

## PRODUCT MONOGRAPH

**Pr**DESFERAL**<sup>®</sup>**

(deferoxamine mesylate for injection, Novartis Std.)

Lyophilized powder

500 mg/vial

Iron and Aluminum Chelating Agent

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Date of Preparation:  
December 20, 1972

Date of Revision:  
July 3, 2019

Novartis Version:  
July 21, 2023

Submission Control No: 222557

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## Pr**DESFERAL**<sup>®</sup>

(deferroxamine mesylate for injection, Novartis Std.)

### PART I: HEALTH PROFESSIONAL INFORMATION

#### SUMMARY PRODUCT INFORMATION

<b>Route of Administration</b>	<b>Dosage Form / Strength</b>	<b>Clinically Relevant Nonmedicinal Ingredients</b>
Parenteral	Lyophilized powder in vials, 500 mg/vial	None. <i>For a complete listing see <b>Dosage Forms, Composition and Packaging</b> section.</i>

#### INDICATIONS AND CLINICAL USE

DESFERAL<sup>®</sup> (deferroxamine mesylate) is indicated for:

- Acute iron intoxication.
- Chronic iron overload due to transfusion-dependent anemias.
- Diagnosis of aluminum overload (DESFERAL (deferroxamine mesylate) infusion test).
- Chronic aluminum overload in patients with End-Stage Renal Failure (ESRF) under maintenance dialysis.

In cases of acute iron intoxication, DESFERAL is an adjunct to, and not a substitute for, standard therapeutic measures which may include:

- Induction of emesis.
- Gastric lavage.
- Maintenance of clear airways.
- Control of peripheral vascular failure.
- Correction of acidosis.

#### **Geriatrics (> 65 years of age):**

Clinical Studies of DESFERAL did not include sufficient numbers of subjects aged 65 years and over to determine whether they respond differently compared to younger subjects. Post marketing reports suggest a possible trend for an increased risk of eye disorders in the geriatric population, specifically the occurrence of color blindness, maculopathy, and scotoma. However, it is unclear if these eye disorders were dose related. Although the number of reports was very small, certain elderly patients may be predisposed to eye disorders when taking DESFERAL.

Post marketing reports also suggest that there may be an increased risk of deafness and hearing loss in the geriatric population (see **ADVERSE REACTIONS**). 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.

### **Pediatrics (< 16 years of age):**

High doses of DESFERAL and concomitant low ferritin levels during the treatment of chronic iron overload in children, have been associated with growth retardation. After reduction of the DESFERAL dose, growth velocity may resume to pre-treatment levels in some patients.

Pediatric patients receiving DESFERAL should be monitored for body weight and longitudinal growth every three months.

## **CONTRAINDICATIONS**

Patients who are hypersensitive to deferoxamine mesylate or component of the container, except where desensitization is successful. For a complete listing, see the **DOSAGE FORMS, COMPOSITION AND PACKAGING** section of the product monograph.

## **WARNINGS AND PRECAUTIONS**

### **General**

Therapy with DESFERAL should be initiated and maintained by physician experienced in the treatment of chronic iron overload due to blood transfusions.

It should be noted that some of the signs and symptoms reported as adverse effects may in fact be manifestations of the underlying disease (iron and/or aluminum overload).

As with all medicines, DESFERAL should be kept out of reach of children.

Rapid intravenous injection of DESFERAL exceeding 15 mg/kg/h has produced flushing of the skin, urticaria, hypotension and shock (see **DOSAGE AND ADMINISTRATION**)

Vitamin C supplements should not be given to patients with cardiac failure because impairment of cardiac function may be experienced in patients with severe chronic iron overload receiving combined treatment of DESFERAL with high doses of vitamin C (more than 500 mg daily) (see **DRUG INTERACTIONS**).

### **Ear/Nose/Throat**

There have been reports of hearing loss and audiometric abnormalities occurring in patients receiving DESFERAL treatment, particularly where the doses used were higher than those recommended and/or where the serum ferritin levels were low. The hearing loss returned to normal in several cases when the drug was discontinued. However in some cases, a residual effect remained. Renal failure patients receiving maintenance dialysis having low ferritin levels may be particularly prone to adverse reactions.

When low-dose therapy is used the risk of adverse reactions is reduced. If disturbances of hearing occur, treatment with DESFERAL should be discontinued in order to further the chances that disturbances of hearing will prove reversible. If treatment with DESFERAL is subsequently resumed using a reduced dosage, auditory examination/testing should be performed at more frequent intervals. It is always important to reconsider the benefit/risk ratio when DESFERAL treatment is resumed after the occurrence of an adverse reaction.

### **Endocrine and Metabolism**

DESFERAL may lower blood sugar, serum calcium, and serum sodium, and increase blood coagulability. Therefore, these parameters should be monitored during therapy, if possible.

In addition, aluminum overload treatment may result in hypocalcaemia decrease serum calcium and aggravation of hyperparathyroidism.

### **Infections and Infestations**

In patients with iron overload it has been reported that infections (including septicemia), especially with Yersinia enterocolitica and Yersinia pseudotuberculosis, may be promoted by DESFERAL (deferroxamine mesylate). If a patient under treatment with DESFERAL develops fever accompanied by acute enteritis / enterocolitis, diffuse abdominal pain, or pharyngitis the treatment should be temporarily withdrawn, appropriate bacteriological tests performed, and suitable antibiotic therapy instituted at once. THIS THERAPY SHOULD INCLUDE SPECIAL COVERAGE FOR YERSINIA ORGANISMS. Treatment with DESFERAL can be resumed after the infection has cleared.

In patients undergoing maintenance hemodialysis while receiving DESFERAL for aluminum and/or iron overload, rare cases of mucormycosis, some with a fatal outcome, have been reported. DESFERAL abolishes the fungistatic effect of serum and increased the *in vitro* growth of the fungus by potentiating iron uptake by the fungus. If any of the suspected signs or symptoms are observed, DESFERAL treatment should be discontinued, mycological tests performed and appropriate treatment instituted immediately. Mucormycosis may also occur in dialysis patients who are not receiving DESFERAL therapy, indicating that other factors, e.g. a compromised immune system, may play a role in the development of this infection.

