



Gamifant® (emapalumab-lzsg) is the **FIRST** and **ONLY** FDA-approved treatment for primary hemophagocytic lymphohistiocytosis (HLH)<sup>1,2</sup>

**The first advance in a quarter century** for patients presenting with life-threatening, inflammatory symptoms of HLH<sup>2,3</sup>

**The only HLH medication** specifically designed to target interferon gamma (IFN $\gamma$ ) overexpression<sup>1,2</sup>

### Indication and Usage

Gamifant® (emapalumab-lzsg) is an interferon gamma (IFN $\gamma$ )-blocking antibody indicated for the treatment of adult and pediatric (newborn and older) patients with primary hemophagocytic lymphohistiocytosis (HLH) with refractory, recurrent, or progressive disease or intolerance with conventional HLH therapy.

### Important Safety Information

Before initiating Gamifant, patients should be evaluated for infection, including latent tuberculosis (TB). Prophylaxis for TB should be administered to patients who are at risk for TB or known to have a positive purified protein derivative (PPD) test result or positive IFN $\gamma$  release assay.

**Please see Important Safety Information on page 6 and enclosed full Prescribing Information.**

## Primary HLH is rapidly progressive and fatal<sup>4</sup>

**Primary HLH is a rare but dramatic health crisis** that presents as a heterogeneous syndrome of rapidly progressive, life-threatening symptoms that can quickly become fatal unless diagnosed and treated, with median survival of under 2 months.<sup>4-6</sup>

- **Primary HLH is a genetic disorder** that typically occurs in infancy and early childhood, manifesting mostly during the first year of life, but may also occur in teens and adults.<sup>4,7</sup>
- **Primary HLH can be challenging to diagnose** due to its variable presentation characterized by fevers, hepatosplenomegaly, severe cytopenias, hyperferritinemia, coagulation defects, liver function impairment, and infections.<sup>4-6</sup>
- **Massive overexpression of IFN $\gamma$  is central** to the cytokine “storm”—uncontrolled release of inflammatory cytokines and overactivation of phagocytes that give the syndrome its name.<sup>8</sup>

## Gamifant<sup>®</sup> (emapalumab-lzsg) targets IFN $\gamma$ , a pivotal cytokine in the pathogenesis of primary HLH<sup>1</sup>

### **Gamifant is a monoclonal antibody that binds to and neutralizes IFN $\gamma$ <sup>1</sup>**

- **The immediate goal of treatment in primary HLH patients is to quickly bring the hyperinflammatory emergency under control** and to prepare for hematopoietic stem cell transplant (HSCT).<sup>4,9,10</sup>
- **Nonclinical data suggest that IFN $\gamma$  plays a pivotal role in the pathogenesis of primary HLH** by being hypersecreted, with consequent downstream effects of hypercytokinemia and inflammation.<sup>1,7,11</sup>
- **Gamifant was shown to neutralize IFN $\gamma$**  as measured by a reduction in the plasma concentrations of CXCL9, a chemokine induced by IFN $\gamma$ .<sup>1</sup>

## Important Safety Information

During Gamifant treatment, patients should be monitored for TB, adenovirus, Epstein-Barr virus (EBV), and cytomegalovirus (CMV) every 2 weeks and as clinically indicated.

Patients should be administered prophylaxis for herpes zoster, *Pneumocystis jirovecii*, and fungal infections prior to Gamifant administration.

Do not administer live or live attenuated vaccines to patients receiving Gamifant and for at least 4 weeks after the last dose of Gamifant. The safety of immunization with live vaccines during or following Gamifant therapy has not been studied.

**Please see Important Safety Information on page 6 and enclosed full Prescribing Information.**

# The Gamifant® (emapalumab-lzsg) pivotal trial represents an important milestone in the treatment of HLH

**Multicenter, open-label, single-arm study** of pharmacokinetics, efficacy, and safety of Gamifant in patients with suspected or confirmed primary HLH who had refractory, recurrent, or progressive disease during conventional HLH therapy or were intolerant of conventional HLH therapy.<sup>1</sup>

- SAFETY was evaluated in 34 patients, 7 of whom were treatment naïve.
- EFFICACY was evaluated in 27 pediatric patients who had already received conventional HLH therapy. Eighty-two percent of these patients had a genetically confirmed primary HLH diagnosis.

**Patients had received a median of 3 prior agents** as part of standard care before enrollment into the trial; prior regimens included combinations of dexamethasone, etoposide, cyclosporine A, and anti-thymocyte globulin.<sup>1</sup>

**Median age of patients** in the study was 1 year (range: 0.1-13 years).<sup>1</sup>

## **Primary endpoint was overall response rate (ORR) at the end of treatment, defined as achievement of either complete or partial response or HLH improvement<sup>1</sup>**

- **63% ORR with Gamifant** (95% CI: 0.42, 0.81;  $P = 0.013$ ).<sup>1</sup>
- **ORR was evaluated using an algorithm** that included the following objective clinical and laboratory parameters: fever, splenomegaly, central nervous system symptoms, complete blood count, fibrinogen and/or D-dimer, ferritin, and soluble CD25 (also referred to as soluble interleukin-2 receptor) levels.<sup>1</sup>
- **Upon completion of the pivotal study**, 22 patients (81%) enrolled in the open-label extension study which monitored patients for up to 1 year after HSCT or after the last Gamifant infusion.<sup>1</sup>

## **Infusion-Related Reactions**

Infusion-related reactions, including drug eruption, pyrexia, rash, erythema, and hyperhidrosis, were reported with Gamifant treatment in 27% of patients. In one-third of these patients, the infusion-related reaction occurred during the first infusion.

