

INDIVIDUALIZE THIOLA EC® (tiopronin) DOSAGES TO HELP PREVENT STONE FORMATION

ThiolaEC
(tiopronin)
Delayed-Release Tablets 100mg/300mg



START

1

Start with the recommended dose of THIOLA EC.^{1*}



Pills shown are not actual size.

- **Adults:** May begin at 800 mg/day.
- **Children ≥20 kg:** May begin at 15 mg/kg/day and avoid dosages >50 mg/kg/day.



MONITOR

2

Measure urinary cystine 1 month after starting THIOLA EC, and every 3 months thereafter.¹

- Conduct a 24-hour urine test to evaluate your patient's cystine levels.

Regularly monitor for early stone detection:

- Sand/gravel in urine²
- Imaging showing presence of stones³
- Kidney stone-related pain⁴



ADJUST

3

Reduction of urinary cystine is proportional to THIOLA EC dosage.¹

- THIOLA EC should be dosed to effect to maintain urinary cystine concentration <250 mg/L.

THIOLA EC Tablet [†]	Potential Urinary Cystine Reduction
300 mg	~75 mg/day
100 mg	~25 mg/day

Please see Dosing Guide on reverse side.

Reminders¹

- Advise patients to take THIOLA EC in combination with high fluid intake, alkali, and diet modification.
- Determine if your patient will be taking THIOLA EC with or without food. Taking THIOLA EC with food may decrease the levels of tiopronin in the blood by approximately 25%.
- Instruct your patients to take THIOLA EC in 3 divided doses, the same times each day.
- THIOLA EC tablets must be swallowed whole.
- Inform patients about the importance of compliance in order to help prevent stone formation.

*Patients with a history of severe toxicity to d-penicillamine may start at a lower dose.

[†]The decrement in urinary cystine produced by tiopronin is generally proportional to the dose. A reduction in urinary cystine of 250–350 mg/day at tiopronin dosage of 1 g/day, and a decline of approximately 500 mg/day at a dosage of 2 g/day, may be expected.

Indications and usage

THIOLA EC® (tiopronin) delayed-release tablets is indicated, in combination with high fluid intake, alkali, and diet modification, for the prevention of cystine stone formation in adults and pediatric patients ≥20 kg with severe homozygous cystinuria, who are not responsive to these measures alone.

Important Safety Information

Contraindications

THIOLA EC is contraindicated in patients with hypersensitivity to tiopronin or any other components of THIOLA EC.

Warnings and precautions

- **Proteinuria:** Proteinuria, including nephrotic syndrome, and membranous nephropathy, has been reported with tiopronin use. Pediatric patients receiving >50 mg/kg of tiopronin per day may be at increased risk for proteinuria. Monitor patients for the development of proteinuria and discontinue therapy in patients who develop proteinuria.
- **Hypersensitivity Reactions:** Hypersensitivity reactions (drug fever, rash, fever, arthralgia and lymphadenopathy) have been reported.

Adverse reactions

The most common adverse reactions (≥10%) are nausea, diarrhea or soft stools, oral ulcers, rash, fatigue, fever, arthralgia, proteinuria, and emesis.

Please see additional Important Safety Information throughout and accompanying full Prescribing Information.

THIOLA EC® (tiopronin) DOSING GUIDE

Guidelines to achieve expected cystine concentration based on AUA recommendations⁵

Dosing ranges based on a pH of 7.

24-hr cystine level per day (mg/day)	Urine output per day (L)*	Additional THIOLA EC dose per day (mg)	Expected cystine concentration (mg/L)
500	2	0	250
	2.5	0	200
	3	0	167
	3.5	0	143
	4	0	125
750	2	1000	250
	2.5	500	250
	3	0	250
	3.5	0	214
	4	0	188
1000	2	2000	250
	2.5	1500	250
	3	1000	250
	3.5	500	250
	4	0	250
1250	2	3000	250
	2.5	2500	250
	3	2000	250
	3.5	1500	250
	4	1000	250
1500	2	4000	250
	2.5	3500	250
	3	3000	250
	3.5	2500	250
	4	2000	250

*Minimal urine output of 2.5 L/day is recommended.⁵

Goal: Calculate dosing based on patient's cystine levels to achieve cystine concentration at 250 mg/L¹

Example:

- Cystine level = 725 mg/day
- pH level = 7
- Urine output per day = 2 L/day

The dosing calculation is:

24-hr cystine level/Urinary output per day = Expected cystine concentration

THIOLA EC dose: 900 mg/day



Pills shown are not actual size.

