

**HIGHLIGHTS OF PRESCRIBING INFORMATION**

These highlights do not include all the information needed to use EPINEPHRINE INJECTION USP safely and effectively. See full prescribing information for EPINEPHRINE INJECTION USP.

**EPINEPHRINE INJECTION USP, 1 mg/mL (1:1,000) ampule for IV infusion and intraocular use**

Initial U.S. Approval: 1939

**INDICATIONS AND USAGE**

Epinephrine is an alpha and beta adrenergic agonist indicated:

- To increase mean arterial blood pressure in adult patients with hypotension associated with septic shock. (1.1)
- For induction and maintenance of mydriasis during intraocular surgery. (1.2)

**DOSAGE AND ADMINISTRATION**

- **Hypotension associated with septic shock:**
  - Dilute epinephrine in dextrose solution prior to infusion. (2.1)
  - Infuse epinephrine into a large vein. (2.1)
  - Intravenous infusion rate of 0.05 mcg/kg/min to 2 mcg/kg/min, titrated to achieve desired mean arterial pressure (2.1)
  - Wean gradually. (2.1)
- **Intraocular surgery:**
  - Dilute 1 mL with 100 to 1000 mL of an ophthalmic irrigation fluid, for ophthalmic irrigation or intracameral injection. (2.2)

**DOSAGE FORMS AND STRENGTHS**

2 mL ampule containing 1 mg/1 mL epinephrine (1:1,000 Injection, USP). (3)

**CONTRAINDICATIONS**

None. (4)

**WARNINGS AND PRECAUTIONS**

- Correct blood volume depletion. (5.1)
- Titrate carefully while patient vital signs are continuously monitored. (5.2)
- Avoid extravasation into tissues, which can cause local necrosis. (5.3)
- Potential for pulmonary edema, which may be fatal (5.4)
- May constrict renal blood vessels and decrease urine formation. (5.5)
- May induce potentially serious cardiac arrhythmias in patients. (5.6)
- MAO inhibitors and antidepressants may prolong hypertension. (5.7)
- Undiluted ophthalmic administration: associated with corneal endothelial damage. (5.8)

**ADVERSE REACTIONS**

Most common adverse reactions (incidence > 1%) to systemically administered epinephrine are headache; anxiety; restlessness; tremor; weakness; dizziness; sweating; palpitations; pallor; peripheral coldness; nausea/vomiting; and/or respiratory difficulties. (6)

To report SUSPECTED ADVERSE REACTIONS, contact Belcher Pharmaceuticals at (727) 471-0850 or FDA at 1-800-FDA-1088 or [www.fda.gov/medwatch](http://www.fda.gov/medwatch).

**DRUG INTERACTIONS**

- Drugs that counter the pressor effects of epinephrine include alpha blockers, vasodilators such as nitrates, diuretics, and antihypertensives. (7.1)
- Drugs that potentiate the pressor effects of epinephrine include sympathomimetics, beta blockers, tricyclic antidepressants, MAO inhibitors, COMT inhibitors, clonidine, doxapram, and oxytocin. (7.2)
- Drugs that increase the arrhythmogenic potential of epinephrine include beta blockers, cyclopropane and halogenated hydrocarbon anesthetics, antihistamines, exogenous thyroid hormones, diuretics, and digitalis glycosides. (7.2)
- Potassium-depleting drugs, including corticosteroids, diuretics, and theophylline, potentiate the hypokalemic effects of epinephrine. (7.2)

**USE IN SPECIFIC POPULATIONS**

- Pregnancy: Epinephrine may lead to fetal anoxia, spontaneous abortion or both. (8.1)
- Avoid breast-feeding with epinephrine infusion. (8.3)

See 17 for PATIENT COUNSELING INFORMATION

Revised: June 2015

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## FULL PRESCRIBING INFORMATION

### 1 INDICATIONS AND USAGE

#### 1.1 Hypotension associated with septic shock

Epinephrine Injection USP, 1 mg/mL (1:1,000) is indicated to increase mean arterial blood pressure in hypotension associated with septic shock.

#### 1.2 Induction and maintenance of mydriasis during intraocular surgery

Induction and maintenance of mydriasis during intraocular surgery.

