Neupogen
Filgrastim

1. NAME OF THE MEDICINAL PRODUCT

Neupogen 30 MU vials (0.3 mg/ml) solution for injection in vials
Neupogen 30 MU pre-filled syringe (0.6 mg/ml) solution for injection in a pre-filled syringe
Neupogen 48 MU pre-filled syringe (0.96 mg/ml) solution for injection in a pre-filled syringe

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Neupogen 30 MU vials:
Each vial contains 30 million units (300 micrograms (µg)) of filgrastim in 1 ml (0.3 mg/ml).

Filgrastim (recombinant methionyl human granulocyte-colony stimulating factor) is produced by r-DNA technology in *E. coli* (K12).

Excipient with known effect:
Each ml of solution contains 50 mg sorbitol.

Neupogen 30 MU pre-filled syringe:
Each pre-filled syringe contains 30 million units (MU)/300 micrograms (µg) of filgrastim in 0.5 ml (0.6 mg/ml).

Filgrastim (recombinant methionyl human granulocyte-colony stimulating factor) is produced by r-DNA technology in *E. coli* (K12).

Excipient with known effect:
Each pre-filled syringe contains 25 mg (or 50 mg/ml) of sorbitol.

Neupogen 48 MU pre-filled syringe:
Each pre-filled syringe contains 48 million units (MU)/480 micrograms (µg) of filgrastim in 0.5 ml (0.96 mg/ml).

Filgrastim (recombinant methionyl human granulocyte-colony stimulating factor) is produced by r-DNA technology in *E. coli* (K12).

Excipient with known effect:
Each pre-filled syringe contains 25 mg (or 50 mg/ml) of sorbitol.

For the full list of excipients, see section 6.1.

3. PHARMACEUTICAL FORM

Neupogen 30 MU vials:
Solution for injection in a vial.
Concentrate for solution for infusion in a vial.

Neupogen 30 MU and 48 MU pre-filled syringe:
Solution for injection in a pre-filled syringe.
Concentrate for solution for infusion in a pre-filled syringe.

Clear, colorless solution.

4. CLINICAL PARTICULARS

4.1 Therapeutic indications

Neupogen is indicated for the reduction in the duration of neutropenia and the incidence of febrile neutropenia in patients treated with established cytotoxic chemotherapy for malignancy (with the exception of chronic myeloid leukemia and myelodysplastic syndromes) and for the reduction in the duration of neutropenia in patients undergoing myeloablative therapy followed by bone marrow transplantation considered to be at increased risk of prolonged severe neutropenia.

The safety and efficacy of Neupogen are similar in adults and children receiving cytotoxic chemotherapy.

Neupogen is indicated for the mobilization of peripheral blood progenitor cells (PBPCs).

In patients, children or adults, with severe congenital, cyclic, or idiopathic neutropenia with an absolute neutrophil count (ANC) of $\leq 0.5 \times 10^9$/l, and a history of severe or recurrent infections, long-term administration of Neupogen is indicated to increase neutrophil counts and to reduce the incidence and duration of infection-related events.

Neupogen is indicated for the treatment of persistent neutropenia (ANC less than or equal to 1.0×10^9/l) in patients with advanced HIV infection, in order to reduce the risk of bacterial infections when other options to manage neutropenia are inappropriate.

4.2 Posology and method of administration

Neupogen therapy should only be given in collaboration with an oncology center which has experience in G-CSF treatment and hematology and has the necessary diagnostic facilities. The mobilization and apheresis procedures should be performed in collaboration with an oncology-hematology center with acceptable experience in this field and where the monitoring of hematopoietic progenitor cells can be correctly performed.

<u>Established cytotoxic chemotherapy</u>

Posology

The recommended dose of Neupogen is 0.5 MU (5 µg)/kg/day. The first dose of Neupogen should be administered at least 24 hours after cytotoxic chemotherapy. In randomized clinical trials, a subcutaneous dose of 230 µg/m^2/day (4.0 to 8.4 µg/kg/day) was used.

Daily dosing with Neupogen should continue until the expected neutrophil nadir is passed and the neutrophil count has recovered to the normal range. Following established chemotherapy for solid tumors, lymphomas, and lymphoid leukemia, it is expected that the duration of treatment required to fulfill these criteria will be up to 14 days. Following induction and consolidation treatment for acute myeloid leukemia the duration of treatment may be substantially longer (up to 38 days) depending on the type, dose and schedule of cytotoxic chemotherapy used.

In patients receiving cytotoxic chemotherapy, a transient increase in neutrophil counts is typically seen 1 to 2 days after initiation of Neupogen therapy. However, for a sustained therapeutic response, Neupogen therapy should not be discontinued before the expected nadir has passed and the neutrophil count has recovered to the normal range. Premature discontinuation of Neupogen therapy, prior to the time of the expected neutrophil nadir, is not recommended.