**Please see Important Safety Information on page 6 and enclosed full Prescribing Information.**

## Administer Gamifant® (emapalumab-lzsg) as an intravenous infusion twice a week (every 3 to 4 days) until HSCT is performed<sup>1</sup>

- **The recommended starting dose** of Gamifant is 1 mg/kg given as an intravenous infusion over 1 hour twice per week.<sup>1</sup>
- **Gamifant should be given concomitantly with dexamethasone** at a starting daily dose (for the steroid) of at least 5 to 10 mg/m<sup>2</sup> and can be tapered according to the judgment of the treating physician.<sup>1</sup>
- **Administer Gamifant** using a non-polyvinyl chloride (PVC) polyolefin infusion bag or a gamma-irradiated, latex-free, PVC-free syringe only. Do not use with ethylene oxide-sterilized syringes.<sup>1</sup>
- **Dose may be increased** to 3 mg/kg at day 3, then to 6 mg/kg at day 6, and up to a maximum of 10 mg/kg after day 9, depending on clinical conditions.<sup>1</sup>
- **After the patient's clinical condition is stabilized**, decrease the dose to the previous level to maintain clinical response until HSCT.<sup>1</sup>

## How to access Gamifant for your patients

### Gamifant is supplied in 10 mg/2 mL and 50 mg/10 mL single-use glass vials.

Gamifant is available for order via our specialty pharmacy or through one of our two specialty distributors. Please note that the patient's insurance coverage may dictate how Gamifant should be ordered. To better understand your patient's benefits please contact **Sobi Patient Services** at 833.597.6530.



#### Specialty pharmacy:

Biologics  
800.850.4306

#### Specialty distributors:

McKesson Plasma and Biologics  
877.625.2566

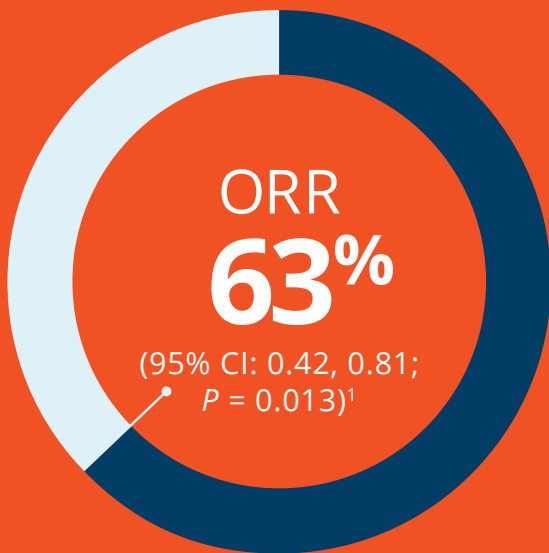
McKesson Specialty Health  
855.477.9800

## Adverse Reactions

In the pivotal trial, the most commonly reported adverse reactions (≥10%) for Gamifant included infection (56%), hypertension (41%), infusion-related reactions (27%), pyrexia (24%), hypokalemia (15%), constipation (15%), rash (12%), abdominal pain (12%), CMV infection (12%), diarrhea (12%), lymphocytosis (12%), cough (12%), irritability (12%), tachycardia (12%), and tachypnea (12%).

Please see Important Safety Information on page 6 and enclosed full Prescribing Information.

Gamifant® (emapalumab-lzsg) was shown to be effective treatment for primary HLH in patients with refractory, recurrent, or progressive disease or who were intolerant of conventional treatment.<sup>1</sup>



**63% overall response rate (ORR) with Gamifant<sup>1</sup>**

- Median duration of first response, defined as time from achievement of first response to loss of first response, was not reached<sup>1</sup>



**70% of patients (19/27) proceeded to hematopoietic stem cell transplantation (HSCT)<sup>1</sup>**

**Adverse Reactions**

Additional selected adverse reactions (all grades) that were reported in less than 10% of patients treated with Gamifant included vomiting, acute kidney injury, asthenia, bradycardia, dyspnea, gastrointestinal hemorrhage, epistaxis, and peripheral edema.

**Please see Important Safety Information on page 6 and enclosed full Prescribing Information.**

## Indication and Usage

Gamifant® (emapalumab-lzsg) is an interferon gamma (IFN $\gamma$ )-blocking antibody indicated for the treatment of adult and pediatric (newborn and older) patients with primary hemophagocytic lymphohistiocytosis (HLH) with refractory, recurrent, or progressive disease or intolerance with conventional HLH therapy.

## Important Safety Information

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During Gamifant treatment, patients should be monitored for TB, adenovirus, Epstein-Barr virus (EBV), and cytomegalovirus (CMV) every 2 weeks and as clinically indicated.