### 2 DOSAGE AND ADMINISTRATION

#### 2.1 Hypotension associated with septic shock

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

Dilute epinephrine in 5 percent dextrose solution or 5 percent dextrose and sodium chloride solution. These dextrose containing fluids provide protection against significant loss of potency by oxidation. **Administration in saline solution alone is not recommended.** Whole blood or plasma, if indicated to increase blood volume, should be administered separately.

Add 1 mL (1 mg) of epinephrine from its ampule to 1,000 mL of a 5 percent dextrose containing solution. Each mL of this dilution contains 1 mcg of epinephrine.

Blood volume depletion should always be corrected as fully as possible before any vasopressor is administered. When, as an emergency measure, intraaortic pressures must be maintained to prevent cerebral or coronary artery ischemia, epinephrine can be administered before and concurrently with blood volume replacement.

Whenever possible, give infusions of epinephrine into a large vein. Avoid using a catheter tie-in technique, because the obstruction to blood flow around the tubing may cause stasis and increased local concentration of the drug. Occlusive vascular diseases (for example, atherosclerosis, arteriosclerosis, diabetic endarteritis, Buerger's disease) are more likely to occur in the lower than in the upper extremity; therefore, avoid the veins of the leg in elderly patients or in those suffering from such disorders. There is potential for gangrene in a lower extremity when infusions of catecholamine are given in an ankle vein.

To provide hemodynamic support in septic shock associated hypotension in adult patients, the suggested dosing infusion rate of intravenously administered epinephrine is 0.05 mcg/kg/min to 2 mcg/kg/min, and is titrated to achieve a desired mean arterial pressure (MAP). The dosage may be adjusted periodically, such as every 10 - 15 minutes, in increments of 0.05 mcg/kg/min to 0.2 mcg/kg/min, to achieve the desired blood pressure goal.

Continuous epinephrine infusion is generally required over several hours or days until the patient's hemodynamic status improves. The duration of perfusion or total cumulative dose cannot be predicted.

After hemodynamic stabilization, wean incrementally over time, such as by decreasing doses of epinephrine every 30 minutes over a 12- to 24-hour period.

## 2.2 Induction and maintenance of mydriasis during intraocular surgery

Epinephrine must be diluted prior to intraocular use. Dilute 1 mL of epinephrine 1 mg/mL (1:1000) in 100 to 1000 mL of an ophthalmic irrigation fluid to create an epinephrine concentration of 1:100,000 to 1:1,000,000 (10 mcg/mL to 1 mcg/mL). Use the irrigating solution as needed for the surgical procedure.

After dilution in an ophthalmic irrigating fluid, epinephrine may also be injected intracamerally as a bolus dose of 0.1 mL at a dilution of 1:100,000 to 1:400,000 (10 mcg/mL to 2.5 mcg/mL).

Inspect visually for particulate matter and discoloration prior to administration. Do not use if the solution is colored or cloudy, or if it contains particulate matter.

## 3 DOSAGE FORMS AND STRENGTHS

2 mL clear glass ampule containing 1 mg/1 mL epinephrine as the hydrochloride in a sterile, preservative free/sulfite free solution, marked Epinephrine Injection USP, 1 mg/mL (1:1,000) [see Dosage and Administration (2)].

## 4 CONTRAINDICATIONS

None.

## 5 WARNINGS AND PRECAUTIONS

### 5.1 Blood Volume Replacement

Correct blood volume depletion before any vasopressor is administered.

### 5.2 Acute Hypertension

Titrate epinephrine infusion while monitoring vital signs. Invasive arterial blood pressure monitoring and central venous pressure monitoring are recommended. Because of varying response to epinephrine, dangerously high blood pressure may occur.

### 5.3 Extravasation

The infusion site should be checked frequently for free flow. Avoid extravasation of epinephrine into the tissues, to prevent local necrosis. Blanching along the course of the infused vein, sometimes without obvious extravasation, may be attributed to vasa vasorum constriction with increased permeability of the vein wall, permitting some leakage. This also may progress on rare occasions to superficial slough. Hence, if blanching occurs, consider changing the infusion site at intervals to allow the effects of local vasoconstriction to subside.