Method of administration

Neupogen may be given as a daily subcutaneous injection or as a daily intravenous infusion diluted in 5% glucose solution given over 30 minutes (see section 6.6). The subcutaneous route is preferred in most cases. There is some evidence from a study of single dose administration that intravenous dosing may shorten the duration of effect. The clinical relevance of this finding to multiple dose administration is not clear. The choice of route should depend on the individual clinical circumstance.

<u>In patients treated with myeloablative therapy followed by bone marrow transplantation</u>

Posology

The recommended starting dose of Neupogen is 1.0 MU (10 µg)/kg/day. The first dose of Neupogen should be administered at least 24 hours following cytotoxic chemotherapy and at least 24 hours after bone marrow infusion.

Once the neutrophil nadir has been passed, the daily dose of Neupogen should be titrated against the neutrophil response as follows:

Neutrophil Count	Neupogen Dose Adjustment
$> 1.0 \times 10^9$/l for 3 consecutive days	Reduce to 0.5 MU (5 µg)/kg/day
Then, if ANC remains $> 1.0 \times 10^9$/l for 3 more consecutive days	Discontinue Neupogen
If the ANC decreases to $< 1.0 \times 10^9$/l during the treatment period the dose of Neupogen should be re-escalated according to the above steps	

ANC = absolute neutrophil count

Method of administration

Neupogen may be given as a 30-minute or 24-hour intravenous infusion or given by continuous 24-hour subcutaneous infusion. Neupogen should be diluted in 20 ml of 5% glucose solution (see section 6.6).

<u>For the mobilization of PBPCs in patients undergoing myelosuppressive or myeloablative therapy followed by autologous PBPC transplantation</u>

Posology

The recommended dose of Neupogen for PBPC mobilization when used alone is 1.0 MU (10 µg)/kg/day for 5 to 7 consecutive days. Timing of leukapheresis: one or two leukapheresis on days 5 and 6 are often sufficient. In other circumstances, additional leukapheresis may be necessary. Neupogen dosing should be maintained until the last leukapheresis.

The recommended dose of Neupogen for PBPC mobilization after myelosuppressive chemotherapy is 0.5 MU (5 µg)/kg/day from the first day after completion of chemotherapy until the expected neutrophil nadir is passed and the neutrophil count has recovered to the normal range. Leukapheresis should be performed during the period when the ANC rises from $< 0.5 \times 10^9$/l to $> 5.0 \times 10^9$/l. For patients who have not had extensive chemotherapy, one leukapheresis is often sufficient. In other circumstances, additional leukapheresis are recommended.

Method of administration

Neupogen for PBPC mobilization when used alone:
Neupogen may be given as a 24-hour subcutaneous continuous infusion or subcutaneous injection. For infusions Neupogen should be diluted in 20 ml of 5% glucose solution (see section 6.6).

Neupogen for PBPC mobilization after myelosuppressive chemotherapy:
Neupogen should be given by subcutaneous injection.

For the mobilization of PBPCs in normal donors prior to allogeneic PBPC transplantation

Posology

For PBPC mobilization in normal donors, Neupogen should be administered at 1.0 MU (10 µg)/kg/day for 4 to 5 consecutive days. Leukapheresis should be started at day 5 and continued until day 6 if needed in order to collect 4×10^6 $CD34^+$ cells/kg recipient body weight.

Method of administration

Neupogen should be given by subcutaneous injection.

In patients with severe chronic neutropenia (SCN)

Posology

Congenital neutropenia: The recommended starting dose is 1.2 MU (12 µg)/kg/day, as a single dose or in divided doses.

Idiopathic or cyclic neutropenia: The recommended starting dose is 0.5 MU (5 µg)/kg/day, as a single dose or in divided doses.

Dose adjustment: Neupogen should be administered daily by subcutaneous injection until the neutrophil count has reached and can be maintained at more than 1.5×10^9/l. When the response has been obtained the minimal effective dose to maintain this level should be established. Long-term daily administration is required to maintain an adequate neutrophil count. After one to two weeks of therapy, the initial dose may be doubled or halved depending upon the patient's response. Subsequently the dose may be individually adjusted every 1 to 2 weeks to maintain the average neutrophil count between 1.5×10^9/l and 10×10^9/l. A faster schedule of dose escalation may be considered in patients presenting with severe infections. In clinical trials, 97% of patients who responded had a complete response at doses ≤ 24 µg/kg/day. The long-term safety of Neupogen administration above 24 µg/kg/day in patients with SCN has not been established.

Method of administration

Congenital, idiopathic or cyclic neutropenia: Neupogen should be given by subcutaneous injection.