Patients should be administered prophylaxis for herpes zoster, *Pneumocystis jirovecii*, and fungal infections prior to Gamifant administration.

Do not administer live or live attenuated vaccines to patients receiving Gamifant and for at least 4 weeks after the last dose of Gamifant. The safety of immunization with live vaccines during or following Gamifant therapy has not been studied.

## Infusion-Related Reactions

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## Adverse Reactions

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Please see accompanying full Prescribing Information for Gamifant.

## Gamifant.com

## References

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## HIGHLIGHTS OF PRESCRIBING INFORMATION

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

**GAMIFANT™ (emapalumab-lzsg) injection, for intravenous use**  
Initial U.S. Approval: 2018

### INDICATIONS AND USAGE

GAMIFANT is an interferon gamma (IFN $\gamma$ ) blocking antibody indicated for the treatment of adult and pediatric (newborn and older) patients with primary hemophagocytic lymphohistiocytosis (HLH) with refractory, recurrent or progressive disease or intolerance with conventional HLH therapy. (1)

### DOSAGE AND ADMINISTRATION

For intravenous infusion only:

- Recommended starting dosage: 1 mg/kg as an intravenous infusion over 1 hour twice per week. (2.1)
- Administer dexamethasone concomitantly with GAMIFANT. (2.3)

### DOSAGE FORMS AND STRENGTHS

Injection:

- 10 mg/2 mL (5 mg/mL) solution in a single-dose vial (3)
- 50 mg/10 mL (5 mg/mL) solution in a single-dose vial (3)

### CONTRAINDICATIONS

- None. (4)

### WARNINGS AND PRECAUTIONS

- Infections: Monitor patients for signs and symptoms and treat promptly. Test for latent tuberculosis. Administer prophylactic treatment against Herpes Zoster, *Pneumocystis jirovecii* and fungal infections. (5.1)
- Live Vaccines: Do not administer live or live attenuated vaccines to patients receiving GAMIFANT. (5.2)
- Infusion-Related Reactions: Monitor patients for infusion-related reactions. Interrupt infusion for severe infusion reactions and institute appropriate medical management. (5.3)

### ADVERSE REACTIONS

The most common adverse reactions ( $\geq 20\%$ ) were: infections, hypertension, infusion-related reactions, and pyrexia. (6.1)

To report SUSPECTED ADVERSE REACTIONS, contact 1-866-773-5274 or FDA at 1-800-FDA-1088 or [www.fda.gov/medwatch](http://www.fda.gov/medwatch).

See 17 for PATIENT COUNSELING INFORMATION and Medication Guide.

Revised: 11/2018

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## FULL PRESCRIBING INFORMATION

### 1 INDICATIONS AND USAGE

GAMIFANT is indicated for the treatment of adult and pediatric (newborn and older) patients with primary hemophagocytic lymphohistiocytosis (HLH) with refractory, recurrent or progressive disease or intolerance with conventional HLH therapy.

### 2 DOSAGE AND ADMINISTRATION

#### 2.1 Recommended Dosing

The recommended starting dose of GAMIFANT is 1 mg/kg given as an intravenous infusion over 1 hour twice per week (every three to four days). Doses subsequent to the initial dose may be increased based on clinical and laboratory criteria [*see Dosage and Administration (2.4)*].

Administer GAMIFANT until hematopoietic stem cell transplantation (HSCT) is performed or unacceptable toxicity. Discontinue GAMIFANT when a patient no longer requires therapy for the treatment of HLH.

#### 2.2 Monitoring to Assess Safety

##### Before Initiating GAMIFANT Treatment

Conduct testing for latent tuberculosis infections using the purified protein derivative (PPD) or IFN $\gamma$  release assay and evaluate patients for tuberculosis risk factors prior to initiating GAMIFANT. Administer tuberculosis prophylaxis to patients at risk for tuberculosis, or known to have a positive PPD test result, or positive IFN $\gamma$  release assay.

##### During GAMIFANT Treatment

Monitor for tuberculosis, adenovirus, EBV and CMV every 2 weeks and as clinically indicated.

#### 2.3 Pre-Medications and Concomitant Medication Information

##### Pre-Medications

Administer prophylaxis for Herpes Zoster, *Pneumocystis jirovecii*, and for fungal infections prior to GAMIFANT administration.

##### Concomitant Medications

For patients who are not receiving baseline dexamethasone treatment, begin dexamethasone at a daily dose of at least 5 to 10 mg/m<sup>2</sup> the day before GAMIFANT treatment begins. For patients who were receiving baseline dexamethasone, they may continue their regular dose provided the dose is at least 5 mg/m<sup>2</sup>. Dexamethasone can be tapered according to the judgment of the treating physician [*see Clinical Studies (14)*].



## 2.4 Dose Modification Based on Response

The GAMIFANT dose may be titrated up if disease response is unsatisfactory (see Table 1) [*see Clinical Pharmacology (12.3)*]. After the patient's clinical condition is stabilized, decrease the dose to the previous level to maintain clinical response.