**Antidote for Extravasation Ischemia:** To prevent sloughing and necrosis in areas in which extravasation has taken place, infiltrate the area with 10 mL to 15 mL of saline solution containing from 5 mg to 10 mg of **phentolamine**, an adrenergic blocking agent. Use a syringe with a fine hypodermic needle, with the solution being infiltrated liberally throughout the area, which is easily identified by its cold, hard, and pallid appearance. Sympathetic blockade with phentolamine causes immediate and conspicuous local hyperemic changes if the area is infiltrated within 12 hours.

#### **5.4 Pulmonary Edema**

There is risk of pulmonary edema because of the peripheral constriction and cardiac stimulation produced.

#### **5.5 Renal Impairment**

Intravenously administered epinephrine initially may produce constriction of renal blood vessels and decrease urine formation.

#### **5.6 Cardiac Arrhythmias**

Epinephrine may induce cardiac arrhythmias in patients, especially those patients suffering from heart disease, organic heart disease, or who are receiving drugs that sensitize the myocardium.

#### **5.7 Prolonged Hypertension**

Patients receiving monoamine oxidase inhibitors (MAOI) or antidepressants of the triptyline or imipramine types may experience severe, prolonged hypertension when given epinephrine.

#### **5.8 Injury with Undiluted Intraocular Solution**

Epinephrine **must** be diluted before intraocular use. Other products of epinephrine containing sodium bisulfite have been associated with corneal endothelial damage when used in the eye at undiluted concentrations (1 mg/mL). Although this Epinephrine product contains no sulfites and is sulfite-free/preservative-free, warning is still advised [*see Dosage and Administration (2.2)*].

### **6 ADVERSE REACTIONS**

#### **6.1 Adverse Reactions Associated with Infusion (for Hypotension Associated with Septic Shock)**

The following adverse reactions associated with the use of epinephrine were identified in the literature. Because these reactions are reported voluntarily from a population of uncertain size, it is not always possible to estimate their frequency reliably or to establish a causal relationship to drug exposure.

*Cardiovascular disorders:* tachycardia, supraventricular tachycardia, ventricular arrhythmias, myocardial ischemia, myocardial infarction, limb ischemia, pulmonary edema

*Gastrointestinal disorders:* Nausea, vomiting

*General disorders and administrative site conditions:* Chest pain, extravasation,

*Metabolic:* hypoglycemia, hyperglycemia, insulin resistance, hypokalemia, lactic acidosis

*Nervous system disorders:* Headache, nervousness, paresthesia, tremor, stroke, central nervous system bleeding

*Psychiatric disorders:* Excitability

*Renal disorders:* Renal insufficiency

*Respiratory:* Pulmonary edema, rales

*Skin and subcutaneous tissue disorders:* Diaphoresis, pallor, piloerection, skin blanching, skin necrosis with extravasation

## 6.2 Adverse Reactions Associated with Intraocular Use (for Mydriasis)

Epinephrine containing sodium bisulfite has been associated with corneal endothelial damage when used in the eye at undiluted concentrations (1 mg/mL). Although this Epinephrine product contains no sulfites and is sulfite-free/preservative-free, warning is still advised [*see Warnings and Precautions (5.8)*].

To report SUSPECTED ADVERSE REACTIONS, contact Belcher Pharmaceuticals at (727) 471-0850 or FDA at 1-800-FDA-1088 or [www.fda.gov/medwatch](http://www.fda.gov/medwatch).

## 7 DRUG INTERACTIONS

### 7.1 Epinephrine's Effects on Other Drugs

**Antihypertensives:** Epinephrine may antagonize the neuronal blockade produced by guanethidine resulting in decreased antihypertensive effect and requiring increased dosage of the latter.

### 7.2 Effects of Other Drugs on Epinephrine

#### Drugs antagonizing pressor effects

- $\alpha$ -blockers, such as phentolamine
- Vasodilators, such as nitrates
- Diuretics
- Antihypertensives

#### Drugs potentiating pressor effects

- Sympathomimetics
- $\beta$ -blockers
- Tricyclic anti-depressants
- Monoamine oxidase (MAO) inhibitors
- Catechol-O-methyl transferase (COMT) inhibitors, such as entacapone
- Clonidine
- Doxapram
- Oxytocin

#### Drugs potentiating arrhythmogenic effects

- $\beta$ -blockers
- Cyclopropane or halogenated hydrocarbon anesthetics, such as halothane
- Antihistamines
- Thyroid hormones
- Diuretics
- Digitalis glycosides

