

PRODUCT MONOGRAPH  
INCLUDING PATIENT MEDICATION INFORMATION

Pr **SOLIRIS**<sup>®</sup>

(eculizumab)

30 mL Parenteral Solution (10 mg/mL)

(Humanized Monoclonal Antibody)

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## RECENT MAJOR LABEL CHANGES

Indications, Generalized Myasthenia Gravis, Section 1, AUG 2018

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## PART I: HEALTH PROFESSIONAL INFORMATION

### 1 INDICATIONS

SOLIRIS® is indicated for:

- Paroxysmal Nocturnal Hemoglobinuria (PNH)

SOLIRIS® (eculizumab) is indicated for the treatment of patients with paroxysmal nocturnal hemoglobinuria (PNH) to reduce hemolysis. SOLIRIS was studied in clinical trials in patients with a history of at least one transfusion during the past two years (see Clinical Trials).

- Atypical Hemolytic Uremic Syndrome (atypical HUS)

SOLIRIS® (eculizumab) is indicated for the treatment of patients with atypical hemolytic uremic syndrome (atypical HUS) to reduce complement-mediated thrombotic microangiopathy.

SOLIRIS is not indicated for the treatment of patients with Shiga toxin-producing *E. coli* related hemolytic uremic syndrome (STEC-HUS).

- Generalized Myasthenia Gravis (gMG)

SOLIRIS® (eculizumab) is indicated in adult patients with generalized Myasthenia Gravis (gMG).

SOLIRIS was studied in clinical trials in patients who were anti-acetylcholine receptor (AChR) antibody positive and refractory, defined as failure of treatment with two or more immunosuppressive therapies (ISTs) either in combination or as monotherapy, or failed at least one IST and required chronic plasmapheresis, plasma exchange (PE), or intravenous immunoglobulin (IVIg) to control symptoms. Patients continued to receive standard therapy throughout the pivotal clinical trial.

SOLIRIS should be administered under the supervision of a qualified health professional familiar with treating atypical HUS, or gMG.

#### 1.1 Pediatrics

##### **Pediatrics (<18 years of age):**

##### PNH

In children and adolescent patients with PNH (aged 11 years to less than 18 years) included in the pediatric PNH Study, the safety profile appeared similar to that observed in adult patients with PNH. The most common adverse reaction reported in pediatric patients was headache.

##### Atypical HUS

Based on the data submitted and reviewed by Health Canada, the safety and efficacy of SOLIRIS in 28 pediatric patients with atypical HUS has been established; therefore, Health Canada has authorized an indication for pediatric use. (See Clinical Trials, atypical HUS)

## gMG

The safety and effectiveness of SOLIRIS for the treatment of gMG in pediatric patients below the age of 18 years have not been established.

Administer vaccinations for the prevention of infection due to *Neisseria meningitidis*, *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib) according to the National Advisory Committee on Immunization (NACI) guidelines.

### 1.2 Geriatrics

Geriatrics (>65 years of age): SOLIRIS may be administered to patients aged 65 years and over. Forty-five patients 65 years of age or older (15 with PNH, 4 with atypical HUS, and 26 with gMG) were treated with SOLIRIS. Although there were no apparent age-related differences observed in these studies, the number of patients aged 65 and over is not sufficient to determine whether they respond similarly to younger patients.

## 2 CONTRAINDICATIONS

SOLIRIS is contraindicated in patients who are hypersensitive to this drug, murine proteins, or to any ingredient in the formulation, including any non-medicinal ingredient, or component of the container. For a complete listing, see **Dosage Forms, Strengths, Composition and Packaging**.

Do not initiate SOLIRIS therapy in patients:

- with unresolved *Neisseria meningitidis* infection
- who are not currently vaccinated against *Neisseria meningitidis* (unless they receive prophylactic treatment with appropriate antibiotics until 2 weeks after vaccination)

Please refer to the **Warnings and Precautions, Serious Meningococcal Infections**.

### 3 SERIOUS WARNINGS AND PRECAUTIONS BOX

#### SERIOUS WARNINGS AND PRECAUTIONS

Cases of serious or fatal meningococcal infections have been reported in patients treated with SOLIRIS. Meningococcal infections may become rapidly life-threatening or fatal if not recognized and treated early.

- Comply with the most current National Advisory Committee on Immunization (NACI) recommendations for meningococcal vaccination in patients with complement deficiencies.
- All patients must be vaccinated with meningococcal vaccines prior to, or at the time of, initiating SOLIRIS, unless the risks of delaying SOLIRIS therapy outweigh the risks of developing a meningococcal infection; revaccinate according to current medical guidelines for vaccine use.
- All patients must be monitored for early signs of meningococcal infections, evaluated immediately if infection is suspected, and treated with antibiotics, if necessary.

Vaccination may not prevent all meningococcal infections.

#### Serious Meningococcal Infections:

Due to its mechanism of action, the use of SOLIRIS increases the patient's susceptibility to meningococcal infection (*Neisseria meningitidis*). Meningococcal disease due to any serogroup may occur. To reduce the risk of infection, all patients must be vaccinated against meningococcal infections prior to, or at the time of, initiating SOLIRIS. Patients who initiate SOLIRIS treatment less than 2 weeks after receiving a meningococcal vaccine must receive treatment with appropriate prophylactic antibiotics until 2 weeks after vaccination. Vaccines against serogroups A, C, Y, W 135 and B where available, are recommended in preventing the commonly pathogenic meningococcal serogroups. Patients must be vaccinated or revaccinated according to current national vaccination guidelines for vaccination use. Vaccination may not be sufficient to prevent meningococcal infection. Consideration should be given to official guidance on the appropriate use of antibacterial agents.

Vaccination, particularly with a vaccine against serogroup B meningococcal infection, may further activate complement. As a result, patients with complement-mediated diseases, including PNH, atypical HUS, and gMG may experience increased signs and symptoms of their underlying disease, such as hemolysis (PNH), TMA complications (atypical HUS) or MG exacerbation (gMG). Therefore, patients should be closely monitored for disease symptoms after recommended vaccination. For patients stabilized on SOLIRIS and receiving maintenance therapy, and for whom additional vaccination is warranted, careful consideration should be given to the timing of vaccination (or booster in patients previously vaccinated against meningococcal infections) relative to administration of SOLIRIS. It is recommended to vaccinate only when the underlying complement mediated disease is clinically controlled with SOLIRIS, and when systemic eculizumab concentrations are considered to be relatively high (i.e. within one week following a SOLIRIS infusion).

Cases of serious or fatal meningococcal infections have been reported in SOLIRIS treated patients. All patients should be monitored for early signs of meningococcal infection, evaluated immediately if infection is suspected, and treated with antibiotics, if necessary. Patients should be informed of these signs and symptoms and steps to take to seek medical care immediately (see **Adverse Reactions**). Discontinue SOLIRIS in patients who are undergoing treatment for serious meningococcal infections.

### **Other Systemic Infections:**

Due to its mechanism of action, SOLIRIS therapy should be administered with caution to patients with active systemic infections. SOLIRIS blocks terminal complement activation; therefore patients may have increased susceptibility to infections, especially with *Neisseria* and encapsulated bacteria. Serious infections with *Neisseria* species (other than *Neisseria meningitidis*), including disseminated gonococcal infections, have been reported. Counsel patients about gonorrhea prevention and advise regular testing for patients at risk. Additionally, Aspergillus infections have occurred in immunocompromised and neutropenic patients. Patients should be provided with information from the Patient Information Brochure to increase their awareness of potential serious infections and their signs and symptoms.

Children treated with SOLIRIS may be at increased risk of developing serious infections due to *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib). Administer vaccinations for the prevention of *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib) infections according to national guidelines. For patients stabilized on eculizumab and receiving maintenance therapy, and for whom additional vaccination is warranted, careful consideration should be given to the timing of vaccination relative to administration of SOLIRIS (see **Warnings and Precautions, Serious Meningococcal Infections**)

Serious infections, infectious agents and subsequent treatments for these infections should be documented for all patients treated with SOLIRIS.

## **4 DOSAGE AND ADMINISTRATION**

### **4.1 Dosing Considerations**

- SOLIRIS should be administered by a healthcare professional and under the supervision of a physician experienced in the management of patients with hematological, renal or neuromuscular disorders.
- Do not administer as an IV Push or Bolus Injection.

### **4.2 Recommended Dose and Dosage Adjustment**

#### Recommended Dosage Regimen - PNH

SOLIRIS therapy consists of:

- 600 mg every 7 days for the first 4 weeks, followed by
- 900 mg for the fifth dose 1 week later, then
- 900 mg every 2 weeks thereafter.

SOLIRIS should be administered at the recommended dosage regimen time points, or within

two days of these time points (see **Warnings and Precautions**).

**Recommended Dosage Regimen – atypical HUS and gMG**

For patients 18 years of age and older SOLIRIS therapy consists of:

- 900 mg weekly for the first 4 weeks, followed by
- 1200 mg for the fifth dose 1 week later, then
- 1200 mg every 2 weeks thereafter

For patients with atypical HUS and less than 18 years of age, administer SOLIRIS based upon body weight, according to the following schedule (**Table 1**):

**Table 1: Dosing recommendations in patients less than 18 years of age**

Patient Body Weight	Induction	Maintenance
40 kg and over	900 mg weekly x 4 doses	1200 mg at week 5; then 1200 mg every 2 weeks
30 kg to less than 40 kg	600 mg weekly x 2 doses	900 mg at week 3; then 900 mg every 2 weeks
20 kg to less than 30 kg	600 mg weekly x 2 doses	600 mg at week 3; then 600 mg every 2 weeks
10 kg to less than 20 kg	600 mg weekly x 1 dose	300 mg at week 2; then 300 mg every 2 weeks
5 kg to less than 10 kg	300 mg weekly x 1 dose	300 mg at week 2; then 300 mg every 3 weeks

The goal of the additional dosing after plasma intervention is to restore and maintain the eculizumab concentration at the same level as that prior to the plasma intervention.

For adult patients with atypical HUS or gMG, and pediatric patients with atypical HUS, supplemental dosing of SOLIRIS is required in the setting of concomitant support with PE/PI (plasmapheresis or plasma exchange; or fresh frozen plasma infusion) (**Table 2**). The goal of the additional dosing after plasma intervention is to restore and maintain the plasma concentration above targeted therapeutic concentration. The impact of IVIg on eculizumab levels in patients with gMG has not been studied.

**Table 2: Supplemental dose of SOLIRIS after PE/PI**

Type of Intervention	Most Recent SOLIRIS Dose	SOLIRIS Dose With Each PE/PI Intervention	Timing of Supplemental SOLIRIS Dose
Plasmapheresis or plasma exchange	300 mg	300 mg per each plasmapheresis or plasma exchange session	Within 60 minutes after each plasmapheresis or plasma exchange
	600 mg or more	600 mg per each plasmapheresis or plasma exchange session	



Fresh frozen plasma infusion	300 mg or more	300 mg per infusion of fresh frozen plasma	60 minutes prior to each infusion of fresh frozen plasma
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Based on pharmacokinetic simulation and data from PNH patients who received plasma intervention while on eculizumab therapy

The recommended doses in **Tables 1** and **2** are based entirely on estimates from a one-compartment model which was demonstrated to adequately describe eculizumab pharmacokinetics.

SOLIRIS should be administered at the recommended dosage regimen time points, or within two days of these time points (see **Warnings and Precautions**).

### 4.3 Administration

DO NOT ADMINISTER AS AN IV PUSH OR BOLUS INJECTION.

The SOLIRIS admixture should be administered by intravenous infusion over 35 minutes in adults and 1-4 hours in pediatric patients via gravity feed, a syringe-type pump, or an infusion pump. Admixed solutions of SOLIRIS are stable for 24 hours at 2-8°C and at room temperature. However, SOLIRIS contains no preservative so infusion of the admixture should begin as soon as possible after mixing.

If an adverse reaction occurs during the administration of SOLIRIS, the infusion may be slowed or stopped at the discretion of the physician. If the infusion is slowed, the total infusion time should not exceed two hours in adults and four hours in children aged less than 12 years. Monitor the patient for at least one hour following completion of the infusion for signs or symptoms of an infusion reaction.

### 4.4 Reconstitution

SOLIRIS must be diluted to a final admixture concentration of 5 mg/mL using the following steps:

- Withdraw the required amount of SOLIRIS from the vial into a sterile syringe
- Transfer the recommended dose to an infusion bag
- Dilute SOLIRIS to a final concentration of 5 mg/mL by adding the appropriate amount (equal volume of diluent to drug volume) of 0.9% Sodium Chloride Injection, USP; 0.45% Sodium Chloride Injection, USP; 5% Dextrose in Water Injection, USP; or Ringer's Injection, USP to the infusion bag.
- The final admixed SOLIRIS 5 mg/mL infusion volume is 60 mL for 300 mg doses, 120 mL for 600 mg doses, 180 mL for 900 mg doses or 240 mL for 1200 mg doses (**Table 3**). Gently invert the infusion bag containing the diluted SOLIRIS solution to ensure thorough mixing of the product and diluent.
- Prior to administration, the admixture should be allowed to adjust to room temperature [18°-25°C, 64°-77°F]. The admixture must not be heated in a microwave or with any heat source other than ambient air temperature. The SOLIRIS admixture should be inspected visually for particulate matter and discoloration prior to administration.

**Table 3: Reconstitution**

Dose	Vial Size	Volume of Diluent to be Added to Vial	Approximate Available Volume	Nominal Concentration per mL
300 mg	30 mL x 1	30 mL	60 mL	5 mg/mL
600 mg	30 mL x 2	60 mL	120 mL	5 mg/mL
900 mg	30 mL x 3	90 mL	180 mL	5 mg/mL
1200 mg	30 mL x 4	120 mL	240 mL	5 mg/mL

Discard any unused portion left in a vial, as the product contains no preservatives.

#### 4.5 Missed Dose

In case of a missed dose, resume the regular schedule as soon as possible.

### 5 OVERDOSAGE

SOLIRIS is to be administered under the supervision of a healthcare professional which minimizes the potential of a significant overdose. No cases of overdose have been reported during clinical studies.

For management of a suspected drug overdose, contact your regional poison control centre.

