

STREPTOMYCIN SULFATE - streptomycin sulfate injection, solution
Roerig

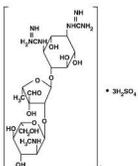
For Intramuscular Use Only

WARNING

THE RISK OF SEVERE NEUROTOXIC REACTIONS IS SHARPLY INCREASED IN PATIENTS WITH IMPAIRED RENAL FUNCTION OR PRE-RENAL AZOTEMIA. THESE INCLUDE DISTURBANCES OF VESTIBULAR AND COCHLEAR FUNCTION. OPTIC NERVE DYSFUNCTION, PERIPHERAL NEURITIS, ARACHNOIDITIS, AND ENCEPHALOPATHY MAY ALSO OCCUR. THE INCIDENCE OF CLINICALLY DETECTABLE, IRREVERSIBLE VESTIBULAR DAMAGE IS PARTICULARLY HIGH IN PATIENTS TREATED WITH STREPTOMYCIN. RENAL FUNCTION SHOULD BE MONITORED CAREFULLY; PATIENTS WITH RENAL IMPAIRMENT AND/OR NITROGEN RETENTION SHOULD RECEIVE REDUCED DOSAGES. THE PEAK SERUM CONCENTRATION IN INDIVIDUALS WITH KIDNEY DAMAGE SHOULD NOT EXCEED 20 TO 25 MCG/ML. THE CONCURRENT OR SEQUENTIAL USE OF OTHER NEUROTOXIC AND/OR NEPHROTOXIC DRUGS WITH STREPTOMYCIN SULFATE, INCLUDING NEOMYCIN, KANAMYCIN, GENTAMICIN, CEPHALORIDINE, PAROMOMYCIN, VIOMYCIN, POLYMYXIN B, COLISTIN, TOBRAMYCIN AND CYCLOSPORINE SHOULD BE AVOIDED. THE NEUROTOXICITY OF STREPTOMYCIN CAN RESULT IN RESPIRATORY PARALYSIS FROM NEUROMUSCULAR BLOCKAGE, ESPECIALLY WHEN THE DRUG IS GIVEN SOON AFTER THE USE OF ANESTHESIA OR OF MUSCLE RELAXANTS. THE ADMINISTRATION OF STREPTOMYCIN IN PARENTERAL FORM SHOULD BE RESERVED FOR PATIENTS WHERE ADEQUATE LABORATORY AND AUDIOMETRIC TESTING FACILITIES ARE AVAILABLE DURING THERAPY.

DESCRIPTION

Streptomycin is a water-soluble aminoglycoside derived from *Streptomyces griseus*. It is marketed as the sulfate salt of streptomycin. The chemical name of streptomycin sulfate is D-Streptamine, O-2-deoxy-2-(methylamino)- α -L-glucopyranosyl-(1 \rightarrow 2)-O-5-deoxy-3-C-formyl- α -L-lyxofuranosyl-(1 \rightarrow 4)-N,N'-bis(aminoiminomethyl)-, sulfate (2:3) (salt). The empirical formula for Streptomycin Sulfate is (C₂₁H₃₉N₇O₁₂)₂•3H₂SO₄ and the molecular weight is 1457.38. It has the following structure:



Streptomycin Sulfate Injection, 1 g/2.5 mL (400 mg/mL), is supplied as a sterile, nonpyrogenic solution for intramuscular use. Each mL contains: Streptomycin sulfate equivalent to 400 mg of streptomycin, sodium citrate dihydrate 12 mg, phenol 0.25% w/v as preservative, sodium metabisulfite 2 mg in Water for Injection. pH range 5.0 to 8.0.

CLINICAL PHARMACOLOGY

Following intramuscular injection of 1 g of streptomycin, as the sulfate, a peak serum level of 25 to 50 mcg/mL is reached within 1 hour, diminishing slowly to about 50 percent after 5 to 6 hours.