#### Drugs potentiating hypokalemic effects

- Potassium depleting diuretics
- Corticosteroids
- Theophylline

## **8 USE IN SPECIFIC POPULATIONS**

### **8.1 Pregnancy**

Pregnancy Category C: Epinephrine has been shown to have developmental effects in rabbits at a subcutaneous dose of 1.2 mg/kg (approximately 30 times the maximum recommended daily subcutaneous or intramuscular dose on a mg/m<sup>2</sup> basis), in mice at a subcutaneous dose of 1 mg/kg (approximately 7 times the maximum recommended daily subcutaneous or intramuscular dose on a mg/m<sup>2</sup> basis), and in hamsters at a subcutaneous dose of 0.5 mg/kg (approximately 5 times the maximum recommended daily subcutaneous or intramuscular dose on a mg/m<sup>2</sup> basis). These effects were not seen in mice at a subcutaneous dose of 0.5 mg/kg (approximately 3 times the maximum recommended daily subcutaneous or intramuscular dose on a mg/m<sup>2</sup> basis). Although there are no adequate and well-controlled studies in pregnant women, epinephrine crosses the placenta (but not the blood-brain barrier) and could lead to fetal anoxia, spontaneous abortion or both. Data from animal studies have shown that epinephrine interferes with ovum implantation and fetus survival in rabbits and has teratogenic potential.

Epinephrine has been shown to have teratogenic effects (including gastroschisis and embryonic lethality) when administered subcutaneous in rabbits at approximately 15 times the maximum recommended intramuscular or subcutaneous dose (on a mg/m<sup>2</sup> basis at a maternal subcutaneous dose of 1.2 mg/kg/day for two to three days).

In mice, teratogenic effects (including embryonic lethality) were observed at approximately 3 times the maximum recommended intramuscular or subcutaneous dose (on a mg/m<sup>2</sup> basis at maternal subcutaneous dose of 1 mg/kg/day for 10 days). These effects were not seen in mice at approximately 2 times the maximum recommended daily intramuscular or subcutaneous dose (on a mg/m<sup>2</sup> basis at a subcutaneous maternal dose of 0.5 mg/kg/day for 10 days).

In hamsters, teratogenic effects were observed at approximately 2 times the maximum recommended intramuscular or subcutaneous dose (on a mg/m<sup>2</sup> basis at a maternal subcutaneous dose of 0.5 mg/kg/day for 4 days).

### **8.2 Labor and Delivery**

Epinephrine usually inhibits spontaneous or oxytocin induced contractions of the pregnant human uterus and may delay the second stage of labor. Avoid epinephrine during the second stage of labor. In dosage sufficient to reduce uterine contractions, the drug may cause a prolonged period of uterine atony with hemorrhage. Avoid epinephrine in obstetrics when maternal blood pressure exceeds 130/80 mmHg.

### **8.3 Nursing Mothers**

Epinephrine is distributed into breast milk. Avoid breast-feeding in mothers receiving infusion of epinephrine.

### **8.4 Pediatric Use**

Safety and effectiveness of epinephrine in pediatric patients with septic shock have not been established.

The safety and effectiveness of epinephrine (at a dilution of 1:100,000 to 1:400,000) for induction and maintenance of mydriasis during intraocular surgery have been established in pediatric patients. Use of epinephrine for induction and maintenance of mydriasis during intraocular surgery in pediatric patients is supported by adequate and well controlled studies in adults and uncontrolled studies in pediatric patients.

### **8.5 Geriatric Use**

Clinical studies of epinephrine for the treatment of hypotension associated with septic shock did not include sufficient numbers of subjects aged 65 and over to determine whether they respond differently from younger subjects. Other reported clinical experience has not identified differences in responses between the elderly and younger patients. In general, dose selection for an elderly patient should be cautious, usually starting at the low end of the dosing range, reflecting the greater frequency of decreased hepatic, renal, or cardiac function, and of concomitant disease or other drug therapy.

For induction and maintenance of mydriasis during intraocular surgery, no overall differences have been observed between elderly and other patients.

## **10 OVERDOSAGE**

### **10.1 Overdosage associated with Infusion (for Hypotension associated with Septic Shock)**

Myocardial ischemia and infarction, cardiomyopathy, pulmonary edema, and renal insufficiency were observed in literature reports of accidental overdoses.