### **Neurologic**

In patients with aluminum-related encephalopathy, high doses of DESFERAL may exacerbate neurological dysfunction (convulsion), probably due to an increase in circulating aluminum. DESFERAL may also precipitate the onset of dialysis dementia. Pretreatment with clonazepam is reported to provide protection against such neurological deterioration.

### **Ophthalmologic**

There have been reports of visual disturbances occurring in patients receiving DESFERAL treatment, particularly where the doses used were higher than those recommended and/or where the serum ferritin levels were low. The visual disturbances returned to normal in several cases when the drug was discontinued. However in some cases, a residual effect remained. Renal failure patients receiving maintenance dialysis having low ferritin levels may be particularly prone to adverse reactions.

Visual symptoms have been reported after single doses of DESFERAL.

During chronic toxicity tests in dogs, high doses of DESFERAL (>200 mg/kg daily) were associated with cataracts. However, cataracts have rarely been observed in humans who receive DESFERAL over prolonged periods.

When low-dose therapy is used the risk of adverse reactions is reduced. If disturbances of vision occur, treatment with DESFERAL should be discontinued in order to further the chances that disturbances of vision will prove reversible. If treatment with DESFERAL is subsequently resumed using a reduced dosage, ophthalmological examination/testing should be performed at more frequent intervals. It is always important to reconsider the benefit/risk ratio when DESFERAL treatment is resumed after the occurrence of an adverse reaction.

### **Renal**

In patients with severe renal failure, caution is indicated as the DESFERAL-metal complexes are excreted mainly via the kidneys. Elimination of chelated iron and aluminum can be increased by dialysis.

Cases of acute renal failure, renal tubular disorder, and blood creatinine increased have been reported (see **ADVERSE REACTIONS**). Monitoring patients for changes in renal function (e.g. increased serum creatinine) should be considered.

### **Respiratory**

Acute Respiratory distress syndrome has been reported in patients with acute iron intoxication and also in thalassemic patients treated with excessively high doses of intravenous DESFERAL for more than one day. The daily dose should not exceed 80 mg/kg up to a maximum of 6.0 grams. Treatment should be terminated at the first signs of respiratory complications (see **DOSAGE AND ADMINISTRATION**).

### **Sensitivity/Resistance**

Patients may develop sensitivity reactions (see **CONTRAINDICATIONS**).

### **Skin**

Flushing of the skin, urticaria, hypotension, and shock have occurred in a few patients following the rapid intravenous injection of DESFERAL (deferoxamine mesylate). Treatment by intravenous route should not exceed 15 mg/kg/h.

### **Special Populations**

#### **Pregnant Women:**

There are no adequate and well-controlled studies conducted in pregnant women. Studies in animals (rabbits) have shown reproductive toxicity/teratogenicity (see **TOXICOLOGY**). The risk to the fetus/mother is unknown. Women of childbearing potential with chronic iron and/or aluminum overload should not receive DESFERAL unless the use of an effective form of contraception, established before treatment, is continued throughout treatment and for at least the first month after treatment. During pregnancy, particularly in the first trimester, DESFERAL should only be used if the hazard of acute iron intoxication is considered to be greater than the potential teratogenic hazard of DESFERAL.

#### **Nursing Women:**

It is not known whether deferoxamine mesylate passes into the breast milk. Because many drugs are excreted in human milk, and because of the potential for serious adverse drug reactions in breast-fed newborns/infants, a decision should be made whether to abstain from breast-feeding or to abstain from using the medicinal product, taking into account the importance of the medicinal product to the mother.

#### **Pediatrics (< 16 years of age):**

Pediatric patients receiving DESFERAL should be monitored for body weight and longitudinal growth every three months.

High doses of DESFERAL and concomitant low ferritin levels during the treatment of chronic iron overload in children, have been associated with growth retardation. After reduction of the DESFERAL dose, growth velocity may resume to pre-treatment levels in some patients.

#### **Geriatrics (> 65 years of age):**

Clinical Studies of DESFERAL did not include sufficient numbers of subjects aged 65 years and over to determine whether they respond differently from the younger subjects. Post marketing reports suggest a possible trend for an increased risk of eye disorders in the geriatric population, specifically the occurrence of color blindness, maculopathy, and scotoma. However, it is unclear

if these eye disorders were dose related. Although the number of reports was very small, certain elderly patients may be predisposed to eye disorders when taking DESFERAL. Post marketing reports also suggest that there may be an increased risk of deafness and hearing loss in the geriatric population. (see **ADVERSE REACTIONS**). 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.

### **Hepatic impairment**

No studies have been performed in patients with hepatic impairment.

### **Monitoring and Laboratory Tests**

Complete ophthalmological examination, audiological testing and studies of visual evoked potential should be carried out before the start of long-term DESFERAL treatment as well as at regular intervals preferably every 3 months, during the time that DESFERAL treatment is continued.

The following parameters (blood sugar, serum calcium, serum sodium, and increase blood coagulability) should be monitored during therapy, if possible.

Pediatric patients receiving DESFERAL should be monitored for body weight and longitudinal growth every three months.

## **ADVERSE REACTIONS**

### **Adverse Drug Reaction Overview**

Some of the signs and symptoms reported as adverse effects may also be manifestations of the underlying disease (iron and/or aluminum overload).

### **Clinical Trial Adverse Drug Reactions**

*Because clinical trials are conducted under very specific conditions the adverse reaction rates observed in the clinical trials may not reflect the rates observed in practice and should not be compared to the rates in the clinical trials of another drug. Adverse drug reaction information from clinical trials is useful for identifying drug-related adverse events and for approximating rates.*

Adverse reactions (Table 1 and section Less Common Clinical Trial Adverse Drug Reactions (<1%)) are ranked under the heading of frequency estimate, the most frequent first, using the following convention: very common ( $\geq 1/10$ ); common ( $\geq 1/100$  to  $< 1/10$ ); uncommon ( $\geq 1/1000$  to  $< 1/100$ ); rare ( $\geq 1/10,000$  to  $< 1/1000$ ); very rare ( $< 1/10,000$ ) including isolated reports. Within each frequency grouping, adverse reactions are ranked in order of decreasing seriousness.

The following unwanted effects have been observed.



