SUMMARY OF PRODUCT CHARACTERISTICS

1. NAME OF THE MEDICINAL PRODUCT

Cefuroxime 50 mg powder for solution for injection

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each vial contains cefuroxime sodium equivalent to 50 mg of cefuroxime.

After reconstitution with 5 ml of solvent (see section 6.6), 0.1 ml solution contains 1 mg of cefuroxime.

For the full list of excipients, see section 6.1.

3. PHARMACEUTICAL FORM

Powder for solution for injection.

White to almost white powder.

4. CLINICAL PARTICULARS

4.1 Therapeutic indications

Antibiotic prophylaxis of postoperative endophthalmitis after cataract surgery (see section 5.1).

Consideration should be given to official guidance on the appropriate use of antibacterial agents, including guidance on the antibiotic prophylaxis on eye surgery.

4.2 Posology and method of administration

Intracameral use. One vial for single-use only.

Posology

Adults:
The recommended dose is 0.1 ml of reconstituted solution (see section 6.6), i.e. 1 mg of cefuroxime.

THE RECOMMENDED DOSE MUST NOT BE EXCEEDED (see section 4.9).

Paediatric population
The optimal dose and the safety of Cefuroxime have not been established in the paediatric population.

Elderly
No dose adjustment is necessary.

Patients with hepatic and renal impairment
Considering the low dose and the expected negligible systemic exposure to cefuroxime using Cefuroxime, no dose adjustment is necessary.

Method of administration
Cefuroxime must be administered after reconstitution by intraocular injection in the anterior chamber of the eye (intracameral use), by an ophthalmic surgeon, in the recommended aseptic conditions of cataract surgery. Only sodium chloride 9 mg/ml (0.9 %) solution for injection must be used when reconstituting Cefuroxime (see section 6.6).

After reconstitution, Cefuroxime should be inspected visually for particulate matter and discoloration prior to administration.
Slowly inject 0.1 ml of the reconstituted solution into the anterior chamber of the eye at the end of the cataract surgery.
Each vial should only be used for the treatment of a single eye.
The vial contains more than the recommended dose of 1 mg (equivalent to 0.1 ml). The extractable reconstituted volume (5 ml) is not to be used in total.
Injection of the entire volume will result in an overdose.
After injection any unused product must be discarded.

For instructions on reconstitution of the medicinal product before administration, see section 6.6.

4.3 Contraindications

Hypersensitivity to cefuroxime or to the cephalosporin group of antibiotics.

4.4 Special warnings and precautions for use

Treatment with Cefuroxime is for intracameral use only.

Special care is indicated in patients who have experienced an allergic reaction to penicillins or any other beta-lactam antibiotics as cross-reactions may occur. The rate of cross-reactivity between penicillins and cefuroxime is low, due to the fact that the side chain is different to that of the penicillin responsible for the initial allergic reaction. A study confirmed that even when there is more definite history of penicillin allergy, it may still be reasonable to administer intracameral cefuroxime, as it still stands that the likelihood of cross-reaction is very small.

In patients at risk for infections with resistant strains, e.g. those with known previous infection or colonisation with MRSA (Methicillin-resistant *Staphylococcus aureus*), alternative prophylactic antibiotic should be considered.

In the absence of data for special patient groups (patients with severe risk of infection, patients with complicated cataracts, patients having combined operations with cataract surgery, patients with severe thyroid disease, patients with less 2000 corneal endothelial cells), Cefuroxime should only be used after careful risk/benefit assessment.

The use of cefuroxime should not be regarded as an isolated measure but other circumstances are also of importance like prophylactic antiseptic treatment.

Corneal endothelial toxicity has not been reported at the recommended concentration of cefuroxime; nevertheless, this risk cannot be excluded and in the post-surgical surveillance, physicians should have in mind this potential risk.

4.5 Interaction with other medicinal products and other forms of interaction

No interaction studies have been performed.
Since the systemic exposure is expected to be negligible, systemic interactions are unlikely.

No incompatibility with most commonly used products in cataract surgery was reported in literature.

4.6 Fertility, pregnancy and lactation

Pregnancy
There are limited amount of data from the use of cefuroxime in pregnant woman. Animal studies do not show any harmful effects on embryonal and foetal development. Cefuroxime reaches the embryo/foetus via the placenta. No effects during pregnancy are anticipated, since systemic exposure to cefuroxime using Cefuroxime is negligible. Cefuroxime can be used during pregnancy.