Toxic effects of overdosage can be counteracted by injection of an alpha-adrenergic blocker (such as phentolamine mesylate) and a beta-adrenergic blocker (such as propranolol). Rapid-acting vasodilators such as nitrites, or alpha-adrenergic blocking agents can be given to counteract the marked pressor effect of large doses of epinephrine causing a sharp rise in the blood pressure. Treatment of acute toxicity is mainly supportive since epinephrine is rapidly inactivated in the body.

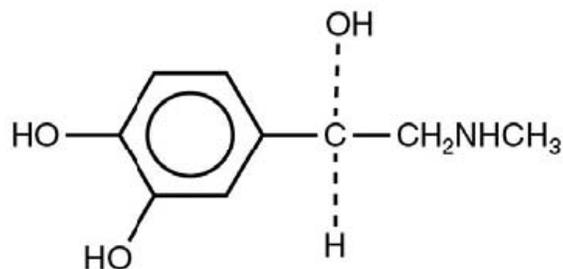
Epinephrine overdosage can also cause transient bradycardia followed by tachycardia, and these may be accompanied by potentially fatal cardiac arrhythmias. Premature ventricular contractions may appear within one minute after injection and may be followed by multifocal ventricular tachycardia (prefibrillation rhythm). Subsidence of the ventricular effects may be followed by atrial tachycardia and occasionally by atrioventricular block. Treatment of arrhythmias consists of administration of a beta-adrenergic blocking drug such as propranolol.

## **11 DESCRIPTION**

Epinephrine Injection USP, 1 mg/mL (1:1,000) is supplied as a sterile aqueous solution that is colorless and nonpyrogenic. Each milliliter contains 1 mg Epinephrine base (as the hydrochloride), Sodium Chloride 9 mg (for isotonicity), and Water for Injection, USP, qs. Contains no sulfites. May contain Hydrochloric Acid for pH adjustment.

The solution contains no preservatives such as sulfites. This sterile solution is to be diluted prior to intravenous or ocular use.

Epinephrine, USP is a sympathomimetic catecholamine (adrenergic agent) designated chemically as 4-[1-hydroxy-2 (methylamino) ethyl]-1,2 benzenediol, a white, microcrystalline powder. It has the following structural formula:



The molecular weight of epinephrine is 183.2.

Epinephrine solution deteriorates rapidly on exposure to air or light, turning pink from oxidation to adrenochrome and brown from the formation of melanin.

## 12 CLINICAL PHARMACOLOGY

### 12.1 Mechanism of Action

Epinephrine acts on both alpha ( $\alpha$ )- and beta ( $\beta$ )-adrenergic receptors. The mechanism of the rise in blood pressure is 3-fold: a direct myocardial stimulation that increases the strength of ventricular contraction (positive inotropic action), an increased heart rate (positive chronotropic action), and peripheral vasoconstriction.

### 12.2 Pharmacodynamics

Intravenous use for hypotension associated with septic shock:

Following intravenous administration of epinephrine, increases in systolic blood pressure and heart rate are observed. Decreases in systemic vascular resistance and diastolic blood pressure are observed at low doses of epinephrine because of  $\beta_2$ -mediated vasodilation, but are overtaken by  $\alpha_1$ -mediated peripheral vasoconstriction at higher doses leading to increase in diastolic blood pressure. The onset of blood pressure increase following an intravenous dose of epinephrine is < 5 minutes and the time to offset blood pressure response occurs within 20 min. Most vascular beds are constricted including renal, splanchnic, mucosal and skin.

Intraocular use for mydriasis

Epinephrine causes mydriasis when administered intraocularly or parenterally.

### 12.3 Pharmacokinetics

Intravenous use for hypotension associated with septic shock:

Following intravenous injection, epinephrine is rapidly cleared from the plasma with an effective half-life of < 5 min. A pharmacokinetic steady state following continuous intravenous infusion is achieved within 10-15 min. In patients with septic shock, epinephrine displays dose-proportional pharmacokinetics in the infusion dose range of 0.03 to 1.7 mcg/kg/min.

Epinephrine is extensively metabolized with only a small amount excreted unchanged. Epinephrine is rapidly degraded to vanillylmandelic acid, an inactive metabolite, by monoamine oxidase and catechol-O-methyltransferase that are abundantly expressed in the liver, kidneys and other extraneuronal tissues. The tissues with the highest contribution to removal of circulating exogenous epinephrine are the liver (32%), kidneys (25%), skeletal muscle (20%), and mesenteric organs (12%).