**Table 1**

<b><u>Nervous system:</u></b>	
Common:	Headache
<b><u>Gastrointestinal:</u></b>	
Common:	Nausea
<b><u>Skin and subcutaneous tissue:</u></b>	
Common:	Urticaria
<b><u>Musculo-skeletal and connective tissue:</u></b>	
Very common:	Arthralgia, myalgia
Common:	Growth retardation and bone disorders (e.g. metaphyseal dysplasia) in higher doses and young children (See <b>WARNINGS AND PRECAUTIONS</b> and Special remarks below)
<b><u>General and administration site:</u></b>	
Very common:	Injection site reaction including pain, swelling, infiltration, erythema, pruritis, eschar, crust (see special remarks below)
Common:	Pyrexia

**Special remarks****Musculo-skeletal and connective tissue disorders:**

Growth retardation and bone disorders (e.g. metaphyseal dysplasia) are common with doses above 60 mg/kg, especially in patients who begin iron chelation during the first three years of life. The risk is considerably reduced with doses of 40 mg/kg or less.

**General disorders and administration site conditions:**

At the injection site, reactions including pain, swelling, infiltration, erythema, pruritus, and eschar/crust are very common, while vesicles, local edema and burning are uncommon. Local manifestations may be accompanied by systemic reactions such as arthralgia/myalgia (very common), headache (common), urticaria (common), nausea (common), pyrexia (common), vomiting (uncommon), abdominal pain (uncommon) or asthma (uncommon).

**Renal and urinary**

Excretion of the iron complex may cause reddish-brown discoloration of the urine.

## **Less Common Clinical Trial Adverse Drug Reactions (<1%)**

### **Blood and lymphatic system**

**Very rare:** Blood disorder (incl. thrombocytopenia, leucopenia)

### **Ear and labyrinth**

**Uncommon:** Deafness neurosensory, tinnitus (see **WARNINGS AND PRECAUTIONS** and special remarks below)

### **Eye**

**Rare:** Loss of vision, scotoma, retinal degeneration, optic neuritis, cataract, visual acuity decreased, blurred vision, night blindness, visual field defects, chromatopsia (impairment of color vision), corneal opacities (see **WARNINGS AND PRECAUTIONS** and special remarks below)

### **Gastrointestinal**

**Uncommon:** Vomiting, abdominal pain

**Very rare:** Diarrhea

### **General and administration site**

**Uncommon:** Injection site reaction including vesicles, edema, burning

### **Immune system**

**Very rare:** Anaphylactic reaction, anaphylactic shock, angioneurotic oedema

### **Infections and infestations**

**Rare:** Mucormycosis (See **WARNINGS AND PRECAUTIONS**)

**Very rare:** Gastroenteritis Yersinia (See **WARNINGS AND PRECAUTIONS**)

### **Musculo-skeletal and connective tissue**

**Very rare:** Bone pain

**Unknown:** Muscle spasms

### **Nervous system**

**Very rare:** Neurological disturbances including dizziness, precipitation or exacerbation of aluminum-related dialysis encephalopathy, neuropathy peripheral, paraesthesia (see **WARNINGS AND PRECAUTIONS**)

**Unknown:** Convulsion

### **Renal and urinary**

**Unknown:** Acute renal failure, renal tubular disorder, blood creatinine increased

### **Respiratory, thoracic and mediastinal:**

**Uncommon:** Asthma

**Very rare:** Acute respiratory distress, lung infiltration (See **WARNINGS AND PRECAUTIONS**)

#### **Skin and subcutaneous tissue**

**Very rare:** Rash generalized

#### **Vascular**

**Rare:** Hypotension, tachycardia and shock (if precautions for administration are not adhered to)

#### **Special remarks**

##### **Ear and labyrinth disorders**

Deafness neurosensory and tinnitus are uncommon if doses are kept within guidelines and if doses are reduced when ferritin levels fall (ratio of the mean daily dose of DESFERAL divided by serum ferritin should be below 0.025).

##### **Eye disorders**

The various eye disorders are rare, except if high doses are given (see **WARNINGS AND PRECAUTIONS**).

##### **Hepatic impairment**

Rare cases of hepatic impairment have been reported in patients who have been treated with DESFERAL, however a causality with the drug is not established.

Rare cases of increased transaminases have been reported in patients who have been treated with DESFERAL, however a causality with the drug is not established.

##### **Nervous system disorders**

Convulsions have mainly been reported in dialyzed patients with aluminum overload.

#### **DRUG INTERACTIONS**

##### **Drug-Drug Interactions**

##### **Concomitant use of Prochlorperazine**

Concurrent treatment with DESFERAL and prochlorperazine, a phenothiazine derivative, may lead to temporary impairment of consciousness.

##### **Concomitant use of Vitamin C**

Where an iron-overload is associated with ascorbic acid deficiency, oral administration of Vitamin C in the standard dosage (150 - 250 mg daily) may serve to enhance excretion of the iron complex in response to DESFERAL. Larger doses of Vitamin C fail to produce an additional effect.

In patients with severe chronic iron overload receiving combined treatment of DESFERAL with high doses of Vitamin C (more than 500 mg daily) impairment of cardiac function may be experienced; the impaired cardiac function proved reversible when the Vitamin C was withdrawn. Cardiac impairment results from high doses of Vitamin C which increases the labile iron within the tissues to toxic levels.

The following precautions should be taken when DESFERAL and Vitamin C are to be used concomitantly:

- Vitamin C supplements should not be given to patients with cardiac failure.
- Cardiac function should be monitored before commencing and during the combined therapy of DESFERAL and Vitamin C.
- Vitamin C therapy should be initiated only after an initial month of regular DESFERAL therapy.
- Vitamin C therapy should be given only if patient is receiving DESFERAL regularly (ideally soon after setting up the pump).
- Daily doses of approximately 200 mg of Vitamin C in adults, 100 mg of Vitamin C in older children and 50 mg of Vitamin C in children under 10 years, should not be exceeded.

### **Concomitant use of Erythropoietin**

There is evidence that aluminum intoxication causes reduced erythropoiesis. In dialysis patients with iron and/or aluminum overload receiving DESFERAL and erythropoietin, it is important to adjust the dosage of the latter when necessary. Regular monitoring of iron stores should also be conducted.