Appreciable concentrations are found in all organ tissues except the brain. Significant amounts have been found in pleural fluid and tuberculous cavities. Streptomycin passes through the placenta with serum levels in the cord blood similar to maternal levels. Small amounts are excreted in milk, saliva, and sweat.

Streptomycin is excreted by glomerular filtration. In patients with normal kidney function, between 29% and 89% of a single 600 mg dose is excreted in the urine within 24 hours. Any reduction of glomerular function results in decreased excretion of the drug and concurrent rise in serum and tissue levels.

Microbiology

Streptomycin sulfate is a bactericidal antibiotic. It acts by interfering with normal protein synthesis.

Streptomycin has been shown to be active against most strains of the following organisms both *in vitro* and in clinical infection. (See INDICATIONS AND USAGE.):

Brucella (brucellosis),

Calymmatobacterium granulomatis (donovanosis, granuloma inguinale),

Escherichia coli, *Proteus spp.*, *Aerobacter aerogenes*, *Klebsiella pneumoniae*, and

Enterococcus faecalis in urinary tract infections,

Francisella tularensis,

Haemophilus ducreyi (chancroid),

Haemophilus influenzae (in respiratory, endocardial, and meningeal infections—concomitantly with another antibacterial agent),

Klebsiella pneumoniae pneumonia (concomitantly with another antibacterial agent),

Mycobacterium tuberculosis,

Pasteurella pestis

Streptococcus viridans, *Enterococcus faecalis* (in endocardial infections—concomitantly with penicillin).

SUSCEPTIBILITY TESTS: Diffusion Techniques

Quantitative methods that require measurement of zone diameters give the most precise estimate of the susceptibility of bacteria to antimicrobial agents. One such standard procedure¹ which has been recommended for use with disks to test susceptibility of organisms to streptomycin uses the 10 mcg streptomycin disk. Interpretation involves the correlation of the diameter obtained in the disk test with the minimum inhibitory concentration (MIC) for streptomycin.

Reports from the laboratory giving results of the standard single disk susceptibility test with a 10 mcg streptomycin disk should be interpreted according to the following criteria:

Zone diameter (mm)	Interpretation
≥15	(S) Susceptible
11–12	(I) Intermediate
≤10	(R) Resistant

A report of "Susceptible" indicates that the pathogen is likely to respond to monotherapy with streptomycin. A report of "Intermediate" indicates that the result be considered equivocal, and, if the organism is not fully susceptible to alternative clinically feasible drugs, the test should be repeated. This category provides a buffer zone which prevents small uncontrolled technical factors from causing major discrepancies in interpretations. A report of "Resistant" indicates that achievable drug concentrations are unlikely to be inhibitory and other therapy should be selected.

Standardized procedures require the use of laboratory control organisms. The 10 mcg streptomycin disk should give the following zone diameter:

Organism	Zone diameter (mm)
<i>E. coli</i> ATCC 25922	12–20
<i>S. aureus</i> ATCC 25923	14–22

Methods Section

Two standardized *in vitro* susceptibility methods are available for testing streptomycin against *Mycobacterium tuberculosis* organisms. The agar proportion method (CDC or NCCLS M24-P) utilizes middlebrook 7H10 medium impregnated with streptomycin at two final concentrations, 2.0 and 10.0 mcg/mL. MIC₉₀ values are calculated by comparing the quantity of organisms growing in the medium containing drug to the control cultures. Mycobacterial growth in the presence of drug ≥1% of the control indicates resistance.

The radiometric broth method employs the BACTEC 460 machine to compare the growth index from untreated control cultures to cultures grown in the presence of 6.0 mcg/mL of streptomycin. Strict adherence to the manufacturer's instructions for sample processing and data interpretation is required for this assay.

Susceptibility test results obtained by these two different methods cannot be compared unless equivalent drug concentrations are evaluated.

The clinical relevance of *in vitro* susceptibility test results for mycobacterial species other than *M. tuberculosis* using either the BACTEC or the proportion method has not been determined.