Calculate your adult cystinuria patient's dosage at THIOLAECdosingGuide.com

Important Safety Information (cont.)

Drug interactions

Avoid alcohol consumption 2 hours before and 3 hours after taking THIOLA EC as THIOLA EC is released faster in the presence of alcohol.

Specific populations

- **Lactation:** Breastfeeding is not recommended during treatment with THIOLA EC.
- **Geriatric Use:** Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection, and it may be useful to monitor renal function.

You may report negative side effects to Retrophin® Medical Information at 1-877-659-5518, or to the FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

Please see additional Important Safety Information throughout and accompanying full Prescribing Information.

References: 1. THIOLA EC [package insert]. San Antonio, TX: Mission Pharmacal Company. 2. Biyani et al. *EAU-EBU Update Series*. 2006;4(5):175-183. 3. Claes et al. *Pediatr Nephrol*. 2012;27(11):2031-2038. 4. What are cystine stones? The National Kidney Foundation website. <https://www.kidney.org/atoz/content/what-are-cystine-stones>. Published March 8, 2016. Accessed September 26, 2019. 5. Pearle et al. *J Urol*. 2014;192(2):316-324.



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HIGHLIGHTS OF PRESCRIBING INFORMATION

These highlights do not include all the information needed to use THIOLA® EC safely and effectively. See full prescribing information for THIOLA EC.

THIOLA EC (tiopronin) delayed-release tablets, for oral use
Initial U.S. Approval: 1988

INDICATIONS AND USAGE

THIOLA EC is a reducing and complexing thiol indicated, in combination with high fluid intake, alkali, and diet modification, for the prevention of cystine stone formation in adults and pediatric patients 20 kg and greater with severe homozygous cystinuria, who are not responsive to these measures alone. (1)

DOSAGE AND ADMINISTRATION

- The recommended initial dosage in adult patients is 800 mg/day. In clinical studies, the average dosage was about 1,000 mg/day. (2.1)
- The recommended initial dosage in pediatric patients 20 kg and greater is 15 mg/kg/day. Avoid dosages greater than 50 mg/kg per day in pediatric patients. (2.1, 5.1, 8.4)
- Administer THIOLA EC in 3 divided doses at the same times each day, with or without food. Maintain a routine pattern with regard to meals. (2.1)
- Swallow THIOLA EC tablets whole. (2.1)
- Measure urinary cystine 1 month after initiation of THIOLA EC and every 3 months thereafter. (2.1)

DOSAGE FORMS AND STRENGTHS

Tablets: 100 mg and 300 mg (3)

CONTRAINDICATIONS

- Hypersensitivity to tiopronin or any component of THIOLA EC (4)

WARNINGS AND PRECAUTIONS

- Proteinuria, including nephrotic syndrome, and membranous nephropathy, has been reported with tiopronin use. Pediatric patients receiving greater than 50 mg/kg of tiopronin per day may be at increased risk for proteinuria. (2.1, 5.1, 8.4)
- Hypersensitivity Reactions have been reported during tiopronin treatment. (4, 5.2)

ADVERSE REACTIONS

Most common adverse reactions (≥10%) are nausea, diarrhea or soft stools, oral ulcers, rash, fatigue, fever, arthralgia, proteinuria, and emesis. (6)

To report SUSPECTED ADVERSE REACTIONS, contact Mission Pharmacal Company at toll-free phone # 1-800-298-1087 or FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

USE IN SPECIFIC POPULATIONS

- Lactation: Breastfeeding is not recommended. (8.2)
- Geriatric: Choose dose carefully and monitor renal function in the elderly. (8.5)

See 17 for PATIENT COUNSELING INFORMATION.

