occur in animals that have had a previous reaction to a cephalosporin or to a penicillin

Risk-benefit should be considered when the following medical problems exist:

Bleeding disorders, history of

(some of the second- and third-generation cephalosporins have been associated with an increased risk of bleeding in people due to a decrease in prothrombin activity, and bleeding is considered a potential human risk with all the cephalosporins; there is evidence of a significant increase in bleeding time after cephalothin administration to beagles, but outside normal reference ranges; clinical problems have not been reported in animals and the clinical significance is unknown)

Hepatic dysfunction, severe

(because cefotaxime, cephalothin, and cephapirin are heptatically metabolized before renal elimination, severe liver dysfunction can inhibit metabolism)

Renal insufficiency

(nephrotoxicity may occur in patients with renal insufficiency who are receiving the full dosage of cephalosporin; dosage should be adjusted)

Side/Adverse Effects

The following side/adverse effects have been selected on the basis of their potential clinical significance (possible signs and, for humans, symptoms in parentheses where appropriate)—not necessarily inclusive:

Those indicating need for medical attention

Incidence unknown

All species

Hypersensitivity reactions—acute anaphylaxis or angioedema, allergic agranulocytosis, [R-31] fever, serum sickness, urticaria)

Dogs

Anemia; thrombocytopenia

Note: Anemia and thrombocytopenia have been seen in dogs given cefotaxime at high doses (three to five times the labeled dose) or for long periods of time (5 to 6 weeks). These side effects appear to be reversible when treatment is discontinued.

Foals and horses

Colic; diarrhea

Note: There have been reports of colic and/or diarrhea in association with the administration of some cephalosporins.

Colic was reported in two of six horses given a single intragastric dose of ceftiofur proxetil. Diarrhea was reported in foals during treatment for infection with a regimen of intravenous cefotaxime every six to eight hours. Although cephalosporins are considered generally safe, horses should be monitored during antibiotic therapy.

Laminitis was reported in one of six mares in association with cefoxitin administration.

Those indicating need for medical attention only if they continue or are bothersome

All species

Anemia:

Acute anaphylaxis and angioedema, allergic agranulocytosis, fever, serum sickness, urticaria

Diarrhea and vomiting—possibly due to local irritation from the oral dosage forms

Diuretic caused by altered gut flora

Local reactions (mild to moderate pain, heat, swelling)—with parenteral dosage forms, especially cephalothin and cephapirin

Phlebitis—with intravenous administration

Note: Diarrhea and vomiting can occur with any dosage but are more common with high doses. Administration of the antibiotic with food may decrease the incidence of gastrointestinal effects.

Cattle

Local ear swelling—with subcutaneous administration of ceftiofur injectable oil suspension

Human side/adverse effects

In addition to the above side/adverse effects reported in animals, the following side/adverse effects have been reported in humans, and are included in the human monograph Cephalosporins (Systemic) in USP DI Volume I; these side/adverse effects are intended for information purposes only and may or may not be applicable to the use of cephalosporins in the treatment of animals:

Incidence more frequent

Esinophilia

Incidence less frequent or rare

Hypersensitivity reactions—have occurred with many cephalosporins, but reported more commonly with cefazolin; hypoprothrombinemia—more frequent for cefotetan; pseudomembranous colitis; thrombophlebitis; urticaria

Incidence rare

Allergic reactions, specifically anaphylaxis: epidermal necrolysis, toxic erythema multiforme; hearing loss—has occurred rarely in pediatric patients being treated for meningitis, but more frequently with cefuroxime; hemolytic anemia, immune, drug-induced—has occurred with many cephalosporins, but reported more commonly with cefotetan; leukopenia, neutropenia, or thrombocytopenia; renal dysfunction; serum sickness-like reactions—may be more frequent with cefaclor; seizures—especially with high doses and in patients with renal function impairment

Overdose

For information in cases of overdose or unintentional ingestion, contact the American Society for the Prevention of Cruelty to Animals (ASPCA) National Animal Poison Control Center (888-426-4435 or 900-443-0000; a fee may be required for consultation) and/or the drug manufacturer.

LD₅₀:

Cefpodoxime proxetil
studies of ceftiofur after a single intramuscular dose of 3 to 5 mg per kg of body weight (mg/kg) in pigs and 1.1 mg/kg in cattle, minimum inhibitory concentration (MIC) for common respiratory disease pathogens, and disk (30 mcg) diffusion data:

<table>
<thead>
<tr>
<th>Zone diameter (millimeters)</th>
<th>MIC (mcg/mL)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 25</td>
<td>≤ 3</td>
<td>Susceptible</td>
</tr>
<tr>
<td>18-20</td>
<td>4</td>
<td>Intermediate</td>
</tr>
<tr>
<td>≤ 17</td>
<td>≥ 8</td>
<td>Resistant</td>
</tr>
</tbody>
</table>

Breakpoints recommended by CLSI, based on pharmacokinetic studies of ceftiofur after a single intramuscular dose of 3 to 5 mg per kg of body weight (mg/kg) in pigs and 1.1 mg/kg in cattle, minimum inhibitory concentration (MIC) for common respiratory disease pathogens, and disk (30 mcg) diffusion data:

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</tr>
</tbody>
</table>

Note: In cattle, the common respiratory disease pathogens used were Histophilus somni (formerly Haemophilus somnius), Mannheimia haemolytica, and Pasteurella multocida. In pigs, these were Actinobacillus pleuropneumoniae, P. multocida, Salmonella choleraesuis, and Streptococcus suis.

Breakpoint recommended by CLSI, based on pharmacokinetic studies of ceftiofur administered by a single intramuscular dose of 2.2 mg/kg in horses, clinical effectiveness data, and MIC data:

<table>
<thead>
<tr>
<th>Zone diameter (millimeters)</th>
<th>MIC (mcg/mL)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 22</td>
<td>≤ 0.25</td>
<td>Susceptible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistant</td>
</tr>
</tbody>
</table>

Note: The disk content was 30 mcg and the pathogen was Streptococcus equi subspecies zooepidemicus.

For oral dosage forms only
Administration of oral cephalosporins, such as cefadroxil, with food appears to decrease nausea in those animals prone to the side effect; however, administration of cefixime with food can decrease the bioavailability of the antibiotic by one half.

For parenteral dosage forms only
Many cephalosporins can be reconstituted with 1% lidocaine to decrease injection pain. See the manufacturer’s package insert.

For treatment of adverse effects

For anaphylaxis

Recommended treatment consists of the following:
- Parenteral epinephrine
- Oxygen administration and breathing support
- Parenteral fluid administration, as needed

CEFACLOR

Summary of Differences
Indications: General considerations—Second-generation cephalosporin.

Oral Dosage Forms
Note: The text between 11 and 16 describes uses not included in U.S. product labeling. Text between 18 and 16 describes uses that are not included in Canadian product labeling. The absence of CAN designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFACLOR CAPSULES USP
Usual dose:

Veterinary-labeled product(s):
- Not commercially available.
- Human-labeled product(s):
  - 500 mg (Rx) [Cefaclor].
  - 250 mg (Rx) [Cefaclor].

Canada—
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 250 mg (Rx) [Apo-Cefaclor; Ceclor].
  - 500 mg (Rx) [Apo-Cefaclor; Ceclor].

Packaging and storage: Store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

USP requirements: Preserve in tight containers. Contain the equivalent of the labeled amount of anhydrous cefaclor, within ±10% to ±20%. Meet the requirements for Identification, Dissolution (80% in 30 minutes in water in Apparatus 2 at 50 rpm), Related compounds, Uniformity of dosage units, and Water (not more than 8.0%).

CEFAKLOR FOR ORAL SUSPENSION USP
Usual dose: See Cefaclor Capsules USP.

Strength(s) usually available: When reconstituted according to manufacturer’s instructions—

Veterinary-labeled product(s)—
- Not commercially available.
- Human-labeled product(s)—
  - 25 mg per mL (Rx) [Cefaclor; Generic].
  - 37.4 mg per mL (Rx) [Cefaclor; Generic].
  - 50 mg per mL (Rx) [Cefaclor; Generic].
Drug interactions and/or related problems: Concurrent administration of probenecid may prolong the serum half-life of cefadroxil. [R-3]

Packaging and storage: Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

Stability: After reconstitution, suspensions retain their potency for 14 days if refrigerated.

Auxiliary labeling:
- Refrigerate.
- Shake well.

USP requirements: Preserve in tight containers. A dry mixture of Cefaclor and one or more suitable buffers, colors, diluents, and flavors. Contains the equivalent of the labeled amount of anhydrous cefadroxil, within –10% to +20%. Meets the requirements for Identification, Uniformity of dosage units (solid packaged in single-unit containers), Deliverable volume (solid packaged in multiple-unit containers), pH (4.5–6.0, in the suspension constituted as directed in the labeling), and Water (not more than 2.0%). [R-14]

CEFADROXIL

Summary of Differences
Indications: General considerations—First-generation cephalosporin.