**Table 1: Dose Titration Criteria**

Treatment Day	GAMIFANT Dose	Criteria for Dose Increase
Day 1	Starting Dose of 1 mg/kg	N/A
On Day 3	Increase to 3 mg/kg	Unsatisfactory improvement in clinical condition, as assessed by a healthcare provider AND at least one of the following: <ul style="list-style-type: none"> <li>▪ Fever – persistence or recurrence</li> <li>▪ Platelet count               <ul style="list-style-type: none"> <li>▪ If baseline &lt; 50,000/mm<sup>3</sup> and no improvement to &gt;50,000/mm<sup>3</sup></li> <li>▪ If baseline &gt; 50,000/mm<sup>3</sup> and less than 30% improvement</li> <li>▪ If baseline &gt; 100,000/mm<sup>3</sup> and decrease to &lt; 100,000/mm<sup>3</sup></li> </ul> </li> <li>▪ Neutrophil count               <ul style="list-style-type: none"> <li>▪ If baseline &lt; 500/mm<sup>3</sup> and no improvement to &gt; 500/mm<sup>3</sup></li> <li>▪ If baseline &gt; 500 -1000/mm<sup>3</sup> and decrease to &lt; 500/mm<sup>3</sup></li> <li>▪ If baseline 1000-1500/mm<sup>3</sup> and decrease to &lt; 1000/ mm<sup>3</sup></li> </ul> </li> <li>▪ Ferritin (ng/mL)               <ul style="list-style-type: none"> <li>▪ If baseline ≥ 3000 ng/mL and &lt; 20% decrease</li> <li>▪ If baseline &lt; 3000 ng/mL and any increase to &gt; 3000 ng/mL</li> </ul> </li> <li>▪ Splenomegaly – any worsening</li> <li>▪ Coagulopathy (both D-Dimer and Fibrinogen must apply)               <ul style="list-style-type: none"> <li>▪ D-Dimer</li> </ul> </li> </ul>
From Day 6 onwards	Increase to 6 mg/kg	

Treatment Day	GAMIFANT Dose	Criteria for Dose Increase
		<ul style="list-style-type: none"> <li>▪ If abnormal at baseline and no improvement</li> <li>▪ Fibrinogen (mg/dL) <ul style="list-style-type: none"> <li>▪ If baseline levels <math>\leq</math> 100 mg/dL and no improvement</li> <li>▪ If baseline levels <math>&gt;</math> 100 mg/dL and any decrease to <math>&lt;</math> 100 mg/dL</li> </ul> </li> </ul>
From Day 9 onwards	Increase to 10 mg/kg	Assessment by a healthcare provider that based on initial signs of response, a further increase in GAMIFANT dose can be of benefit

## 2.5 Instructions for Preparation and Administration

### Preparation

GAMIFANT vials are for single-use only.

Prepare the solution for infusion as follows:

- Calculate the dose (mg/kg), total volume (mL) of GAMIFANT required and the number of GAMIFANT vials needed based on patient actual body weight [*see Dosage and Administration (2.1)*].
- Inspect GAMIFANT vials visually for particulate matter and discoloration prior to dilution. GAMIFANT is a clear to slightly opalescent, colorless to slightly yellow liquid. Do not administer if discolored or foreign particulate matter is present.
- Withdraw the necessary amount of GAMIFANT solution and dilute with 0.9% Sodium Chloride Injection, USP to a maximum concentration of 2.5 mg/mL. Do not dilute product to less than 0.25 mg/mL.
- Discard any unused portion left in the vial(s).
- The diluted solution can be placed in either a syringe or an infusion bag, depending on the volume needed.
- Use a gamma irradiated latex-free, polyvinyl chloride (PVC)-free syringe. Do not use with ethylene oxide-sterilized syringes.
- Use a non-PVC polyolefin infusion bag.

## Administration

- Administer GAMIFANT diluted solution intravenously over 1 hour through an intravenous line containing a sterile, non-pyrogenic, low-protein binding 0.2 micron in-line filter.
- Do not infuse GAMIFANT concomitantly with other agents and do not add any other product to the infusion bag or syringe.
- Do not store any unused portion of the infusion solution for reuse. Any unused product or waste material should be disposed of in accordance with local requirements.

## Storage of Diluted Solution

This product does not contain a preservative.

If not administered immediately:

- Store the diluted solution of GAMIFANT under refrigeration at 2°C to 8°C (36°F to 46°F) for no more than 4 hours from the time of dilution.
- If refrigerated, allow the diluted solution to come to room temperature prior to administration.
- Do not freeze. Do not shake.

## **3            DOSAGE FORMS AND STRENGTHS**

GAMIFANT is a clear to slightly opalescent, colorless to slightly yellow preservative-free solution available as:

Injection:

- 10 mg/2 mL (5 mg/mL) in a single-dose vial
- 50 mg/10 mL (5 mg/mL) in a single-dose vial

## **4            CONTRAINDICATIONS**

None.

## **5            WARNINGS AND PRECAUTIONS**

### **5.1        Infections**

GAMIFANT may increase the risk of fatal and serious infections to include specific pathogens favored by IFN $\gamma$  neutralization, including mycobacteria, Herpes Zoster virus, and Histoplasma Capsulatum.

Do not administer GAMIFANT in patients with infections caused by these pathogens until appropriate treatment has been initiated.