Gallium-67-imaging results may be distorted due to rapid urinary excretion of DESFERAL-bound Gallium-67. Discontinuing DESFERAL treatment 48 hours prior to scintigraphy is recommended.

## **DOSAGE AND ADMINISTRATION**

### **Dosing Considerations**

DESFERAL (deferoxamine mesylate) SHOULD ONLY BE GIVEN PARENTERALLY. THE DOSE SHOULD NOT EXCEED 6.0 GRAMS IN A TWENTY-FOUR HOUR PERIOD. Although DESFERAL can be given by intramuscular injection, in most cases it exerts a considerably greater effect when administered by continuous infusion either intravenously (especially in cases of acute iron intoxication) or subcutaneously (especially in patients with chronic iron overload).

Rapid intravenous injection of DESFERAL exceeding 15 mg/kg/h has produced flushing of the skin, urticaria, hypotension and shock (see **WARNINGS AND PRECAUTIONS**).

### **Hepatic impairment**

No studies have been performed in patients with hepatic impairment.

## **Recommended Dose and Dosage Adjustment**

### **Acute Iron Intoxication**

DESFERAL is an adjunct to standard measures generally used in the treatment of acute iron intoxication, which may include induction of emesis, gastric lavage, maintenance of clear airways, control of peripheral vascular failure, and correction of acidosis.

Treatment should be adapted to the severity of the intoxication, with reference to serum iron (SI) and total iron binding capacity (TIBC) which should be regularly monitored. In addition, the total amount of iron ingested and remaining in the gastrointestinal tract should be taken into account.

DESFERAL should be instituted I.V. or I.M. in:

- a) All patients with SI > TIBC (>500 µg/dL or 89.5 µmol/L),
- b) Any patient with SI > 350 µg/dL or 62.6 µmol/L (if TIBC is unavailable) and evidence of free iron, or
- c) Any patient where SI is not readily available and the patient demonstrates the signs and symptoms of iron intoxication.

Note: Leukocytosis (WBC > 15,000/mm<sup>3</sup>), hyperglycemia (blood sugar > 150 mg/dL) or diarrhea strongly suggest SI will be in the toxic range.

**INTRAVENOUS INFUSION:** The intravenous route should be used when the patient is hypotensive, in shock or major clinical findings are present. In general, provided infusion lines can be readily established and maintained, and SI levels and TIBC can be readily monitored, intravenous infusion is the preferred route of administration. Infusion rates should be adapted to the severity of intoxication. The rate of infusion should not exceed 15 mg/kg/h and should be reduced as soon as the situation permits, usually after 4 to 6 hours such that the total intravenous dose does not exceed 80 mg/kg up to a maximum of 6.0 grams in 24 hours. Acute respiratory distress syndrome has been reported following intravenous administration of excessive doses of DESFERAL. Treatment should be interrupted if signs of toxicity occur.

**INTRAMUSCULAR ROUTE:** The intramuscular route may be used when the patient is normotensive. When administering DESFERAL in children by the intramuscular route, initially inject 90 mg/kg. This may be followed by 45 mg/kg every four to twelve hours, as necessary, up to a maximum of 6 grams per 24 hours. **IN CHILDREN, THE MAXIMUM SINGLE INJECTION SHOULD NOT EXCEED 1.0 GRAM (2.0 GRAMS IN ADULTS).** Attention should be given to volume of solution injected and in small children, two injection sites may be required.

Duration of treatment with DESFERAL by either route will depend on the patient's condition and should be based on the SI levels and TIBC.

The effectiveness of treatment is dependent on an adequate output of urine in order to ensure that the iron complex ferrioxamine is excreted from the body. If oliguria or anuria develop, peritoneal dialysis or hemodialysis may become necessary to remove the ferrioxamine.

### **Chronic Iron Overload**

The daily dose of DESFERAL in children and adults should be tailored to the iron burden of the individual patient as reflected by serum ferritin levels and 24-hour urinary iron excretion. These levels should be monitored daily initially and thereafter at longer intervals (but not less than once every 2 weeks).

Intravenous infusions usually prove somewhat more effective than subcutaneous infusions, but the latter are particularly suitable for ambulant patients.

For subcutaneous infusions, a portable light-weight infusion pump is a practical, effective means of promoting sustained and substantial net urinary iron excretion. The usual needle used is a 25-gauge or 27-gauge, butterfly type, placed in the subcutaneous tissues of the anterior abdominal wall.

The drug should not be given at concentrations higher than 95 mg/mL when given subcutaneously as this increases the risk of local reactions by the subcutaneous route.

For the purpose of infusion treatment the average daily dose range is 1.0 - 4.0 g (20 - 60 mg/kg depending upon iron load) administered S.C. or I.V. over a period of approximately 12 hours. In some cases it is possible to achieve a further increase in iron excretion by infusing the same daily dose over a 24-hour period. When administered S.C. by pump, DESFERAL should normally be given 4 to 7 times per week depending on the severity of the iron overload. Patients with serum ferritin levels less than 2000 ng/mL require approximately 25 mg/kg/day. Doses of 35 mg/kg/day are required when serum ferritin levels are in the range of 2000 ng/mL to 3000 ng/mL. Higher doses should be administered only if tests the benefits outweigh the risks associated with repeated high daily doses.

For intramuscular treatment when more effective subcutaneous infusions are not feasible, the average initial dose is 0.5 - 1 g daily, given in 1 - 2 injections. The maintenance dose will depend on the patient's iron excretion rate.

Since the iron excretion rates obtained with the above-mentioned modes of administration vary from patient to patient, one should first determine which route and dosage will yield the best results for the individual.

### **Diagnosis of Aluminum Overload**

**Use in adults with ESRF:** Serum aluminum levels should be determined before and after DESFERAL administration. The DESFERAL Infusion Test is recommended in patients with serum aluminum levels exceeding 60 ng/mL (2.22  $\mu$ mol/L) associated with serum ferritin levels above 100 ng/mL. A blood sample is taken just prior to a hemodialysis session to determine the baseline serum aluminum level. A 5.0 mg/kg dose of DESFERAL is given as a single, slow I.V.

infusion at an infusion rate not exceeding 15 mg/kg/h, ideally during post-dialysis to avoid loss of free drug. An acceptable compromise is during the last 60 minutes of the hemodialysis session. A continuous increase in serum aluminum during the 24-48 hour period following administration is suggestive of aluminum overload. The Test is considered positive if the serum aluminum levels increase above baseline by more than 150 ng/mL (5.55  $\mu$ mol/L) when a second blood sample is taken at the start of the next hemodialysis session.