Revised: 06/2019

FULL PRESCRIBING INFORMATION: CONTENTS*

- INDICATIONS AND USAGE
- DOSAGE AND ADMINISTRATION
 - Recommended Dosage
 - Monitoring
- DOSAGE FORMS AND STRENGTHS
- CONTRAINDICATIONS
- WARNINGS AND PRECAUTIONS
 - Proteinuria
 - Hypersensitivity Reactions
- ADVERSE REACTIONS
 - Clinical Trials Experience
 - Postmarketing Experience
- DRUG INTERACTIONS
 - Alcohol

8 USE IN SPECIFIC POPULATIONS

- Pregnancy
- Lactation
- Pediatric Use
- Geriatric Use

10 OVERDOSAGE**11 DESCRIPTION****12 CLINICAL PHARMACOLOGY**

- Mechanism of Action
- Pharmacodynamics
- Pharmacokinetics

13 NONCLINICAL TOXICOLOGY

- Carcinogenesis, Mutagenesis, Impairment of Fertility

16 HOW SUPPLIED/STORAGE AND HANDLING**17 PATIENT COUNSELING INFORMATION**

* Sections or subsections omitted from the full prescribing information are not listed.

FULL PRESCRIBING INFORMATION**1 INDICATIONS AND USAGE**

THIOLA EC is indicated, in combination with high fluid intake, alkali, and diet modification, for the prevention of cystine stone formation in adults and pediatric patients 20 kg and greater with severe homozygous cystinuria, who are not responsive to these measures alone.

2 DOSAGE AND ADMINISTRATION**2.1 Recommended Dosage**

Adults: The recommended initial dosage in adult patients is 800 mg/day. In clinical studies, the average dosage was about 1,000 mg/day.

Pediatrics: The recommended initial dosage in pediatric patients weighing 20 kg and greater is 15 mg/kg/day. Avoid dosages greater than 50 mg/kg per day in pediatric patients [see *Warnings and Precautions* (5.1), *Pediatric Use* (8.4)].

Administer THIOLA EC in 3 divided doses at the same times each day, with or without food. Maintain a routine pattern with regard to meals. Swallow THIOLA EC tablets whole.

Consider starting THIOLA EC at a lower dosage in patients with history of severe toxicity to d-penicillamine.

2.2 Monitoring

Measure urinary cystine 1 month after starting THIOLA EC and every 3 months thereafter. Adjust THIOLA EC dosage to maintain urinary cystine concentration less than 250 mg/L.

Assess for proteinuria before treatment and every 3 to 6 months during treatment [see *Warnings and Precautions* (5.1)].

Discontinue THIOLA EC in patients who develop proteinuria, and monitor urinary protein and renal function. Consider restarting THIOLA EC treatment at a lower dosage after resolution of proteinuria.

3 DOSAGE FORMS AND STRENGTHS

Tablets for oral use:

100 mg tablets: round, white to off-white and imprinted in red with "T1" on one side

300 mg tablets: round, white to off-white and imprinted in red with "T3" on one side

4 CONTRAINDICATIONS

THIOLA EC is contraindicated in patients with hypersensitivity to tiopronin or any other components of THIOLA EC [see *Warnings and Precautions* (5.2)].

5 WARNINGS AND PRECAUTIONS**5.1 Proteinuria**

Proteinuria, including nephrotic syndrome, and membranous nephropathy, have been reported with tiopronin use. Pediatric patients receiving greater than 50 mg/kg of tiopronin per day may be at increased risk for proteinuria. [see *Dosage and Administration* (2.2), *Adverse Reactions* (6.1, 6.2) *Pediatric Use* (8.4)]. Monitor patients for the development of proteinuria and discontinue therapy in patients who develop proteinuria [see *Dosage and Administration* (2.2)].

5.2 Hypersensitivity Reactions

Hypersensitivity reactions (drug fever, rash, fever, arthralgia and lymphadenopathy) have been reported [see *Contraindications* (4)].