In 32% of patients receiving GAMIFANT in clinical trials, serious infections such as sepsis, pneumonia, bacteremia, disseminated histoplasmosis, necrotizing fasciitis, viral infections, and perforated appendicitis were observed. The reported infections were viral (41%), bacterial (35%), fungal (9%), and the pathogen was not identified in 15% of cases.

Evaluate patients for tuberculosis risk factors and test for latent infection (PPD testing, PCR, or IFN $\gamma$  release assay) prior to initiating GAMIFANT. Administer tuberculosis prophylaxis to patients at risk for tuberculosis or known to have a positive purified protein derivative (PPD) test result [see *Dosage and Administration (2.2)*].

Administer prophylaxis for Herpes Zoster, *Pneumocystis jirovecii*, and fungal infection to mitigate the risk to patients while receiving GAMIFANT. Employ surveillance testing during treatment with GAMIFANT.

Closely monitor patients receiving GAMIFANT for signs or symptoms of infection, promptly initiate a complete diagnostic workup appropriate for an immunocompromised patient, and initiate appropriate antimicrobial therapy.

## **5.2 Increased Risk of Infection with Use of Live Vaccines**

Do not administer live or live attenuated vaccines to patients receiving GAMIFANT and for at least 4 weeks after the last dose of GAMIFANT. The safety of immunization with live vaccines during or following GAMIFANT therapy has not been studied.

## **5.3 Infusion-Related Reactions**

Infusion-related reactions including drug eruption, pyrexia, rash, erythema, and hyperhidrosis were reported with GAMIFANT treatment in 27% of patients. In one-third of these patients, the infusion-related reaction occurred during the first infusion.

All infusion related reactions were reported as mild to moderate. Monitor patients for infusion-related reactions. Interrupt infusion for infusion reactions and institute appropriate medical management prior to continuing infusion at a slower rate.

# **6 ADVERSE REACTIONS**

The following adverse reactions are described elsewhere in the labeling:

- Infections [see *Warnings and Precautions (5.1)*]
- Infusion-Related Reactions [see *Warnings and Precautions (5.3)*]

## **6.1 Clinical Trial Experience**

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

The safety data described in this section reflect exposure to GAMIFANT in which 34 patients with untreated primary HLH and previously treated patients with primary HLH (NCT01818492) received GAMIFANT at a starting dose of 1 mg/kg every 3 days with dose increases up to 10

mg/kg [see *Dosage and Administration (2.1)* and *Clinical Studies (14)*]. The median duration of treatment with GAMIFANT was 59 days (range: 4 to 245 days) and the median cumulative dose was 25 mg/kg (range: 4 to 254 mg/kg).

The median age of study population was 1 year (range: 0.1 to 13 years), 53% were female, and 65% were Caucasian.

Serious adverse reactions were reported in 53% of patients. The most common serious adverse reactions ( $\geq 3\%$ ) included infections, gastrointestinal hemorrhage, and multiple organ dysfunction. Fatal adverse reactions occurred in two (6%) of patients and included septic shock and gastrointestinal hemorrhage.

Disseminated histoplasmosis led to drug discontinuation in one patient. The most commonly reported adverse reactions ( $\geq 20\%$ ) were infections, hypertension, infusion-related reactions, and pyrexia. Adverse reactions reported in  $\geq 10\%$  of patients during treatment with GAMIFANT are presented in Table 2.

**Table 2: Adverse Reactions Reported in  $\geq 10\%$  of Patients with Primary HLH**

<b>Adverse Reactions</b>	<b>GAMIFANT (%) (N = 34)</b>
Infections <sup>a</sup>	56
Hypertension <sup>b</sup>	41
Infusion-related reactions <sup>c</sup>	27
Pyrexia	24
Hypokalemia	15
Constipation	15
Rash	12
Abdominal pain	12
Cytomegalovirus infection	12
Diarrhea	12
Lymphocytosis	12
Cough	12
Irritability	12
Tachycardia	12
Tachypnea	12

<sup>a</sup>Includes viral, bacterial, fungal, and infections in which no pathogen was identified

<sup>b</sup>Includes secondary hypertension

<sup>c</sup>Includes events of drug eruption, pyrexia, rash, erythema, and hyperhidrosis

Additional selected adverse reactions (all grades) that were reported in less than 10% of patients treated with GAMIFANT included: vomiting, acute kidney injury, asthenia, bradycardia, dyspnea, gastro-intestinal hemorrhage, epistaxis, and peripheral edema.

## **6.2 Immunogenicity**

As with all therapeutic proteins, there is potential for immunogenicity. The detection of antibody formation is highly dependent on the sensitivity and specificity of the assay. Additionally, the observed incidence of antibody (including neutralizing antibody) positivity in an assay may be influenced by several factors, including assay methodology, sample handling, timing of sample collection, concomitant medications, and underlying disease. For these reasons, comparison of the incidence of antibodies in the studies described below with the incidence of antibodies in other studies or to other emapalumab products may be misleading.

The immunogenicity of emapalumab-lzsg has been evaluated using an electrochemiluminescence-based immunoassay (ECLIA). A total of 64 subjects were evaluated for anti-therapeutic antibodies (ATAs) to emapalumab-lzsg after treatment with GAMIFANT. ATAs were detected in 3/64 subjects (5%) who received GAMIFANT.