Oral Dosage Forms

CEFADROXIL FOR ORAL SUSPENSION USP
Usual dose:
Skin and soft tissue infections—
- Cats: Oral, 22 mg per kg of body weight every twenty-four hours. [R-37; 38]
- Dogs: Oral, 22 mg per kg of body weight every twelve hours.
Urinary tract infections—Dogs: Oral, 22 mg per kg of body weight every twelve hours. [R-37; 38]

Strength(s) usually available: When reconstituted according to manufacturer’s instructions—
U.S.:
- Veterinary-labeled product(s)—50 mg per mL (Rx) [Cefa-Drops].
- Human-labeled product(s)—25 mg per mL (Rx) [Apo-Cefaclor; Ceclor].
50 mg per mL (Rx) [Apo-Cefaclor; Ceclor].
75 mg per mL (Rx) [Apo-Cefaclor; Ceclor].

Packaging and storage: Store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

Stability: When reconstituted according to manufacturer’s directions and refrigerated, suspensions retain their potency for 14 days. [R-37]

USP requirements: Preserve in tight containers. A dry mixture of Cefadroxil and one or more suitable buffers, colors, diluents, and flavors. Contains the equivalent of the labeled amount of anhydrous cefadroxil, within –10% to +20%. Meets the requirements for Identification, Uniformity of dosage units (solid packaged in single-unit containers), Deliverable volume (solid packaged in multiple-unit containers), pH (4.5–6.0, in the suspension constituted as directed in the labeling), and Water (not more than 2.0%). [R-14]

CEFAZOLIN

Summary of Differences
Indications: General considerations—First-generation cephalosporin.

Parenteral Dosage Forms
Note: The dosing and strengths of the dosage forms available are expressed in terms of cefazolin base (not the sodium salt). The text between US and CA describes uses not included in U.S. product labeling. Text between CAN and KC describes uses that are not included in Canadian product labeling. The US or CAN designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFAZOLIN INJECTION USP
Usual dose: Although Cefazolin Injection USP is the same antimicrobial as Cefazolin For Injection USP, it is only available frozen in premixed dilute concentrations, making it less practical for veterinary use. For dosing information, see Cefazolin For Injection USP.

Strength(s) usually available: U.S.—
Human-labeled product(s):
- 500 mg (base) in 50 mL (Rx) [Ancef].
- 1 gram (base) in 50 mL (Rx) [Ancef].
Canada—
- Not commercially available.

Packaging and storage: Store at –10 °C (14 °F) or below, unless otherwise specified by the manufacturer.

Preparation of dosage form: Cefazolin sodium injection should be thawed at room temperature, and all ice crystals should have melted, before administration. Thawing should not be forced by immersion in water baths or by microwave irradiation.

Stability: See manufacturer’s product labeling for stability information.

Incompatibilities: The admixture of cefazolin sodium injection with other medications is not recommended. The admixture of beta-lactam antibacterials (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

USP requirements: Preserve in Containers for Injections. Maintain in the frozen state. A sterile solution of Cefazolin and Sodium
Bicarbonate in a diluent containing one or more suitable toxicity-adjusting agents. It meets the requirements for Labeling under Injections. The label states that it is to be thawed just prior to use, describes conditions for proper storage of the resultant solution, and directs that the solution is not to be refrozen. Contains the labeled amount, within –10% to +15%. Meets the requirements for Identification, Bacterial endotoxins, Sterility, pH (4.5–7.0), and Particulate matter.**[R-14]**

**CEFAZOLIN FOR INJECTION USP**

**Usual dose:****[R-39; R-40]**—Dogs:

- Intravenous, 22 mg (base) per kg of body weight every two hours, or 8 mg (base) per kg of body weight every hour, starting at the beginning of surgery and continuing until the end of surgery.*[R-82]
- Or 30 mg (base) per kg of body weight every four to eight hours has been used for the treatment of susceptible bacterial infections, based on pharmacokinetics studies.*[R-2; R-39; R-44]

Note: The above dose is based on pharmacokinetic studies, including studies performed during surgical procedures.*[R-39; R-40]

Also for dogs, an intramuscular or intravenous dose of 20 to 35 mg (base) per kg of body weight every four to eight hours for infections**[R-82]** described as being of the same dose, administered for two to four weeks, is likely to be effective for treatment of bone, skin, and soft tissue infections in dogs.*[R-14]

**Strength(s) usually available:**

- U.S.—**[R-39]**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 500 mg (base) (Rx) [Ancef; Kefzol; GENERIC].
    - 1 gram (base) (Rx) [Ancef; Kefzol; GENERIC].
    - 5 grams (base) (Rx) [Ancef].
    - 10 grams (base) (Rx) [Ancef; Kefzol; GENERIC].

- Canada—**[R-44]**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 50 mg (base) (Rx) [Kefzol].
    - 500 mg (base) (Rx) [Ancef; Kefzol; GENERIC].
    - 1 gram (base) (Rx) [Ancef; Kefzol; GENERIC].
    - 10 grams (base) (Rx) [Ancef; Kefzol; GENERIC].

**Packaging and storage:** Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

**Preparation of dosage form:** To prepare the 100 mg of cefazolin (base) per mL dilution commonly used in veterinary practice for intramuscular or intravenous administration, 9.6 mL of sterile water for injection should be added to each 1-gram vial.*[R-39; R-44]

See manufacturer’s package insert for other preparation instructions.

**Stability:** See manufacturer’s product labeling for stability information.

**Incompatibilities:** The admixture of beta-lactam antibacterials (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

**USP requirements:** Preserve in Containers for Injections. Contains an amount of Cefazolin Sodium equivalent to the labeled amount of cefazolin, within –10% to +15%. Meets the requirements for Constituted solution, Identification, Specific rotation (–10° to –24°), Bacterial endotoxins, Sterility, pH (4.0–6.0, in a solution containing 100 mg of cefazolin per mL), Uniformity of dosage units, Water (not more than 6.0%), and Particulate matter, and for Labeling under Injections.*[R-14]

**CEFIXIME**

**Summary of Differences**

Indications: General considerations—Third-generation cephalosporin. Veterinary Dosing Information: Administration with food decreases the bioavailability by one half.

**Oral Dosage Forms**

Note: The text between **[R-14]** and **[R-15]** describes uses not included in U.S. product labeling. Text between **[R-15]** and **[R-16]** describes uses that are not included in Canadian product labeling.

There are also some pharmacokinetic data to suggest that the same dose, administered for two to four weeks, is likely to be effective for treatment of bone, skin, and soft tissue infections in dogs.*[R-14]

**Strength(s) usually available:** When reconstituted according to manufacturer's directions—

- U.S.—
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 20 mg per mL (Rx) [Suprax].

- Canada—
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 20 mg per mL (Rx) [Suprax].

**Packaging and storage:** Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

**Stability:** After reconstitution, suspension retains its potency for 14 days at room temperature or if refrigerated.

**Auxiliary labeling:** • Shake well.

**USP requirements:** Preserve in tight containers. A dry mixture of Cefixime and one or more suitable diluents, flavors, preservatives, and suspending agents. Label it to indicate that the cefixime contained therein is in the trihydrate form. Contains the labeled amount of anhydrous cefixime, within –10% to +20%, per mL when constituted as directed in the labeling. Meets the requirements for Identification, Uniformity of dosage units (solid packaged in single-unit containers), Deliverable volume (solid packaged in multiple-unit containers), pH (2.5–4.5, in the suspension constituted as directed in the labeling), and Water (not more than 2.0%).* [R-14]

**CEFIXIME TABLETS USP**

**Usual dose:** See Cefixime for Oral Suspension USP.

**Strength(s) usually available:**

- U.S.—
CEFOTAXIME

Summary of Differences
Indications: General considerations—Third-generation cephalosporin. Pharmacology/pharmacokinetics:
Biotransformation—Significant metabolism occurs with the major pathway yielding a desacetyl derivative. Desacetylcefotaxime is less active against staphylococci but acts synergistically with the parent compound against sensitive gram-negative bacteria.\(^{[6]}\)
Distribution—In people, when administered at high doses, cefotaxime enters the cerebrospinal fluid in therapeutic concentrations when meninges are inflamed.\(^{[8]}\)
Medical considerations/contraindications: Severe hepatic dysfunction can inhibit metabolism.\(^{[6]}\)

Parenteral Dosage Forms
Note: The dosing and strengths of the dosage forms available are expressed in terms of cefotaxime free acid (not the sodium salt).
The text between \(^{[5]}\) and \(^{[6]}\) describes uses not included in U.S. product labeling. Text between \(^{[6]}\) and \(^{[7]}\) describes uses that are not included in Canadian product labeling.
The \(^{[6]}\) or \(^{[6,\text{CAN}}\) designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFOTAXIME INJECTION USP
Usual dose:
Note: \(^{[2]}\)\(^{,\text{CAN}}\) Cats—Although the efficacy and safety have not been established, an intramuscular or intravenous dose of 20 to 80 mg (free acid) per kg of body weight every six hours has been used in the treatment of susceptible bacterial infections in cats, based on pharmacokinetic data.\(^{[10,42]}\)
\(^{[1]}\)\(^{,\text{CAN}}\) Dogs—Although the efficacy and safety have not been established, a subcutaneous dose of 50 mg (free acid) per kg of body weight every twelve hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data. When administered intramuscularly, the dose should be repeated every eight hours.\(^{[10,43]}\)
\(^{[1]}\)\(^{,\text{CAN}}\) Foals—Although the efficacy and safety have not been established, an intravenous dose of 40 mg (free acid) per kg of body weight every six hours has been used in the treatment of neonatal sepsis or susceptible bacterial meningitis in foals.\(^{[10,42]}\)

Strength(s) usually available:
U.S.\(^{[8,44]}\)
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 20 mg (free acid) per mL (Rx) [Claforan].
  - 40 mg (free acid) per mL (Rx) [Claforan].
Canada—
- Not commercially available.