### 6 DOSAGE FORMS, STRENGTHS, COMPOSITION AND PACKAGING

**Table 4: Dosage Forms, Strengths, Composition and Packaging**

Route of Administration	Dosage Form / Strength/Composition	Non-medicinal Ingredients
Intravenous (IV) infusion	300 mg single-use vial	Polysorbate 80 (vegetable origin) Sodium chloride Sodium phosphate dibasic Sodium phosphate monobasic Water for Injection USP

SOLIRIS is a sterile, clear, colorless, preservative-free 10 mg/mL solution for intravenous (IV) infusion and is supplied in 30-mL single-use vials. The product is formulated at pH 7.0 and each vial contains 300 mg of eculizumab, 13.8 mg sodium phosphate monobasic, 53.4 mg sodium phosphate dibasic, 263.1 mg sodium chloride, 6.6 mg polysorbate 80 (vegetable origin) and Water for Injection, USP.

SOLIRIS is supplied as 300 mg single-use vials each containing 30 mL of 10 mg/mL sterile, preservative-free eculizumab solution. Each carton contains one vial.

## 7 DESCRIPTION

SOLIRIS is a formulation of eculizumab which is a recombinant humanized monoclonal IgG2/4k antibody that binds to the human C5 complement protein and inhibits the activation of terminal complement. Eculizumab contains human constant regions and murine complementarity-determining regions grafted onto the human framework light-and heavy-chain variable regions. Eculizumab is composed of two 448 amino acid heavy chains and two 214 amino acid light chains and has a molecular weight of approximately 148 kDa.

Eculizumab is produced in a murine myeloma (NS0 cell line) expression system and purified by affinity and ion exchange chromatography. The bulk drug substance manufacturing process also includes specific viral inactivation and removal steps.

## 8 WARNINGS AND PRECAUTIONS

Please see the **Serious Warnings and Precautions Box** at the beginning of Part I: Health Professional Information.

### General

#### *Allergy/Infusion Reactions*

As with all protein products, administration of SOLIRIS may result in infusion reactions, including anaphylaxis or other hypersensitivity reactions. In clinical trials for PNH, atypical HUS, and gMG, no patients experienced an infusion reaction which required discontinuation of SOLIRIS. Post-marketing reports of infusion reactions have been received (see **Sensitivity/Resistance** section). Interrupt SOLIRIS infusion and institute appropriate treatment and supportive measures if signs of cardiovascular instability or respiratory compromise occur.

#### *Monitoring Disease Manifestations after SOLIRIS Discontinuation/Missed Dose*

#### Treatment Discontinuation for PNH

Since SOLIRIS therapy increases the number of PNH cells (e.g., in the double-blind, placebo-controlled PNH Study C04-001, the proportion of PNH RBCs increased among SOLIRIS-treated patients by a median of 28% from baseline (range from -25% to 69%), patients who discontinue treatment with SOLIRIS may be at increased risk for serious hemolysis. Serious hemolysis is identified by serum LDH levels greater than the pre-treatment level, along with any of the following: greater than 25% absolute decrease in PNH clone size (in the absence of dilution due to transfusion) in one week or less; a hemoglobin level of <5 gm/dL or a decrease of >4 gm/dL in one week or less; angina; change in mental status; a 50% increase in serum creatinine level; or thrombosis. Monitor any patient who discontinues SOLIRIS for at least 8 weeks to detect serious hemolysis and other reactions.

If serious hemolysis occurs after SOLIRIS discontinuation, consider the following procedures/treatments: blood transfusion (packed RBCs), or exchange transfusion if the PNH RBCs are >50% of the total RBCs by flow cytometry, anticoagulation, corticosteroids, or reinstatement of SOLIRIS, but this was not tested in clinical trials.

In clinical studies, 16 of 196 patients with PNH discontinued treatment with SOLIRIS. Patients were followed for evidence of worsening hemolysis and no serious hemolysis was observed.

Monitor patients after discontinuing SOLIRIS for at least 8 weeks to detect hemolysis.

#### Treatment Discontinuation for atypical HUS

SOLIRIS treatment is recommended to continue for the patient's lifetime, unless the discontinuation of SOLIRIS is clinically indicated (see **Warnings and Precautions**).

Thrombotic microangiopathy complications were observed after SOLIRIS discontinuation in the atypical HUS clinical studies. If patients with atypical HUS discontinue treatment with SOLIRIS they should be monitored closely for signs and symptoms of thrombotic microangiopathy complications. Monitoring may be insufficient to predict or prevent severe thrombotic microangiopathy complications in patients with atypical HUS after discontinuation of SOLIRIS.

Thrombotic microangiopathy (TMA) complications post discontinuation can be identified by (i) Any two, or repeated measurement of any one, of the following: a decrease in platelet count of 25% or more as compared to either baseline or to peak platelet count during SOLIRIS treatment; an increase in serum creatinine of 25% or more as compared to baseline or to nadir during SOLIRIS treatment; or, an increase in serum LDH of 25% or more as compared to baseline or to nadir during SOLIRIS treatment; or by (ii) any one of the following: a change in mental status or seizures; angina or dyspnoea; or thrombosis.

Monitor any patient who discontinues SOLIRIS for at least 12 weeks to detect thrombotic microangiopathy complications.

If thrombotic microangiopathy complications occur after SOLIRIS discontinuation, consider reinstatement of SOLIRIS treatment, plasma therapy therapy [plasmapheresis, plasma exchange, or fresh frozen plasma (PE/PI)], or appropriate organ-specific supportive measures including renal support with dialysis, respiratory support with mechanical ventilation or anticoagulation. In atypical HUS clinical studies, 18 patients (5 in the prospective studies) discontinued SOLIRIS treatment. Seven (7) thrombotic microangiopathy complications were observed following the missed dose in 5 patients and SOLIRIS was re-initiated in 4 of these 5 patients.

#### Treatment Discontinuation for generalized Myasthenia Gravis

Use of SOLIRIS in gMG treatment has only been studied in the setting of chronic administration. Patients that discontinue SOLIRIS treatment should be carefully monitored for signs and symptoms of deterioration of disease.

#### *Immunization*

Prior to initiating SOLIRIS therapy, it is recommended that patients with PNH, atypical HUS or gMG receive immunizations according to current immunization guidelines. Additionally, all patients must receive a meningococcal vaccine prior to, or at the time of receiving SOLIRIS. Patients less than 2 years of age and those who are treated with SOLIRIS less than 2 weeks after receiving a meningococcal vaccine must receive treatment with appropriate prophylactic antibiotics until 2 weeks after vaccination. Vaccines against serotypes A, C, Y, W135, and B, are recommended in preventing the commonly pathogenic meningococcal serotypes.

Children treated with SOLIRIS may be at increased risk of developing serious infections due to *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib). Administer vaccinations for the prevention of *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib) infections according to NACI guidelines. Additionally, Aspergillus infections have occurred in

immunocompromised and neutropenic patients. Use caution when administering SOLIRIS to patients with any systemic infection.

#### *Immunosuppressant and Anticholinesterase Therapies*

Patients in gMG clinical trials continued treatment with immunosuppressant and anticholinesterase therapies while on SOLIRIS treatment. Withdrawal of immunosuppressant and anticholinesterase therapies during SOLIRIS treatment for gMG was not assessed in the placebo-controlled studies.

When immunosuppressant and anticholinesterase therapies are decreased or discontinued, patients should be monitored closely for signs of disease exacerbation.

#### **Carcinogenesis and Mutagenesis**

Carcinogenesis and mutagenesis studies have not been performed. There is no evidence to suggest that the use of SOLIRIS is associated with carcinogenesis (see **Toxicology** section).

#### **Cardiovascular**

In atypical HUS clinical trials, serious cardiovascular events such as hypertension, venous thrombosis and tachycardia were observed.

#### **Dependence/Tolerance**

There is no evidence to suggest that the use of SOLIRIS is associated with drug abuse or dependence.

#### **Driving and Operating Machinery**

The influence of SOLIRIS on the ability to drive or operate machinery has not been studied.

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

There were no serious ENT adverse events.

#### **Endocrine and Metabolism**

There were no serious endocrine or metabolic adverse events.

#### **Gastrointestinal**

Rare episodes of severe abdominal pain were reported.

#### **Genitourinary**

Serious urinary tract infections and disseminated gonococcal infections have been reported. Counsel patients about gonorrhea prevention and advise regular testing for patients at-risk.

#### **Hematologic**

The safety and efficacy of SOLIRIS has not been established in patients with underlying hematologic diseases (e.g., hemolytic anemia, sickle cell anemia, thalassemia, and porphyria). In clinical trials, analysis by history of bone marrow failure showed that eculizumab was effective in reducing the burden of hemolysis (as measured by hemolysis indicator LDH AUC) and reduced transfusion requirements in subjects with both PNH and history of bone marrow failure (e.g., aplastic anemia, myelodysplasias).

#### **Hepatic/Biliary/Pancreatic**

There were no serious hepatic dysfunctions after SOLIRIS therapy. The safety and efficacy of SOLIRIS have not been assessed in patients with hepatic disease.

## Immune

Infrequent antibody responses have been detected in SOLIRIS-treated patients across all clinical studies. In PNH placebo controlled studies, low antibody responses have been reported with a frequency (3.4%) similar to that of placebo (4.8%).

In patients with atypical HUS treated with SOLIRIS, antibodies to SOLIRIS were detected in 3/100 (3%) by ECL bridging format assay. 1/100 (1%) of atypical HUS patients had low positive values for neutralizing antibodies.

In a gMG placebo controlled study, none (0/62) of the SOLIRIS treated patients showed antidrug antibody response during the 26 week active treatment.

There has been no observed correlation of antibody development to clinical response or adverse events.

**SOLIRIS blocks terminal complement; therefore patients may have increased susceptibility to *Neisseria meningitidis* (see boxed **Warning: Serious Meningococcal Infections** section above).**

## Infections

Patients are at increased risk of serious infections caused by *Neisseria* and encapsulated bacteria. Meningococcal sepsis is the most serious adverse reaction experienced by patients receiving SOLIRIS.

In clinical studies, 2 out of 196 patients with PNH developed serious meningococcal infections while receiving treatment with SOLIRIS; both had been vaccinated. In clinical studies among non-PNH patients, meningococcal meningitis occurred in one unvaccinated patient. In addition, 3 out of 130 previously vaccinated patients with atypical HUS developed meningococcal infections while receiving treatment with SOLIRIS.

No meningococcal infections were reported in completed gMG clinical studies.

Use caution when administering SOLIRIS to patients with any systemic infection.

## Monitoring and Laboratory Tests

### PNH

PNH patients receiving SOLIRIS therapy should be monitored for intravascular hemolysis by measuring LDH levels and may require dose adjustment within the recommended  $14 \pm 2$  day dosing schedule during the maintenance phase (up to every 12 days).

### Atypical HUS

Patients with atypical HUS receiving SOLIRIS therapy should be monitored for early signs of thrombotic microangiopathy (TMA) including a decrease in platelet count, and increases in serum LDH and creatinine levels. Follow patients for signs of TMA by monitoring serial platelet counts, serum LDH, and creatinine during SOLIRIS therapy and for a minimum of 12 weeks after discontinuation of SOLIRIS (see **Monitoring after Discontinuation**). Patients may require dose adjustment within the recommended  $14 \pm 2$  day dosing schedule during the maintenance phase (up to every 12 days).

## gMG

There are no laboratory tests available for monitoring patients with gMG receiving SOLIRIS therapy.

### **Neurologic**

Transient, severe headaches were reported. Headache (occurred mostly in the initial phase of dosing) is most common adverse reaction in patients treated with SOLIRIS.

### **Ophthalmologic**

There were no serious ophthalmologic adverse events.

### **Peri-Operative Considerations**

There is no data on continuing or discontinuing SOLIRIS or adjusting dose for Peri-Operative considerations.

### **Psychiatric**

There were no serious psychiatric adverse events.

### **Renal**

The safety and efficacy of SOLIRIS have not been assessed in patients with renal disease (except with atypical HUS).

### **Respiratory**

There were no serious respiratory adverse events.

### **Sensitivity/Resistance**

As with all infusions with biologic agents, there is a risk of infusion reactions and anaphylaxis. (For information regarding allergic/infusion reactions, see **General: Allergy/Infusion Reactions** above).

### **Sexual Health**

#### ***Reproduction***

See section on **Pregnant Women** below.

#### ***Fertility***

No specific study on fertility has been conducted.

### **Thrombosis Prevention and Management**

In clinical studies of patients with PNH, there were fewer thrombotic events with SOLIRIS treatment than during the same period of time prior to treatment (see **Table 20** Thromboembolic events). The effect of withdrawal of anticoagulant therapy during SOLIRIS treatment has not been established. Therefore, treatment with SOLIRIS should not alter anticoagulant management.

## **8.1 Special Populations**

### **8.1.1 Pregnant Women**

Data in pregnant women treated with eculizumab from clinical trials and in a postmarketing setting, including PNH and atypical HUS registries, indicate that eculizumab is unlikely to

increase the risk of malformative or fetoneonatal toxicity in the PNH and atypical HUS patient population. There is insufficient data to adequately characterize the safety of eculizumab in pregnant women with gMG.

The use of SOLIRIS may be considered during pregnancy, if clinically needed.

In the general population, the estimated risks of major birth defects and miscarriage in clinically recognized pregnancies are 2-4% and 10-20%, respectively.

Limited data are available from reports of pregnancy-related outcomes from the safety database. Analysis of available data show no difference in the risk of overall major birth defects for eculizumab (0.94 per 100 live-births) compared with the background rate for major birth defects of 2.7% in the U.S. reference population of the Metropolitan Atlanta Congenital Defects Program (MACDP) or 2-3% in the U.K. reference population. The rate of fetal death (miscarriage and stillbirth) observed in the safety database is estimated to be 16.2%. The estimated background rate of miscarriage in clinically recognized pregnancies in the U.S. general population is 15-20%.

The background risk of birth defects for the indicated population of PNH or atypical HUS is not thought to be different than that in the general population. Rates of miscarriage and still birth are reported to be as high as 26% and 10% respectively in PNH. Methodological limitations of this data analysis include the use of MACDP and published literature on PNH and atypical HUS as the external comparator group. The MACDP population is not disease-specific, evaluates women and infants from a limited geographic area, and does not include outcomes for births that occurred at <20 weeks gestation.

Animal reproduction studies have not been conducted with SOLIRIS due to lack of pharmacologic activity in non-human species. Reproductive toxicology studies were conducted in mice using the murine surrogate molecule BB5.1, which assessed effect of C5 blockade on the reproductive system. No specific test-article related reproductive toxicities were identified in these studies.

### **8.1.2 Breast-feeding**

Limited data available suggest that eculizumab is not excreted in human milk.

The developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for eculizumab and any potential adverse effects on the breastfed child from eculizumab or from the underlying maternal condition.