6 ADVERSE REACTIONS

The following adverse reactions are discussed in greater detail in other sections of the labeling:

- Proteinuria [see *Warnings and Precautions* (5.1)]
- Hypersensitivity [see *Warnings and Precautions* (5.2)]

6.1 Clinical Trials Experience

Because clinical trials are conducted under widely varying conditions, the adverse reaction rates observed in the clinical trials of the drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

Adverse reactions occurring at an incidence of ≥5% in an uncontrolled trial in 66 patients with cystinuria age 9 to 68 years are shown in the table below. Patients in group 1 had previously been treated with d-penicillamine; those in group 2 had not. Of those patients who had stopped taking d-penicillamine due to toxicity (34 out of 49 patients in group 1), 22 were able to continue treatment with THIOLA. In those without prior history of d-penicillamine treatment, 6% developed reactions of sufficient severity to require THIOLA withdrawal.

Table 1 presents adverse reactions ≥5% in either treatment group occurring in this trial.

Table 1: Adverse Reactions Occurring in One or More Patients

System Organ Class	Adverse Reaction	Group 1 Previously treated with d-penicillamine (N = 49)	Group 2 Naïve to d-penicillamine (N = 17)	
Blood and Lymphatic System Disorders	anemia	1 (2%)	1 (6%)	
	Gastrointestinal Disorders	nausea	12 (25%)	2 (12%)
		emesis	5 (10%)	–
		diarrhea/soft stools	9 (18%)	1 (6%)
		abdominal pain	–	1 (6%)
General Disorders and Administration Site Conditions	oral ulcers	6 (12%)	3 (18%)	
	fever	4 (8%)	–	
	weakness	2 (4%)	2 (12%)	
	fatigue	7 (14%)	–	
peripheral (edema)	peripheral (edema)	3 (6%)	1 (6%)	
	chest pain	–	1 (6%)	
	Metabolism and Nutrition Disorders	anorexia	4 (8%)	–
Musculoskeletal and Connective Tissue Disorders	arthralgia	–	2 (12%)	
	Renal and Urinary Disorders	proteinuria	5 (10%)	1 (6%)
Respiratory, Thoracic and Mediastinal Disorders		impotence	–	1 (6%)
	cough	–	1 (6%)	
Skin and Subcutaneous Tissue Disorders	rash	7 (14%)	2 (12%)	
	ecchymosis	3 (6%)	–	
	pruritus	2 (4%)	1 (6%)	
	urticaria	4 (8%)	–	
	skin wrinkling	3 (6%)	1 (6%)	

Taste Disturbance

A reduction in taste perception may develop. It is believed to be the result of chelation of trace metals by tiopronin. Hypogeusia is often self-limited.

6.2 Postmarketing Experience

Adverse reactions have been reported from the literature, as well as during post-approval use of THIOLA. Because the post-approval reactions are reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to THIOLA exposure.

Adverse reactions reported during the postmarketing use of THIOLA are listed by body system in **Table 2**.

Table 2: Adverse Reactions Reported for THIOLA Pharmacovigilance by System Organ Class and Preferred Term

System Organ Class	Preferred Term
Cardiac Disorders	congestive heart failure
Ear and Labyrinth Disorder	vertigo
Gastrointestinal Disorders	abdominal discomfort; abdominal distension; abdominal pain; chapped lips; diarrhea; dry mouth; dyspepsia; eructation; flatulence; gastrointestinal disorder; gastroesophageal reflux disease; nausea; vomiting; jaundice; liver transaminitis
General Disorders and Administration Site Conditions	asthenia; chest pain; fatigue; malaise; pain; peripheral swelling; pyrexia; swelling
Investigations	glomerular filtration rate decreased; weight increased
Metabolism and Nutrition Disorders	decreased appetite; dehydration; hypophagia
Musculoskeletal and Connective Tissue Disorders	arthralgia; back pain; flank pain; joint swelling; limb discomfort; musculoskeletal discomfort; myalgia; neck pain; pain in extremity
Nervous System Disorders	ageusia; burning sensation; dizziness; dysgeusia; headache; hypoesthesia
Renal and Urinary Disorders	nephrotic syndrome; proteinuria; renal failure
Skin and Subcutaneous Tissue Disorders	dry skin; hyperhidrosis; pemphigus foliaceus; pruritus; rash; rash pruritic; skin irritation; skin texture abnormal; skin wrinkling; urticaria