Packaging and storage: Store at –20 °C (–4 °F) or below, unless otherwise specified by manufacturer.\(^{[6,44]}\)

Preparation of dosage form: Cefotaxime sodium injection should be thawed at room temperature, and all ice crystals should have melted, before administration.\(^{[6,44]}\)

Stability: See manufacturer’s product labeling for stability information.

USP requirements: Preserve in single-dose containers. Maintain in the frozen state. A sterile solution of Cefotaxime Sodium in Water for Injection. Contains one or more suitable buffers, and it may contain Dextrose or Sodium Chloride as a toxicity-adjusting agent. It meets the requirements for Labeling under Injections. The label states that it is to be thawed just prior to use, describes conditions for proper storage of the resultant solution, and directs that the solution is not to be refrozen. Contains an amount of cefotaxime sodium equivalent to the labeled amount of cefotaxime, within ±10%. Meets the requirements for Identification, Bacterial endotoxins, Sterility, pH (5.0–7.5), Particulate matter, and Chromatographic purity.\(^{[6,44]}\)

CEFOTAXIME FOR INJECTION USP
Usual dose: See Cefotaxime Injection USP.

Size(s) usually available:
U.S.\(^{[8,44]}\)
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 500 mg (free acid) (Rx) [Claforan].
  - 1 gram (free acid) (Rx) [Claforan].
  - 2 grams (free acid) (Rx) [Claforan].
  - 10 grams (free acid) (Rx) [Claforan].
Canada—
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 500 mg (free acid) (Rx) [Claforan].
  - 1 gram (free acid) (Rx) [Claforan].
  - 2 grams (free acid) (Rx) [Claforan].

Packaging and storage: Prior to reconstitution, store below 30 °C (86 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

Additional information: A solution containing 1 gram of cefotaxime sodium in 14 mL of sterile water for injection is isotonic.\(^{[6,44]}\)
**CEFOTETAN**

**Summary of Differences**
Indications: General considerations—Second-generation cephalosporin.

**Parenteral Dosage Forms**
Note: The dosing and strengths of the dosage forms available are expressed in terms of cefotetan base (not the disodium salt).

The text between ELUS and EL describes uses that are not included in Canadian product labeling. The ELUS designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

**CEFOTETAN FOR INJECTION USP**

**Usual dose:**
Note: ELUS,CAN Dogs—Although the efficacy and safety have not been established, an intravenous dose of 30 mg (base) per kg of body weight every eight hours or the same dose administered subcutaneously every twelve hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data.EL

**Size(s) usually available:**

**U.S.—**
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 1 gram (base) (Rx) [Cefotan].
  - 2 grams (base) (Rx) [Cefotan].
  - 10 grams (base) (Rx) [Cefotan].

**Canada—**
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 1 gram (base) (Rx) [Cefotan].
  - 2 grams (base) (Rx) [Cefotan].

**Packaging and storage:** Prior to reconstitution, do not store above 22 °C (72 °F), unless otherwise specified by manufacturer. Protect from light.

**Preparation of dosage form:** Dilutions should be prepared according to manufacturer’s instructions.

**Stability:** See manufacturer’s product labeling for stability information.

**Incompatibilities:** The admixture of beta-lactam antibacterials and aminoglycosides may result in substantial mutual inactivation. They should not be mixed in the same intravenous bag or bottle.

**USP requirements:** Preserve in containers for Sterile Solids. Contains an amount of Cefotetan Disodium equivalent to the labeled amount of cefotetan, within –10% to +20%. Meets the requirements for Constituted solution, Bacterial endotoxins, Sterility, and Particulate matter, for Identification, pH, and Water under Cefotetan Disodium, for Uniformity of dosage units, and for Labeling under Injections.EL

**CEFOXITIN**

**Summary of Differences**
Indications: General considerations—Second-generation cephalosporin; good activity against anaerobic organisms, but only active against some Bacteroides fragilis.EL

Pharmacology/pharmacokinetics: Distribution—In people, when administered at high doses, cefoxitin enters the cerebrospinal fluid in therapeutic concentrations when meninges are inflamed.EL

Drug interactions and/or related problems: Concurrent administration with probenecid may prolong the serum half-life of cefoxitin.EL

**Parenteral Dosage Forms**
Note: The dosing and strengths of the dosage forms available are expressed in terms of cefoxitin base (not the sodium salt).

The text between ELUS and EL describes uses that are not included in Canadian product labeling. The ELUS designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

**CEFOXITIN INJECTION USP**

**Usual dose:**
Note: ELUS,CAN Dogs—Although the efficacy and safety have not been established, an intravenous dose of 30 mg (base) per kg of body weight every six hours or the same dose administered subcutaneously every eight hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data.EL

**Horses—**
Although the efficacy and safety have not been established, an intravenous dose of 20 mg (base) per kg of body weight every four to six hours has been used in the treatment of susceptible bacterial infections in horses, based on pharmacokinetic data.EL

**Strength(s) usually available:**

**U.S.—**
- Veterinary-labeled product(s):
  - Not commercially available.
- Human-labeled product(s):
  - 20 mg (base) per mL (Rx) [Mefoxin].
  - 40 mg (base) per mL (Rx) [Mefoxin].

**Canada—**
- Not commercially available.

**Packaging and storage:** Store at –20 °C (–4 °F) or below, unless otherwise specified by manufacturer.EL

**Preparation of dosage form:** See manufacturer’s product labeling.

**USP requirements:** Preserve in Containers for Injections. Maintain in the frozen state. A sterile solution of Cefoxitin Sodium and one or more suitable buffer substances in Water for Injection. Contains Dextrose or Sodium Chloride as a tonicity-adjusting agent. It meets the requirements for Labeling under Injections. The label states that it is to be thawed just prior to use, describes conditions for proper storage of the resultant solution, and directs that the solution is not to be refrozen. Contains an amount of cefoxitin sodium equivalent to the labeled amount of cefoxitin, within –10% to +20%. Meets the requirements for Identification,
Bacterial endotoxins, Sterility, pH (4.5–8.0), and Particulate matter.

CEFOXITIN FOR INJECTION USP
Usual dose: See Cefoxitin Injection USP.

Size(s) usually available:
U.S.—
Veterinary-labeled product(s):
Not commercially available.
Human-labeled product(s):
1 gram (base) (Rx) [Mefoxin].
2 grams (base) (Rx) [Mefoxin].
10 grams (base) (Rx) [Mefoxin].

Canada—
Veterinary-labeled product(s):
Not commercially available.
Human-labeled product(s):
1 gram (base) (Rx) [Mefoxin; GENERIC].
2 grams (base) (Rx) [Mefoxin; GENERIC].
10 grams (base) (Rx) [Mefoxin].

Packaging and storage: Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

USP requirements: Preserve in Containers for Sterile Solids. Contains Cefoxitin Sodium equivalent to the labeled amount of cefoxitin, within –10% to +20%. Meets the requirements for Constituted solution, Bacterial endotoxins, Sterility, and Particulate matter, for Identification tests, pH, and Water under Cefoxitin Sodium, for Uniformity of dosage units, and for Labeling under Injections.

CEFPODOXIME PROXETIL

Summary of Differences

Oral Dosage Forms
Note: The dosing and strengths of the dosage forms available are expressed in terms of the active cefpodoxime moiety (not the proxetil ester).