In patients with HIV infection

Posology

For reversal of neutropenia:
The recommended starting dose of Neupogen is 0.1 MU (1 µg)/kg/day, with titration up to a maximum of 0.4 MU (4 µg)/kg/day until a normal neutrophil count is reached and can be maintained (ANC > 2.0×10^9/l). In clinical studies, > 90% of patients responded at these doses, achieving reversal of neutropenia in a median of 2 days.

In a small number of patients (< 10%), doses up to 1.0 MU (10 µg)/kg/day were required to achieve reversal of neutropenia.

For maintaining normal neutrophil counts:
When reversal of neutropenia has been achieved, the minimal effective dose to maintain a normal neutrophil count should be established. Initial dose adjustment to alternate day dosing with 30 MU (300 µg)/day is recommended. Further dose adjustment may be necessary, as determined by the patient's ANC, to maintain the neutrophil count at > 2.0×10^9/l. In clinical studies, dosing with 30 MU (300 µg)/day on 1 to 7 days per week was required to maintain the ANC > 2.0×10^9/l, with the median dose frequency being 3 days per week. Long-term administration may be required to maintain the ANC > 2.0×10^9/l.

Method of administration

Reversal of neutropenia or maintaining normal neutrophil counts: Neupogen should be given by subcutaneous injection.

Older people

Clinical trials with Neupogen have included a small number of elderly patients but special studies have not been performed in this group and therefore specific dosage recommendations cannot be made.

Patients with renal impairment

Studies of Neupogen in patients with severe impairment of renal or hepatic function demonstrate that it exhibits a similar pharmacokinetic and pharmacodynamic profile to that seen in normal individuals. Dose adjustment is not required in these circumstances.

Pediatric use in the SCN and cancer settings

Sixty-five percent of the patients studied in the SCN trial program were under 18 years of age. The efficacy of treatment was clear for this age group, which included most patients with congenital neutropenia. There were no differences in the safety profiles for pediatric patients treated for SCN.

Data from clinical studies in pediatric patients indicate that the safety and efficacy of Neupogen are similar in both adults and children receiving cytotoxic chemotherapy.

The dosage recommendations in pediatric patients are the same as those in adults receiving myelosuppressive cytotoxic chemotherapy.

4.3 Contraindications

Hypersensitivity to the active substance or to any of the excipients listed in section 6.1.

4.4 Special warnings and precautions for use

Special warnings and precautions across indications

Hypersensitivity

Hypersensitivity, including anaphylactic reactions, occurring on initial or subsequent treatment have been reported in patients treated with Neupogen. Permanently discontinue Neupogen in patients with clinically significant hypersensitivity. Do not administer Neupogen to patients with a history of hypersensitivity to filgrastim or pegfilgrastim.

Pulmonary adverse effects

Pulmonary adverse effects, in particular interstitial lung disease, have been reported after G-CSF administration. Patients with a recent history of lung infiltrates or pneumonia may be at higher risk. The onset of pulmonary signs, such as cough, fever and dyspnea in association with radiological signs of pulmonary infiltrates and deterioration in pulmonary function may be preliminary signs of acute respiratory distress syndrome (ARDS). Neupogen should be discontinued and appropriate treatment given.

Glomerulonephritis

Glomerulonephritis has been reported in patients receiving filgrastim and pegfilgrastim. Generally, events of glomerulonephritis resolved after dose reduction or withdrawal of filgrastim and pegfilgrastim. Urinalysis monitoring is recommended.

Capillary leak syndrome

Capillary leak syndrome, which can be life-threatening if treatment is delayed, has been reported after granulocyte-colony stimulating factor administration, and is characterized by hypotension, hypoalbuminemia, edema and hemoconcentration. Patients who develop symptoms of capillary leak syndrome should be closely monitored and receive standard symptomatic treatment, which may include a need for intensive care (see section 4.8).

Splenomegaly and splenic rupture

Generally asymptomatic cases of splenomegaly and cases of splenic rupture have been reported in patients and normal donors following administration of Neupogen. Some cases of splenic rupture were fatal. Therefore, spleen size should be carefully monitored (e.g. clinical examination, ultrasound). A diagnosis of splenic rupture should be considered in donors and/or patients reporting left upper abdominal or shoulder tip pain. Dose reductions of Neupogen have been noted to slow or stop the progression of splenic enlargement in patients with severe chronic neutropenia, and in 3% of patients a splenectomy was required.

Malignant cell growth

Granulocyte-colony stimulating factor can promote growth of myeloid cells *in vitro* and similar effects may be seen on some non-myeloid cells *in vitro*.

Myelodysplastic syndrome or chronic myeloid leukemia

The safety and efficacy of Neupogen administration in patients with myelodysplastic syndrome, or chronic myelogenous leukemia have not been established. Neupogen is not indicated for use in these conditions. Particular care should be taken to distinguish the diagnosis of blast transformation of chronic myeloid leukemia from acute myeloid leukemia.