7 DRUG INTERACTIONS

7.1 Alcohol

Tiopronin is released faster from THIOLA EC in the presence of alcohol and the risk for adverse events associated with THIOLA EC when taken with alcohol is unknown. Avoid alcohol consumption 2 hours before and 3 hours after taking THIOLA EC [see *Clinical Pharmacology* (12.3)].

8 USE IN SPECIFIC POPULATIONS

8.1 Pregnancy

Risk Summary

Available published case report data with tiopronin have not identified a drug-associated risk for major birth defects, miscarriage, or adverse maternal or fetal outcomes. Renal stones in pregnancy may result in adverse pregnancy outcomes (see *Clinical Considerations*). In animal reproduction studies, there were no adverse developmental outcomes with oral administration of tiopronin to pregnant mice and rats during organogenesis at doses up to 2 times a 2 grams/day human dose (based on mg/m²). The estimated background risk of major birth defects and miscarriage for the indicated population is unknown. All pregnancies have a background risk of birth defect, loss, or other adverse outcomes. In the U.S. general population, the estimated background risk of major birth defects and miscarriage in clinically recognized pregnancies are 2% to 4% and 15% to 20%, respectively.

Clinical Considerations

Disease-associated maternal and/or embryo/fetal risk

Renal stones in pregnancy may increase the risk of adverse pregnancy outcomes, such as preterm birth and low birth weight.

Data

Animal Data

No findings of fetal malformations could be attributed to the drug in reproduction studies in mice and rats at doses up to 2 times the highest recommended human dose of 2 grams/day (based on mg/m²).

8.2 Lactation

Risk Summary

There are no data on the presence of tiopronin in either human or animal milk or on the effects of the breastfed child. A published study suggests that tiopronin may suppress milk production. Because of the potential for serious adverse reactions, including nephrotic syndrome, advise patients that breastfeeding is not recommended during treatment with THIOLA EC.

8.4 Pediatric Use

THIOLA EC is indicated in pediatric patients weighing 20 kg or more with severe homozygous cystinuria, in combination with high fluid intake, alkali, and diet modification, for the prevention of cystine stone formation who are not responsive to these measures alone. This indication is based on safety and efficacy data from a trial in patients 9 years to 68 years of age and clinical experience. Proteinuria, including nephrotic syndrome, has been reported in pediatric patients. Pediatric patients receiving greater than 50 mg/kg tiopronin per day may be at greater risk [see *Dosage and Administration* (2.1, 2.2), *Warnings and Precautions* (5.1) and *Adverse Reactions* (6.1)].

THIOLA EC tablets are not approved for use in pediatric patients weighing less than 20 kg or in pediatric patients unable to swallow tablets [see *Recommended Dosage* (2.1)].

8.5 Geriatric Use

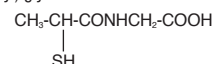
This drug is known to be substantially excreted by the kidney, and the risk of adverse reactions to this drug may be greater in patients with impaired renal function. Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection, and it may be useful to monitor renal function.

10 OVERDOSAGE

There is no information on overdosage with tiopronin.

11 DESCRIPTION

THIOLA EC (tiopronin) delayed-release tablets are a reducing and cystine-binding thiol drug (CBTD) for oral use. Tiopronin is N-(2-Mercaptopropionyl) glycine and has the following structure:



Tiopronin has the empirical formula C₅H₉NO₃S and a molecular weight of 163.20. In this drug product tiopronin exists as a dl racemic mixture.

Tiopronin is a white crystalline powder, which is freely soluble in water.