The diagnostic capability of the DESFERAL Infusion Test is greatly enhanced if performed in conjunction with histological and biochemical examination of a bone biopsy.

**Use in children with ESRF:** Little clinical experience has been gained to date on use of DESFERAL in aluminum-overloaded children, the condition being rare in the very young. Dosage should be adapted from the adult dose at the discretion of the physician and adjusted for body-weight (15 - 20 mg/kg).

### **Chronic Aluminum Overload in Patients with ESRF**

The precise dosage should be individually determined and adapted during the course of treatment.

DESFERAL should be used in the treatment of patients having symptoms or evidence of organ dysfunction due to aluminum overload. In addition, treatment should be considered in symptomatic patients if serum aluminum levels are consistently above 60 ng/mL (2.22  $\mu$ mol/L) and are associated with a positive DESFERAL Infusion Test (see above), particularly if bone biopsy findings present evidence of aluminum-related bone disease. DESFERAL should be given once weekly at a 5.0 mg/kg dose administered as a slow intravenous infusion not exceeding 15 mg/kg/h infusion rate, ideally during post-dialysis to avoid loss of free drug. An acceptable compromise is during the last 60 minutes of the hemodialysis session.

After completion of the first 3-month course of DESFERAL treatment, followed by a 4-week wash out period, the DESFERAL Infusion Test should be performed. If two successive performed at 1-month intervals yield an increase in serum aluminum levels of less than 75 ng/mL (2.78  $\mu$ mol/L) above baseline, further treatment is not recommended.

**Patients on continuous ambulatory or cyclic peritoneal dialysis:** A 5.0 mg/kg dose once per week prior to the final daily exchange. The intraperitoneal route is recommended in these patients, however, DESFERAL is equally effective when administered I.M., by slow I.V., or S.C. infusion. The mode of administration should be individually determined and the dosage adapted during the course of therapy.

### **Administration**

#### **Reconstitution of Lyophilized Vials:**

The sterile lyophilized powder in each vial should be reconstituted under aseptic conditions just prior to dilution, only with Sterile Water for Injection. The DESFERAL solution is clear and colorless to slightly yellow at the recommended concentration of 95 mg/mL, and darker yellow

at the recommended concentration of 213 mg/ml. This concentration may produce a stronger yellow-colored solution. The drug should be completely dissolved before the solution is withdrawn.

The final volume (Approximate Available Volume) of the reconstituted Lyophilized Vial is greater than the specified volume of Sterile Water for injection.

**a) Reconstitution of Lyophilized Vials for Subcutaneous Administration**

Vial Size	Volume of Sterile Water for Injection to be Added to Vial	Approximate Available Volume	Nominal Concentration per mL
500 mg	5 mL	5.3 mL	95 mg/mL

**b) Reconstitution of Lyophilized Vials for Intravenous Administration (may be further diluted)**

Vial Size	Volume of Sterile Water for Injection to be Added to Vial	Approximate Available Volume	Nominal Concentration per mL
500 mg	5 mL	5.3 mL	95 mg/mL

**c) Reconstitution of Lyophilized Vials for Intramuscular Administration**

Vial Size	Volume of Sterile Water for Injection to be Added to Vial	Approximate Available Volume	Nominal Concentration per mL
500 mg	2 mL	2.3 mL	213 mg/mL

**Dilution of Reconstituted Solution for I.V. Infusion:**

Reconstituted solutions that have been prepared with Sterile Water for Injection can be further diluted with physiological saline (0.9%), glucose in water or Ringer's lactate for infusion prior to infusion. The use of freshly prepared diluted solutions is recommended. Reconstituted solutions and solutions further diluted for infusion should be used or discarded within 24 hours from reconstitution when protected from heat (i.e., store below 23°C) due to the possibility of microbial contamination during preparation. Discard any infusion solution found to have particulate matter or discoloration.

**Incompatibilities:**

Heparin injectable solution or physiological saline (0.9%) should not be used to reconstitute the vials of lyophilized powder.

**OVERDOSAGE**

Since DESFERAL (deferoxamine mesylate) is available only for parenteral administration, acute intoxication is unlikely to occur.



Tachycardia, hypotension and gastrointestinal symptoms have occasionally developed in patients who received overdoses of DESFERAL.

Inadvertent I.V. administration of an overdose of DESFERAL may be associated with acute but transient vision loss, aphasia, agitation, headache, nausea, bradycardia and hypotension.

Acute respiratory distress syndrome including death has been reported following treatment with excessively high intravenous doses of DESFERAL (see **WARNINGS AND PRECAUTIONS**).

High doses of DESFERAL for the treatment of chronic iron and/or aluminum overload have resulted in visual disturbances and hearing loss (see **WARNINGS AND PRECAUTIONS**).

#### Treatment:

There is no specific antidote.

Signs and symptoms of overdosage may be eliminated by reducing the dosage or interrupting treatment.

DESFERAL is dialyzable.

For management of a suspected drug overdose, contact your regional Poison Control Centre.
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## **ACTION AND CLINICAL PHARMACOLOGY**

### **Mechanism of Action**

DESFERAL (deferoxamine mesylate) is a chelating agent which forms complexes predominantly with trivalent iron and aluminum ions; it is thus of value in the treatment of acute/chronic iron intoxication, and also chronic aluminum overload in dialysis patients with end-stage renal failure (ESRF).

DESFERAL complexes with iron to form ferrioxamine, a stable chelate, which cannot take part in further chemical reactions. It can also mobilize and chelate tissue-bound aluminum, forming an aluminoxamine complex. Both complexes - ferrioxamine and aluminoxamine - are freely soluble in water and are readily excreted through the kidneys. Excreted ferrioxamine gives the urine a characteristic reddish colour. Some of the DESFERAL-metal complexes are also excreted in feces.