Treatment-emergent ATAs were detected in 1/33 (3%) of patients in the primary HLH clinical trial. The ATAs in this patient were found to have neutralizing ability. One patient receiving GAMIFANT through compassionate use developed transient non-neutralizing treatment-emergent ATAs. In both of these patients, ATAs occurred within the first 9 weeks following the initiation of GAMIFANT treatment. In addition, one healthy subject tested positive for ATAs following a single dose of GAMIFANT. No evidence of an altered safety or efficacy profile was identified in the primary HLH patients who developed antibodies to emapalumab-lzsg.

## **7 DRUG INTERACTIONS**

### **7.1 Effect of GAMIFANT on Cytochrome P450 Substrates**

The formation of CYP450 enzymes may be suppressed by increased levels of cytokines (such as IFN $\gamma$ ) during chronic inflammation. By neutralizing IFN $\gamma$ , use of GAMIFANT may normalize CYP450 activities which may reduce the efficacy of drugs that are CYP450 substrates due to increased metabolism.

Upon initiation or discontinuation of concomitant GAMIFANT, monitor for reduced efficacy and adjust dosage of CYP450 substrate drugs as appropriate.

## **8 USE IN SPECIFIC POPULATIONS**

### **8.1 Pregnancy**

#### Risk Summary

There are no available data on GAMIFANT use in pregnant women to inform a drug-associated risk of adverse developmental outcomes. In an animal reproduction study, a murine surrogate

anti-mouse IFN $\gamma$  antibody administered to pregnant mice throughout gestation crossed the placental barrier, and no fetal harm was observed (*see Data*).

The estimated background risk of major birth defects and miscarriage for the indicated population is unknown. All pregnancies have a background risk of birth defect, loss, or other adverse outcomes. In the U.S. general population, the estimated background risk of major birth defects and miscarriage in clinically recognized pregnancies is 2 to 4% and 15 to 20%, respectively.

## Data

### *Animal Data*

In a mouse embryo-fetal development study, a murine surrogate anti-mouse IFN $\gamma$  antibody was administered every 3-4 days throughout organogenesis and late gestation at doses of 0, 30, 75 or 150 mg/kg/occasion. The surrogate antibody was detected in the plasma of all treated pregnant mice and their corresponding fetuses. No maternal toxicity occurred and there was no evidence of teratogenicity or effects on embryo-fetal survival or growth.

## **8.2 Lactation**

### Risk Summary

There is no information regarding the presence of emapalumab-lzsg in human milk, the effects on the breastfed child, or the effects on milk production. Published data suggest that only limited amounts of therapeutic antibodies are found in breast milk and they do not enter the neonatal and infant circulations in substantial amounts.

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

## **8.4 Pediatric Use**

Safety and effectiveness of GAMIFANT have been established in pediatric patients, newborn and older, with primary HLH that is reactivated or refractory to conventional therapies. Use of GAMIFANT is supported by a single-arm trial in 27 pediatric patients with reactivated or refractory primary HLH. This study included pediatric patients in the following age groups: 5 patients newborn to 6 months, 10 patients 6 months to 2 years, and 12 patients from 2 years to 13 years [*see Clinical Studies (14)*].

## **8.5 Geriatric Use**

Clinical studies of GAMIFANT did not include sufficient numbers of subjects aged 65 and over to determine whether they respond differently from younger subjects. Other reported clinical experience has not identified differences in responses between the elderly and younger patients.

## 11 DESCRIPTION

Emapalumab-lzsg is an interferon gamma (IFN $\gamma$ ) blocking antibody. Emapalumab-lzsg is produced in Chinese Hamster Ovary cells by recombinant DNA technology. Emapalumab-lzsg is an IgG1 immunoglobulin with a molecular weight of approximately 148 kDa.

GAMIFANT (emapalumab-lzsg) injection for intravenous use is a sterile, preservative-free, clear to slightly opalescent, colorless to slightly yellow solution provided in single-dose vials that require dilution prior to intravenous infusion.

Each vial contains 10 mg/2 mL or 50 mg/10 mL emapalumab-lzsg at a concentration of 5 mg/mL. Each mL also contains the following inactive ingredients: L-Histidine (1.55 mg), L-Histidine monohydrochloride, monohydrate (3.14 mg), Polysorbate 80 (0.05 mg), sodium chloride (7.30 mg), and Water for Injection, USP.

## 12 CLINICAL PHARMACOLOGY

### 12.1 Mechanism of Action

Emapalumab-lzsg is a monoclonal antibody that binds to and neutralizes interferon gamma (IFN $\gamma$ ). Nonclinical data suggest that IFN $\gamma$  plays a pivotal role in the pathogenesis of HLH by being hypersecreted.

### 12.2 Pharmacodynamics

#### *IFN $\gamma$ Inhibition*

Emapalumab-lzsg reduces the plasma concentrations of CXCL9, a chemokine induced by IFN $\gamma$ .

#### *Cardiac Electrophysiology*

At a dose of 3 mg/kg GAMIFANT does not prolong the QT interval to any clinically relevant extent.

### 12.3 Pharmacokinetics

The pharmacokinetics of emapalumab-lzsg were evaluated in healthy adult subjects and in patients with primary HLH.

