LEVOFLOXACIN - levofloxacin solution
Akorn Inc.

HIGHLIGHTS OF PRESCRIBING INFORMATION
These highlights do not include all the information needed to use LEVOFLOXACIN OPHTHALMIC SOLUTION safely and effectively. See full prescribing information for LEVOFLOXACIN OPHTHALMIC SOLUTION.

INDICATIONS AND USAGE
Levofloxacin ophthalmic solution is indicated for the treatment of bacterial conjunctivitis caused by susceptible strains of the following organisms:

Gram-positive bacteria
- Corynebacterium species*
- Staphylococcus aureus
- Staphylococcus epidermidis
- Streptococcus pneumonia
- Streptococcus (Groups C/F)
- Streptococcus (Group G)
- Viridans group streptococci*

Gram-negative bacteria
- Acinetobacter lwoffii*
- Haemophilus influenzae
- Serratia marcescens*

* Efficacy for this organism was studied in fewer than 10 infections (1)

DOSAGE AND ADMINISTRATION

Days 1 and 2
Instill one to two drops in the affected eye(s) every 2 hours while awake, up to 8 times per day.

Days 3 through 7
Instill one to two drops in the affected eye(s) every 4 hours while awake, up to 4 times per day. (2)

DOSAGE FORMS AND STRENGTHS
10 mL bottle filled with 5 mL sterile ophthalmic solution of levofloxacin, 0.5% (3)

CONTRAINDICATIONS
Levofloxacin ophthalmic solution is contraindicated in patients with a history of hypersensitivity to levofloxacin, to other quinolones, or to any of the components in this medication. (4)

WARNINGS AND PRECAUTIONS
- Hypersensitivity and anaphylaxis have been reported with systemic use of levofloxacin as well as topical use of other fluoroquinolones, including levofloxacin ophthalmic solution. (5.1)
- Prolonged use may result in the overgrowth of non-susceptible organisms, including fungi. (5.2)
- Patients should not wear contact lenses if they have signs or symptoms of bacterial conjunctivitis. (5.3)

ADVERSE REACTIONS
The most frequently reported adverse reactions in the overall study population were transient decreased vision, fever, foreign body sensation, headache, transient ocular burning, ocular pain or discomfort, pharyngitis and photophobia. These reactions occurred in approximately 1% to 3% of patients. Other reported reactions occurring in less than 1% of patients included allergic reactions, lid edema, ocular dryness, and ocular itching. (6)

To report SUSPECTED ADVERSE REACTIONS, contact Akorn, Inc. at 1-800-932-5676 or FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.
See 17 for PATIENT COUNSELING INFORMATION.

Revised: 2/2017

FULL PRESCRIBING INFORMATION: CONTENTS*
1 INDICATIONS AND USAGE
2 DOSAGE AND ADMINISTRATION
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2 DOSAGE AND ADMINISTRATION

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Instill one to two drops in the affected eye(s) every 4 hours while awake, up to 4 times per day.

3 DOSAGE FORMS AND STRENGTHS

10 mL bottle filled with 5 mL sterile ophthalmic solution of levofloxacin, 0.5%.

4 CONTRAINDICATIONS

Levofoxacin ophthalmic solution is contraindicated in patients with a history of hypersensitivity to levofloxacin, to other quinolones, or to any of the components in this medication.

5 WARNINGS AND PRECAUTIONS

5.1 Hypersensitivity Reactions
In patients receiving systemically administered quinolones, including levofloxacin, serious and occasionally fatal hypersensitivity (anaphylactic) reactions have been reported, some following the first dose. Some reactions were accompanied by cardiovascular collapse, loss of consciousness, angioedema, (including laryngeal, pharyngeal or facial edema), airway obstruction, dyspnea, urticaria and itching. If allergic reaction to levofloxacin occurs, discontinue the drug. Serious acute hypersensitivity reactions may require immediate emergency treatment. Oxygen and airway management should be administered as clinically indicated.