Nonclinical reproductive toxicology studies conducted in mice with the murine surrogate molecule BB5.1 identified no adverse effect to pups resulting from consuming milk from treated dams.

### **8.1.3 Pediatrics**

#### **Pediatrics (< 18 years of age):**

In children and adolescent patients with PNH (aged 11 years to less than 18 years) included in the pediatric PNH Study, the safety profile appeared similar to that observed in adult patients



with PNH. The most common adverse reaction reported in pediatric patients was headache.

Four clinical studies assessing the safety and effectiveness of SOLIRIS for the treatment of atypical HUS included a total of 28 pediatric patients (ages 2 months to 17 years). The safety and effectiveness of SOLIRIS for the treatment of atypical HUS appear similar in pediatric and adult patients. Alexion also conducted a retrospective chart review in patients with atypical HUS treated with SOLIRIS outside of the scope of a clinical trial which included 19 pediatric patients.

Administer vaccinations for the prevention of infection due to *Neisseria meningitidis*, *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib) according to NACI guidelines (see **Warnings and Precautions**).

SOLIRIS has not been studied in pediatric patients with gMG.

#### **8.1.4 Geriatrics**

45 patients 65 years of age or older (15 with PNH, 4 with atypical HUS and 26 with gMG) were treated with SOLIRIS. Although there were no apparent age-related differences observed in these studies, the number of patients aged 65 and over is not sufficient to determine whether they respond differently from younger patients.

No overall differences in safety were reported between elderly ( $\geq 65$  years) and younger patients with gMG ( $< 65$  years).

## **9 ADVERSE REACTIONS**

### **9.1 Adverse Reaction Overview**

The most common adverse reaction was headache, (occurred mostly in the initial phase), and, of all meningococcal infections the most frequently reported serious adverse reaction was meningococcal sepsis.

Patients with PNH who discontinue treatment with SOLIRIS may be at increased risk for serious hemolysis. Thrombotic microangiopathy complications were observed after SOLIRIS discontinuation in the atypical HUS clinical studies.

Patients who discontinue SOLIRIS should be closely monitored.

### **9.2 Clinical Trial Adverse 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 reaction information from clinical trials is useful for identifying drug-related adverse events and for approximating rates. In a Phase III (study C01-004) multi-center, double blind, placebo-controlled trial, 87 transfusion-dependent patients ( $\geq 18$  years of age) with PNH were randomized to receive either

SOLIRIS (43) or placebo (44). The duration of treatment was 6 months for both treatment groups.

Drug related adverse events occurring in 2 or more SOLIRIS-treated patients are summarized in **Table 5**. The most frequent adverse events were headache and fatigue. Most headaches were mild and did not persist after the initial administration phase of SOLIRIS and resolved within 24-48 hours of SOLIRIS infusion.

**Table 5: Adverse Reactions\* Reported in ≥2 patients in PNH Study C04-001**

	C04-001	
	SOLIRIS (N=43)	Placebo (N=44)
GASTROINTESTINAL		
NAUSEA	2 ( 4.7%)	1 ( 2.3%)
ABDOMINAL PAIN	2 ( 4.7%)	1 ( 2.3%)
GENERAL		
FATIGUE	3 ( 7.0%)	0 (0.0%)
INFECTIONS AND INFESTATIONS		
UPPER RESPIRATORY TRACT INFECTION	2 ( 4.7%)	0 (0.0%)
ORAL HERPES	2 ( 4.7%)	0 (0.0%)
NERVOUS SYSTEM		
HEADACHE	15 (34.9%)	2 ( 4.5%)
SKIN AND SUBCUTANEOUS TISSUE		
DRY SKIN	2 ( 4.7%)	0 (0.0%)

\*Drug-related Adverse Events occurring at a higher frequency (1 or more patients) in the SOLIRIS-treated patients relative to placebo

Among 193 patients with PNH treated with SOLIRIS in the single arm, clinical study or the follow-up study (C04-002), adverse reactions were similar to those reported in the placebo-controlled clinical study. Serious adverse reactions occurred among 16% of the patients in these studies. The most common serious adverse reactions were: viral infection (2%), headache (2%), anemia (2%), and pyrexia (2%).

### Atypical HUS

The safety of SOLIRIS therapy in patients with atypical HUS was evaluated in four prospective, single-arm studies, three in adult and adolescent patients (Studies C08-002, C08-003, and C10-004), one in pediatric and adolescent patients (Study C10-003), and one retrospective study (Study C09-001r).

The data described below (**Table 6**) were derived from 78 adult and adolescent patients with atypical HUS enrolled in studies C08-002, C08-003, and C10-004. All patients received the recommended dosage of SOLIRIS, and the median exposure was 67 weeks (range: 2-145 weeks). The most commonly reported serious adverse events (SAE) were infections (24%), hypertension (5%), chronic renal failure (5%), and renal impairment (5%).

**Table 6** summarizes all adverse drug reactions reported in at least 10% of patients in atypical

HUS Studies C08-002, C08-003, and C10-004 combined.

**Table 6: Per Patient Incidence of Adverse Drug Reactions (ADRs) in 10% or More Adult and Adolescent Patients Enrolled in Atypical HUS Study C08-002, Atypical HUS Study C08-003, and Atypical HUS Study C10-004 Separately and in Total**

MedDRA ver. 15.1	Number (%) of Patients			
	Study C08-002 (N=17)	Study C08-003, (N=20)	Study C10-004 (N=41)	Total (N=78)
<b>Blood and Lymphatic System Disorders</b>				
Leukopenia	2 (11.8)	2 (10.0)	0 (0.0)	4 (5.1)
Lymphopenia	0 (0.0)	2 (10.0)	0 (0.0)	2 (2.6)
<b>Gastrointestinal Disorders</b>				
Nausea	2 (11.8)	0 (0.0)	0 (0.0)	2 (2.6)
Vomiting	3 (17.6)	0 (0.0)	1 (2.4)	4 (5.1)
<b>Nervous System Disorders</b>				
Headache	1 (5.9)	3 (15.0)	0 (0.0)	4 (5.1)
<b>Respiratory, Thoracic and Mediastinal Disorders</b>				
Cough <sup>a</sup>	0 (0.0)	2 (10.0)	0 (0.0)	2 (2.6)
<b>Vascular Disorders</b>				
Hypertension <sup>b</sup>	3 (17.6)	0 (0.0)	0 (0.0)	3 (3.8)

<sup>a</sup> Includes preferred terms Cough and Productive Cough

<sup>b</sup> Includes preferred terms Hypertension and Accelerated Hypertension

In Studies C08-002A/B, C08-003A/B, and C10-004 combined, 60% (47/78) of patients experienced a serious adverse event (SAE). The most commonly reported SAEs were infections (24%), hypertension (5%), chronic renal failure (5%), and renal impairment (5%).

#### Generalized Myasthenia Gravis (gMG)

In a 26-week placebo-controlled trial evaluating the effect of SOLIRIS for the treatment of gMG (gMG Study ECU-MG-301), 62 patients received SOLIRIS at the recommended dosage regimen and 63 patients received placebo. Patients were 19 to 79 years of age, and 66% were female. **Table 7** displays the most common adverse reactions from gMG Study ECU-MG-301 that occurred in ≥5% of SOLIRIS-treated patients and at a greater frequency than placebo.

**Table 7: Adverse Reactions Reported in 5% or More of SOLIRIS-Treated Patients in ECU-MG-301 Study and at a Greater Frequency than in Placebo-Treated Patients**

	SOLIRIS (N=62) n (%)	Placebo (N=63) n (%)
<b>Gastrointestinal Disorders</b>		
Abdominal Pain	5 (8)	3 (5)
<b>General Disorders and Administration Site Conditions</b>		

Peripheral edema	5 (8)	3 (5)
Pyrexia	4 (7)	2 (3)
<b>Infections and Infestations</b>		
Herpes simplex virus infections	5 (8)	1 (2)
<b>Injury, Poisoning, and Procedural Complications</b>		
Contusion	5 (8)	2 (3)
<b>Musculoskeletal and Connective Tissue Disorders</b>		
Musculoskeletal pain	9 (15)	5 (8)

The most common adverse reactions ( $\geq 10\%$ ) that occurred in SOLIRIS-treated patients in the long-term extension to gMG Study ECU-MG-301, Study ECU-MG-302, that are not included in **Table 7** were headache (26%), nasopharyngitis (24%), diarrhea (15%), arthralgia (12%), upper respiratory tract infection (11%), and nausea (10%).

#### Cumulative studies

Supportive safety data were obtained from 17 completed and one ongoing clinical study that included 473 patients exposed to eculizumab in three disease populations, including PNH, aHUS, and gMG.

**Table 8** lists the adverse reactions observed in eculizumab completed and ongoing clinical trials, including PNH, atypical HUS, and gMG studies. Adverse reactions reported at a very common ( $\geq 1/10$ ), common ( $\geq 1/100$  to  $< 1/10$ ), or uncommon ( $\geq 1/1,000$  to  $< 1/100$ ) frequency with eculizumab, are listed by system organ class and preferred term. Within each frequency grouping, adverse reactions are presented in order of decreasing seriousness.

**Table 8: Adverse Reactions reported in 473 patients included in overall eculizumab clinical trials, including patients with PNH, atypical HUS, and gMG**

MedDRA System Organ Class	Very Common ( $\geq 1/10$ )	Common ( $\geq 1/100$ to $< 1/10$ )	Uncommon ( $\geq 1/1,000$ to $< 1/100$ )
<b>Infection and infestations</b>	Nasopharyngitis, Upper respiratory tract infection, Urinary tract infection	Bronchitis, Influenza, Sinusitis, Viral infection, Oral herpes, Pneumonia, Cystitis, Lower respiratory tract infection, Cellulitis, Infection, Fungal infection, Gastrointestinal infection, Tooth infection,	Gingivitis, Septic shock, Abscess, Haemophilus infection, Peritonitis, Genitourinary tract gonococcal infection, Impetigo

		<sup>a</sup> Meningococcal infection, Sepsis	
<b>Neoplasms benign, malignant and unspecified (including cysts and polyps)</b>			Malignant melanoma, Myelodysplastic syndrome
<b>Blood and lymphatic system disorders</b>		Anaemia, Leukopenia, Haemolysis, Thrombocytopenia, Lymphopenia	Coagulopathy, Abnormal clotting factor, Red blood cell agglutination
<b>Immune system disorders</b>		Hypersensitivity	
<b>Endocrine disorders</b>			Basedow's disease
<b>Metabolism and nutrition disorders</b>		Decreased appetite	
<b>Psychiatric disorders</b>		Insomnia, Depression, Anxiety	Sleep disorder, Abnormal dreams, Mood swings
<b>Nervous system disorders</b>	Headache, Dizziness	Paraesthesia, Syncope, Dysgeusia	Tremor
<b>Eye disorders</b>		Vision blurred	Conjunctival irritation
<b>Ear and labyrinth disorders</b>		Vertigo, Tinnitus	
<b>Cardiac disorders</b>		Palpitations	
<b>Vascular disorders</b>		Hypertension, Haematoma, Hypotension	Hot flush, Accelerated hypertension, Vein disorder
<b>Respiratory, thoracic and mediastinal disorders</b>	Cough Oropharyngeal pain	Epistaxis Dyspnoea Rhinorrhoea Nasal congestion	Throat irritation
<b>Gastrointestinal disorders</b>	Diarrhoea, Nausea, Vomiting, Abdominal pain	Constipation, Dyspepsia, Abdominal distension, Gastrooesophageal reflux disease	Gingival pain
<b>Hepatobiliary disorders</b>			Jaundice
<b>Skin and subcutaneous</b>		Rash, Pruritus,	Skin depigmentation

<b>tissue disorders</b>		Alopecia, Dry skin, Erythema, Urticaria, Dermatitis, Hyperhidrosis, Petechiae	
<b>Musculoskeletal and connective tissue disorders</b>	Back pain, Arthralgia, Pain in extremity, Myalgia	Muscle spasms, Neck pain, Joint swelling, Bone pain	Trismus
<b>Renal and urinary disorders</b>		Renal impairment, Dysuria, Haematuria	
<b>Reproductive system and breast disorders</b>			Menstrual disorder, Spontaneous penile erection
<b>General disorders and administration site conditions</b>	Pyrexia, Fatigue	Influenza like illness, Chest pain, Asthenia, Chills, Chest discomfort, Oedema	Feeling hot, Infusion site pain, Extravasation, Injection site paraesthesia
<b>Investigations</b>			Alanine aminotransferase increased Gamma-glutamyltransferase increased, Haemoglobin decreased, Aspartate aminotransferase increased, Haematocrit decreased
<b>Injury, poisoning and procedural complication</b>		Infusion related reaction	

\*See Section 9.1 Adverse Reaction Overview

<sup>a</sup>Meningococcal infection includes the following group of PTs: Meningococcal sepsis, Meningococcal meningitis, Neisseria infection

### 9.3 Less Common Clinical Trial Adverse Reactions

**Table 8** lists uncommon ( $\geq 1/1,000$  to  $< 1/100$ ) frequency adverse reactions with eculizumab.

## 9.4 Abnormal Laboratory Findings: Hematologic, Clinical Chemistry and Other Quantitative Data

### PNH

CTC Grades 3 and 4 laboratory abnormalities were tabulated for PNH patients who had normal values at baseline (**Table 9**). Laboratory abnormalities were seen in 0% (creatinine) to 15.6% (direct bilirubin) of SOLIRIS-treated patients and they occurred at similar or slightly lower frequency in placebo-treated patients.

**Table 9: CTC Grade 3/4 Laboratory Abnormalities in Clinical Studies of SOLIRIS in PNH Patients**

	Percent of patients*	
	SOLIRIS (N=195)	Placebo (N=44)
Neutropenia	14.8	3.8
Thrombocytopenia	0.8	6.4
Elevated ALT	1.1	2.5
Elevated AST	11.1	N/A**
Elevated Direct Bilirubin	15.6	8.3
Elevated total Bilirubin	3.6	0
Elevated BUN	5.5	0
Elevated Creatinine	0	0

\*Worst on-study values in patients with normal baseline

CTC grades: neutropenia (Grade 3  $\geq 0.5-1.0 \times 10^9/L$ , Grade 4  $< 0.5 \times 10^9/L$ ); thrombocytopenia (Grade 3  $\geq 10-50 \times 10^9/L$ , Grade 4  $< 10 \times 10^9/L$ , Grade 4  $< 10 \times 10^9/L$ ); Elevated AST and ALT (Grade 3  $> 3-10 \times ULN$ , Grade 4  $> 10 \times ULN$ ); Elevated Bilirubin (Grade 3  $> 3-10 \times ULN$ , Grade 4  $> 10 \times ULN$ ); Elevated BUN; Elevated Creatinine (Grade 3  $> 3-6 \times ULN$ , Grade 4  $> 6 \times ULN$ )

\*\* All placebo treated patients had elevated AST at baseline

Low titer human anti-human antibodies were detected in 3/140 (2.1%) of PNH patients treated with SOLIRIS and in 1/44 (2.3%) of placebo-treated PNH patients. These low titer antibodies occurred transiently and with no apparent correlation between antibody development and either clinical response (i.e., reduction in hemolysis) or adverse events to SOLIRIS; these responses in the placebo group were therefore considered as false positive.