Breastfeeding
Cefuroxime is expected to be excreted in human milk in very small quantities. Adverse effects at therapeutic doses are not expected after Cefuroxime use. Cefuroxime can be used during breastfeeding.

Fertility
There are no data on the effects of cefuroxime sodium on fertility in humans. Reproductive studies in animals have shown no effects on fertility.

4.7 Effects on ability to drive and use machines

Not relevant.

4.8 Undesirable effects

No particular adverse effects were reported in the literature when cefuroxime is administered as intraocular injection except the following:

Immune system disorders
Very rare (<1/10,000): Anaphylactic reaction.

Eye disorders
Not known (frequency cannot be estimated from the available data): Macular oedema with serous retinal detachment, anterior segment syndrome, retinal hemorrhagic infarction and anaphylactic reaction.

A serious detachment of retinal pigment and sensory epithelia during the early postoperative period after cataract surgery in one patient was reported that might be caused by a toxic reaction to intracameral cefuroxime.

Reporting of suspected adverse reactions
Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions via the Yellow Card Scheme, website: www.mhra.gov.uk/yellowcard or search for MHRA Yellow Card in the Google Play or Apple App Store.

4.9 Overdose

The reported cases of overdose are those described in the literature after incorrect dilution and non-authorised use of cefuroxime intended for systemic administration.

Inadvertent high-dose (3-fold the recommended dose) intracameral cefuroxime was administered to 6 patients following an incorrect dilution due to homemade cefuroxime dilution protocol. These injections did not cause any detectable adverse effect in any patient even on ocular tissues.

Toxicity data were available following intracameral injection, during cataract surgery, of 40 to 50-fold the recommended dose of cefuroxime in 6 patients after a dilution error. Initial mean visual acuity was 20/200. Severe anterior segment inflammation was present, and retinal optical coherence tomography showed extensive macular oedema. Six weeks after surgery, mean visual acuity reached 20/25. Macular optical coherence tomography profile returned to normal. A 30% decrease of scotopic electroretinography was, however, observed in all patients.

Administration of incorrectly diluted cefuroxime (10-100 mg per eye) to 16 patients resulted in ocular toxicity including corneal oedema resolving in weeks, transient raised intraocular pressure, loss of corneal endothelial cells and changes in the electroretinography. A number of these patients had permanent and severe vision loss.

5. Pharmacological properties

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Sensory Organs - Ophthalmologicals - Anti-infectives - Antibiotics, ATC code: S01AA27

Mechanism of action
Cefuroxime inhibits bacterial cell wall synthesis following attachment to penicillin binding proteins (PBPs). This results in the interruption of cell wall (peptidoglycan) biosynthesis, which leads to bacterial cell lysis and death.

Pharmacodynamic effects
For cephalosporins, the most important pharmacokinetic-pharmacodynamic index correlating with in vivo efficacy has been shown to be the percentage of the dosing interval (%T) that the unbound concentration remains above the minimum inhibitory concentration (MIC) of cefuroxime for individual target species (i.e. %T>MIC).

After intracameral injection of 1 mg cefuroxime, cefuroxime levels in the aqueous humour were over MIC for several relevant species for up to 4 - 5 hours after surgery.

The antibacterial activity of cefuroxime covers a wide spectrum of activity against gram positive bacteria and limited activity against gram negative organisms.

Mechanism of resistance
Bacterial resistance to cefuroxime may be due to one or more of the following mechanisms:
- hydrolysis by beta-lactamases. Cefuroxime may be efficiently hydrolysed by certain of the extended-spectrum betalactamases (ESBLs) and by the chromosomally-encoded (AmpC) enzyme that may be induced or stably derepressed in certain aerobic gram-negative bacterial species;
- reduced affinity of penicillin-binding proteins for cefuroxime;
- outer membrane impermeability, which restricts access of cefuroxime to penicillin binding proteins in gram-negative bacteria;
- bacterial drug efflux pumps.

Methicillin-resistant *staphylococci* (MRS) are resistant to all currently available β-lactam antibiotics including cefuroxime.

Penicillin-resistant *Streptococcus pneumoniae* are cross-resistant to cephalosporins such as cefuroxime through alteration of penicillin binding proteins.