5.2 Growth of Resistant Organisms with Prolonged Use
As with other anti-infectives, prolonged use may result in overgrowth of non-susceptible organisms, including fungi. If superinfection occurs, discontinue use and institute alternative therapy. Whenever clinical judgment dictates, the patient should be examined with the aid of magnification, such as slit-lamp biomicroscopy, and where appropriate, fluorescein staining.

5.3 Avoidance of Contact Lens Wear
Patients should be advised not to wear contact lenses if they have signs and symptoms of bacterial conjunctivitis.

6 ADVERSE REACTIONS

The most frequently reported adverse reactions in the overall study population were transient decreased vision, fever, foreign body sensation, headache, transient ocular burning, ocular pain or discomfort, pharyngitis and photophobia. These reactions occurred in approximately 1% to 3% of patients. Other reported reactions occurring in less than 1% of patients included allergic reactions, lid edema, ocular dryness, and ocular itching.

8 USE IN SPECIFIC POPULATIONS
8.1 Pregnancy
Pregnancy Category C

Teratogenic Effects: Levofloxacin at oral doses of 810 mg/kg/day in rats caused decreased fetal body weight and increased fetal mortality. No teratogenic effect was observed when rabbits were dosed orally as high as 50 mg/kg/day, at which systemic exposure was approximately 2,250 times that observed at the maximum recommended human ophthalmic dose, or when dosed intravenously as high as 25 mg/kg/day, at which systemic exposure was approximately 1000 times that observed at the maximum recommended human ophthalmic dose.

There are, however, no adequate and well-controlled studies in pregnant women. Levofloxacin should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

8.3 Nursing Mothers

Levofloxacin has not been measured in human milk. Based upon data from ofloxacin, it can be presumed that levofloxacin is excreted in human milk. Caution should be exercised when levofloxacin ophthalmic solution is administered to a nursing mother.

8.4 Pediatric Use

Safety and effectiveness in children below the age of six years have not been established. Oral administration of systemic quinolones has been shown to cause arthropathy in immature animals. There is no evidence that the ophthalmic administration of levofloxacin has any effect on weight bearing joints.

8.5 Geriatric Use

No overall differences in safety or effectiveness have been observed between elderly and other adult patients.

11 DESCRIPTION

Levofloxacin ophthalmic solution, 0.5% is a sterile topical ophthalmic solution. Levofloxacin is a fluoroquinolone antibacterial active against a broad spectrum of Gram-positive and Gram-negative ocular pathogens. Levofloxacin is a fluorinated 4-quinolone containing a six-member (pyridobenzoxazine) ring from positions 1 to 8 of the basic ring structure. Levofloxacin is the pure (-)-(S)-enantiomer of the racemic drug substance, ofloxacin. It is more soluble in water at neutral pH than ofloxacin. Its structural formula is:

![Structural Formula of Levofloxacin](attachment:structural_formula.png)

\[ C_{18}H_{20}FN_{3}O_{4} \cdot \frac{1}{2} H_{2}O \quad \text{Mol Wt 370.38} \]
Chemical Name: (-)-(S)-9-fluoro-2,3-dihydro-3-methyl-10-(4-methyl-1-piperazinyl)-7-oxo-7H-
pyrido[1,2,3-de]-1,4 benzoxazine-6-carboxylic acid hemihydrate.

Levofloxacin (hemihydrate) is a yellowish-white crystalline powder.

Each mL levofloxacin ophthalmic solution, 0.5% contains 5.12 mg of levofloxacin hemihydrate equivalent to 5 mg levofloxacin.

Contains: Active: Levofloxacin 0.5% (5 mg/mL); Preservative: Benzalkonium Chloride 0.005%; Inactives: Sodium Chloride and Water for Injection. May also contain Sodium Hydroxide and/or Hydrochloric Acid to adjust pH to approximately 6.5.

Levofloxacin ophthalmic solution, 0.5% is isotonic with an osmolality of approximately 300 mOsm/kg.