Following a 1 mg/kg emapalumab-lzsg dose, median steady state peak concentration was 44 mcg/mL, which was 2.9 times higher than after the first dose. The median steady state trough concentration was 25 mcg/mL, which was 4.3 times higher than after the first dose.

Emapalumab-lzsg AUC increases slightly more than proportionally between 1 and 3 mg/kg doses, and less than proportionally at 3, 6, and 10 mg/kg doses.

Emapalumab-lzsg exhibits target-mediated clearance dependent on IFN $\gamma$  production, which can vary between and within patients as a function of time and can affect the recommended dosage [see *Dosage and Administration (2.2)*]. Emapalumab-lzsg steady state is achieved by the 7th infusion when the IFN $\gamma$  production is moderate. At high IFN $\gamma$  production, steady-state is reached earlier due to a shorter half-life.



### *Distribution*

The central and peripheral volumes of distribution in a subject with body weight of 70 kg are 4.2 and 5.6 L, respectively.

### *Elimination*

Emapalumab-lzsg elimination half-life is approximately 22 days in healthy subjects, and ranged from 2.5 to 18.9 days in HLH patients.

Emapalumab-lzsg clearance is approximately 0.007 L/h in healthy subjects.

In patients, the total clearance of emapalumab-lzsg was significantly influenced by the production of IFN $\gamma$ , demonstrating target mediated clearance of emapalumab-lzsg.

### *Metabolism*

The metabolic pathway of emapalumab-lzsg has not been characterized. Like other protein therapeutics, GAMIFANT is expected to be degraded into small peptides and amino acids via catabolic pathways.

### Specific Populations

Body weight (2 to 82 kg) was a significant covariate of emapalumab-lzsg pharmacokinetics, supporting body weight-based dosing.

No clinically significant differences in the pharmacokinetics of emapalumab-lzsg were observed based on age (0.02 to 56 year), sex (53% Females), race (71.4% Caucasian, 12.2% Asian and 8.2% Black), renal impairment including dialysis, or hepatic impairment (mild, moderate, and severe).

### Drug Interaction Studies

No drug-drug interaction studies have been conducted with GAMIFANT.

## **13 NONCLINICAL TOXICOLOGY**

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

No carcinogenicity or genotoxicity studies have been conducted with emapalumab-lzsg.

No studies have been conducted to evaluate the effects of emapalumab-lzsg on fertility; however, no adverse effects on male or female reproductive organs were observed in the 8- or 13-week repeat-dose toxicity studies in cynomolgus monkeys.

## **14 CLINICAL STUDIES**

The efficacy of GAMIFANT was evaluated in a multicenter, open-label, single-arm trial NI-0501-04 (NCT01818492) in 27 pediatric patients with suspected or confirmed primary HLH with either refractory, recurrent, or progressive disease during conventional HLH therapy or who were intolerant of conventional HLH therapy.

Patients were required to fulfill the following criteria for enrollment: primary HLH based on a molecular diagnosis or family history consistent with primary HLH or five out of the 8 criteria fulfilled: fever, splenomegaly, cytopenias affecting 2 of 3 lineages in the peripheral blood (hemoglobin  $< 9$ , platelets  $< 100 \times 10^9/L$ , neutrophils  $< 1 \times 10^9/L$ ), hypertriglyceridemia (fasting triglycerides  $> 3$  mmol/L or  $\geq 265$  mg/dL) and/or hypofibrinogenemia ( $\leq 1.5$  g/L), hemophagocytosis in bone marrow, spleen, or lymph nodes with no evidence of malignancy, low or absent NK-cell activity, ferritin  $\geq 500$  mcg/L, soluble CD25  $\geq 2400$  U/mL. Patients had to have evidence of active disease as assessed by treating physician. Patients had to fulfill one of the following criteria as assessed by the treating physician: having not responded or not achieved a satisfactory response or not maintained a satisfactory response to conventional HLH therapy, or intolerance to conventional HLH treatments. Patients with active infections caused by specific pathogens favored by IFN $\gamma$  neutralization were excluded from the trial (e.g., mycobacteria and *Histoplasma Capsulatum*). Patients received prophylaxis for Herpes Zoster, *Pneumocystis jirovecii*, and fungal infections.

Twenty-seven patients enrolled and received treatment in the study and twenty patients (74%) completed the study. Seven patients (26%) were prematurely withdrawn. Twenty-two patients (81%) enrolled onto the open-label extension study which monitored patients for up to 1 year after HSCT or after the last GAMIFANT infusion (NI-0501-05; NCT02069899).

The study treatment duration was up to 8 weeks after which patients could continue treatment on the extension study. All patients received an initial starting dose of GAMIFANT of 1 mg/kg every 3 days. Subsequent doses could be increased to a maximum of 10 mg/kg based on clinical and laboratory parameters interpreted as unsatisfactory response. Forty-four percent of patients remained at a dose of 1 mg/kg, 30% of patients increased to 3-4 mg/kg and 26% of patients increased to 6-10 mg/kg. The median time to dose increase was 27 days (range: 3-31 days) with 22% of patients requiring a dose increase in the first week of treatment.