Each THIOLA EC tablet contains 100 or 300 mg of tiopronin. The inactive ingredients in THIOLA EC tablets include lactose monohydrate, hydroxypropyl cellulose, hydroxypropyl cellulose (low substitute), magnesium stearate, hydroxypropyl methylcellulose E5, methacrylic acid: ethyl acrylate copolymer (Eudragit E 100), talc, triethyl citrate.

12 CLINICAL PHARMACOLOGY

12.1 Mechanism of Action

The goal of therapy is to reduce urinary cystine concentration below its solubility limit. Tiopronin is an active reducing agent which undergoes thiol-disulfide exchange with cystine to form a mixed disulfide of tiopronin-cystine. From this reaction, a water-soluble mixed disulfide is formed and the amount of sparingly soluble cystine is reduced.

12.2 Pharmacodynamics

The decrement in urinary cystine produced by tiopronin is generally proportional to the dose. A reduction in urinary cystine of 250-350 mg/day at tiopronin dosage of 1 g/day, and a decline of approximately 500 mg/day at a dosage of 2 g/day, might be expected. Tiopronin has a rapid onset and offset of action, showing a fall in cystine excretion on the first day of administration and a rise on the first day of drug withdrawal.

12.3 Pharmacokinetics

Absorption

THIOLA EC Tablets

When THIOLA IR and THIOLA EC single doses were given to fasted healthy subjects (n = 39) in a crossover study, the median time to peak plasma levels (T_{max}) were 1 (range: 0.5 to 2.1) and 3 (range: 1.0 to 6.0) hours, respectively. The peak exposure (C_{max}) and total exposure (AUC₀₋₁) of tiopronin from THIOLA EC tablets were decreased by 22% and 7% respectively compared to THIOLA IR tablets.

Food Effects

Administration of the THIOLA EC tablet with food decreases C_{max} of tiopronin by 13% and AUC₀₋₁ by 25% compared to THIOLA EC administered in a fasted state. Since the drug is dosed to effect, the study results support administration of THIOLA EC tablets with or without food; administer at the same time each day with a routine pattern with regard to meals.

Elimination

Excretion

When tiopronin is given orally, up to 48% of dose appears in urine during the first 4 hours and up to 78% by 72 hours.

Drug Interactions

Alcohol

An *in vitro* dissolution study was conducted to evaluate the impact of alcohol (5, 10, 20, and 40%) on the dose dumping of THIOLA EC tablets. The study results showed that the addition of alcohol to the dissolution media increases the dissolution rate of THIOLA EC tablets in the acidic media of 0.1N HCl [see *Drug Interactions* (7.1)].

13 NONCLINICAL TOXICOLOGY

13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility

Carcinogenesis

Long-term carcinogenicity studies in animals have not been performed.

Mutagenesis

Tiopronin was not genotoxic in the chromosomal aberration, sister chromatid exchange, and *in vivo* micronucleus assays.

Impairment of Fertility

High doses of tiopronin in experimental animals have been shown to interfere with maintenance of pregnancy and viability of the fetus. In 2 published male fertility studies in rats, tiopronin at 20 mg/kg/day intramuscular (IM) for 60 days induced reductions in testis, epididymis, vas deferens, and accessory sex glands weights and in the count and motility of cauda epididymal sperm.

16 HOW SUPPLIED/STORAGE AND HANDLING

100 mg delayed-release, round, white to off-white tablet imprinted with "T1" on one side with red ink and blank on the other side: Bottles of 300 **NDC** 0178-0902-01.

300 mg delayed-release, round, white to off-white tablet imprinted with "T3" on one side with red ink and blank on the other side: Bottles of 90 **NDC** 0178-0901-90.

Store at 25°C (77°F); excursions permitted to 15-30°C (59-86°F) [see *USP Controlled Room Temperature*].

17 PATIENT COUNSELING INFORMATION

Administration Instructions

Advise patients to swallow THIOLA EC tablets intact and not to chew, crush, or split the tablets.

Lactation

Advise women that breastfeeding is not recommended during treatment with THIOLA EC [see *Use in Specific Populations* (8.2)].



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