12 CLINICAL PHARMACOLOGY

12.1 Mechanism of Action
Levofloxacin is a member of the fluoroquinolone class of anti-infective drugs. (See 12.4 Microbiology).

12.3 Pharmacokinetics
Levofloxacin concentration in plasma was measured in 15 healthy adult volunteers at various time points during a 15-day course of treatment with levofloxacin ophthalmic solution. The mean levofloxacin concentration in plasma 1 hour postdose, ranged from 0.86 ng/mL on Day 1 to 2.05 ng/mL on Day 15. The highest maximum mean levofloxacin concentration of 2.25 ng/mL was measured on Day 4 following 2 days of dosing every 2 hours for a total of 8 doses per day. Maximum mean levofloxacin concentrations increased from 0.94 ng/mL on Day 1 to 2.15 ng/mL on Day 15, which is more than 1,000 times lower than those reported after standard oral doses of levofloxacin.

Levofloxacin concentration in tears was measured in 30 healthy adult volunteers at various time points following instillation of a single drop of levofloxacin ophthalmic solution. Mean levofloxacin concentrations in tears ranged from 34.9 to 221.1 mcg/mL during the 60-minute period following the single dose. The mean tear concentrations measured 4 and 6 hours postdose were 17.0 and 6.6 mcg/mL. The clinical significance of these concentrations is unknown.

12.4 Microbiology
Levofloxacin is the L-isomer of the racemate, ofloxacin, a quinolone antimicrobial agent. The antibacterial activity of ofloxacin resides primarily in the L-isomer. The mechanism of action of levofloxacin and other fluoroquinolone antimicrobials involves the inhibition of bacterial topoisomerase IV and DNA gyrase (both of which are type II topoisomerases), enzymes required for DNA replication, transcription, repair, and recombination.

Levofloxacin has in vitro activity against a wide range of Gram-negative and Gram-positive microorganisms and is often bactericidal at concentrations equal to or slightly greater than inhibitory concentrations.

Fluoroquinolones, including levofloxacin, differ in chemical structure and mode of action from β-lactam antibiotics and aminoglycosides, and therefore may be active against bacteria resistant to β-lactam antibiotics and aminoglycosides. Additionally, β-lactam antibiotics and aminoglycosides may be active against bacteria resistant to levofloxacin.

Resistance to levofloxacin due to spontaneous mutation in vitro is a rare occurrence (range: 10^-8 to 10^-10).

Levofloxacin has been shown to be active against most strains of the following microorganisms, both in vitro and in clinical infections as described in the INDICATIONS AND USAGE section:

Aerobic gram-positive microorganisms
Corynebacterium species*
Staphylococcus aureus
Staphylococcus epidermidis
Streptococcus pneumonia
Streptococcus (Groups C/F)
Streptococcus (Group G)
Viridans group streptococci*

**Aerobic gram-negative microorganisms**
Acinetobacter lwoffii*
Haemophilus influenzae
Serratia marcescens*
* Efficacy for this organism was studied in fewer than 10 infections.

The following *in vitro* data are also available, but their clinical significance in ophthalmic infections is unknown. The safety and effectiveness of levofloxacin in treating ophthalmological infections due to these microorganisms have not been established in adequate and well-controlled trials.

These organisms are considered susceptible when evaluated using systemic breakpoints. However, a correlation between the *in vitro* systemic breakpoint and ophthalmological efficacy has not been established. The list of organisms is provided as guidance only in assessing the potential treatment of conjunctival infections. Levofloxacin exhibits *in vitro* minimal inhibitory concentrations (MICs) of 2 mcg/mL or less (systemic susceptible breakpoint) against most (≥ 90%) strains of the following ocular pathogens:

**Aerobic gram-positive microorganisms**
Enterococcus faecalis
Staphylococcus saprophyticus
Streptococcus agalactiae
Streptococcus pyogenes

**Aerobic gram-negative microorganisms**
Acinetobacter anitratus
Acinetobacter baumannii
Citrobacter koseri
Citrobacter freundii
Enterobacter aerogenes
Enterobacter agglomerans
Enterobacter cloacae
Escherichia coli
Haemophilus parainfluenzae
Klebsiella oxytoca
Klebsiella pneumonia
Legionella pneumophila

* Efficacy for this organism was studied in fewer than 10 infections.
**13 NONCLINICAL TOXICOLOGY**

### 13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility

In a long term carcinogenicity study in rats, levofloxacin exhibited no carcinogenic or tumorigenic potential following daily dietary administration for 2 years at doses up to 100 mg/kg/day, corresponding to plasma levels that were 1235 times the maximum clinical exposure, based on Cmax.