INDICATIONS AND USAGE

Streptomycin is indicated for the treatment of individuals with moderate to severe infections caused by susceptible strains of microorganisms in the specific conditions listed below:

1. *Mycobacterium tuberculosis*: The Advisory Council for the Elimination of Tuberculosis, the American Thoracic Society, and the Center for Disease Control recommend that either streptomycin or ethambutol be added as a fourth drug in a regimen containing

isoniazid (INH), rifampin and pyrazinamide for initial treatment of tuberculosis unless the likelihood of INH or rifampin resistance is very low. The need for a fourth drug should be reassessed when the results of susceptibility testing are known. In the past when the national rate of primary drug resistance to isoniazid was known to be less than 4% and was either stable or declining, therapy with two and three drug regimens was considered adequate. If community rates of INH resistance are currently less than 4%, an initial treatment regimen with less than four drugs may be considered.

Streptomycin is also indicated for therapy of tuberculosis when one or more of the above drugs is contraindicated because of toxicity or intolerance. The management of tuberculosis has become more complex as a consequence of increasing rates of drug resistance and concomitant HIV infection. Additional consultation from experts in the treatment of tuberculosis may be desirable in those settings.

2. Non-tuberculosis infections: The use of streptomycin should be limited to the treatment of infections caused by bacteria which have been shown to be susceptible to the antibacterial effects of streptomycin and which are not amenable to therapy with less potentially toxic agents.

- a. *Pasteurella pestis* (plague),
- b. *Francisella tularensis* (tularemia),
- c. *Brucella*,
- d. *Calymmatobacterium granulomatis* (donovanosis, granuloma inguinale),
- e. *H. ducreyi* (chancroid),
- f. *H. influenzae* (in respiratory, endocardial, and meningeal infections—concomitantly with another antibacterial agent),
- g. *K. pneumoniae* pneumonia (concomitantly with another antibacterial agent),
- h. *E. coli*, *Proteus*, *A. aerogenes*, *K. pneumoniae*, and *Enterococcus faecalis* in urinary tract infections,
- i. *Streptococcus viridans*, *Enterococcus faecalis* (in endocardial infections—concomitantly with penicillin),
- j. Gram-negative bacillary bacteremia (concomitantly with another antibacterial agent).

CONTRAINDICATIONS

A history of clinically significant hypersensitivity to streptomycin is a contraindication to its use. Clinically significant hypersensitivity to other aminoglycosides may contraindicate the use of streptomycin because of the known cross-sensitivity of patients to drugs in this class.

WARNINGS

Ototoxicity

Both vestibular and auditory dysfunction can follow the administration of streptomycin. The degree of impairment is directly proportional to the dose and duration of streptomycin administration, to the age of the patient, to the level of renal function and to the amount of underlying existing auditory dysfunction. The ototoxic effects of the aminoglycosides, including streptomycin, are potentiated by the co-administration of ethacrynic acid, mannitol, furosemide and possibly other diuretics.

The vestibulotoxic potential of streptomycin exceeds that of its capacity for cochlear toxicity. Vestibular damage is heralded by headache, nausea, vomiting and disequilibrium. Early cochlear injury is demonstrated by the loss of high frequency hearing. Appropriate monitoring and early discontinuation of the drug may permit recovery prior to irreversible damage to the sensorineural cells.

Sulfites

Streptomycin contains sodium metabisulfite, a sulfite that may cause allergic type reactions including anaphylactic symptoms and life-threatening or less severe asthmatic episodes in certain susceptible people. The over-all prevalence of sulfite sensitivity in the general population is unknown and probably low. Sulfite sensitivity is seen more frequently in asthmatic than in non-asthmatic people.

Pregnancy

Streptomycin can cause fetal harm when administered to a pregnant woman. Because streptomycin readily crosses the placental barrier, caution in use of the drug is important to prevent ototoxicity in the fetus. If this drug is used during pregnancy, or if the patient becomes pregnant while taking this drug, the patient should be apprised of the potential hazard to the fetus.

PRECAUTIONS

General

Baseline and periodic caloric stimulation tests and audiometric tests are advisable with extended streptomycin therapy. Tinnitus, roaring noises, or a sense of fullness in the ears indicates need for audiometric examination or termination of streptomycin therapy or both.