Theoretically chelation occurs on a 1:1 molar basis, hence 100 parts by weight of DESFERAL can bind approximately 8.5 and 4.1 parts by weight of trivalent iron and aluminum respectively.

Although primarily effective in raising iron and aluminum excretion, DESFERAL may also cause a slight increase in the excretion of sodium and calcium.

### **Pharmacodynamics**

DESFERAL (deferoxamine mesylate) is a chelating agent which forms complexes predominantly with trivalent iron and aluminum ions: the complex formation constants are  $10^{31}$  and  $10^{25}$  respectively. Affinity for divalent ions such as iron, copper, zinc and calcium is substantially lower (complex formation constants  $\leq 10^{14}$ ). It has little influence on the excretion of trace elements.

Following parenteral administration of DESFERAL, tissue iron and aluminum are mobilized resulting in a sharp rise in serum iron and/or aluminum concentration(s).

DESFERAL chelates iron, either free or bound in ferritin and hemosiderin, forming the complex ferrioxamine. DESFERAL can also mobilize and chelate tissue-bound aluminum forming an aluminoxamine complex. Since both ferrioxamine and aluminoxamine are completely excreted, DESFERAL promotes iron and aluminum excretion in the urine and feces, thereby reducing pathological iron and/or aluminum deposits in the organs.

Clinical studies have shown that ascorbic acid, when taken orally at least 3 days before DESFERAL is given, considerably enhances (by an average of 96%) the iron excretion. This action of ascorbic acid is probably due to its reducing property which facilitates the mobilization of iron from ferritin by producing a dissociable pool of ferrous ions that are then available for binding to transferrin or a chelating agent such as deferoxamine. DESFERAL is not capable of removing iron from the bone marrow or from the erythrocytes.

### **Pharmacokinetics**

**Absorption:** DESFERAL is very poorly absorbed orally but well absorbed by the intramuscular and subcutaneous routes.

**Distribution:** The serum protein-binding rate is less than 10%. It is distributed throughout all body fluids.

**Metabolism:** Metabolites were isolated and identified from the urine of patients being treated for iron overload. The metabolism reactions to occur were transamination and oxidation yielding an acid metabolite, beta-oxidation also yielding an acid metabolite, decarboxylation and N-hydroxylation yielding natural metabolites.

**Excretion:** It is excreted through the kidneys by glomerular filtration and tubular secretion.

In healthy subjects and in patients with transfusion-induced iron overload, plasma concentrations of between 80 and 130  $\mu\text{mol/L}$  were recorded 3 minutes after an intravenous injection of deferoxamine (10 mg/kg), these concentrations falling to one-half within 5-10 minutes and thereafter declining more slowly. This rapid fall in the concentration is due not only to distribution and excretion of the active substance but also both to formation of the iron complex ferrioxamine (which commences within a few minutes and the extent of which depends on the individual's iron status) and to metabolic transformation.

During continuous subcutaneous or intravenous infusion of deferoxamine (100 mg/kg in 24 mL sterile water at a rate of 1 mL per hour), the plasma concentrations of deferoxamine and ferrioxamine in healthy subjects rose - depending on the subject's individual iron status (serum ferritin concentration) - to a plateau after 6 or, more frequently, after 12 hours, i.e. to maximum levels of 20 µmol/L for deferoxamine and 2.75 µmol/L for ferrioxamine. The corresponding values in patients were 8.3 µmol/L for deferoxamine and 12.9 µmol/L for ferrioxamine. The 48-hour urinary excretion averaged 118 µmol in the healthy subjects and 836 µmol in the patients. In patients with hemochromatosis, the increase in iron excretion occurring in response to deferoxamine was roughly just as high in the feces as in the urine.

Within 12 hours after deferoxamine had been administered to 20 volunteers, 33.1% of the dose was excreted in the urine (the bulk of it in the first 3 hours) in the form of deferoxamine and ferrioxamine and the remainder in the form of metabolites; the corresponding figure in a patient with hemochromatosis was 60.5% of the dose. There are reported cases where deferoxamine was diluted with water and given by mouth or stomach tube after gastric aspiration and lavage in the treatment of acute iron overload. The aqueous deferoxamine solution was left in the stomach to bind unabsorbed iron in the gastrointestinal tract to prevent further absorption. Note however, that the efficacy of oral deferoxamine for this purpose is not clearly established.

In ESRF dialysis patients who received 40 mg/kg DESFERAL infused I.V. over 1 hour, plasma concentration at the end of infusion was 152 µmol/L (85.2 µg/mL) when the infusion was given between dialysis sessions. Plasma concentrations of DESFERAL were between 13 and 27% lower when the infusion was administered during dialysis. In all cases, concentrations of ferrioxamine were approximately 7.0 µmol/L (4.3 µg/mL); and for aluminoxamine 2.0-3.0 µmol/L (1.2-1.8 µg/mL). After infusion was discontinued, plasma concentration of DESFERAL decreased rapidly with a half-life of 20 minutes. A smaller fraction of the dose was eliminated with a longer half-life of 14 hours. The plasma concentrations of aluminoxamine continued to increase for up to 48 hours after infusion and reached values of approximately 7.0 µmol/L (4.0 µg/mL). Following dialysis the plasma concentration of aluminoxamine dropped to 2.2 µmol/L (1.3 µg/mL).

During peritoneal dialysis DESFERAL is absorbed if administered in the dialysis fluid.

### **STORAGE AND STABILITY**

Store between 15-25 °C. Do not store above 25°C.

### **DOSAGE FORMS, COMPOSITION AND PACKAGING**

DESFERAL (deferoxamine mesylate for injection) 500 mg vials:

Each 7.5 mL vial of white to practically white sterile lyophilized powder contains the medicinal ingredient deferoxamine mesylate (500 mg) for injection without non-medicinal ingredients. Available in cartons of 10 vials.