Levofloxacin was not mutagenic in the following assays: Ames bacterial mutation assay (S. typhimurium and E. coli), CHO/HGPRT forward mutation assay, mouse dominant lethal test, rat unscheduled DNA synthesis assay, and the *in vivo* mouse sister chromatid exchange assay. It was positive in the *in vitro* chromosomal aberration (CHL cell line) and *in vitro* sister chromatid exchange (CHL/IU cell line) assays. Levofloxacin caused no impairment of fertility or reproduction in rats at oral doses as high as 360 mg/kg/day, at which systemic exposure was estimated to be 23,000 times that at the maximum recommended human ophthalmic dose.

### 14 CLINICAL STUDIES

In randomized, double-masked, multicenter controlled clinical trials where patients were dosed for 5 days, levofloxacin ophthalmic solution demonstrated clinical cures in 79% of patients treated for bacterial conjunctivitis on the final study visit day (day 6-10). Microbial outcomes for the same clinical trials demonstrated an eradication rate for presumed pathogens of 90%.

### 16 HOW SUPPLIED/STORAGE AND HANDLING

Levofloxacin ophthalmic solution, 0.5% is supplied in a white, low density polyethylene bottle with a controlled dropper tip and a tan polypropylene cap in the following size:

5 mL fill in a 10 mL capacity bottle - NDC 17478-106-10

**Storage:** Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].

### 17 PATIENT COUNSELING INFORMATION

#### 17.1 Avoid Contamination of the Product

Advise patients to avoid contaminating the applicator tip with material from the eye, finger, or other source.

#### 17.2 Avoid Contact Lens Wear

Advise patients not to wear contact lenses if they have signs and symptoms of bacterial conjunctivitis.
17.3 Hypersensitivity Reactions

Systemically administered quinolones, including levofloxacin, have been associated with hypersensitivity reactions, even following a single dose. Advise patients to discontinue use immediately and contact their physician at the first sign of a rash or allergic reaction.

AKORN
Manufactured by:
Akorn, Inc.
Lake Forest, IL 60045
LV00N Rev. 02/17

Principal Display Panel – 5mL Bottle Label
NDC 17478-106-10
Levofloxacin Ophthalmic Solution 0.5%
Rx Only
5 mL

Principal Display Panel – 5mL Carton Label
NDC 17478-106-10
Levofloxacin Ophthalmic Solution 0.5%
FOR TOPICAL APPLICATION IN THE EYE
5 mL
Rx Only
Akorn
LEVOFLOXACIN
levofloxacin solution

Product Information

Product Type: HUMAN PRESCRIPTION DRUG
Route of Administration: OPHTHALMIC

Active Ingredient/Active Moiety

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<th>Ingredient Name</th>
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<td>levofloxacin (UNII: 6GNT3Y5LMF) (levofloxacin anhydrous - UNIERIX4EB9Y14)</td>
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<td>5 mg in 1 mL</td>
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### Inactive Ingredients

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<td>hydrochloric acid</td>
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<td>sodium hydroxide</td>
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<td>water</td>
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### Packaging

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<td>1 in 1 CARTON</td>
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<td>1</td>
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<td>5 mL in 1 BOTTLE, DROPPER; Type 0: Not a Combination Product</td>
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### Marketing Information

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### Labeler

- Akorn Inc. (062649876)

### Establishment

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<th>Business Operations</th>
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Revised: 11/2017

Akorn Inc.