The text between [R-110] describes uses not included in U.S. product labeling. Text between [R-110] and [R-112] describes uses that are not included in Canadian product labeling. The [R-110] or [R-112] designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFPODOXIME PROXETIL TABLETS USP
Usual dose: Skin and soft tissue infections—Dogs: Oral, 5 to 10 mg per kg of body weight a day for five to seven days or for two to three days past the end of clinical signs, up to a maximum of twenty-eight days.

Note: Although the safety and efficacy have not been established, pharmacokinetic data suggest an oral dose of 10 mg per kg of body weight every six to twelve hours produces plasma concentrations that would be necessary to treat infections caused by bacteria with a minimum inhibitory concentration ≤ 0.2 mcg/mL for administration every twelve hours and ≤ 0.5 mcg/mL for administration every six hours. Although adverse effects were not reported in six foals administered cefpodoxime for three days, two of six adult horses given a single dose of cefpodoxime proxetil (10 mg/kg) developed mild colic (pelvic flexure impaction) within twenty-four to forty-eight hours. It is not known if this effect was due to the medication, change to a new diet just before the study, or other factors.

Strength(s) usually available:
U.S.—
Veterinary-labeled product(s)—
100 mg (Rx) [Simplicef].
200 mg (Rx) [Simplicef].

Canada:
Veterinary-labeled product(s)—
Not commercially available.

Packaging and storage: Store at controlled room temperature, 20 to 25 °C (68 and 77 °F), unless otherwise specified by the manufacturer. Keep in a tightly closed container.

Caution: People handling this medication should be careful to avoid repeated or prolonged exposure in order to prevent the sensitization to antimicrobials that can occur in susceptible individuals. Direct contact with the skin or mucous membranes should be avoided. Those with a known hypersensitivity should avoid exposure to this medication.

USP requirements: Preserve in tight containers, at room temperature. Contains an equivalent amount of the labeled amount of cefpodoxime, within ±10%. Meets the requirements for Identification, Dissolution (70% in 30 minutes in a solution [pH 3.0 ± 0.1] in Apparatus 2 at 75 rpm), Uniformity of dosage units, and Water (not more than 5%).

CEFTAZIDIME

Summary of Differences
Indications: General considerations—Third-generation cephalosporin. Good activity against Pseudomonas species.

Parenteral Dosage Forms
Note: The dosing and strengths of the dosage forms available are expressed in terms of ceftazidime base (not the sodium salt). The text between [R-110] and [R-112] describes uses not included in U.S. product labeling. Text between [R-110] and [R-111] describes uses that are not included in Canadian product labeling. The [R-110] or [R-111] designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFTAZIDIME FOR INJECTION USP
Usual dose:
[ElUS; CAN] Bacterial infections (treatment)—Dogs: Although the safety and efficacy have not been established, pharmacokinetic and minimum inhibitory concentration data suggest an intramuscular or intravenous dose of 30 mg per kg of body weight every six hours or a subcutaneous dose of 30 mg per kg of body weight every four to six hours should be effective in the treatment of gram-negative bacterial infections, including Pseudomonas species.
Some experts believe that administration every eight hours may be sufficient for some organisms, based on established pharmacokinetic/pharmacodynamic criteria. Data also suggest a continuous intravenous infusion of ceftazidime beginning with a loading dose of 4.4 mg per kg of body weight followed by 4.1 mg per kg of body weight an hour, administered in intravenous fluids, should also be effective.\textsuperscript{13,16-17}

Size(s) usually available:

- U.S.:
  - Veterinary-labeled product(s)—
    - Not commercially available.
  - Human-labeled product(s)—
    - 500 mg (Rx) [Ceptaz (L-arginine); content in products containing it is 349 mg per gram]; Fortaz (sodium carbonate; sodium content of products with sodium carbonate is 54 mg per gram); Tazicef (sodium carbonate); GENERIC.
    - 1 gram (Rx) [Ceptaz (L-arginine); Fortaz (sodium carbonate); Tazicef (sodium carbonate); GENERIC].
    - 2 grams (Rx) [Ceptaz (L-arginine); Fortaz (sodium carbonate); Tazicef (sodium carbonate); GENERIC].
    - 6 grams (Rx) [Fortaz (sodium carbonate); Tazicef (sodium carbonate); GENERIC].
    - 10 grams (Rx) [Ceptaz (L-arginine)].
- Canada:
  - Veterinary-labeled product(s)—
    - Not commercially available.
  - Human-labeled product(s)—
    - 1 gram (Rx) [Fortaz; GENERIC].
    - 2 grams (Rx) [Fortaz; GENERIC].
    - 6 grams (Rx) [Fortaz; GENERIC].

Packaging and storage: Prior to reconstitution, store between 15 and 30 °C (59 and 86 °F), unless otherwise specified by the manufacturer. Protect from light.

Preparation of dosage form: After reconstitution of the sodium carbonate formulation, carbon dioxide is formed, causing positive pressure inside the vial and sometimes significant “fizzing.” The pressure may require venting. To prepare solution for intramuscular use, 1.5 mL of suitable diluent (see manufacturer's package insert) should be added to each 500-mg vial, or 3 mL of diluent should be added to each 1-gram vial. To prepare initial dilution for intravenous use, 3 or 5 mL of suitable diluent (see manufacturer's package insert) should be added to each 500-mg vial, or 10 mL of diluent should be added to each 1- or 2-gram vial, according to manufacturer's labeling instructions. For direct intermittent intravenous use, the resulting solution should be administered slowly over a 3- to 5-minute period. For intravenous infusion, the resulting solution may be further diluted in suitable fluids according to the manufacturer’s labeling instructions.

Caution—Human product labeling states that use of diluents containing benzyl alcohol is not recommended for preparation of medications for use in neonates. A fatal toxic syndrome consisting of metabolic acidosis, CNS depression, respiratory problems, renal failure, hypotension, and possibly seizures and intracranial hemorrhages has been associated with this human use.

Stability: After reconstitution for intramuscular use with sterile water for injection, bacteriostatic water for injection, or lidocaine hydrochloride injection, solutions retain their potency for at least 18 hours at room temperature or for 7 days if refrigerated. Solutions that are frozen immediately after reconstitution with sterile water for injection in the original container retain their potency for at least 3 months at –20 °C (–4 °F).

After reconstitution for intravenous use, solutions retain their potency for at least 18 hours at room temperature or for 7 days if refrigerated. Solutions that are frozen immediately after reconstitution with sterile water for injection in the original container retain their potency for at least 3 months at –20 °C (–4 °F).

Once thawed, solutions should not be refrozen. Thawed solutions retain their potency for at least 8 hours at room temperature or for at least 4 days if refrigerated.

Incompatibilities: The admixture of ceftazidime with other medications, including pentamidine isethionate, is not recommended.

The admixture of beta-lactam antibacterials (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation. If they are administered concurrently, they should be administered in separate sites. Do not mix them in the same intravenous bag or bottle.

Vancomycin is physically incompatible with ceftazidime and a precipitate may form, depending on the concentration. Therefore, the intravenous lines should be flushed between the administration of these two medications if they are to be given through the same tubing.

USP requirements: Preserve in Containers for Sterile Solids, protected from light. A sterile mixture of Sterile Ceftazidime and Sodium Carbonate or Arginine. Contains not less than 90.0% and not more than 105.0% of ceftazidime, on the dried and sodium carbonate- or arginine-free basis, and contains the labeled amount, within –10% to +20%. Meets the requirements for Identification, Bacterial endotoxins, Sterility, pH (5.0–7.5, in a solution constituted in the sealed container, taking care to relieve the pressure inside the container during constitution, containing 100 mg of ceftazidime per mL), Loss on drying (not more than 12.5%, where it contains arginine; not more than 13.5% where it contains sodium carbonate), Particulate matter, Sodium carbonate (where present), Limit of pyridine, and Content of arginine (where present), for Uniformity of dosage units, and for Labeling under Injections.\textsuperscript{8-14}

**CEFTIOFUR**

**Summary of Differences**

Indications: General considerations—Third-generation cephalosporin.

Pharmacology/pharmacokinetics—Biotransformation—

Biotransformation to an active antibacterial metabolite, desfuroylceftiofur, occurs.\textsuperscript{8-66}

Drug interactions and/or related problems: Probencid has not been shown to alter the excretion of cefotiofur.\textsuperscript{8-70}

Side/adverse effects: Often-reversible anemia and thrombocytopenia can occur in animals given three to five times the recommended dose of cefotiofur.\textsuperscript{8-66}

**Parenteral Dosage Forms**

Note: The dosing and strengths of the dosage forms available are expressed in terms of cefotiofur free acid (not the sodium salt). The text between\textsuperscript{11,15} describes uses not included in U.S.
product labeling. Text between ELUS and EL describes uses that are not included in Canadian product labeling.