Beta-lactamase negative, ampicillin resistant (BLNAR) strains of *H. influenzae* should be considered resistant to cefuroxime despite apparent in vitro susceptibility.

Breakpoints:
The list of micro-organisms presented hereafter has been targeted to the indication (see section 4.1).

Cefuroxime should be used for intracameral application only and should not be used to treat systemic infections (see section 5.2); clinical breakpoints are not relevant for this route of administration. Epidemiological cut-off values (ECOFF), distinguishing the wild-type population from isolates with acquired resistance traits are as follows:

	ECOFF (mg/L)
Staphylococcus aureus	≤ 4
Streptococcus pneumoniae	≤ 0.125
E. coli	≤ 8
Proteus mirabilis	≤ 4
H. influenzae	≤ 2

Susceptibility of *staphylococci* to cefuroxime is inferred from the methicillin susceptibility.
The susceptibility of *streptococcus* groups A, B, C and G can be inferred from their susceptibility to benzylpenicillin.

Continued use of intracameral cefuroxime, may increase prevalence of resistant strains, especially Enterococci spp. Cefuroxime doesn't cover methicillin-resistant Staphylococcus aureus or methicillin-resistant Staphylococcus epidermidis. Two studies from 2019 showed that, even though the use of intracameral cefuroxime was an important protective factor against postoperative endophthalmitis, there has been a shift in pathogens from cefuroxime-sensitive to cefuroxime-resistant microorganisms in the last years (Friling et al., 2019; García-Sáenz et al., 2019 (37th ESCR Congress).

Information from clinical trials
An academic prospective randomized partially masked multicentre cataract surgery study was performed on 16,603 patients. Twenty-nine patients (24 in "without cefuroxime" groups and 5 in "intracameral cefuroxime" groups) presented with endophthalmitis, of whom 20 (17 in "without cefuroxime" groups and 3 in "intracameral cefuroxime" groups) were classified as having proven infective endophthalmitis. Among these 20 proven endophthalmitis: 10 patients are in group "placebo eye drops and without cefuroxime", 7 patients in group "levofloxacine eye drops and without cefuroxime", 2 patients in group "placebo eye drops and intracameral cefuroxime" and 1 patient in group "levofloxacine eye drops and intracameral cefuroxime. The administration of intracameral cefuroxime prophylactic regimen at 1mg in 0.1 ml sodium chloride 9 mg/ml (0.9 %) solution for injection was associated with a 4.92-fold decrease in the risk for total postoperative endophthalmitis.

Two prospective studies (Wedje 2005 and Lundström 2007) and 5 retrospective studies were supportive to the pivotal ESCRS study further substantiating the efficacy of intracameral cefuroxime in postoperative endophthalmitis.

A retrospective study, including 16 patients with cataract operations from 2004 to 2012, indicated a four-fold reduction in the rate of postoperative endophthalmitis with intracameral cefuroxime use (Myneni et al., 2013). In another study, the incidence, aetiology, and outcomes of endophthalmitis

were reviewed during a 20-year period between 1999 and 2018 (Malmin et al., 2020). This study found that the use of intracameral cefuroxime led to a more than six-fold decrease of postoperative endophthalmitis. A long-term cohort study from France reported on 6,371,242 cataract surgeries performed in 3,983,525 patients undergoing phacoemulsification cataract surgery between 2005 and 2014 (Creuzot-Garcher et al., 2016). During this 10-year period, the incidence of acute post-operative endophthalmitis decreased from 0.145% to 0.053% due to intracameral injection of cefuroxime. Intraoperative cefuroxime irrigation prophylaxis of acute-onset endophthalmitis after phacoemulsification surgery was investigated in a retrospective, comparative, interventional cohort study including patients who underwent phacoemulsification between 2012 and 2019 (Ma et al., 2020). From this study, no adverse events related to the irrigation of cefuroxime were found. Intraoperative cefuroxime irrigation was found to reduce the rate of postoperative endophthalmitis after phacoemulsification by 7-fold.
A Cochrane systematic review from 2017 found moderate-certainty evidence to suggest that using antibiotic eye drops in addition to antibiotic injection probably lowers the chance of endophthalmitis compared with using injections or eye drops alone and recommends practitioners to rely on current evidence to make informed decisions regarding prophylaxis choices (Gower et al., 2017). However, a systematic review from 2018 indicate that intracameral antibiotics alone may be as effective as intracameral plus topical antibiotics (Bowen et al., 2018).