In the rheumatoid arthritis clinical trial of SOLIRIS, one patient exhibited an increase in anti-DNA antibody titer from 1:40 to 1:80 that was deemed an adverse drug reaction. Nine SOLIRIS- and one placebo-treated patient had anti-DNA antibody titers of  $> 1:80$  at the end of 26 weeks of treatment. The clinical significance of these observations is unknown.

### Atypical HUS

Overall, laboratory events were uncommon and no clinically meaningful changes in laboratory values were reported.

### gMG

Overall, there were no clinically meaningful differences between the placebo arm and the eculizumab arm in the change from Baseline in any hematology or chemistry parameters. No difference between treatment arms was observed in ECG parameters.

## 9.5 Clinical Trial Adverse Reactions (Pediatrics)

### PNH

In children and adolescent PNH patients (aged 11 years to less than 18 years) included in the pediatric PNH Study, the safety profile appeared similar to that observed in adult PNH patients. The most common adverse reaction reported in pediatric patients was headache.

### Atypical HUS

Atypical HUS Study C10-003 included 22 pediatric and adolescent patients, of which 18 pediatric patients were less than 12 years of age. All patients received the recommended dosage of SOLIRIS. Median exposure was 44 weeks (range: 1 dose-87 weeks).

**Table 10** summarizes all adverse events reported in at least 10% of patients enrolled in Study C10-003.

**Table 10: Per Patient Incidence of Adverse Reactions in 10% or More Patients Enrolled in Study C10-003**

	1 month to <12 yrs (n=18)	Total (n=22)
<b>Eye Disorders</b>	3 (17)	3 (14)
<b>Gastrointestinal Disorders</b>		
Abdominal pain	6 (33)	7 (32)
Diarrhea	5 (28)	7 (32)
Vomiting	4 (22)	6 (27)
Dyspepsia	0	3 (14)
<b>General Disorders and Administration Site Conditions</b>		
Pyrexia	9 (50)	11 (50)
<b>Infections and Infestations</b>		
Upper respiratory tract infection	5 (28)	7 (32)
Nasopharyngitis	3 (17)	6 (27)
Rhinitis	4 (22)	4 (18)
Urinary Tract infection	3 (17)	4 (18)
Catheter site infection	3 (17)	3 (14)
<b>Musculoskeletal and Connective Tissue Disorders</b>		
Muscle spasms	2 (11)	3 (14)
<b>Nervous System Disorders</b>		
Headache	3 (17)	4 (18)
<b>Renal and Urinary Disorders</b>	3 (17)	4 (18)
<b>Respiratory, Thoracic and Mediastinal Disorders</b>		
Cough	7 (39)	8 (36)



	1 month to <12 yrs (n=18)	Total (n=22)
Oropharyngeal pain	1 (6)	3 (14)
<b>Skin and Subcutaneous Tissue Disorders</b>		
Rash	4 (22)	4 (18)
<b>Vascular Disorders</b>		
Hypertension	4 (22)	4 (18)

In Study C10-003, 59% (13/22) of patients experienced a serious adverse event (SAE). The most commonly reported SAEs were hypertension (9%), viral gastroenteritis (9%), pyrexia (9%), and upper respiratory infection (9%). One patient discontinued SOLIRIS due to an adverse event (severe agitation).

Analysis of retrospectively collected adverse event data from pediatric and adult patients enrolled in atypical HUS Study C09-001r (N=30) revealed a safety profile that was similar to that which was observed in the two prospective studies. Atypical HUS Study C09-001r included 19 pediatric patients less than 18 years of age.

Overall, the safety of SOLIRIS in pediatric patients with atypical HUS enrolled in Study C09-001r appeared similar to that observed in adult patients. The most common ( $\geq 15\%$ ) adverse drug reactions occurring in pediatric patients are presented in **Table 11**.

**Table 11: Adverse Reactions Occurring in at Least 15% of Patients Less than 18 Years of Age Enrolled in atypical HUS Study C09-001r**

MedDRA ver. 11.0	Number (%) of Patients			
	< 2 yrs. (n=5)	2 to < 12 yrs. (n=10)	12 to <18 yrs. (n=4)	Total (n=19)
<b>General Disorders and Administration Site Conditions</b>				
Pyrexia	4 (80)	4 (40)	1 (25)	9 (47)
<b>Gastrointestinal Disorders</b>				
Diarrhea	1 (20)	4 (40)	1 (25)	6 (32)
Vomiting	2 (40)	1 (10)	1 (25)	4 (21)
<b>Infections and Infestations</b>				
Upper respiratory tract infection <sup>a</sup>	2 (40)	3 (30)	1 (25)	6 (32)
<b>Respiratory, Thoracic and Mediastinal Disorders</b>				
Cough	3 (60)	2 (20)	0 (0)	5 (26)
Nasal congestion	2 (40)	2 (20)	0 (0)	4 (21)
<b>Cardiac Disorders</b>				
Tachycardia	2 (40)	2 (20)	0 (0)	4 (21)

<sup>a</sup>includes the preferred terms upper respiratory tract infection and nasopharyngitis

One patient discontinued treatment due to serious adverse events of persistent worsening renal function, fever, increased creatinine and pancytopenia considered unrelated to SOLIRIS administration. One patient discontinued treatment with SOLIRIS whose systemic lupus had been misdiagnosed as atypical HUS (see section regarding **Monitoring After SOLIRIS Discontinuation / Missed Dose**).

### gMG

SOLIRIS has not been studied in pediatric patients with gMG.

## **9.6 Post-Market Adverse Reactions**

Overall, safety data from post-marketing reports for patients with PNH or atypical HUS are consistent with the known safety profile observed in clinical studies. Cases of serious or fatal meningococcal infections have been reported.

Post-marketing experience in patients with gMG is limited; however, clinical trial data demonstrated no difference of SOLIRIS safety profile across indication.

## **10 DRUG INTERACTIONS**

### **10.1 Overview**

Drug interaction studies have not been performed with SOLIRIS.

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

Interactions with other drugs have not been established.

### **10.3 Drug-Food Interactions**

Interactions with food have not been established.

### **10.4 Drug-Herb Interactions**

Interactions with herbal products have not been established.

### **10.5 Drug-Laboratory Test Interactions**

Interactions with laboratory tests have not been established.

### **10.6 Drug-Lifestyle Interactions**

There are no drug-lifestyle interactions known at this time.

## 11 ACTION AND CLINICAL PHARMACOLOGY

### 11.1 Mechanism of Action

Eculizumab, the active ingredient in SOLIRIS, is a monoclonal antibody that specifically binds to the complement protein C5 with high affinity, thereby inhibiting its cleavage to C5a and C5b and preventing the generation of the terminal complement complex C5b-9 and free C5a.

SOLIRIS inhibits terminal complement-mediated intravascular hemolysis in patients with PNH and complement-mediated thrombotic microangiopathy (TMA) in patients with atypical HUS. In patients with gMG, the mechanism of action of SOLIRIS is unknown. It is presumed to inhibit the terminal complement mediated C5b-9 complex deposition at the Neuromuscular Junction (NMJ).

### 11.2 Pharmacodynamics

Pharmacodynamic activity measured by free C5 concentrations of  $<0.5\mu\text{g/mL}$ , is correlated with essentially complete blockade of terminal complement activity in patients with PNH, atypical HUS, and gMG.

### 11.3 Pharmacokinetics

Following intravenous maintenance doses of 900 mg once every 2 weeks in patients with PNH, the week 26 observed mean  $\pm$  SD serum eculizumab maximum concentration ( $C_{\text{max}}$ ) was  $194 \pm 76 \mu\text{g/mL}$  and the trough concentration ( $C_{\text{trough}}$ ) was  $97 \pm 60 \mu\text{g/mL}$ . Following intravenous maintenance doses of 1200 mg once every 2 weeks in patients with aHUS, the week 26 observed mean  $\pm$  SD  $C_{\text{trough}}$  was  $242 \pm 101 \mu\text{g/mL}$ .

Following intravenous maintenance doses of 1200 mg once every 2 weeks in patients with gMG, the week 26 observed mean  $\pm$  SD  $C_{\text{max}}$  was  $783 \pm 288 \mu\text{g/mL}$  and the  $C_{\text{trough}}$  was  $341 \pm 172 \mu\text{g/mL}$ .

Steady state was achieved 4 weeks after starting eculizumab treatment, with accumulation ratio of approximately 2-fold in all studied indications. Population pharmacokinetic analyses showed that eculizumab pharmacokinetics were dose- linear and time-independent over the 600 mg to 1200 mg dose range, with inter-individual variability of 21% to 38%.

**Absorption:** SOLIRIS is administered intravenously; therefore, eculizumab bioavailability is assumed to be 100% with immediate absorption into the vascular space.

**Distribution:** SOLIRIS is a humanized antibody and is expected to have distribution similar to native human antibodies, primarily limited to the vascular space. The eculizumab volume of distribution for a typical 70 kg patient was 5 L to 8 L.

**Metabolism:** Eculizumab contains only naturally- occurring amino acids and has no known active metabolites. Human antibodies are predominately catabolized by lysosomal enzymes to small peptides and amino acids.

**Elimination:** The half-life of eculizumab is 11.3± 3.4 days.

### **Special Populations and Conditions**

**Renal Insufficiency:** The pharmacokinetics of SOLIRIS have been studied in patients with atypical HUS with a range of renal impairment and age. There have been no observed differences in pharmacokinetic parameters noted in these subpopulations of patients with atypical HUS.

### **Drug Interactions**

Intravenous human immunoglobulin (IVIg) treatment may interfere with the endosomal neonatal Fc receptor (FcRn) recycling mechanism of monoclonal antibodies such as eculizumab and thereby decrease serum eculizumab concentrations. Drug interaction studies have not been conducted with eculizumab in patients treated with IVIg.

## **12 STORAGE, STABILITY AND DISPOSAL**

SOLIRIS vials must be stored in the original carton until time of use under refrigerated conditions at 2-8 °C and protected from light. SOLIRIS vials may be held in the original carton at room temperature (not more than 25 °C) for a single period of up to 3 days. Do not use beyond the expiration date stamped on the carton. Refer to **Dosage and Administration: Reconstitution** for information on the stability and storage of diluted solutions of SOLIRIS.

## **13 SPECIAL HANDLING INSTRUCTIONS**

Do not Freeze. Do Not Shake.

## PART II: SCIENTIFIC INFORMATION

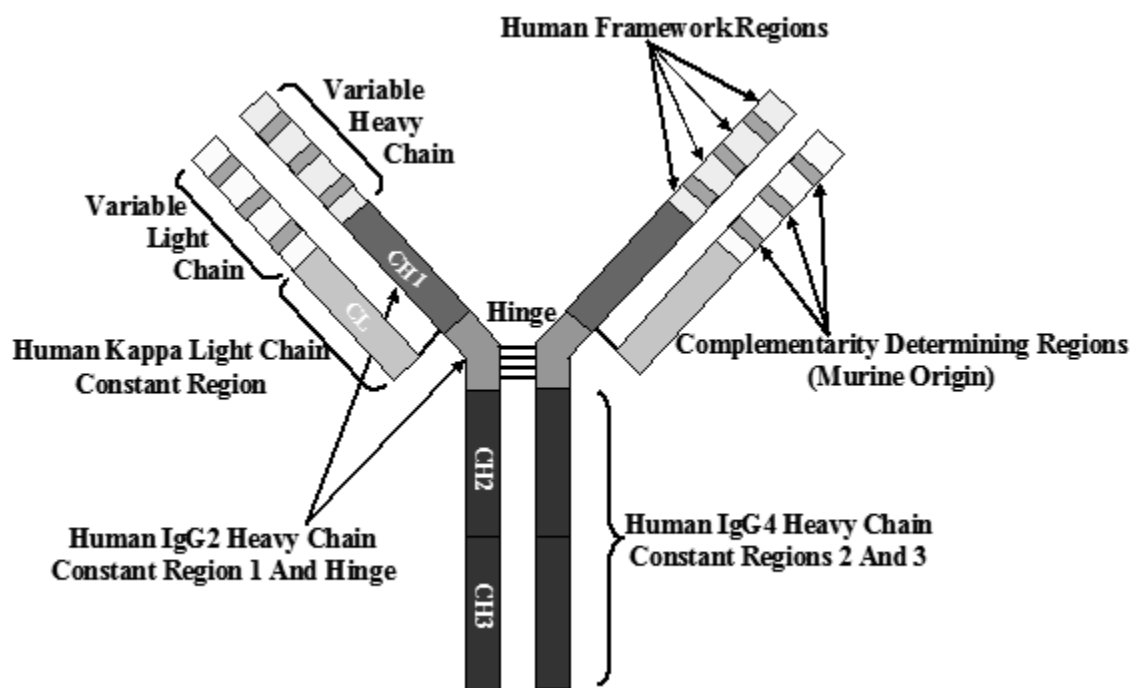
### 14 PHARMACEUTICAL INFORMATION

#### Drug Substance

Proper name: eculizumab

Molecular mass: Approximately 148 kDa

Structural formula:



Physicochemical properties:

#### Product Characteristics

SOLIRIS is a formulation of eculizumab which is a recombinant humanized monoclonal IgG2/4  $\kappa$  antibody that binds to the human C5 complement protein and inhibits the activation of terminal complement. Eculizumab contains human constant regions and murine complementarity-determining regions grafted onto the human framework light- and heavy-chain variable regions. Eculizumab is composed of two 448 amino acid heavy chains and two 214 amino acid light chains and has a molecular weight of approximately 148 kDa.

Eculizumab is produced in a murine myeloma (NS0 cell line) expression system and purified by affinity and ion exchange chromatography.

#### Viral Inactivation

The bulk drug substance manufacturing process includes specific viral inactivation and removal steps.