## PART II: SCIENTIFIC INFORMATION

### PHARMACEUTICAL INFORMATION

#### Drug Substance

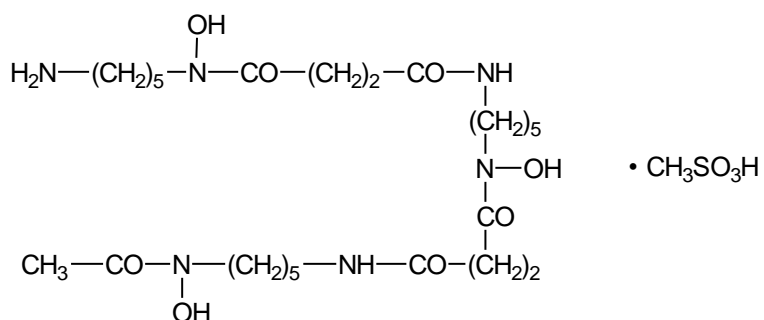
Proper name: Deferoxamine mesylate

Chemical name: N-[5-(3-[(5-Aminopentyl)-hydroxycarbamoyl]-propionamido)-pentyl]-3-[(5-(N-hydroxyacetamido)pentyl)-carbamoyl]-propionyl-hydroxamethansulphonic acid

Molecular formula:  $C_{25}H_{48}N_6O_8 \cdot CH_3SO_3H$

Molecular mass: 656.8 (560.7 free base)

Structural formula:



Physicochemical properties: Description: Practically odorless white crystalline powder.

Solubility (at 20°C): Water (>20%), abs. ethanol (0.1%), acetone (0.006%), chloroform (0.007%), dichloromethane (0.007%)

pK<sub>a</sub>: 8.30, 9.05, 9.90, >11

Melting point: about 150°C

## DETAILED PHARMACOLOGY

See ACTION AND CLINICAL PHARMACOLOGY.

## TOXICOLOGY

### Acute Toxicity Studies

	<b>I.V.</b>	<b>SUBCUTANEOUS</b>	<b>ORAL</b>
Mouse	340 mg/kg	1600 mg/kg	>3000 mg/kg
Rat	520 mg/kg	>1000 mg/kg	>1000 mg/kg
Rabbit	600 mg/kg	-	-

The signs of acute intoxication in the animal species tested were nonspecific paralysis, ataxia and acute respiratory failure.

### Subacute Toxicity Studies

500 mg/kg of deferoxamine was given to rats for 28 days by the subcutaneous route. There was a slight reduction in the white blood cell count and some inhibition of growth. There was no evidence of any damage to parenchymal organs or to bone marrow.

### Chronic Toxicity Studies

Subcutaneous doses of up to 400 mg/kg of deferoxamine were given to rats for three months. There was no alteration in growth rate, renal function, blood picture, or resistance to intercurrent disease in the animals so treated.

In rabbit, cat and dog, intravenous injection of doses of 10 to 30 mg/kg produced an acute fall in blood pressure. If smaller doses were given previously the reaction was attenuated or abolished.

### Reproduction Studies

Skeletal anomalies have been observed in the fetuses of two animal species at doses just above those recommended for human use. DESFERAL (deferoxamine mesylate) should therefore not be used in women of childbearing potential unless the use of an effective form of contraception, established before treatment, is continued throughout treatment and for at least the first month after treatment.

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**PART III: CONSUMER INFORMATION****Pr DESFERAL<sup>®</sup>**

(deferroxamine mesylate for injection, Novartis Std.)

**This leaflet is part III of a three-part "Product Monograph" published when DESFERAL<sup>®</sup> was approved for sale in Canada and is designed specifically for Consumers. This leaflet is a summary and will not tell you everything about DESFERAL. Contact your doctor or pharmacist if you have any questions about the drug.**

**ABOUT THIS MEDICATION****What the medication is used for:**

DESFERAL is used in the treatment of following conditions:

- acute iron poisoning as an adjunct to the standard treatments,
- chronic iron overload due to frequent blood transfusion,
- chronic aluminum overload in patients with end-stage kidney failure required dialysis.

DESFERAL is also used to test for aluminum overload.

**What it does:**

DESFERAL contains the active substance deferroxamine, which is a so-called "chelator". It works by binding to excess iron or aluminum in the blood and removing them from the body (through the urine and feces).

**When it should not be used:**

- If you are allergic (hypersensitive) to deferroxamine.

**What the medicinal ingredient is:**

Deferroxamine mesylate.

**What the nonmedicinal ingredients are:**

Not applicable. The DESFERAL vials contain the medicinal ingredient deferroxamine mesylate without non-medicinal ingredients.

**What dosage forms it comes in:**

DESFERAL is available as 500 mg lyophilized powder for injection in vials.

**WARNINGS AND PRECAUTIONS**

The treatment with DESFERAL should be started and followed up by a doctor experienced in the treatment of chronic iron or aluminum overload.

**BEFORE you use DESFERAL talk to your doctor or pharmacist if you:**

- have any hearing or eye sight problems. DESFERAL may cause hearing problems and eye sight problems;
- have high blood sugar (diabetes);
- have blood clotting problems;

- have any neurological problems (convulsion, dementia);
- severe kidney problem that does not require dialysis;
- lung disease or problem breathing;
- are pregnant or planning to become pregnant. DESFERAL can harm the unborn child, especially if it is used during the first 3 months of pregnancy. If the treatment with DESFERAL is needed, female patients who can get pregnant should use an effective birth control method before starting, while taking, and for at least one month after the last treatment with DESFERAL;
- are breastfeeding.

DESFERAL may reduce growth rate. Patients under 16 years of age should be monitored for body weight and height every three months.

Increased risk of eye disorders have been reported in patients older than 65 years of age.

**Effects on ability to drive or use machines:**

DESFERAL may affect your sight or hearing, make you feel dizzy, or cause other disturbances of nervous function. If you experience such effects, you should not drive or use machines.

**INTERACTIONS WITH THIS MEDICATION**

Tell your doctor or pharmacist if you are taking or have recently taken any other medicines in addition to DESFERAL, including medicines obtained without a prescription. You may need to change the dosage or stop taking one of the medicines.

**Drugs that may interact with DESFERAL include:**

- medicines containing prochlorperazine, a neuroleptic drug used to treat neurological disorders
- vitamin C
- erythropoietin
- gallium-67, a medicine given before imaging (scanning, which is used in diagnosis of certain diseases)

In patients without heart failure, their doctor may tell them to take vitamin C one month before and during regular treatment with DESFERAL. The maximum daily dose of vitamin C should not exceed 200 mg for adult patients, 100 mg in older children and 50 mg for children under 10 years of age. However, their doctor also needs to monitor their heart function.