The ELUS or ELCAN designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEFTIOFUR FOR INJECTION

Usual dose:

**Escherichia coli** infections—

*Escherichia coli* Chickens<sup>EL</sup>, day-old: Subcutaneous, 0.08 to 0.2 mg (free acid) per chick as a single dose<sup>[R-14]</sup>

Withdrawal times—US: Not labeled for use in chicks older than one day of age.<sup>[R-11]</sup>

*Turkey poults,* day-old: Subcutaneous, 0.17 to 0.5 mg (free acid) per poult as a single dose.<sup>[R-11]</sup>

Withdrawal times—US and Canada: Not labeled for use in turkey poults older than one day of age.<sup>[R-11; 12]</sup>

**Pneumonia**

**Cattle:** Intramuscular or ELUS, 1.1 to 2.2 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-14]</sup>

Withdrawal times—US and Canada: Meat—4 days, Milk—None.<sup>[R-11; 12]</sup> Product labeling states that treatment should not exceed five days for withdrawal times to apply.<sup>[R-11; 12]</sup>

**Goats**: Intramuscular, 1.1 to 2.2 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-14]</sup>

Withdrawal times—US: Meat—0 days, Milk—None.<sup>[R-11; 12]</sup>

**Pigs:** Intramuscular, 3 to 5 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-11]</sup>

Withdrawal times—US: Meat—4 days.<sup>[R-11; 12]</sup> Canada: Meat—24 hours.<sup>[R-14]</sup> Product labeling states that treatment should not exceed three days for withdrawal times to apply.

**Sheep:** Intramuscular, 1.1 to 2.2 mg (free acid) per kg of body weight every twenty-four hours for three days.<sup>[R-11; 97]</sup> If a satisfactory response is not seen, the dose may be repeated on the fourth and fifth days.<sup>[R-11; 97]</sup> Note: Canadian product labeling lists a dose of 2 mg (free acid) per kg of body weight a day for three days for use in lambs.<sup>[R-12]</sup>

Withdrawal times—Sheep: US—Meat: 0 days, Milk: None.<sup>[R-11]</sup>

**Lambs:** Canada—Meat: 24 hours.<sup>[R-12]</sup>

**Podo dermatitis—Cattle:** Intramuscular or ELUS, subcutaneous<sup>EL</sup>, 1.1 to 2.2 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-11; 12]</sup>

Withdrawal times—US and Canada: Meat—4 days, Milk—None.<sup>[R-11; 12]</sup> Product labeling states that treatment should not exceed five days for withdrawal times to apply.

**Respiratory tract infections—Horses:** Intramuscular, 2.2 to 4.4 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-11; 12]</sup>

Note: ELUS,CAN For treatment of susceptible infections in foals, a dose of 2.2 to 6.6 mg (free acid) per kg of body weight every twelve to twenty-four hours has been used, based on pharmacokinetic data.<sup>[R-48]</sup>


**Urinary tract infections—Dogs:** Subcutaneous, 2.2 mg (free acid) per kg of body weight every twenty-four hours.<sup>[R-11; 12]</sup>

Note: ELUS,CAN For treatment of bacterial infections other than urinary tract infections in dogs, a dose of 2.2 to 4.4 mg (free acid) per kg of body weight every twenty-four hours has been used, based on pharmacokinetic data.<sup>[R-74; 76]</sup>

Note: ELUS,CAN Mastitis, severe coliform (treatment adjunct)—Cows: Although the efficacy has not been established, there is some evidence to suggest that the labeled dose of intramuscularly administered ceftiofur, 2.2 mg per kg of body weight a day for five days, may improve survival rates for cows with severe coliform mastitis by controlling bacteremia.<sup>[R-139]</sup> Other treatment may include administration of an intramammary antimicrobial, intravenous fluids, or an anti-inflammatory medication.

Extra-label withdrawal—There are insufficient data at this time for the Food Animal Residue Avoidance Databank to estimate a milk withdrawal interval when ceftiofur is administered parenterally to cows with severe mastitis.<sup>[R-145]</sup> The medication is distributed more efficiently to inflamed mammary tissue and, while milk concentrations are not considered therapeutic, there is a possibility they could exceed residue limits in some cows. Testing the milk from each cow treated, with a drug screening test sensitive to ceftiofur, is recommended to insure ceftiofur residues are avoided. If a positive test occurs, milk is discarded until the next daily test is negative; that is, until twenty-four hours after the last positive test.<sup>[R-146]</sup>

Note: ELUS,CAN Retained fetal membranes (treatment)—Cows: Although the safety and efficacy have not been established, there is some evidence to suggest that intrauterine administration of ceftiofur, 1000 mg as a single total dose, may improve survival rates for dairy cows, by decreasing the risk of being culled from the herd.<sup>[R-148]</sup>

Extra-label withdrawal—There are insufficient data at this time for the Food Animal Residue Avoidance Databank to estimate a meat or milk withdrawal interval after single-dose intrauterine administration of ceftiofur to cows with retained fetal membranes.<sup>[R-148]</sup> Because of the lack of information regarding intrauterine ceftiofur absorption in cows with retained fetal membranes, we cannot preclude the possibility of delayed absorption and prolonged residues. Testing the milk of each treated cow with an appropriate drug screening test is recommended to insure ceftiofur residues are avoided in milk. If a positive test occurs, milk is discarded until the next daily test is negative; that is, until twenty-four hours after the last positive test. There is no established antimortem test for residues in meat. The urine Live Animal Swab Test (LAST, MedTox Diagnostics, Inc., www.medtox.com, 800-334-1116) may be useful to screen for the possibility of antibiotic residues after an extended withdrawal.<sup>[R-165; 144]</sup>

**Strength(s) usually available:** When reconstituted according to manufacturer’s instructions—

**U.S.**<sup>[R-41]</sup>

Veterinary-labeled product(s)—

50 mg (free acid) per mL (Rx) [Naxcel].

**Canada**<sup>[R-12]</sup>

Veterinary-labeled product(s)—

50 mg (free acid) per mL (Rx) [Excenel].

**Packaging and storage:**

Store unconstituted product at controlled room temperature, 20 to 25 °C (68 to 77 °F), unless otherwise specified by manufacturer.

Store reconstituted product either in a refrigerator at 2 to 8 °C (36 to 46 °F) for up to seven days or at controlled room temperature, 20 to 25 °C (68 to 77 °F), for up to twelve hours,<sup>[R-11]</sup> unless otherwise specified by manufacturer. Protect from light.

**Caution:** People handling this medication should be careful to avoid repeated or prolonged exposure to avoid the sensitization to antimicrobials that can occur in susceptible individuals.<sup>[R-106]</sup> Direct contact with eyes, mouth, or skin should be avoided.<sup>[R-106]</sup> Those with a known hypersensitivity should avoid exposure to this medication.<sup>[R-106]</sup>

**Preparation of dosage form:** To prepare dilution for intramuscular
use, 20 or 80 mL of sterile water for injection should be added to the 1-gram or 4-gram vial, respectively.\[R-11\]

**Stability:**\[R-11\]
After reconstitution, solutions retain their potency for 7 days when refrigerated at 2 to 8 °C (36 to 46 °F) or 12 hours at room temperature, 15 to 30 °C (59 to 86 °F).

After reconstitution, solutions may be frozen for up to eight weeks. Frozen ceftiofur sodium may be thawed at room temperature or under warm to hot running water. Solutions should not be refrozen. Variations in color do not affect potency.

**USP requirements:** Not in USP.\[R-14\]

### CEFTIOFUR INJECTABLE OIL SUSPENSION

#### Usual dose:

**Pneumonia—**

- **Cattle:**
  - Beef or nonlactating dairy cattle—Subcutaneous, 6.6 mg per kg of body weight, as a single dose administered in the middle third of the posterior aspect of the ear or in the posterior aspect of the ear where it attaches to the head.\[R-106; 165\] Avoid all blood vessels when administering this medication.\[R-106\]
  - Lactating dairy cattle—Subcutaneous, 6.6 mg per kg of body weight, as a single dose administered in the posterior aspect of the ear where it attaches to the head (the base of the ear).\[R-106\]

**Withdrawal times—**

- US: Meat—13 days, Milk—None.\[R-145\]

This product is not labeled for use in preruminating calves intended to be processed for veal.\[R-145\] Using a different site of administration, such as subcutaneous administration in the neck area, or administering a higher dose than recommended on product labeling, may result in violative tissue residues.\[R-196\]

**Note:** Intra-arterial injection is likely to cause *sudden death*.\[R-106\] Of 6000 cattle in clinical studies, 9 died acutely; 3 of these deaths were confirmed to be due to accidental intra-arterial injection.\[R-106\] See the manufacturer’s product labeling for more information on method of injection.\[R-106\]

After the subcutaneous injection is complete and the needle is being withdrawn, product labeling recommends applying pressure to the needle insertion point and massaging toward the base of the ear.\[R-106\]

**Pigs:** Intramuscular, 5 mg per kg of body weight, as a single dose administered in the postauricular or posterior neck subcutaneous area.\[R-107\] The volume of injection at each site should not be more than two mL.\[R-107\]

**Withdrawal times—**

- US: Meat—14 days.\[R-106\] If administered as recommended on product labeling, a transient reaction at the injection site may cause some local trim loss of edible tissue.\[R-107\] The administration of this medication at a dose higher than recommended, by a route of administration not recommended on product labeling, or by an injection volume of more than 2 mL in one site may result in violative tissue residues.\[R-106\]

**Strength(s) usually available:** When reconstituted according to manufacturer’s instructions—

- **U.S.:**\[R-108; 107\]
  - Veterinary-labeled product(s)—
    - 100 mg per mL (Rx) \[*Excede for Swine*].
    - 200 mg per mL (Rx) \[*Excede*].
  - Canada:
    - Veterinary-labeled product(s)—
      - Not commercially available.