### **Special Populations**

#### Elderly

In a pharmacokinetic study of 45-minute epinephrine infusions given to healthy men aged 20 to 25 years and healthy men aged 60 to 65 years, the mean plasma metabolic clearance rate of epinephrine at steady state was greater among the older men (144.8 versus 78 mL/kg/min for a 14.3 ng/kg/min infusion).

#### Body Weight

Body weight has been found to influence epinephrine pharmacokinetics. Higher body weight was associated with a higher plasma epinephrine clearance and a lower concentration plateau.

#### Intraocular use:

When administered intraocularly, epinephrine has a rapid onset and short duration of action.

The extent of human systemic exposure at the labeled intraocular dose has not been evaluated, however, significant systemic concentrations or plasma exposure of epinephrine are not expected when administered intraocularly.

## **13 NONCLINICAL TOXICOLOGY**

### **13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility**

Adequate carcinogenesis studies have not been reported. An equivocal response of epinephrine was found when tested in *Salmonella typhimurium* strain TA 100 in the absence of metabolic activation system (S9) and negative in the presence of activation system (S9). There are no data from either animal or human studies regarding potential for the impairment of fertility.

The potential for epinephrine to impair reproductive performance has not been evaluated, but epinephrine has been shown to decrease implantation in female rabbits dosed subcutaneously with 1.2 mg/kg/day (15-fold the highest human intramuscular or subcutaneous daily dose) during gestation days 3 to 9.

There are no data from human studies regarding potential for the impairment of fertility.

### **13.2 Animal Toxicology and/or Pharmacology**

Epinephrine was associated with metabolic effects, decreased mesenteric, coronary and renal conductance in a sheep model of septic shock. Data from hemolysis study have shown that epinephrine at 1:1,000 dilution is non-hemolytic. Epinephrine infusion significantly increased the MAP (69 vs. 86 mmHg) and cardiac output (6.4 vs. 7.1 L/min) and decreased renal blood flow (330 vs. 247 mL/min).

## 14 CLINICAL STUDIES

### 14.1 Treating Hypotension from Septic Shock with Epinephrine

Fourteen clinical studies from the literature documented that epinephrine increases the mean arterial pressure (MAP) in patients with hypotension associated with septic shock.

### 14.2 Induction and Maintenance of Mydriasis during Intraocular Surgery

In randomized, controlled studies, patients undergoing routine cataract extraction were evaluated after receiving intraocular irrigation with or without epinephrine diluted up to 1:1,666,666 (0.6 mcg/mL). Patients have also been evaluated after receiving bolus intracameral injections of epinephrine diluted between 1:25,000 (40 mcg/mL) and 1:400,000 (2.5 mcg/mL).

In patients with similar pupil diameters at baseline, with or without the use of preoperative mydriatic agents, mydriasis was maintained better in the eyes receiving epinephrine by an average of one to two millimeters in pupil diameter. Pupil constriction to 5mm or less occurred more often in the patients not receiving epinephrine.

Mean pulse rate and blood pressure showed no significance difference between patients receiving epinephrine and controls and there was no increased incidence of ventricular dysrhythmias in patients receiving epinephrine.

## 16 HOW SUPPLIED/STORAGE AND HANDLING

Epinephrine Injection USP, 1 mg/mL (1:1,000) is a sterile solution containing 1 mg/1 mL epinephrine as the hydrochloride in each 2 mL clear glass ampule. Epinephrine contains no preservatives, such as sulfites. Supplied in a box of 10 single-use ampules (NDC 62250-103-10).

Epinephrine is light sensitive. Protect from light until ready to use.

Do not refrigerate. Protect from freezing.

Store at room temperature, between 20 - 25°C (68 - 77°F). Protect from alkalis and oxidizing agents.

Inspect visually for particulate matter and discoloration prior to administration. Do not use the solution if it is colored or cloudy, or if it contains particulate matter.

Do not use after the expiration date.

## 17 PATIENT COUNSELING INFORMATION

If possible, interrogate patients regarding any pre-existing conditions, such as heart disease or diabetes, medications that they are taking, or any known hypersensitivity to sympathomimetic drugs.

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