## 15 CLINICAL TRIALS

### 15.1 Trial Design and Study Demographics

#### PNH

The safety and efficacy of SOLIRIS in patients with PNH with hemolysis were assessed in a randomized, double-blind, placebo-controlled 26 week study (C04-001); PNH patients were also treated with SOLIRIS in a single arm 52 week study (C04-002); and in a long term extension study (E05-001). Patients received meningococcal vaccination prior to receipt of SOLIRIS. In all studies, the dose of SOLIRIS was 600 mg study drug every  $7 \pm 2$  days for 4 weeks, followed by 900 mg  $7 \pm 2$  days later, then 900 mg every  $14 \pm 2$  days for the study duration. SOLIRIS was administered as an intravenous infusion over 25 – 45 minutes.

In study C04-001, patients with PNH with at least 4 transfusions in the prior 12 months, flow cytometric confirmation of at least 10% PNH cells and platelet counts of at least 100,000/ $\mu$ L were randomized to either SOLIRIS (n = 43) or placebo (n = 44). Prior to randomization, all patients underwent an initial observation period to confirm the need for RBC transfusion and to identify the hemoglobin concentration (the "set-point") which would define each patient's hemoglobin stabilization and transfusion outcomes. The hemoglobin set-point was less than or equal to 9 g/dL in patients with symptoms and was less than or equal to 7 g/dL in patients without symptoms. Primary efficacy endpoints were hemoglobin stabilization (patients who maintained a hemoglobin concentration above the hemoglobin set-point and avoid any RBC transfusion for the entire 26 week period) and blood transfusion requirement. Fatigue and health-related quality of life were relevant secondary endpoints. Hemolysis was monitored mainly by the measurement of serum LDH levels, and the proportion of PNH RBCs was monitored by flow cytometry. Patients receiving anticoagulants and systemic corticosteroids at baseline continued these medications. Major baseline characteristics were balanced (see **Table 12**).

In the non-controlled Study C04-002, patients with PNH with at least one transfusion in the prior 24 months and at least 30,000 platelets/ $\mu$ L received SOLIRIS over a 52 week period. Concomitant medications included anti-thrombotic agents in 63% of the patients and systemic corticosteroids in 40% of the patients. Baseline characteristics are shown in **Table 12**.

**Table 12: Patient Demographics and Characteristics in C04-001 and C04-002**

Parameter	C04-001		C04-002
	Placebo N=44	SOLIRIS N=43	SOLIRIS N=97
Mean Age (SD)	38.4 (13.4)	42.1 (15.5)	41.1 (14.4)
Range	(18.0, 78.0)	(20.0, 85.0)	(18.0, 78.0)
Gender – Female (%)	29 (65.9)	23 (53.5)	49 (50.5)
History of Aplastic Anemia or MDS <sup>a</sup> (%)	12 (27.3)	8 (18.7)	29 (29.9)
Concomitant Anticoagulants (%)	20 (45.5)	24 (55.8)	59 (61)
Concomitant Steroids / Immunosuppressant Treatments (%)	16 (36.4)	14 (32.6)	46 (47.4)
Discontinued treatment	10	2	1
PRBC in previous 12 months, median (Q1,Q3)	17.0 (13.5, 25.0)	18.0 (12.0, 24.0)	8.0 (4.0, 24.0)
Range	(7.0, 44.0)	(7.0, 36.0)	(0.0, 66.0)

Mean Hgb level (g/dL) at set point (SD) Range	7.7 (0.75) (6.2, 9.0)	7.8 (0.79) (6.1, 8.8)	N/A
Pre-treatment LDH levels (median, U/L) Range	2,234.5 (636.0, 5530.0)	2,032.0 (499.0, 5962.0)	2,051.0 (537.0, 5245.0)
Free Hemoglobin at baseline (median, mg/dL) Range	46.2 (11.2, 502.0)	40.5 (7.5, 764.0)	34.9 (2.0, 317.5)

<sup>a</sup>MDS=myeloplastic syndrome

### Atypical HUS

Four single-arm prospective studies (atypical HUS Studies C08-002, C08-003, C10-004, and C10-003) evaluated the safety and efficacy of SOLIRIS for the treatment of atypical HUS. Patients with atypical HUS received meningococcal vaccination prior to receipt of SOLIRIS or received prophylactic treatment with antibiotics until 2 weeks after vaccination. In all studies, the dose of SOLIRIS in adult and adolescent patients was 900 mg every 7 ± 2 days for 4 weeks, followed by 1200 mg 7 ± 2 days later, then 1200 mg every 14 ± 2 days thereafter.

Study C09-001r was a retrospective chart review. The dosage regimen for pediatric patients weighing less than 40 kg enrolled in Study C10-003 was based on body weight [see **Dosage and Administration**].

- Efficacy evaluations were based on thrombotic microangiopathy (TMA) endpoints, including platelet count change from baseline
- Hematologic normalization (*maintenance of normal platelet counts and LDH levels for at least four weeks*)
- Complete TMA response (*hematologic normalization plus at least a 25% reduction in serum creatinine for a minimum of four weeks*)
- TMA-event free status (*absence for at least 12 weeks of a decrease in platelet count of >25% from baseline, plasma exchange or plasma infusion, and new dialysis requirement*)
- Daily TMA intervention rate (*defined as the number of plasma exchange or plasma infusion interventions and the number of dialyses required per patient per day*)

### Atypical HUS Resistant to PE/PI (Study C08-002)

Study C08-002 enrolled patients who displayed signs of thrombotic microangiopathy (TMA) despite receiving at least four PE/PI treatments the week prior to screening. One patient had no PE/PI the week prior to screening because of PE/PI intolerance. In order to qualify for enrollment, patients were required to have a platelet count ≤150 x 10<sup>9</sup>/L, evidence of hemolysis such as an elevation in serum LDH, and serum creatinine above the upper limits of normal, without the need for chronic dialysis. The median patient age was 28 (range: 17 to 68 years). Patients enrolled in Study C08-002 were required to have ADAMTS-13 activity level above 5%; observed range of values in the trial were 70%-121%. Seventy-six percent (76%) of patients had an identified complement regulatory factor mutation or auto-antibody. **Table 13** summarizes the key baseline clinical and disease-related characteristics of patients enrolled in Study C08-002.

**Table 13: Baseline Characteristics of Patients Enrolled in Study C08-002**

Parameter	Study C08-002 N = 17
Time from atypical HUS diagnosis until screening in months, median (min, max)	10 (0.26, 236)
Time from current clinical TMA manifestation until screening in months, median (min, max)	<1 (<1, 4)
Baseline platelet count ( $\times 10^9/L$ ), median (range)	118 (62, 161)
Baseline LDH (U/L), median (range)	269 (134, 634)

Patients in Study C08-002 received SOLIRIS for a minimum of 26 weeks. Study C08-002. The median duration of SOLIRIS therapy was approximately 100 weeks (range: 2 weeks to 145 weeks), and the primary endpoint was change in platelet count from baseline through Week 26.

### **Atypical HUS Sensitive to PE/PI (Study C08-003)**

Study C08-003 enrolled patients undergoing chronic PE/PI who generally did not display hematologic signs of ongoing thrombotic microangiopathy (TMA). All patients had received PT at least once every two weeks, but no more than three times per week, for a minimum of eight weeks prior to the first SOLIRIS dose. Patients on chronic dialysis were permitted to enroll in Study C08-003. The median patient age was 28 years (range: 13 to 63 years). Patients enrolled in Study C08-003 were required to have ADAMTS13 activity level above 5%; observed range of values in the trial were 37%-118%. Seventy percent of patients had an identified complement regulatory factor mutation or auto-antibody.

**Table 14** summarizes the key baseline clinical and disease-related characteristics of patients enrolled in Study C08-003.

**Table 14: Baseline Characteristics of Patients Enrolled in Study C08-003**

Parameter	Study C08-003 N=20
Time from atypical HUS diagnosis until screening in months, median (min, max)	48 (0.66, 286)
Time from current clinical TMA manifestation until screening in months, median (min, max)	9 (1, 45)
Baseline platelet count ( $\times 10^9/L$ ), median (range)	218 (105, 421)
Baseline LDH (U/L), median (range)	200 (151, 391)

Patients in Study C08-003 received SOLIRIS for a minimum of 26 weeks. The primary endpoint was TMA Event-Free status defined as no decrease in platelet count >25% AND no PT AND no new dialysis for 12 consecutive weeks during the study period. In Study C08-003, the median duration of SOLIRIS therapy was approximately 114 weeks (range: 26 to 129 weeks).



### **Adult Patients with atypical HUS (Study C10-004)**

Study C10-004 enrolled patients who displayed signs of thrombotic microangiopathy (TMA). In order to qualify for enrollment, patients were required to have a platelet count < lower limit of normal range (LLN), evidence of hemolysis such as an elevation in serum LDH, and serum creatinine above the upper limits of normal, without the need for chronic dialysis. The median patient age was 35 (range: 18 to 80 years). All patients enrolled in Study C10-004 were required to have ADAMTS13 activity level above 5%; observed range of values in the trial were 28-116%. Fifty-one percent of patients had an identified complement regulatory factor mutation or auto-antibody. A total of 35 patients received PE/PI prior to eculizumab. **Table 15** summarizes the key baseline clinical and disease-related characteristics of patients enrolled in Study C10-004.

**Table 15: Baseline Characteristics of Patients Enrolled in Study C10-004**

<b>Parameter</b>	<b>Study C10-004 N = 41</b>
Time from atypical HUS diagnosis until screening in months, median (range)	0.79 (0.03 – 311)
Time from current clinical TMA manifestation until first study dose in months, median (range)	0.52 (0.03-19)
Baseline platelet count ( $\times 10^9/L$ ), median (range)	125 (16 – 332)
Baseline LDH (U/L), median (range)	375 (131 – 3318)

Patients in Study C10-004 received SOLIRIS for a minimum of 26 weeks. The submission primary endpoint was the responder rate defined by the proportion of patients with complete TMA response as evidenced by normalization of hematological parameters [platelet count and lactate dehydrogenase (LDH)] and  $\geq 25\%$  decrease in serum creatinine from baseline during treatment with eculizumab. Complete TMA response is defined as two consecutive measurements obtained at least 4 weeks apart. In Study C10-004, the median duration of SOLIRIS therapy was approximately 50 weeks (range: 13 weeks to 86 weeks).

### **Pediatric and Adolescent Patients with atypical HUS (atypical HUS Study C10-003)**

Atypical HUS Study C10-003 enrolled patients who were required to have a platelet count < lower limit of normal range (LLN), evidence of hemolysis such as an elevation in serum LDH above the upper limits of normal, serum creatinine level  $\geq 97$  percentile for age without the need for chronic dialysis. The median patient age was 6.5 years (range: 5 months to 17 years). Patients enrolled in Study C10-003 were required to have ADAMTS13 activity level above 5%; observed range of values in the trial were 38%-121%. Fifty percent of patients had an identified complement regulatory factor mutation or auto-antibody. A total of 10 patients received PE/PI prior to eculizumab. **Table 16** summarizes the key baseline clinical and disease-related characteristics of patients enrolled in atypical HUS Study C10-003.

**Table 16: Baseline Characteristics of Patients Enrolled in atypical HUS C10-003**

Parameter	Patients 1 month to <12 years (N = 18)	All Patients (N = 22)
Time from atypical HUS diagnosis until screening in months, median (range)	0.51 (0.03 – 58)	0.56 (0.03-191)
Time from current clinical TMA manifestation until first study dose in months, median (range)	0.23 (0.03 – 4)	0.2 (0.03-4)
Baseline platelet count (x10 <sup>9</sup> /L), median (range)	110 (19-146)	91 (19-146)
Baseline LDH (U/L) median (range)	1510 (282-7164)	1244 (282-7164)

Patients in atypical HUS Study C10-003 received SOLIRIS for a minimum of 26 weeks. The primary endpoint was responder rate defined by the proportion of patients with Complete TMA response as evidenced by normalization of hematological parameters [platelet count and lactate dehydrogenase (LDH)] and  $\geq 25\%$  improvement in serum creatinine from baseline during treatment with eculizumab. Complete TMA response is defined as two consecutive measurements obtained at least four weeks apart. In atypical HUS Study C10-003, the median duration of SOLIRIS therapy was approximately 44 weeks (range: 1 dose to 88 weeks).

#### Generalized Myasthenia Gravis

**Table 17: Summary of Patient Demographics for Clinical Trials in gMG**

Study	Trial Design	Dosage, Route of Administration, and Duration	Number of Study Subjects	Mean Age (years)	Percent Female
ECU-MG-301	Randomized, double-blind, placebo controlled, multicenter, Phase III	Dosage: 900 mg every 7 $\pm$ 2 days for 4 weeks, followed by 1200 mg every 14 $\pm$ 2 days  Route of Administration: IV over 35 minutes  Duration: 26 Weeks	125	46	66%
ECU-MG-302	Open-label, multicenter, extension of Study ECU-MG-301	Dosage: 900 mg every 7 $\pm$ 2 days for 4 weeks, followed by 1200 mg every 14 $\pm$ 2 days	117	47	67.5%

		Route of Administration: IV over 35 minutes			
		Duration: Up to 4 years			

SOLIRIS was studied in clinical trials in patients who were anti-acetylcholine receptor (AChR) antibody positive and refractory, defined as failure of treatment with two or more immunosuppressive therapies (ISTs) either in combination or as monotherapy, or failed at least one IST and required chronic plasmapheresis, plasma exchange (PE), or intravenous immunoglobulin (IVIg) to control symptoms. Patients continued to receive standard therapy throughout the pivotal clinical trial.

## 15.2 Study Results

### **PNH Study C04-001 and C04-002**

In Study C04-001, patients treated with SOLIRIS had significantly reduced ( $p < 0.001$ ) hemolysis resulting in improvements in anemia as indicated by increased percentage of patients with hemoglobin stabilization and reduced median RBC transfusions compared to placebo treated patients (see **Table 18**). These effects were seen among patients within each of the three pre-study RBC transfusion strata (4 - 14 units; 15 - 25 units; >25 units), with the exception of no statistically significant hemoglobin stabilization in patients who previously required >25 units; however, this must be interpreted with caution since the numbers in each stratum are limited (see **Table 19**). Patients reported less fatigue and improved health-related quality of life. Because of the study sample size and duration, the effects of SOLIRIS on thrombotic events could not be determined.

In Study C04-002, 96 of the 97 enrolled patients completed the study (one patient died following a thrombotic event). A reduction in intravascular hemolysis, as measured by median serum LDH levels, was achieved for the treatment (see **Table 20**).