**Packaging and storage:** Store at controlled room temperature, 20 to 25 °C (68 and 77 °F), unless otherwise specified by manufacturer.\[R-106\] Protect from freezing.

**Caution:** People handling this medication should be careful to avoid repeated or prolonged exposure to prevent the sensitization to antimicrobials that can occur in susceptible individuals.\[R-106\] Direct contact with eyes, mouth, or skin should be avoided.\[R-106\] Those with a known hypersensitivity should avoid exposure to this medication.\[R-106; 107\]

**Stability:** Labeling on the suspension for use in cattle states that the product should be used within 30 days of removing the first dose.\[R-106\] Labeling on the suspension for use in pigs states that the product should be used within 12 weeks of removing the first dose.\[R-107\]

**Auxiliary labeling:**\[R-106; 107\]

Shake well before using.

Keep out of the reach of children and pets.

**USP requirements:** Not in USP.\[R-14\]

### CEFTIOFUR INJECTABLE SUSPENSION

#### Usual dose:

**Intramuscular or subcutaneous, 2.2 mg per kg of body weight every twenty-four hours for five days.**\[R-81; 99\]

**Pododermatitis—**

- Cattle: Intramuscular or subcutaneous, 1.1 to 2.2 mg per kg of body weight every twenty-four hours.\[R-81\]

**Pneumonia—**

- Cattle: Intramuscular or subcutaneous, 1.1 to 2.2 mg per kg of body weight every twenty-four hours.\[R-81\]

Alternatively, the clinician may choose, based on the severity of disease, pathogen susceptibility, and the clinical response, to administer intramuscularly or subcutaneously, 2.2 mg per kg of body weight every forty-eight hours for two doses.\[R-81\]

**Withdrawal times—**

- US: Meat—3 days, Milk—None.\[R-99\]
  - Product labeling states that treatment should not exceed five days for withdrawal times to apply for cattle.\[R-81\] This product is not labeled for use in preruminating calves. Discoloration of local edible tissues may persist beyond 11 days of neck injections and beyond 28 days of intramuscular injection in the rear leg, resulting in trim loss at slaughter.\[R-81\]

**Canada—**

- Meat: 3 days, Milk: None.\[R-99\]
  - Product labeling states that treatment should not exceed five days for withdrawal times to apply for cattle.\[R-81; 99\]

**Trim-out of edible tissues or milk.**\[R-81; 99\]

**Pigs:** Intramuscular, 3 to 5 mg per kg of body weight every twenty-four hours for three days.\[R-81; 99\]

**Withdrawal times—**

- US: Meat—4 days.\[R-81\]
  - Canada: Meat—2 days.\[R-81\]

**US and Canada: Pigs—**

- Trim-out of edible tissue at slaughter may occur within 11 days of injection because of areas of discoloration associated with the injection site.\[R-81; 99\]
  - Product labeling states that treatment should not exceed three days for withdrawal times to apply to pigs.\[R-81; 99\]

Administration by unapproved routes may cause illegal residues in edible tissues or milk.\[R-81; 99\]
Note: Mastitis, severe coliform (treatment adjunct); or retained fetal membranes (treatment)—Cows: See Cefotriaxone for Injection above in this monograph.

Strength(s) usually available:

U.S.—
Veterinary-labeled product(s):
50 mg per mL (Rx) [Excenel RTU].
Note: Be aware that this product differs from Excenel available in Canada.

Canada—
Veterinary-labeled product(s):
50 mg per mL (Rx) [Excenel RTU].

Packaging and storage: Store at controlled room temperature, 20 to 25 °C (68 and 77 °F), unless otherwise specified by manufacturer. Protect from freezing.

Caution: People handling this medication should be careful to avoid repeated or prolonged exposure to avoid the sensitization to antimicrobials that can occur in susceptible individuals. Direct contact with eyes, mouth, or skin should be avoided. Those with a known hypersensitivity should avoid exposure to this medication.

Auxiliary labeling:
• Shake well before using. Canadian product labeling recommends shaking the bottle for a minimum of ten seconds or until contents are resuspended.
• Keep out of reach of children.

USP requirements: Not in USP.

CEPHALEXIN

Summary of Differences
Indications: General considerations—First-generation cephalosporin.

Oral Dosage Forms
Note: The text between 11 and 12 describes uses not included in U.S. product labeling. Text between 13 and 14 describes uses that are not included in Canadian product labeling. The ELUS or ELUS,CAN designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEPHALEXIN CAPSULES USP
Usual dose:

Note: ELUS,CAN Birds—Although the efficacy and safety have not been established, an oral dose of 35 to 50 mg per kg of body weight every two to six hours has been used in the treatment of susceptible bacterial infections in birds, based on pharmacokinetic studies. In general, larger birds maintain measurable serum concentrations of cephalexin longer than do smaller birds; adequate concentrations may be achieved in larger birds with a six-hour dosing interval.

ELUS,CAN Cats and dogs—Although the safety and efficacy have not been established, an oral dose of 15 to 30 mg per kg of body weight every six to twelve hours has been recommended in the treatment of susceptible bacterial infections, based on pharmacokinetic data. However, the lowest dose in the range, 15 mg per kg of body weight every twelve hours or 30 mg per kg of body weight a day, has only been clinically investigated for superficial pyodermas, with evidence of efficacy.

For other infections, many clinicians consider 22 mg per kg of body weight to be the low end of the range, when administered every twelve hours. Dosing every six to eight hours is recommended for gram-negative infections while less frequent administration is considered appropriate for more susceptible organisms.

ELUS,CAN Horses—Although the safety and efficacy have not been established, pharmacokinetic data suggest an oral dose of 30 mg per kg of body weight every eight hours produces plasma concentrations that would be necessary to treat infections caused by bacteria with a minimum inhibitory concentration ≤ 0.5 mcg/mL. Investigations have only used single-dose administration, leaving the safety of multiple-dose regimens unknown.

Strength(s) usually available:

U.S.—
Veterinary-labeled product(s):
Not commercially available.
Human-labeled product(s):
250 mg (Rx) [Keflex; GENERIC].
500 mg (Rx) [Keflex; GENERIC].

Canada—
Veterinary-labeled product(s):
Not commercially available.
Human-labeled product(s):
250 mg (Rx) [Novo-Lexin].
500 mg (Rx) [Novo-Lexin].

Packaging and storage: Store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

USP requirements: Preserve in tight containers. Contain the equivalent of the labeled amount of anhydrous cephalxin, within –10% to +20%. Meet the requirements for Identification, Dissolution (80% in 30 minutes in water in Apparatus 1 at 100 rpm), Uniformity of dosage units, and Water (not more than 10.0%).

CEPHALEXIN FOR ORAL SUSPENSION USP
Usual dose: See Cephalexin Capsules USP.

Strength(s) usually available: When reconstituted according to manufacturer’s instructions—U.S.—
Veterinary-labeled product(s)—Not commercially available.
Human-labeled product(s)—
25 mg per mL (Rx) [Keflex; GENERIC].
50 mg per mL (Rx) [Keflex; GENERIC].

Canada—
Veterinary-labeled product(s)—Not commercially available.
Human-labeled product(s)—
25 mg per mL (Rx) [Keflex; Novo-Lexin; PMS-Cephalexin].
50 mg per mL (Rx) [Keflex; Novo-Lexin; PMS-Cephalexin].

Packaging and storage: Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

Stability: After reconstitution, suspensions retain their potency for 14 days if refrigerated.

Auxiliary labeling:
• Refrigerate.
• Shake well.

**USP requirements:** Preserve in tight containers. A dry mixture of Cephalexin and one or more suitable buffers, colors, diluents, and flavors. Contains the equivalent of the labeled amount of anhydrous cephalexin per ml. when constituted as directed in the labeling, within –10% to +20%. Meets the requirements for Identification, Uniformity of dosage units (solid packaged in single-unit containers), Deliverable volume (solid packaged in multiple-unit containers), pH (3.0–6.0, in the suspension constituted as directed in the labeling), and Water (not more than 2.0%).[R-14]

**CEPHALEXIN TABLETS USP**

**Usual dose:** See Cephalexin Capsules USP.

**Strength(s) usually available:**

- **U.S.—**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 250 mg (Rx) [GENERIC].
    - 500 mg (Rx) [GENERIC].