Care should be taken by individuals handling streptomycin for injection to avoid skin sensitivity reactions. As with all intramuscular preparations, Streptomycin Sulfate Injection should be injected well within the body of a relatively large muscle and care should be taken to minimize the possibility of damage to peripheral nerves. (See DOSAGE AND ADMINISTRATION.)

Extreme caution must be exercised in selecting a dosage regimen in the presence of preexisting renal insufficiency. In severely uremic patients a single dose may produce high blood levels for several days and the cumulative effect may produce ototoxic sequelae. When streptomycin must be given for prolonged periods of time alkalization of the urine may minimize or prevent renal irritation.

A syndrome of apparent central nervous system depression, characterized by stupor and flaccidity, occasionally coma and deep respiratory depression, has been reported in very young infants in whom streptomycin dosage had exceeded the recommended limits. Thus, infants should not receive streptomycin in excess of the recommended dosage.

In the treatment of venereal infections such as granuloma inguinale, and chancroid, if concomitant syphilis is suspected, suitable laboratory procedures such as a dark field examination should be performed before the start of treatment, and monthly serologic tests should be done for at least four months.

As with other antibiotics, use of this drug may result in overgrowth of nonsusceptible organisms, including fungi. If superinfection occurs, appropriate therapy should be instituted.

Drug Interactions

The ototoxic effects of the aminoglycosides, including streptomycin, are potentiated by the co-administration of ethacrynic acid, furosemide, mannitol and possibly other diuretics.

Pregnancy

Category D

See WARNINGS section.

Nursing Mothers

Because of the potential for serious adverse reactions in nursing infants from streptomycin, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatric Use

(See DOSAGE AND ADMINISTRATION.)

ADVERSE REACTIONS

The following reactions are common: vestibular ototoxicity (nausea, vomiting, and vertigo); paresthesia of face; rash; fever; urticaria; angioneurotic edema; and eosinophilia.

The following reactions are less frequent: cochlear ototoxicity (deafness); exfoliative dermatitis; anaphylaxis; azotemia; leucopenia; thrombocytopenia; pancytopenia; hemolytic anemia; muscular weakness; and amblyopia.

Vestibular dysfunction resulting from the parenteral administration of streptomycin is cumulatively related to the total daily dose. When 1.8 to 2 g/day are given, symptoms are likely to develop in the large percentage of patients—especially in the elderly or patients with impaired renal function—within four weeks. Therefore, it is recommended that caloric and audiometric tests be done prior to, during, and following intensive therapy with streptomycin in order to facilitate detection of any vestibular dysfunction and/or impairment of hearing which may occur.

Vestibular symptoms generally appear early and usually are reversible with early detection and cessation of streptomycin administration. Two to three months after stopping the drug, gross vestibular symptoms usually disappear, except for the relative inability to walk in total darkness or on very rough terrain.

Although streptomycin is the least nephrotoxic of the aminoglycosides, nephrotoxicity does occur rarely.

Clinical judgment as to termination of therapy must be exercised when side effects occur.

DOSAGE AND ADMINISTRATION

Intramuscular Route Only

Adults: The preferred site is the upper outer quadrant of the buttock, (*i.e.*, gluteus maximus), or the mid-lateral thigh.

Children: It is recommended that intramuscular injections be given preferably in the mid-lateral muscles of the thigh. In infants and small children the periphery of the upper outer quadrant of the gluteal region should be used only when necessary, such as in burn patients, in order to minimize the possibility of damage to the sciatic nerve.

The deltoid area should be used only if well developed such as in certain adults and older children, and then only with caution to avoid radial nerve injury. Intramuscular injections should not be made into the lower and mid-third of the upper arm. As with all intramuscular injections, aspiration is necessary to help avoid inadvertent injection into a blood vessel.