**Table 18: Efficacy Outcomes in PNH Study C04-001**

	PNH Study C04-001		
	Placebo N=44	SOLIRIS N=43	P-Value
Percentage of patients with stabilized Hemoglobin levels at end of study	0	49	< 0.001 <sup>a</sup>
Median PRBC transfused during treatment (range)	10 (2.0, 21.0)	0 (0.0, 16.0)	< 0.001 <sup>b</sup>
Transfusion Avoidance during treatment (%)	0	51	< 0.001 <sup>a</sup>
Median LDH levels at end of study (U/L) (Range)	2,167 (1183, 5643)	239 (142, 2984)	< 0.001 <sup>b</sup>
Median LDH AUC at end of study (U/L x Day) (Range) <sup>c</sup>	411,822 (161414, 886544)	58,587 (32,417, 792,006)	< 0.001 <sup>b</sup>
Median Free Hemoglobin at end of study (mg/dL) (Range)	62 (0.7, 386)	5 (2.9, 194)	< 0.001 <sup>b</sup>
FACIT-Fatigue (effect size) <sup>d</sup>		1.13	< 0.001 <sup>e</sup>

<sup>a</sup>P value calculated using Fisher's exact test

<sup>b</sup>P value calculated with Wilcoxon rank sum test

<sup>c</sup>LDH AUC: For PNH Study C04-001, LDH AUC was calculated using trapezoid rule for the actual LDH values

<sup>d</sup>FACIT effect size: For PNH Study C04-001, effect size was based on the difference between eculizumab and placebo group

<sup>e</sup>P value calculated using the 2 sided t-test

**Table 19: Efficacy Outcomes in PNH Study C04-001 by Transfusion Strata**

Outcome Measure	Transfusion Strata <sup>a</sup>	Placebo (N)	SOLIRIS (N)	P-Value
Percentage of patients with stabilized Hemoglobin levels at end of study (%) (N)	Overall	0 (44)	49 (43)	< 0.001 <sup>b</sup>
	4 – 14 Units	0 (15)	80 (15)	< 0.001 <sup>b</sup>
	15 – 25 Units	0 (18)	29 (17)	0.02
	>25 Units	0 (11)	36 (11)	ns
Median PRBC transfused during treatment (N) (Range)	Overall	10 (44) (2.0, 21.0)	0 (43) (0.0, 16.0)	< 0.001 <sup>c</sup>
	4 – 14 Units	6 (15) (2.0, 2.00)	0 (15) (0.0, 4.0)	< 0.001 <sup>c</sup>
	15 – 25 Units	10 (18) (2.0, 21.0)	2 (17) (0.0, 15.0)	< 0.001 <sup>c</sup>
	>25 Units	18 (11) (10.0, 20.0)	3 (11) (0.0, 16.0)	< 0.001 <sup>c</sup>
Transfusion Avoidance during treatment (%) (N)	Overall	0 (44)	51 (43)	< 0.001 <sup>b</sup>
	4 – 14 Units	0 (15)	80 (15)	< 0.001 <sup>b</sup>
	15 – 25 Units	0 (18)	35 (17)	0.008
	>25 Units	0 (11)	36 (11)	ns
Median LDH AUC at end of study (U/L x Day) (N) (Range)	Overall	411,822 (44) (161414, 886544)	58,587 (43) (32417, 792006)	< 0.001 <sup>c</sup>
	4 – 14 Units	398,573 (15) (230352, 697638)	53,610 (15) (38341, 792006)	< 0.001 <sup>c</sup>
	15 – 25 Units	420,338 (18) (161414, 886544)	56,127 (17) (32417, 90115)	< 0.001 <sup>c</sup>
	>25 Units	441880 (11) (234605, 711934)	67,181 (11) (33231, 242072)	< 0.001 <sup>c</sup>

<sup>a</sup>Transfusion strata based on transfusion data 12 months prior to study screening

<sup>b</sup>P value calculated with Fisher's exact test; ns = not significant (P>0.05)

<sup>c</sup>P value calculated with Wilcoxon rank sum test

**Table 20: Efficacy Outcomes in PNH Study C04-002**

	PNH Study C04-002 <sup>a</sup>	
	SOLIRIS N=97	P- Value
Median LDH levels at end of study (U/L) (Range)	269 (106, 2117)	< 0.001 <sup>b</sup>
Median LDH AUC at end of study (U/L x Day) (Range) <sup>c</sup>	-632,264 (-1788824, -74498)	< 0.001 <sup>b</sup>
Median Free Hemoglobin at end of study (mg/dL) (Range)	5 (1.1, 85)	< 0.001 <sup>b</sup>
FACIT-Fatigue (effect size) <sup>d</sup>	1.01	< 0.001 <sup>e</sup>

<sup>3</sup>Results from Study PNH Study C04-002 refer to pre- versus post-treatment comparisons.

<sup>b</sup>P value calculated with Wilcoxon signed rank test

<sup>c</sup>LDH AUC: For PNH Study C04-002, LDH AUC was calculated using trapezoid rule for change of LDH from baseline.

<sup>d</sup>FACIT effect size: For PNH Study C04-002, effect size was based on change from baseline.

<sup>e</sup>P value calculated using the 2 sided t-test

From the 195 patients that originated in PNH Study C04-001, PNH Study C04-002 and other initial studies, SOLIRIS-treated PNH patients were enrolled in a long term extension study (PNH Extension Study). All patients sustained a reduction in intravascular hemolysis over a total SOLIRIS exposure time ranging from 10 to 54 months. There were fewer thrombotic events with SOLIRIS treatment than during the same period of time prior to treatment (see **Table 21**). However, the majority of patients received concomitant anticoagulants; the effect of anticoagulant withdrawal during eculizumab therapy was not studied (see **Warnings and Precautions**).

**Table 21: Thromboembolic Events in Patients during SOLIRIS Treatment Period Compared to Thromboembolic Events during the Same Period of Time Pre-SOLIRIS Treatment**

	<b>PNH Extension Study (All studies combined)</b>
<b>Pre-Treatment</b>	
Patients (n)	195
Thrombotic Events (n)	39
Patient Years (n)	272.1
Thromboembolic Event Rate (n per 100 patient-years)	14.33
<b>SOLIRIS Treatment</b>	
Patients (n)	195
Thromboembolic Events (n)	3
Patient Years (n)	281.0
Thromboembolic Event Rate (n per 100 patient-years)	1.07 (P<0.001) <sup>a</sup>

<sup>a</sup>p value calculated with a non-parametric signed rank test

### **Atypical HUS Resistant to PE/PI (Study C08-002)**

Renal function, as measured by eGFR, was improved and maintained during SOLIRIS therapy. The mean eGFR ( $\pm$ SD) increased from  $23 \pm 15$  mL/min/1.73m<sup>2</sup> at baseline to  $56 \pm 40$  mL/min/1.73m<sup>2</sup> by 26 weeks; this effect was maintained through 2 years ( $56 \pm 30$  mL/min/1.73m<sup>2</sup>). Four of the five patients who required dialysis at baseline were able to discontinue dialysis.

Reduction in terminal complement activity and an increase in platelet count relative to baseline were observed after commencement of SOLIRIS. SOLIRIS reduced signs of complement-mediated TMA activity, as shown by an increase in mean platelet counts from baseline to 26 weeks. In Study C08-002, mean platelet count ( $\pm$  SD) increased from  $109 \pm 32 \times 10^9/L$  at baseline to  $169 \pm 72 \times 10^9/L$  by one week; this effect was maintained through 26 weeks ( $210 \pm 68 \times 10^9/L$ , and 2 years ( $205 \pm 46 \times 10^9/L$ ). When treatment was continued for more than 26 weeks, two additional patients achieved Hematologic Normalization as well as Complete TMA response. Hematologic Normalization and Complete TMA response were maintained by all responders.

**Table 22** summarizes the efficacy results for Study C08-002.

**Table 22: Efficacy Results for Study C08-002**

Efficacy Parameter	Study C08-002 at 26 wks <sup>a</sup> N=17	Study C08-002 at 2 yrs <sup>b</sup> N=17
Platelet Count Normalization <sup>c</sup>	14 (82)	15 (88)
Complete TMA response, n (%) Median Duration of complete TMA response, weeks (range)	11 (65) 38 (25, 56)	13 (77) 99 (25, 139)
eGFR improvement $\geq 15$ mL/min/1.73 m <sup>2</sup> , n (%) Median duration of eGFR improvement, days (range)	9 (53) 251 (70, 392)	10 (59) ND
Hematologic normalization, n (%) Median Duration of hematologic normalization, weeks (range)	13 (76) 37 (25, 62)	15 (88) 99 (25, 145)
TMA event-free status, n (%)	15 (88)	15 (88)
Daily TMA intervention rate, median (range) Before eculizumab On eculizumab treatment	0.88 (0.04, 1.59) 0 (0, 0.31)	0.88 (0.04, 1.59) 0 (0, 0.31)

<sup>a</sup>At data cut-off (September 8, 2010).

<sup>b</sup>At data cut-off (April 20, 2012).

<sup>c</sup>Normal platelet count is defined as  $\geq 150 \times 10^9/L$ .

### **Atypical HUS Sensitive to PE/PI (Study C08-003)**

Renal function, as measured by eGFR, was maintained during SOLIRIS therapy. The mean eGFR ( $\pm$  SD) was  $31 \pm 19$  mL/min/1.73m<sup>2</sup> at baseline, and was maintained through 26 weeks ( $37 \pm 21$  mL/min/1.73m<sup>2</sup>) and 2 years ( $40 \pm 18$  mL/min/1.73m<sup>2</sup>). No patient required new dialysis with SOLIRIS.

Reduction in terminal complement activity was observed in all patients after the commencement of SOLIRIS. SOLIRIS reduced signs of complement-mediated TMA activity, as shown by an increase in mean platelet counts from baseline to 26 weeks. Platelet counts were maintained at normal levels despite the elimination of PE/PI. The mean platelet count ( $\pm$  SD) was  $228 \pm 78 \times 10^9/L$  at baseline,  $233 \pm 69 \times 10^9/L$  at week 26, and  $224 \pm 52 \times 10^9/L$  at 2 years. When treatment was continued for more than 26 weeks, six additional patients achieved Complete TMA response. Complete TMA Response and Hematologic Normalization were maintained by all responders.

**Table 23** summarizes the efficacy results for Study C08-003.

**Table 23: Efficacy Results of Patients Enrolled in Study C08-003**

<b>Efficacy Parameter</b>	<b>Study C08-003 at 26 wks<sup>a</sup> N=20</b>	<b>Study C08-003 at 2 yrs<sup>b</sup> N=20</b>
Complete TMA response, n (%)	5 (25)	11 (55)
Median duration of complete TMA response, weeks (range)	32 (12, 38)	68 (38, 109)
eGFR improvement $\geq 15$ mL/min/1.73 m <sup>2</sup> , n (%)	1 (5)	8 (40)
TMA Event-free status n (%)	16 (80)	19 (95)
Daily TMA intervention rate, median (range)		
Before eculizumab	0.23 (0.05, 1.09)	0.23 (0.05, 1.09)
On eculizumab treatment	0	0
Hematologic normalization <sup>d</sup> , n (%)	18 (90)	18 (90)
Median duration of hematologic normalization, weeks (range) <sup>c</sup>	38 (22, 52)	114 (33, 125)

<sup>a</sup>At data cut-off (September 8, 2010).

<sup>b</sup>At data cut-off (April 20, 2012).

<sup>c</sup>Calculated at each post-dose day of measurement (excluding Days 1 to 4) using a repeated measurement ANOVA model.

<sup>d</sup>In atypical HUS Study C08-003, 85% of patients had normal platelet counts and 80% of patients had normal serum LDH levels at baseline, so hematologic normalization in this population reflects maintenance of normal parameters in the absence of PE/PI.

In atypical HUS studies C08-002, C08-003, and C10-004, a total of 43% of patients with no known mutation in the gene encoding for complement regulatory protein achieved Complete TMA response compared, to 54% of patients with a known mutation. In pediatric and adolescents Study C10-003, complete TMA response was achieved in 55% of patients with no known mutation compared to 73% in patients with a known mutation. The number of patients in each group was small. Efficacy outcomes were independent whether patient had in an identified genetic mutation

### **Retrospective Chart Review of Patients with atypical HUS (Study C09-001r)**

Exploratory analyses were conducted in the retrospective chart review (Study C09-001r) and results were generally consistent with results of the two prospective studies. SOLIRIS reduced signs of complement-mediated TMA activity, as shown by an increase in mean platelet counts from baseline. Mean platelet count ( $\pm$  SD) increased from  $171 \pm 83 \times 10^9/L$  at baseline to  $233 \pm 109 \times 10^9/L$  after one week of therapy; this effect was maintained through 26 weeks (mean platelet count ( $\pm$  SD) at week 26:  $254 \pm 79 \times 10^9/L$ ).

A total of 19 pediatric patients (ages 2 months to 17 years) received SOLIRIS in Study C09-001r. The median duration of SOLIRIS therapy was 16 weeks (range 4 to 70 weeks) for children < 2 years of age (n=5), 31 weeks (range 19 to 63 weeks) for children 2 to <12 years of age (n=10), and 38 weeks (range 1 to 69 weeks) for patients 12 to 18 years of age (n=4). Fifty three percent of pediatric patients had an identified complement regulatory factor mutation or

auto-antibody. Eighty nine percent (17/19, 89%) of these pediatric patients achieved a platelet count normalization and 42% (8/19) had hematologic normalization and complete TMA responses. The daily TMA intervention rate decreased from a median of 0.31 prior to eculizumab to 0 after eculizumab. No pediatric patient required new dialysis.

**Table 24: Efficacy Results in Pediatric Patients Enrolled in Study C09-001r**

Efficacy Parameter	<2 yrs. (n=5)	2 to <12 yrs. (n=10)	12 to <18 yrs. (n=4)	Total (n=19)
Patients with Hematologic Normalization and Complete TMA Response	2/5 (40)	5/9 (56)	1/3 (33)	8 (47)
Patients with eGFR improvement $\geq$ 15 mL/min/1.73 m <sup>2</sup> , n (%) <sup>b</sup>	2 (40)	6 (60)	1 (25)	9 (47)
Platelet count normalization, n (% <sup>a</sup> )	4 (80)	10 (100)	3 (75)	17 (89)
Daily TMA intervention rate, median (range)				0.31 (0.00, 2.38)
Before eculizumab	1 (0, 2)	<1 (0.07, 1.46)	<1 (0, 1)	0.00
On eculizumab treatment	<1 (0, <1)	0 (0, <1)	0 (0, <1)	(0.00, 0.08)

<sup>a</sup> Platelet count normalization was defined as a platelet count of at least 150,000 X 10<sup>9</sup>/L on at least two consecutive measurements spanning a period of at least 4 weeks.