- **Canada—**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 250 mg (Rx) [Apo-Cephalex; Keflex; Novo-Lexin; Nu-Cephalex; PMS-Cephalexin].
    - 500 mg (Rx) [Apo-Cephalex; Keflex; Novo-Lexin; Nu-Cephalex; PMS-Cephalexin].

**Packaging and storage:** Store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

**USP requirements:** Preserve in tight containers. They are prepared from Cephalexin or Cephalexin Hydrochloride. The label states whether the Tablets contain Cephalexin or Cephalexin Hydrochloride. Contain the equivalent of the labeled amount of anhydrous cephalexin, within –10% to +20%. Meet the requirements for Identification, Dissolution (80% in 30 minutes in water in Apparatus 1 [use 40-mesh cloth] at 100 rpm for cephalexin and 75% in 45 minutes in water in Apparatus 1 [use 10-mesh cloth] at 150 rpm for cephalexin hydrochloride), Uniformity of dosage units, and Water (not more than 9.0% where Tablets contain cephalexin; not more than 8.0% where Tablets contain cephalexin hydrochloride).[R-14]

**CEPHALEXIN HYDROCHLORIDE TABLETS USP**

**Usual dose:** See Cephalexin Capsules USP.

**Strength(s) usually available:**

- **U.S.—**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 500 mg (Rx) [Keftab].

- **Canada—**
  - Not commercially available.

**Packaging and storage:** Store between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

**USP requirements:** Preserve in tight containers. They are prepared from Cephalexin or Cephalexin Hydrochloride. The label states whether the Tablets contain Cephalexin or Cephalexin Hydrochloride. Contain the equivalent of the labeled amount of anhydrous cephalexin, within –10% to +20%. Meet the requirements for Identification, Dissolution (80% in 30 minutes in water in Apparatus 1 [use 40-mesh cloth] at 100 rpm for cephalexin and 75% in 45 minutes in water in Apparatus 1 [use 10-mesh cloth] at 150 rpm for cephalexin hydrochloride), Uniformity of dosage units, and Water (not more than 9.0% where Tablets contain cephalexin; not more than 8.0% where Tablets contain cephalexin hydrochloride).[R-14]

**CEPHALOTHIN FOR INJECTION USP**

**Usual dose:**

- **Note:** [R-14] Birds—Although the efficacy and safety have not been established, an intramuscular dose of 100 mg (base) per kg of body weight every two to six hours has been used in the treatment of susceptible bacterial infections in birds, based on pharmacokinetic studies.[R-34] In general, larger birds maintain measurable serum concentrations of cephalothin longer than do smaller birds; adequate concentrations may be achieved in larger birds with a six-hour dosing interval.[R-34] Dogs—Although the efficacy and safety have not been established, an intramuscular or intravenous dose of 10 to 30 mg (base) per kg of body weight every four to eight hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data.[R-38] Horses—Although the efficacy and safety have not been established, an intramuscular or intravenous dose of 10 to 25 mg (base) per kg of body weight every four hours has been used in the treatment of susceptible bacterial infections in horses, based on pharmacokinetic data.[R-4; 19]

**Size(s) usually available:**

- **U.S.—**
  - Not commercially available.

- **Canada—**
  - Veterinary-labeled product(s):
    - Not commercially available.
  - Human-labeled product(s):
    - 1 gram (base) (Rx) [Ceporacin; Kefin].

**Packaging and storage:** Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by the manufacturer.

**Preparation of dosage form:** Dilutions should be prepared according to the manufacturer’s instructions.[R-22; 53]
Stability: After reconstitution, solutions retain their potency for 96 hours if refrigerated. Solutions for intramuscular use retain their potency for 12 hours at room temperature. A precipitate may form in the solution. Upon being warmed to room temperature and shaken, the precipitate will dissolve. Concentrated solutions will darken in color, especially at room temperature. However, slight discoloration does not affect potency. If frozen immediately after reconstitution with sterile water for injection, 5% dextrose injection, or 0.9% sodium chloride injection, solutions retain their potency in the original container up to 12 weeks at –20 °C (–4 °F). Once thawed, solutions should not be refrozen.

Incompatibilities: The admixture of other medications with cephalothin sodium injection is not recommended. The admixture of beta-lactam antibiotics (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

USP requirements: Preserve in Containers for Sterile Solids. Contains an amount of Cephalothin Sodium equivalent to the labeled amount of cephalothin, within –10% to +15%. May contain Sodium Bicarbonate. Meets the requirements for Constituted solution, Specific rotation (+124° to +134°), calculated on the dried and sodium bicarbonate-free basis), Content of sodium bicarbonate (if present), Bacterial endotoxins, Sterility, pH (6.0–8.5, in the solution constituted as directed in the labeling), Uniformity of dosage units, and Particulate matter, for Identification, Crystallinity, pH, and Water under Cephalothin Sodium, and for Labeling under Injections.

CEPHAPIRIN

Summary of Differences
Indications: General considerations—First-generation cephalosporin. Pharmacology/pharmacokinetics: Human biotransformation—Hepatic metabolism to the desacetyl form occurs. Drug interactions and/or related problems: Concurrent administration with probenicid may prolong the serum half-life of cephapirin. Medical considerations/contraindications: In people, severe hepatic dysfunction can inhibit metabolism. Side/adverse effects: Local reactions may occur.

Parenteral Dosage Forms
Note: The dosing and strengths of the dosage forms available are expressed in terms of cephalothin base (not the sodium salt). The text between §1 and §3 describes uses not included in U.S. product labeling. Text between §4 and §6 describes uses that are not included in Canadian product labeling. The §1,§4 or §1,§2 designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEPHAPIRIN FOR INJECTION USP
Usual dose:
Note: §5,§6,§7 Dogs—Although the efficacy and safety have not been established, an intramuscular or intravenous dose of 10 to 30 mg per kg of body weight every four to eight hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data.

El Cefapirin for Injection USP

Size(s) usually available:
U.S.—
Veterinary-labeled product(s):
Not commercially available.

Canada—
Not commercially available.

Packaging and storage: Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

Incompatibilities: The admixture of beta-lactam antibiotics (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

CEPHRADINE

Summary of Differences
Indications: General considerations—First-generation cephalosporin.

Oral Dosage Forms
Note: The text between §1 and §2 describes uses not included in U.S. product labeling. Text between §3 and §5 describes uses that are not included in Canadian product labeling. The §1,§3 designation can signify a lack of product availability in the country indicated. See also the Strength(s) usually available section for each dosage form.

CEPHRADINE CAPSULES USP
Usual dose:
Note: §1,§3 Dogs—Although the efficacy and safety have not been established, an oral dose of 10 to 25 mg per kg of body weight every six to twelve hours has been used in the treatment of susceptible bacterial infections in dogs, based on pharmacokinetic data.

El Cefradine Capsules USP

Size(s) usually available:
U.S.—
Veterinary-labeled product(s):
Not commercially available.

Canada—
Not commercially available.

Packaging and storage: Store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

Incompatibilities: The admixture of beta-lactam antibiotics (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

CEPHAPIRIN FOR INJECTION CANADA

Size(s) usually available:
Canada—
Veterinary-labeled product(s):
Not commercially available.

Packaging and storage: Hold product at temperatures between 4°C and 25°C (39°F and 77°F), except as noted. Store in a dark place, unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

Incompatibilities: The admixture of beta-lactam antibiotics (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.

CEPHRADINE CAPSULES CANADA

Size(s) usually available:
Canada—
Veterinary-labeled product(s):
Not commercially available.

Packaging and storage: Store below 40°C (104°F), preferably between 15 and 30°C (59 and 86°F), unless otherwise specified by manufacturer.

Preparation of dosage form: Dilutions should be prepared according to manufacturer’s instructions.

Stability: See manufacturer’s product labeling for stability information.

Incompatibilities: The admixture of beta-lactam antibiotics (penicillins and cephalosporins) and aminoglycosides may result in substantial mutual inactivation; they should not be mixed in the same intravenous bag or bottle.
Strength(s) usually available:

U.S.—

Veterinary-labeled product(s):
Not commercially available.

Human-labeled product(s):
250 mg (Rx) [Velosef; GENERIC].
500 mg (Rx) [Velosef; GENERIC].

Canada—

Not commercially available.