5.2 Pharmacokinetic properties

The systemic exposure following intracameral injection has not been studied but is expected to be negligible.

After intracameral injection at the recommended single dose of 0.1 ml of a 10 mg/ml solution of cefuroxime in cataract patients, the mean intracameral level of cefuroxime was 2614 ± 209 mg/l (10 patients) 30 seconds and 1027 ± 43 mg/l (9 patients) 60 minutes after drug administration.

5.3 Preclinical safety data

Effects in non-clinical studies were observed only at exposures considered sufficiently in excess of the maximum human exposure indicating little relevance to clinical use.

Intravitreal injection of 1 mg cefuroxime in albino rabbits resulted in levels of 19-35 mg/l and 600-780 mg/l after 30 min following injection in the aqueous and in the vitreous, respectively. Levels after 6 h decreased to 1.9-7.3 and 190-260 mg/l respectively in these two structures. There was no increase in the intraocular pressure during the first 3 days. Histopathology showed no degenerative changes compared to saline.

ERG: a-, b- and c- waves diminished up until 14 days both in the control and antibiotic-injected eyes.

Recovery occurred and may be slower than in control. ERG showed no definite changes suggestive of retinal toxicity up to 55 days after intravitreal administration.

6. Pharmaceutical particulars

6.1 List of excipients

None

6.2 Incompatibilities

This medicinal product must not be mixed with other medicinal products except those mentioned in section 6.6.

6.3 Shelf life

2 years.

After reconstitution: the product should be used immediately.

6.4 Special precautions for storage

Store the vial in the original package in order to protect from light.

6.5 Nature and contents of container

10 ml clear glass vial, stoppered with bromobutyl rubber stopper and sealed with flip-off cap.

Box of 1 x 50 mg, 10 x 50mg or 20 x 50mg vials together with the corresponding amount of 5-micron sterile filter needles.

Not all pack sizes may be marketed.

6.6 Special precautions for disposal and other handling

Cefuroxime must be administered by intracameral injection, by an ophthalmic surgeon in the recommended aseptic conditions of cataract surgery.

VIAL IS FOR SINGLE USE ONLY.

Each vial should only be used for the treatment of a single eye.
The flag label of the vial should be stuck on the patient's file, as applicable.

The reconstituted solution should be visually inspected and should only be used if it is a clear, colourless to yellowish solution free from visible particles. The medicinal product should be discarded if particles are visible in the solution.

To prepare the product for intracameral administration, please adhere to the following instructions:

1. The integrity of the flip-off cap should be checked before withdrawing it

2. Before inserting a sterile needle, the outer part of the rubber stopper of the vial should be disinfected.

3. The needle should be pushed vertically into the centre of the vial stopper, keeping the vial in an upright position. Then, 5 ml of sodium chloride 9 mg/ml (0.9 %) solution for injection must be injected into the vial using aseptic technique.

4. The solution should be shaken gently until it is clear, colourless to yellowish and free from visible particles.

5. A sterile needle (18G x 1½", 1.2 mm x 40 mm) with 5-micron filter (acrylic co-polymer membrane) must be assembled onto a 1 ml sterile syringe. This syringe should be pushed vertically into the centre of the vial stopper while keeping the vial in an upright position.

6. At least 0.1 ml of the solution should be aseptically aspired. The remaining reconstituted solution in the vial (4.9 ml) must be discarded.

7. The 5-micron filter needle should be disconnected from the syringe and the syringe should be assembled with an appropriate anterior chamber cannula.

8. The air, as well as the excess drug, must be carefully expelled from the syringe by slowly depressing the plunger so that the plunger tip aligns with the line that marks 0.1 ml on the syringe. The syringe is ready for injection.

After use, the remaining reconstituted solution must be discarded. It must not be kept for subsequent use.

Any unused medicinal product or waste material should be disposed of in accordance with local requirements.

7. MARKETING AUTHORISATION HOLDER

Consilient Health Ltd.,
Floor 3, Block 3, Miesian Plaza, Dublin 2, D02 Y754, Ireland

8. MARKETING AUTHORISATION NUMBER(S)

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9. DATE OF FIRST AUTHORISATION/RENEWAL OF THE AUTHORISATION

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10. DATE OF REVISION OF THE TEXT

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