<sup>b</sup> Of the 9 patients who experienced an eGFR improvement of at least 15 mL/min/1.73 m<sup>2</sup>, one received dialysis throughout the study period and another received SOLIRIS as prophylaxis following renal allograft transplantation.

### **Adult Patients with atypical HUS (Study C10-004)**

Complete TMA Response was achieved by 23 patients (56%; 95% CI: 40, 72) through Week 26 and by 26 patients (63%; 95% CI 47, 78) through data cut-off. All patients who achieved a response through Week 26 remained in response through data cut-off. The median duration of Submission Complete TMA Response through data cut-off was nine months (range 1-17 months).

Thirty-six patients (88%; 95% CI: 74, 96) achieved a Hematologic Normalization through Week 26 and 40 patients (98%; 95% CI: 87, 99) through data cut-off. Hematologic Normalization was maintained in all 40 responders. The median duration of Hematologic Normalization through data cut-off was 10 months (range 2-17 months).

Renal function, as measured by eGFR, was improved during SOLIRIS therapy. The mean eGFR ( $\pm$  SD) increased from 17  $\pm$  12 mL/min/1.73m<sup>2</sup> at baseline to 47  $\pm$  24 mL/min/1.73m<sup>2</sup> by 26 weeks. Of the 24 patients who required dialysis at study baseline, 5 patients discontinued dialysis prior to the first dose of SOLIRIS and 15 were able to discontinue dialysis during SOLIRIS treatment.

Reduction in terminal complement activity and an increase in platelet count relative to baseline were observed after commencement of SOLIRIS. SOLIRIS reduced signs of complement-mediated TMA activity, as shown by an increase in mean platelet counts from baseline to 26 weeks. In Study C10-004, mean platelet count ( $\pm$  SD) increased from 119  $\pm$  66 x10<sup>9</sup>/L at baseline to 200  $\pm$  84 x10<sup>9</sup>/L by one week; this effect was maintained through 26 weeks (mean platelet count ( $\pm$ SD) at week 26: 252  $\pm$  70 x10<sup>9</sup>/L).



**Table 25** summarizes the efficacy results for Study C10-004.

**Table 25: Results of Atypical HUS study C10-004**

<b>Efficacy Parameter</b>	<b>Study C10-004 (N = 41)</b>
Platelet Count Normalization <sup>a</sup>	40 (98%)
Complete TMA response, n (%), 95% CI	23 (56), 40,72
Median duration of submission complete TMA response, weeks (range)	42 (6, 75)
Patients with eGFR improvement $\geq 15$ mL/min/1.73 m <sup>2</sup> , n (%)	22 (54)
Hematologic Normalization, n (%)	36 (88)
Median duration of hematologic normalization, weeks (range)	46 (10, 75)
TMA Event-free Status, n (%)	37 (90)
Daily TMA Intervention Rate, median (range)	
Before eculizumab	0.63 (0, 1.38)
On eculizumab treatment	0 (0, 0.58)

<sup>a</sup>Normal platelet count is defined as  $\geq 150 \times 10^9/L$ .

### **Pediatric and Adolescent Patients with atypical HUS (Study C10-003)**

The primary endpoint was responder rate defined by the proportion of patients with Complete TMA response as evidenced by normalization of hematological parameters [platelet count and lactate dehydrogenase (LDH)] and  $\geq 25\%$  improvement in serum creatinine from baseline during treatment with eculizumab. Complete TMA response is defined as two consecutive measurements obtained at least four weeks apart. In atypical HUS Study C10-003, the median duration of SOLIRIS therapy was approximately 44 weeks (range: 1 dose to 88 weeks). Complete TMA response was achieved in 14 of the 22 patients (64%; 95% CI: 41, 83) through Week 26 and in 15 patients (68%; 95% CI: 45, 86) through data cut-off. All 15 patients maintained their response through data cut-off, with a median duration of eight months (range 3 - 18 months).

For the 18 pediatric patients <12 years old, Complete TMA Response rates were similar through Week 26 (11 patients [61%; 95% CI: 36, 83]) and through data cut-off (12 patients [67%; 95% CI: 41, 87]).

Hematologic Normalization was observed in 18 of 22 patients (82%; 95% CI: 60, 95) through Week 26 and increased to 20 patients (91%; 95% CI: 71, 99) through data cut-off. Hematologic Normalization was maintained in all 20 responders through data cut-off with a median duration of 8 months (range 3 – 18 months).

For the 18 pediatric patients <12 years old, Hematologic Normalization was achieved in 14 patients (78; 95% CI: 52, 94) through Week 26 and 16 patients (89%; 95% CI: 65, 99) through data cut-off.

Renal function, as measured by median eGFR, was improved during SOLIRIS therapy. The mean eGFR ( $\pm$  SD) increased from  $33 \pm 30$  mL/min/1.73m<sup>2</sup> at baseline to  $98 \pm 44$  mL/min/1.73m<sup>2</sup> by 26 weeks. Among the 20 patients with a CKD stage  $\geq 2$  at baseline, 17 (85%) achieved a CKD improvement of  $\geq 1$  stage. Among the 16 patients ages 1 month to <12 years with a CKD stage  $\geq 2$  at baseline, 14 (88%) achieved a CKD improvement by  $\geq 1$  stage. Nine of the 11 patients who required dialysis at study baseline were able to discontinue dialysis for the duration of SOLIRIS treatment. Responses were similar across all ages from 5 months to 17 years of age.

Reduction in terminal complement activity was observed in all patients after commencement of SOLIRIS. SOLIRIS reduced signs of complement-mediated TMA activity, as shown by an increase in mean platelet counts from baseline to 26 weeks. The mean platelet count ( $\pm$  SD) increased from  $88 \pm 42 \times 10^9/L$  at baseline to  $281 \pm 123 \times 10^9/L$  by one week; this effect was maintained through 26 weeks (mean platelet count ( $\pm$ SD) at week 26:  $293 \pm 106 \times 10^9/L$ ). In atypical HUS C10-003, responses to SOLIRIS were similar in patients with and without identified mutations in genes encoding complement regulatory factor proteins or auto-antibodies to factor H.

**Table 26** summarizes the efficacy results for atypical HUS Study C10-003.

**Table 26: Efficacy Results for atypical HUS Study C10-003**

Efficacy Parameter	Patients 1 month to <12 years (N = 18)	All Patients (N = 22)
Platelet Count Normalization <sup>a</sup>		21 (96%)
Complete TMA response, n (%)	11 (61)	14 (64)
95% CI	36, 83	41, 83
Median Duration of complete TMA response, weeks (range) <sup>b</sup>	40 (14, 77)	37 (14, 77)
eGFR improvement $\geq 15$ mL/min/ 1.73•m <sup>2</sup> •n (%)	16 (89)	19 (86)
Complete Hematologic Normalization, n (%)	14 (78)	18 (82)
Median Duration of complete hematologic normalization, weeks (range)	38 (14, 77)	38 (14, 77)
TMA Event-Free Status, n (%)	17 (94)	21 (95)
Daily TMA Intervention rate, median (range)		
Before eculizumab treatment	0.2 (0, 1.7)	0.4 (0, 1.7)
On eculizumab treatment	0 (0, 0.01)	0 (0, 0.01)

<sup>a</sup>Normal platelet count is defined as  $\geq 150 \times 10^9/L$ .

<sup>b</sup>Through data cutoff (October 12, 2012)

## **Efficacy Results for Study ECU-MG-301**

Data from 125 patients in a prospective controlled study (Study ECU-MG-301) was used to evaluate the efficacy of SOLIRIS in the treatment of patients with gMG.

In Study ECU-MG-301, patients with gMG with a positive serologic test for anti-AChR antibodies, MGFA (Myasthenia Gravis Foundation of America) clinical classification class II to IV and MG-ADL total score  $\geq 6$  were randomized to either SOLIRIS (n=62) or placebo (n=63). Randomization was stratified based on the assessment of clinical classification by the MGFA. Baseline characteristics were similar between treatment groups, including mean age at diagnosis (38 years in each group), gender [66% female (SOLIRIS) versus 65% female (placebo)], and mean duration of gMG [9.9 (SOLIRIS) versus 9.2 (placebo) years]. Also similar between the two treatment groups were the percentages of patients who were previously treated with at least 3 ISTs [50% (SOLIRIS) versus 54 (placebo)], who had experienced an MG crisis [21% (SOLIRIS) versus 15.9% (placebo)], who had any prior ventilation support [24.2% (SOLIRIS) versus 22.2% (placebo)], and who had required intubation [17.7% (SOLIRIS) versus 14.3% (placebo)].

All patients with gMG enrolled in the trial were refractory as defined by the following pre-specified criteria:

- Failed treatment for at least one year with 2 or more immunosuppressant therapies (either in combination or as monotherapy), i.e., patients continued to have impairment in activities of daily living despite immunosuppressant therapies;
- or
- Failed at least one immunosuppressant therapy and required chronic plasma exchange (PE) or intravenous immunoglobulins (IVIg) to control symptoms, i.e., patients require PE or IVIg on a regular basis for the management of muscle weakness at least every 3 months over previous 12 months.

Immunosuppressants included, but were not limited to, corticosteroids, azathioprine, mycophenolate, methotrexate, cyclosporine, tacrolimus, or cyclophosphamide.

Patients received meningococcal vaccination prior to initiating treatment with SOLIRIS or received prophylactic treatment with appropriate antibiotics until 2 weeks after vaccination. In Study ECU-MG-301, the dose of SOLIRIS in adult patients with gMG was 900 mg every  $7 \pm 2$  days for 4 weeks, followed by 1200 mg at Week  $5 \pm 2$  days, then 1,200 mg every  $14 \pm 2$  days for the study duration. SOLIRIS was administered as an intravenous infusion over 35 minutes. Patients continued to receive stable doses of standard therapy during the trial. One hundred and eighteen (118) of the 125 (94%) patients completed the 26-week treatment period.

## **Efficacy Results for Study ECU-MG-301**

The primary endpoint for Study ECU-MG-301 was the change from baseline in the MG Activities of Daily Living Profile (MG-ADL – a patient reported outcome measure validated in gMG) total score at Week 26. The MG-ADL is a categorical scale that assesses the impact on daily function of 8 signs or symptoms that are typically affected in gMG. Each item is assessed on a

4-point scale where a score of 0 represents normal function and a score of 3 represents loss of ability to perform that function (total score 0-24).

The key secondary endpoint was the change from baseline in the Quantitative MG Scoring System (QMG – a physician reported outcome measure validated in gMG) total score at Week 26. The QMG is a 13-item categorical scale assessing muscle weakness. Each item is assessed on a 4-point scale where a score of 0 represents no weakness and a score of 3 represents severe weakness (total score 0-39).

Efficacy results for the pre-specified repeated measures analyses of the primary and key secondary endpoint are provided in **Table 27**. These results are based on analyses that ignored the use of rescue medication and other efficacy-related protocol deviations.

**Table 27: Results of Study ECU-MG-301 in gMG - Efficacy Outcomes Change from Baseline to Week 26**

<b>Efficacy Endpoints: Total score change from baseline at Week 26</b>	<b>SOLIRIS (n=62) (SEM)</b>	<b>Placebo (n=63) (SEM)</b>	<b>SOLIRIS change relative to placebo-LS Mean Difference (95% CI)</b>	<b>p-value (using repeated measures analysis)</b>
<b>MG-ADL*</b>	-4.2 (0.49)	-2.3(0.48)	-1.9 (-3.3, -0.6)	0.0058
<b>QMG*</b>	-4.6 (0.60)	-1.6 (0.59)	-3.0 (-4.6, -1.3)	0.0006

SEM = Standard Error of the Mean CI= Confidence Interval LS-Mean = Least Squares Mean

\* The change from baseline to week 26 in MG-ADL and QMG score was analyzed using a repeated measures analysis of variance with treatment, visit, and a treatment by visit interaction as fixed factors, and a randomization stratification variable, baseline score and immunosuppressive therapy treatment status as covariates. These analyses ignore the use of rescue medication and the occurrence of other efficacy-related protocol deviations. There were 6 subjects in the SOLIRIS arm and 12 subjects in the placebo arm that required rescue medication.

In Study ECU-MG-301, a clinical responder in the MG-ADL total score was defined as having at least a 3-point improvement. The proportion of clinical responders at Week 26 with no rescue therapy was 59.7% on SOLIRIS compared with 39.7% on placebo.

In Study ECU-MG-301, a clinical responder in the QMG total score was defined as having at least a 5-point improvement. The proportion of clinical responders at Week 26 with no rescue therapy was 45.2% on SOLIRIS compared with 19% on placebo.

Also evaluated was the Myasthenia Gravis Quality of Life 15-item scale (MG-QoL15), a validated disease specific questionnaire, in which a 7- to 8-point improvement is indicative of treatment impact. At Week 26, using a repeated measures analysis, the change from baseline for SOLIRIS patients showed an improvement of 12.6 points compared with 5.4 points for placebo patients, representing a treatment effect difference of 7.2 points favoring SOLIRIS.

Available data suggest that clinical response is usually achieved by 12 weeks of SOLIRIS treatment. Discontinuation of the therapy should be considered in a patient who shows no evidence of therapeutic benefit by 12 weeks.

Based on an interim analysis of an ongoing, open-label extension to Study ECU-MG-301, the remaining subjects who were initially randomized to SOLIRIS continue to demonstrate a sustained effect beyond 26 weeks.

## 16 NON-CLINICAL TOXICOLOGY

The specificity of eculizumab for C5 in human serum was evaluated in two *in vitro* studies.

The tissue cross-reactivity of eculizumab was evaluated by assessing binding to a panel of 38 human tissues. C5 expression in the human tissue panel examined in this study is consistent with published reports of C5 expression, as C5 has been reported in smooth muscle, striated muscle, and renal proximal tubular epithelium. No unexpected tissue cross-reactivity was observed.

In a 26 week toxicity study performed in mice with a surrogate antibody directed against murine C5, treatment did not affect any of the toxicity parameters examined. Haemolytic activity during the course of the study was effectively blocked in both female and male mice.