Packaging and storage: Store below 30 °C (86 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

USP requirements: Preserve in tight containers. The quantity of cephradine stated in the labeling is in terms of anhydrous cephradine. Contain the labeled amount of cephradine, within –10% to +20%, calculated as the sum of cephradine and cephalexin. Meet the requirements for Identification, Dissolution (75% in 45 minutes in 0.12 N hydrochloric acid in Apparatus 1 at 100 rpm), Uniformity of dosage units, and Loss on drying (not more than 7.0%).

CEPHRADINE FOR ORAL SUSPENSION USP

Usual dose: See Cephradine Capsules USP.

Strength(s) usually available: When reconstituted according to manufacturer’s instructions—

U.S.:

Veterinary-labeled product(s)—
Not commercially available.

Human-labeled product(s)—
25 mg per mL (Rx) [Velosef; GENERIC].
50 mg per mL (Rx) [Velosef; GENERIC].

Canada:

Not commercially available.

Packaging and storage: Prior to reconstitution, store below 40 °C (104 °F), preferably between 15 and 30 °C (59 and 86 °F), unless otherwise specified by manufacturer. Store in a tight container.

Stability: After reconstitution, suspensions retain their potency for 7 days at room temperature or for 14 days if refrigerated.

Auxiliary labeling:
• Refrigerate.
• Shake well.

USP requirements: Preserve in tight containers. A dry mixture of Cephradine and one or more suitable buffers, colors, diluents, and flavors. Contains the labeled amount of cephradine, within –10% to +25%, calculated as the sum of cephradine and cephalexin. Meets the requirements for Identification, Uniformity of dosage units (solid packaged in single-unit containers), Deliverable volume (solid packaged in multiple-unit containers), pH (3.5–6.0, in the suspension constituted as directed in the labeling), and Water (not more than 1.5%).

Developed: 08/02/95
Revised: 11/06/06
Interim revision: 07/08/98; 11/5/99; 09/30/02; 04/04/03

Table 1. Pharmacology/Pharmacokinetics*

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<th>Half-life of Elimination (hr)</th>
<th>VolD, Steady State (L/kg)</th>
<th>Clearance (mL/min/kg)</th>
<th>Route; Dose (mg/kg)</th>
<th>Tmax (min)</th>
<th>Cmax (mcg/mL)</th>
<th>Bioavailability (%)</th>
<th>Route; Dose (mg/kg)</th>
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<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
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| Cephalothin| Birds   | 1.4 0.22 2.5  
|           | Dogs    | 1.6 0.29 4  
|           | Horses  | 2 0.25 3.4  
| Cephalothin| Pigs    | 1     
| Cephalothin| IM; 10  | 90 24.2 63  
|           | IM; 10  | 90 20.3 57  
|           | Oral; 30| 60 10.1  
|           | IV; 15  | 58 3.5 5  
| Cephalothin| IM; 100 | 30 18   
| Cephalothin| IV; 15  | 47 11.3 65  
| Cephalothin| IM; 20  | 25 14.8 95  
| Cephalothin| IV; 20  | 90 13.2  
| Cephalothin| IM; 20  | 25 14.8 95  
| Cefapirin  | Calves  | IM; 10  20 6.3  
|           | Cows    | IM; 10  10 13.3  
|           | Dogs    | IM; 20  10 21.2  
|           | Foals   | IM; 20  25 14.8 95  
| Cephradine | Dogs    | 1.4 0.4 6.7  
|           | Foals   | 1.6 0.17 10  
| Cefaclor   | Dogs    | 2     3.75  
| Cefotetan  | Dogs    | 1.1   IV; 30 SC; 30 30-60 84  
| Cefoxin    | Calves  | 42-55 1.1 0.32 4.9  
|           | Dogs    | 0.7; 1.3 0.8 0.12 4.32  
|           | Horses  | IV; 20  IM; 20 77  
| Cefotaxime | Calves  | 90 3.5–4 0.34  
|           | Dogs    | 82–92 7 to 8 0.22  
|           | Oral; 5 | 240 3.4 Fed; 20–28 55  
|           | Oral; 5 | 360 2  
|           | Oral; 5 (6 days) | 144 4.8  
| Cefotaxime | cats   | 3.5 13.5 IV; 10 IM; 10  
|           | Dogs    | 0.8 0.4 10.5  
|           | Goats   | 0.4 0.6 5.2  
|           | Foals   | IV; 40  
|           | Sheep   | 0.3–04 0.78 2.9  
| Cefpodoxime| Dogs    | 4.7 0.13 0.38  
|           | Horses  | IV; 10 Oral; 10  
|           | Foals   | IV; 10 Oral; 10  
|           | (7 days–4 mo.) | Oral; 10 74  
|           | Pigs    | Oral; 10 234 23.3  
| Ceftriaxone| Calves  | 2.3 0.29 1.8  
|           | Cows    | 1.4 0.39 3.1  
|           | IM; 10  | 133 164 63  
|           | IM; 10  | 48 1.3  
|           | IM; 10  | 102–120 0.74–0.81  
|           | Oral; 10 | 234 23.3  
|           | IM; 10  | 0.7 11.6 77  

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<th>Species</th>
<th>Ceftiofur†</th>
<th>Alpacas†</th>
<th>Calves (7 days)</th>
<th>Cattle (5 to 9 mo.)</th>
<th>Cows, lactating</th>
<th>Chicks (2 to 3 days)</th>
<th>Cockatiels</th>
<th>Deer</th>
<th>Dogs</th>
<th>Elephants, Asian</th>
<th>Foals</th>
<th>Goats</th>
<th>Adult</th>
<th>Lactating</th>
<th>Horses</th>
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<th>Llamas</th>
<th>Parrots, Amazon</th>
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<td></td>
<td>IV; 50</td>
<td>IM; 50</td>
<td>IM; 2.2</td>
<td>SC; 5</td>
<td>SC; 5</td>
<td>IV; 2.2</td>
<td>IM; 1.1</td>
<td>IM; 2.2</td>
<td>0.25</td>
<td>0.26</td>
<td>0.26</td>
<td>0.31</td>
<td>0.19</td>
<td>0.25</td>
<td>60-480</td>
<td>26-70</td>
</tr>
<tr>
<td>Snakes (30 °C, with bacterial infection)</td>
<td>20.6</td>
<td>0.22</td>
<td>0.22</td>
<td></td>
<td>IV; 20</td>
<td>IM; 20</td>
<td>IM; 2.2</td>
<td>SC; 5</td>
<td>SC; 5</td>
<td>IV; 2.2</td>
<td>IM; 1.1</td>
<td>IM; 2.2</td>
<td>0.25</td>
<td>0.26</td>
<td>0.26</td>
<td>0.31</td>
<td>0.19</td>
<td>0.25</td>
<td>60-480</td>
<td>26-70</td>
</tr>
<tr>
<td>Turtles, loggerhead (at 24 °C)</td>
<td>20.6</td>
<td>0.42</td>
<td>0.22</td>
<td></td>
<td>IV; 20</td>
<td>IM; 20</td>
<td>IM; 2.2</td>
<td>SC; 5</td>
<td>SC; 5</td>
<td>IV; 2.2</td>
<td>IM; 1.1</td>
<td>IM; 2.2</td>
<td>0.25</td>
<td>0.26</td>
<td>0.26</td>
<td>0.31</td>
<td>0.19</td>
<td>0.25</td>
<td>60-480</td>
<td>26-70</td>
</tr>
</tbody>
</table>
Abbreviations: IM = Intramuscular, IV = Intravenous, SQ = Subcutaneous, VolD = Volume of distribution, Tmax = Time to peak concentration, Cmax = Peak serum concentration.

Assays for the serum concentrations of ceftiofur listed generally include ceftiofur and either active metabolites or desfuroylceftiofur-related metabolites.

†Data is from administration of ceftiofur sodium, which this study concluded, based on nearly equivalent results, would have comparable therapeutic efficacy to ceftiofur hydrochloride.

‡Results were reported as harmonic mean.
55. Cephalomycin package insert (Cefadyl, Bristol—US), Rec 7/13/93.
59. Panel comment, 6/16/95.
74. Panel comment, 6/16/95.
75. Manufacturer comment, 9/25/95.
76. Panel comment, 5/25/95.
80. Panel comment, 6/16/95.
91. Panel comment, 6/19/96.
92. Panel comment, 6/18/96.
93. Reviewer comment, 8/30/96.
95. Panel comment, 8/29/96.
98. Panel comment, 10/2/96.
100. Manufacturer comment, Rec 2/24/97.


143. Communication with the Food Animal Residue Avoidance Databank, 12/22/05.

144. Committee comment, Rec 1/4/06.

145. Committee comment, Rec 1/4/06.

146. Communication with the Food Animal Residue Avoidance Databank, Rec 2/15/06.


162. Committee comment, Rec 2/24/06.

163. Communication with MedTox Diagnostics, 6/21/06.

164. Committee consensus, 9/15/06.