**PROPER USE OF THIS MEDICATION**

Your doctor has chosen the right dose and method of administration for your particular condition. Follow your doctor's instructions carefully. Make sure you use the medication exactly as your doctor tells you.

**Usual dose:*****Acute iron poisoning***



DESFERAL can be used in cases of poisoning with iron preparations. This treatment is carried out in hospital.

**Chronic iron overload**

Daily doses of 20 to 60 mg per kilogram bodyweight. DESFERAL can be given by slow infusion under the skin (subcutaneously), by infusion into a vein (intravenously), or by injection into a muscle (intramuscularly).

**Chronic aluminum overload in patients with severe kidney disease**

DESFERAL is usually given once a week by slow infusion into a vein during the last 60 minutes of a dialysis session, or 5 hours before a dialysis session, depending on the aluminum concentration in your blood.

The dose of DESFERAL is 5 mg per kilogram of bodyweight.

The duration of treatment and any change in your individual dose of DESFERAL will depend on the results of the tests carried out by your doctor.

**Diagnosis of aluminum overload**

If you are receiving dialysis, your doctor will want to test whether you have aluminium overload. You will be given 5 mg of DESFERAL per kilogram of bodyweight by slow infusion into a vein during the last 60 minutes of a dialysis session. The aluminium content of blood samples taken just before this dialysis session and the next one will be determined.

**Overdose:**

In case of drug overdose, contact a health care practitioner, hospital emergency department or regional Poison Control Centre immediately, even if there are no symptoms.

**Missed Dose:**

If you have missed a dose of DESFERAL, tell your doctor at once.

**SIDE EFFECTS AND WHAT TO DO ABOUT THEM**

As with all medicines, DESFERAL can cause side effects. The following are the possible side effects of DESFERAL:

**Very common side effects:** (affecting more than 10 in 100 patients)

- injection site reaction such as pain, swelling, reddening, itching of the skin, eschar (dead tissue that sheds from healthy skin), crust formation, small blisters, burning
- joint or muscle pain

**Common side effects:** (affecting more than 1 and less than 10 in 100 patients)

- nausea
- headache
- itchy rash
- fever

- reduced growth rate, bone disorders

**Uncommon side effects:** (affecting between 1 and 10 in 1000 patients)

- vomiting
- abdominal pain

**Very rare side effects:** (affecting less than 1 in 10,000 patients)

- diarrhea
- skin rash
- sensation of numbness or tingling in fingers and toes

**Unknown frequency:**

- muscle spasms
- abnormal liver or kidney function test results
- a low blood level of calcium, and worsening hyperparathyroidism in patients treated for aluminum overload
- reddish-brown urine
- low blood pressure, increased heart rate and shock

If any of the side effects gets serious or you experience any other side effects not listed in this leaflet, please tell your doctor or pharmacist.

SERIOUS SIDE EFFECTS, HOW OFTEN THEY HAPPEN AND WHAT TO DO ABOUT THEM			
Symptom / effect	Talk with your doctor or pharmacist		Stop taking drug and call your doctor or pharmacist
	Only if severe	In all cases	
<b>Uncommon</b>			
Disturbances of hearing such as ringing or noise in the ears, hearing loss		√	
<b>Rare</b>			
Disturbances of vision such as blurred eyesight, abnormal colour vision, night blindness, black spots in the vision, loss of vision, clouding of the lens of the eye, visual field defects or decreased sharpness of vision		√	
Fungal or bacterial infections leading to high fever, shortness of breath, acute diarrhea, abdominal pain, general discomfort or sore throat		√	
Dizziness, light-headedness (signs of low blood pressure that can occur when the drug is given too rapidly)		√	
<b>Very rare</b>			

**SERIOUS SIDE EFFECTS, HOW OFTEN THEY HAPPEN AND WHAT TO DO ABOUT THEM**

Symptom / effect	Talk with your doctor or pharmacist		Stop taking drug and call your
Breathlessness due to lung disorders		√	
Unusual bleeding/bruising (a sign that levels of blood platelets are low)	√		
Fever, sore throat or mouth ulcers due to infections (a sign that levels of white blood cells are low)	√		
Rash, itching, hives, difficulty breathing or swallowing, feeling of tightness in the chest with wheezing or coughing, dizziness, swelling mainly of the face and throat (signs of a severe allergic reaction or asthma)		√	
Disturbances of the nervous system		√	
<b>Unknown</b>			
Severely decreased output of urine (sign of a kidney problem)		√	
Convulsions (mainly in patients on dialysis)		√	

*This is not a complete list of side effects. For any unexpected effects while taking DESFERAL, contact your doctor or pharmacist.*

**HOW TO STORE IT**

- Keep out of reach and sight of children and pets.
- Do not use DESFERAL after the expiry date shown on the pack.
- Store the DESFERAL vials containing the dry active substance between 15-25 °C. Do not store above 25°C.
- One vial is for single use only. The product should be used immediately after the solution has been made up (reconstituted), i.e. treatment should start within 3 hours. When the solution has been prepared under recognized sterile conditions, it may be stored for a maximum period of 24 hours at room temperature before the start of treatment. Opaque or cloudy solutions should be discarded.
- Remember to return any unused vials to your pharmacist.

**Reporting Side Effects**

You can report any suspected side effects associated with the use of health products to Health Canada by:

- Visiting the Web page on Adverse Reaction Reporting (<https://www.canada.ca/en/health-canada/services/drugs-health-products/medeffect-canada/adverse-reaction-reporting.html>) for information on how to report online, by mail or by fax; or
- Calling toll-free at 1-866-234-2345.

*NOTE: Contact your health professional if you need information about how to manage your side effects. The Canada Vigilance Program does not provide medical advice.*

**MORE INFORMATION**

This document plus the full product monograph, prepared for health professionals can be found at:

<http://www.novartis.ca>

or by contacting the sponsor, Novartis Pharmaceuticals Canada Inc., at: 1-800-363-8883

This leaflet was prepared by Novartis Pharmaceuticals Canada Inc.

Last revised July 3, 2019

DESFERAL is a registered trademark

Novartis Version: July 21, 2023