Animal reproduction studies have not been conducted with eculizumab due to lack of pharmacologic activity in non-human species. No clear treatment-related effects or adverse effects were observed in reproductive toxicology studies in mice with a surrogate terminal complement inhibitory antibody. When maternal exposure to the antibody occurred during organogenesis, two cases of retinal dysplasia and one case of umbilical hernia were observed among 230 offspring born to mothers exposed to the higher antibody dose (approximately 4 times the maximum recommended human SOLIRIS dose, based on a body weight comparison); however, the exposure did not increase foetal loss or neonatal death. These findings were not directly attributable to C5 blockade upon expert review.

No animal studies have been conducted to evaluate the genotoxic and carcinogenic potential of eculizumab or its effect on fertility.

**READ THIS FOR SAFE AND EFFECTIVE USE OF YOUR MEDICINE**  
**PATIENT MEDICATION INFORMATION**

**SOLIRIS®**  
Eculizumab

Read this carefully before you start taking SOLIRIS and each time you get a refill. This leaflet is a summary and will not tell you everything about this drug. Talk to your healthcare professional about your medical condition and treatment and ask if there is any new information about SOLIRIS.

**SERIOUS WARNINGS AND PRECAUTIONS**

**SOLIRIS increases the risk of serious infections including meningococcal infections. There have been reports of serious meningococcal infections including death, in patients treated with SOLIRIS. Meningococcal infections can quickly cause death, deafness, brain damage and/or loss of limbs, especially if not recognized and treated early.**

- **You must be vaccinated with a meningococcal vaccine prior to, or at the time of, initiating SOLIRIS, unless the risks of delaying SOLIRIS therapy outweigh the risks of developing a meningococcal infection; you may be revaccinated according to current medical guidelines for vaccine use.**
- **You must be monitored for early signs of meningococcal infections, evaluated immediately if infection is suspected, and treated with antibiotics, if necessary.**
- **Vaccination may not prevent all meningococcal infections.**

BEFORE you start SOLIRIS, talk to your doctor or pharmacist if you have Meningococcal infection (severe infection of the linings of the brain and sepsis) and other *Neisseria* infections including disseminated gonorrhoea. If you receive SOLIRIS when you have a serious infection, contact your doctor immediately if there is any worsening of symptoms of the infection. You should also check that you have received all recommended vaccinations before starting SOLIRIS.

Meningitis vaccination does not prevent all types of meningitis infections.

If you are at risk of gonorrhoea, ask your doctor or pharmacist for advice before using this medicine.

Meningococcal infection symptoms

Because of the importance of rapidly identifying and treating certain types of infection in patients who receive SOLIRIS, you will be provided a card to carry with you, listing specific trigger symptoms. This card is named: "Patient Safety Card". You should carry this card with you at all times during treatment and for 3 months after your last dose of SOLIRIS. Show it to any health care professional you see during this time. Immediately inform your doctor if you identify any symptoms.

If you experience any of the following symptoms, you should immediately inform your doctor:

- headache with nausea or vomiting
- headache and a fever
- headache with a stiff neck or stiff back
- fever

- fever and a rash
- confusion
- muscle aches with flu-like symptoms
- eyes sensitive to light

### **What is SOLIRIS used for?**

SOLIRIS is used to treat patients with:

- Paroxysmal Nocturnal Hemoglobinuria (PNH) to reduce hemolysis (destruction of red blood cells);
- Chronic atypical Hemolytic Uremic Syndrome (atypical HUS), a very rare disease that affects the blood system, kidney and sometimes other body organs;
- Generalized Myasthenia Gravis, a disease affecting the muscles

### **How does SOLIRIS work?**

The active substance in SOLIRIS, eculizumab, is a monoclonal antibody that blocks part of your immune system called the C5 complement protein.

In patients with PNH and atypical HUS, the complement proteins are over-active and damage the patients' own blood cells. In patients with gMG, over-active complement proteins damage the junction between the nerves and muscles (neuromuscular junction). SOLIRIS works by preventing complement proteins from damaging blood cells and the neuromuscular junction, thereby helping to relieve the symptoms of these diseases.

SOLIRIS also lowers the ability of your immune system to fight infection.

### **What are the ingredients in SOLIRIS?**

Medicinal ingredients: eculizumab

Non-medicinal ingredients: polysorbate 80 (vegetable origin), sodium chloride, sodium phosphate dibasic, sodium phosphate monobasic, Water for Injection (USP)

### **SOLIRIS comes in the following dosage forms:**

SOLIRIS is supplied as 300 mg single-use vials each containing 30 mL of 10 mg/mL sterile, preservative-free eculizumab solution.

### **Do not use SOLIRIS if:**

- You have any allergies to this drug or its ingredients
- Your doctor confirms a serious infection, such as an active *Neisseria meningitidis* infection (in the brain, spinal cord or blood)
- You have not received a meningococcal vaccine prior to or at the time of initiating

**To help avoid side effects and ensure proper use, talk to your healthcare professional before you take SOLIRIS. Talk about any health conditions or problems you may have, including if you:**

Have a disease that alters your immune system (such as HIV/AIDS) or take medication that alters your immune system (such as prednisone).

### **Other warnings you should know about:**

Fungal infections caused by *Aspergillus* have occurred in immunocompromised patients with abnormally low white blood cells. Inform your doctor before you take SOLIRIS if you have any infections.

### Allergic Reactions:

Serious allergic reactions can happen during your SOLIRIS infusion. Tell your doctor or nurse immediately if you get any of these symptoms during your SOLIRIS infusion:

- Chest pain
- Trouble breathing or shortness of breath
- Swelling of your face, tongue or throat
- Feel faint or pass out

### Pregnancy and Nursing:

Data in pregnant women treated with SOLIRIS from clinical trials and postmarketing setting, including PNH and atypical HUS registries, indicate SOLIRIS is unlikely to increase the risk of harm to the fetus. There is no clinical data available on the use of SOLIRIS in pregnant gMG patients SOLIRIS may be considered during pregnancy, if clinically needed. Tell your doctor if you are pregnant or nursing.

**Tell your healthcare professional about all the medicines you take, including any drugs, vitamins, minerals, natural supplements or alternative medicines.**

### How to take SOLIRIS

SOLIRIS is given through a vein [“I.V.” or “intravenously”], usually over 35 minutes, and must be administered by a health care professional.

#### Usual dose:

The usual dose of SOLIRIS for PNH patients is:

- 600 mg of SOLIRIS every 7 days for the first 4 weeks, followed by
- 900 mg of SOLIRIS for the fifth dose 1 week later, then
- 900 mg of SOLIRIS every 2 weeks thereafter

The usual dose of SOLIRIS for atypical HUS patients and gMG patients 18 years of age or older is:

- 900 mg of SOLIRIS weekly for the first 4 weeks, followed by
- 1200 mg of SOLIRIS for the fifth dose 1 week later, then
- 1200 mg of SOLIRIS every 2 weeks thereafter

If you are less than 18 years of age, the usual dose of SOLIRIS for atypical HUS will be based on your body weight according to the following schedule:

Patient Body Weight	Induction	Maintenance
40 kg and over	900 mg weekly x 4 doses	1200 mg at week 5; then 1200 mg every 2 weeks
30 kg to less than 40 kg	600 mg weekly x 2 doses	900 mg at week 3; then 900 mg every 2 weeks
20 kg to less than 30 kg	600 mg weekly x 2 doses	600 mg at week 3; then 600 mg every 2 weeks
10 kg to less than 20 kg	600 mg weekly x 1 dose	300 mg at week 2; then 300 mg every 2 weeks
5 kg to less than 10 kg	300 mg weekly x 1 dose	300 mg at week 2;



		then 300 mg every 3 weeks
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SOLIRIS should be administered at the recommended dates or within 48 hours of the recommended date. Your doctor should know by blood tests if SOLIRIS is working.

**Overdose:**

SOLIRIS should be given by a healthcare professional. This minimizes the chance of an overdose. No cases of overdose were seen in clinical studies.

If you think you have taken too much SOLIRIS, contact your healthcare professional, hospital emergency department or regional poison control centre immediately, even if there are no symptoms.

**Missed Dose or Stopping Treatment:**

Tell your doctor right away if you have missed a dose or if you are considering stopping treatment. Stopping treatment with SOLIRIS may cause side effects.

If you have PNH and miss a dose of SOLIRIS you may experience the following symptoms or problems from red blood cell destruction:

- A sudden or severe drop in your red blood cell count causing anemia
- Confusion or drowsiness
- Chest pain/angina
- Kidney problems including kidney failure
- Blood clots

If you have atypical HUS and miss a dose of SOLIRIS, your blood clotting may be abnormal, causing symptoms including:

- Stroke
- Confusion
- Seizure
- Chest pain
- Trouble breathing
- Kidney problems
- Swelling in arms or legs
- A drop in your platelet count which may cause easy bleeding and easy bruising

If you have PNH and stop treatment of SOLIRIS, your doctor will need to monitor you closely for at least 8 weeks after stopping treatment.

If you have atypical HUS, your doctor will need to monitor you closely during treatment and for at least 12 weeks after stopping SOLIRIS for signs of worsening atypical HUS symptoms or problems related to abnormal clotting.

If you have gMG and stop treatment with SOLIRIS, your doctor will need to monitor you closely for at least 12 weeks after stopping treatment for signs of worsening of gMG symptoms.

**What are possible side effects from using SOLIRIS?**

In all clinical studies, including PNH and atypical HUS clinical trials, the most serious side effect was meningococcal sepsis, which is a common presentation of meningococcal infections in

patients treated with SOLIRIS.

- **You must be vaccinated with a meningococcal vaccine prior to, or at the time of, initiating SOLIRIS, unless the risks of delaying SOLIRIS therapy outweigh the risks of developing a meningococcal infection; you may be revaccinated according to current medical guidelines for vaccine use.**
- **You must be monitored for early signs of meningococcal infections, evaluated immediately if infection is suspected, and treated with antibiotics, if necessary.**
- **Vaccination may not prevent all meningococcal infections.**
- **You must carry your Safety Card at all time. If you experience any symptoms listed in your safety card immediately seek for medical care.**

These are not all the possible side effects you may feel when taking SOLIRIS. If you experience any side effects not listed here, contact your healthcare professional.

The most common side effects in people with PNH treated with SOLIRIS include headache, stuffy nose, sore throat, nausea, fever, joint aches and pains, fatigue, and cold sores.

The most common side effects in people with atypical HUS treated with SOLIRIS include high blood pressure, diarrhea, headache, nausea, vomiting, low white blood cell count, bladder infection, hair loss, cold sore, low lymphocyte count, cough, joint pain, weakness, and viral infection.

The most common side effects in children with atypical HUS treated with SOLIRIS include common viral cold, and rash.

The most common side effects in people with gMG treated with SOLIRIS include headache, upper respiratory infection, nasopharyngitis, myasthenia gravis, nausea, and diarrhea.

<b>Serious side effects and what to do about them</b>			
Symptom / effect	Talk to your healthcare professional		Stop taking drug and get immediate medical help
	Only if severe	In all cases	
<b>VERY COMMON</b> Headache	<b>X</b>		
<b>COMMON</b> High Blood Pressure		<b>X</b>	
Low white blood cell count		<b>X</b>	
Infection of the lung (pneumonia)			<b>X</b>
Respiratory Tract infection		<b>X</b>	
Infection of the urinary system (urinary tract infection)		<b>X</b>	
Rash	<b>X</b>		
Abdominal discomfort or pain	<b>X</b>		
Agitation	<b>X</b>		
Anemia		<b>X</b>	
Chills	<b>X</b>		
Deafness	<b>X</b>		

Diarrhea	X		
Flu-like illness	X		
Fever		X	
Light headedness(dizziness)	X		
Low blood pressure		X	
Infection		X	
<b>UNCOMMON</b>			
Meningococcal infection including Meningococcal sepsis		X	X
Fungal infection		X	
Serious allergic reaction which causes difficulty in breathing or dizziness (anaphylactic reaction)			X
Hypersensitivity			X
Breathing difficulty			X
Inflammation of the peritoneum (the tissue that lines most of the organs of the abdomen)		X	
Increase of liver enzymes		X	
Relatively few platelets in blood (thrombocytopenia)		X	
Kidney disorder		X	
Muscle Aches	X		
Neck pain		X	
Pain in extremity		X	
Swelling (Face or Leg)			X
<b>RARE</b>			
Jaundice		X	
Disease with thyroid overactivity (Basedow's disease)		X	
Menstrual disorder	X		
Infusion related reaction		X	
Blood in urine		X	
Blood clot in vein			X
Bone marrow disorder		X	
Bacterial sexual transmitted disease		X	
Skin tumor (melanoma)			X

If you have a troublesome symptom or side effect that is not listed here or becomes bad enough to interfere with your daily activities, talk to your healthcare professional.

### **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 \(http://www.hc-sc.gc.ca/dhp-mps/medeff/report-declaration/index-eng.php\)](http://www.hc-sc.gc.ca/dhp-mps/medeff/report-declaration/index-eng.php) 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.*

### **Reporting Suspected Side Effects**

Should you require information related to the management of the side effect, please contact your healthcare provider. The Public Health Agency of Canada, Health Canada and Alexion Pharma cannot provide medical advice.

### **Storage:**

Store in original carton in a refrigerator (2°C - 8°C).

Protect from light.

Vial in original carton can stay at room temperature (not more than 25°C) for only one single period up to 3 days.

Do not use past the expiry date stamped on the carton.

**DO NOT FREEZE. DO NOT SHAKE.**

Keep out of reach and sight of children.

### **If you want more information about SOLIRIS:**

- Talk to your healthcare professional
- Find the full product monograph that is prepared for healthcare professionals and includes this Patient Medication Information by visiting the [Health Canada website](#); the manufacturer's website [www.alexion.com](http://www.alexion.com), or by calling 1-888-765-4747.

Alexion Pharmaceuticals, Inc. has established Registries for PNH and atypical HUS in order to continue to monitor and evaluate the safety and effectiveness of SOLIRIS. You are encouraged to participate and advised that participation may involve long-term follow-up. Information regarding the PNH Registry can be found at <http://www.pnhregistry.com> or by contacting the PNH Registry hotline at: 1-800-913-4893; or email: [pnhregistry@iconplc.com](mailto:pnhregistry@iconplc.com) or by calling 1-888- SOLIRIS (1-888-765-4747). For information regarding the atypical HUS Registry, please email: [aHUS-Registry@incresearch.com](mailto:aHUS-Registry@incresearch.com) or call 1-888-SOLIRIS (1-888-765-4747). You can only participate in the Registry through your doctor.

This document plus the full Product Monograph, prepared for health professionals, are available by contacting the sponsor, Alexion Pharma GmbH, at 1-888-765-4747.

This leaflet was prepared by Alexion Pharma GmbH.

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