Injection sites should be alternated. As higher doses or more prolonged therapy with streptomycin may be indicated for more severe or fulminating infections (endocarditis, meningitis, etc.), the physician should always take adequate measures to be immediately aware of any toxic signs or symptoms occurring in the patient as a result of streptomycin therapy.

1. **TUBERCULOSIS:** The standard regimen for the treatment of drug susceptible tuberculosis has been two months of INH, rifampin and pyrazinamide followed by four months of INH and rifampin (patients with concomitant infection with tuberculosis and HIV may require treatment for a longer period). When streptomycin is added to this regimen because of suspected or proven drug resistance (see **INDICATIONS AND USAGE** section), the recommended dosing for streptomycin is as follows:

	<i>Daily</i>	<i>Twice Weekly</i>	<i>Thrice Weekly</i>
Children	20–40 mg/kg Max 1 g	25–30 mg/kg Max 1.5 g	25–30 mg/kg Max 1.5 g
Adults	15 mg/kg Max 1 g	25–30 mg/kg Max 1.5 g	25–30 mg/kg Max 1.5 g

Streptomycin is usually administered daily as a single intramuscular injection. A total dose of not more than 120 g over the course of therapy should be given unless there are no other therapeutic options. In patients older than 60 years of age the drug should be used at a reduced dosage due to the risk of increased toxicity. (See **BOXED WARNING**.)

Therapy with streptomycin may be terminated when toxic symptoms have appeared, when impending toxicity is feared, when organisms become resistant, or when full treatment effect has been obtained. The total period of drug treatment of tuberculosis is a minimum of 1 year; however, indications for terminating therapy with streptomycin may occur at any time as noted above.

2. **TULAREMIA:** One to 2 g daily in divided doses for 7 to 14 days until the patient is afebrile for 5 to 7 days.

3. **PLAGUE:** Two grams of streptomycin daily in two divided doses should be administered intramuscularly. A minimum of 10 days of therapy is recommended.

4. **BACTERIAL ENDOCARDITIS:**

- a. *Streptococcal endocarditis:* In penicillin-sensitive alpha and non-hemolytic streptococcal endocarditis (penicillin MIC \leq 0.1 mcg/mL), streptomycin may be used for 2-week treatment concomitantly with penicillin. The streptomycin regimen is 1 g b.i.d. for the first week, and 500 mg b.i.d. for the second week. If the patient is over 60 years of age, the dosage should be 500 mg b.i.d. for the entire 2-week period.
- b. *Enterococcal endocarditis:* Streptomycin in doses of 1 g b.i.d. for 2 weeks and 500 mg b.i.d. for an additional 4 weeks is given in combination with penicillin. Ototoxicity may require termination of the streptomycin prior to completion of the 6-week course of treatment.

5. **CONCOMITANT USE WITH OTHER AGENTS:** For concomitant use with other agents to which the infecting organism is also sensitive: Streptomycin is considered a second-line agent for the treatment of gram-negative bacillary bacteremia, meningitis, and pneumonia; brucellosis; granuloma inguinale; chancroid, and urinary tract infection.

For adults: 1 to 2 grams in divided doses every six to twelve hours for moderate to severe infections. Doses should generally not exceed 2 grams per day.

For children: 20 to 40 mg/kg/day (8 to 20 mg/lb/day) in divided doses every 6 to 12 hours. (Particular care should be taken to avoid excessive dosage in children.)

Parenteral drug products should be inspected visually for particulate matter and discoloration prior to administration, whenever solution and container permit.

HOW SUPPLIED

Streptomycin Sulfate Injection, USP is supplied in packages of 10 ampules (NDC 0049-0620-33). Each ampule contains streptomycin sulfate equivalent to 1 g of streptomycin in 2.5 mL.

Store under refrigeration at 36° to 46°F (2° to 8°C).

REFERENCES

1. National Committee for Clinical Laboratory Standards. Performance Standards for Antimicrobial Disk Susceptibility Tests—Fourth Edition. Approved Standard NCCLS Document M2-A4. Vol. 10, No. 7. NCCLS, Villanova, PA 1990.

Rx Only



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