All patients received dexamethasone as background HLH treatment with doses between 5 to 10 mg/m<sup>2</sup>/day. Cyclosporine A was continued if administered prior to screening. Patients receiving methotrexate and glucocorticoids administered intrathecally at baseline could continue these treatments.

In Study NI-0501-04, the median patient age was 1 year (0.2 to 13). Fifty-nine percent of the patients were female, 63% were Caucasian, 11% were Asian, and 11% were Black.

A genetic mutation known to cause HLH was present in 82% of patients. The most frequent causative mutations were FHL3-UNC13D (MUNC 13-4) (26%), FHL2-PRF1 (19%), and Griscelli Syndrome type 2 (19%).

The HLH mutations in the population enrolled are described in Table 3.

**Table 3: HLH Mutations in Patients with Primary HLH with Prior Therapy**

	<b>GAMIFANT (N=27)</b>
<b>HLH Genetic Confirmation</b>	22 (82)
FHL3 – UNC13D	7 (26)
FHL2 – PRF1	5 (19)
Griscelli Syndrome type 2 (RAB27A)	5 (19)
FHL5 – STXBP2 (UNC18B)	2 (7.4)
FHL4 – STX11	1 (3.7)
X-linked Lymphoproliferative Disorder 1	1 (3.7)
X-linked Lymphoproliferative Disorder 2	1 (3.7)

All patients received previous HLH treatments. Patients received a median of 3 prior agents before enrollment into the trial. Prior regimens included combinations of the following agents: dexamethasone, etoposide, cyclosporine A, and anti-thymocyte globulin.

At baseline entry into the study, 78% of patients had elevated ferritin levels, thrombocytopenia (70% with platelet count of  $< 100 \times 10^9$  cells/L), hypertriglyceridemia (67%) with triglyceride level  $> 3$  mmol/L. Central nervous system findings were present in 37% of patients. Forty-one percent of patients had active infections not due to specific pathogens favored by IFN $\gamma$  neutralization at the time of GAMIFANT initiation.

The efficacy of GAMIFANT was based upon overall response rate (ORR) at the end of treatment, defined as achievement of either a complete or partial response or HLH improvement. ORR was evaluated using an algorithm that included the following objective clinical and laboratory parameters: fever, splenomegaly, central nervous system symptoms, complete blood count, fibrinogen and/or D-dimer, ferritin, and soluble CD25 (also referred to as soluble interleukin-2 receptor) levels. Complete response was defined as normalization of all HLH abnormalities (i.e., no fever, no splenomegaly, neutrophils  $> 1 \times 10^9$ /L, platelets  $> 100 \times 10^9$ /L, ferritin  $< 2,000$   $\mu$ g/L, fibrinogen  $> 1.50$  g/L, D-dimer  $< 500$   $\mu$ g/L, normal CNS symptoms, no worsening of sCD25  $> 2$ -fold baseline). Partial response was defined as normalization of  $\geq 3$  HLH abnormalities. HLH improvement was defined as  $\geq 3$  HLH abnormalities improved by at least 50% from baseline.

**Table 4: Overall Response Rate at End of Treatment**

	<b>GAMIFANT (N=27)</b>
<b>Overall Response Rate</b>	
N (%)	17 (63)
(95% CI)	(0.42, 0.81)
p-value†	0.013
<b>Overall Response by Category</b>	
Complete response, n (%)	7 (26)
Partial response	8 (30)
HLH improvement	2 (7.4)

†p-value based on Exact Binomial Test at a one-sided significance level of 2.5% comparing proportion of patients with overall response to hypothesized null hypothesis of 40%.

CI = confidence interval

The median duration of first response, defined as time from achievement of first response to loss of first response, is not reached (range: 4-56+ days). Seventy percent (19/27) of patients proceeded to HSCT.

## **16 HOW SUPPLIED/STORAGE AND HANDLING**

GAMIFANT (emapalumab-lzsg) injection is a sterile, clear to slightly opalescent, colorless to slightly yellow solution supplied in the following packaging configuration:

NDC 72171-501-01 – containing one 10 mg/2 mL (5 mg/mL) single-dose vial

NDC 72171-505-01 – containing one 50 mg/10 mL (5 mg/mL) single-dose vial

Store GAMIFANT in a refrigerator at 2°C to 8°C (36°F to 46°F) in original carton to protect from light. Do not freeze or shake. This product contains no preservative.

## **17 PATIENT COUNSELING INFORMATION**

Advise the patient to read the FDA-approved patient labeling (Medication Guide).

### **Infections**

Inform patients and their caregivers of the risk of developing infections during treatment with GAMIFANT, and to report any symptoms of infection [see *Warnings and Precautions (5.1)*].

### **Vaccinations**

Advise patients and their caregivers that the patient should not receive live or live attenuated vaccines during GAMIFANT treatment [see *Warnings and Precautions (5.2)*].

### **Infusion-Related Reactions**

Advise patients and their caregivers of the potential for developing infusion-related reactions during treatment with GAMIFANT [see *Warnings and Precautions (5.3)*].

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Novimmune SA  
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890 Winter Street  
Waltham, MA 02451

**Manufactured at:**

Patheon Italia S.p.A  
2° Trav. SX Via Morolense, 5  
03013-Ferentino Italy

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