Acute myeloid leukemia

In view of limited safety and efficacy data in patients with secondary AML, Neupogen should be administered with caution. The safety and efficacy of Neupogen administration in *de novo* AML patients aged < 55 years with good cytogenetics (t(8;21), t(15;17), and inv(16)) have not been established.

Thrombocytopenia

Thrombocytopenia has been reported in patients receiving Neupogen. Platelet counts should be monitored closely, especially during the first few weeks of Neupogen therapy. Consideration should be given to temporary discontinuation or dose reduction of Neupogen in patients with severe chronic neutropenia who develop thrombocytopenia (platelet count $< 100 \times 10^9$/l).

Leukocytosis

White blood cell counts of 100×10^9/l or greater have been observed in less than 5% of cancer patients receiving Neupogen at doses above 0.3 MU/kg/day (3 µg/kg/day). No undesirable effects directly attributable to this degree of leukocytosis have been reported. However, in view of the potential risks associated with severe leukocytosis, a white blood cell count should be performed at regular intervals during Neupogen therapy. If leukocyte counts exceed 50×10^9/l after the expected nadir, Neupogen should be discontinued immediately. When administered for PBPC mobilization, Neupogen should be discontinued or its dosage should be reduced if the leukocyte counts rise to $> 70 \times 10^9$/l.

Immunogenicity

As with all therapeutic proteins, there is a potential for immunogenicity. Rates of generation of antibodies against filgrastim is generally low. Binding antibodies do occur as expected with all biologics; however, they have not been associated with neutralizing activity at present.

Aortitis

Aortitis has been reported after G-CSF administration in healthy subjects and in cancer patients. The symptoms experienced included fever, abdominal pain, malaise, back pain and increased inflammatory markers (e.g. c-reactive protein and white blood cell count). In most cases aortitis was diagnosed by CT scan and generally resolved after withdrawal of G-CSF. See section 4.8.

Special warnings and precautions associated with co-morbidities

Special precautions in sickle cell trait and sickle cell disease

Sickle cell crises, in some cases fatal, have been reported with the use of Neupogen in patients with sickle cell trait or sickle cell disease. Physicians should use caution when prescribing Neupogen in patients with sickle cell trait or sickle cell disease.

Osteoporosis

Monitoring of bone density may be indicated in patients with underlying osteoporotic bone diseases who undergo continuous therapy with Neupogen for more than 6 months.

Special precautions in cancer patients

Neupogen should not be used to increase the dose of cytotoxic chemotherapy beyond established dosage regimens.

Risks associated with increased doses of chemotherapy

Special caution should be used when treating patients with high-dose chemotherapy, because improved tumor outcome has not been demonstrated and intensified doses of chemotherapeutic agents may lead to increased toxicities including cardiac, pulmonary, neurologic, and dermatologic effects (please refer to the prescribing information of the specific chemotherapy agents used).

Effect of chemotherapy on erythrocytes and thrombocytes

Treatment with Neupogen alone does not preclude thrombocytopenia and anemia due to myelosuppressive chemotherapy. Because of the potential of receiving higher doses of chemotherapy (e.g. full doses on the prescribed schedule) the patient may be at greater risk of thrombocytopenia and anemia. Regular monitoring of platelet count and hematocrit is recommended. Special care should be taken when administering single or combination chemotherapeutic agents which are known to cause severe thrombocytopenia.

The use of Neupogen mobilized PBPCs has been shown to reduce the depth and duration of thrombocytopenia following myelosuppressive or myeloablative chemotherapy.

Myelodysplastic syndrome and acute myeloid leukemia in breast and lung cancer patients

In the post-marketing observational study setting, myelodysplastic syndrome (MDS) and acute myeloid leukemia (AML) have been associated with the use of pegfilgrastim, an alternative G-CSF medicine, in conjunction with chemotherapy and/or radiotherapy in breast and lung cancer patients. A similar association between filgrastim and MDS/AML has not been observed. Nonetheless, patients with breast cancer and patients with lung cancer should be monitored for signs and symptoms of MDS/AML.

Other special precautions

The effects of Neupogen in patients with substantially reduced myeloid progenitors have not been studied. Neupogen acts primarily on neutrophil precursors to exert its effect in elevating neutrophil counts. Therefore, in patients with reduced precursors neutrophil response may be diminished (such as those treated with extensive radiotherapy or chemotherapy, or those with bone marrow infiltration by tumor).

Vascular disorders, including veno-occlusive disease and fluid volume disturbances, have been reported occasionally in patients undergoing high-dose chemotherapy followed by transplantation.

There have been reports of graft versus host disease (GvHD) and fatalities in patients receiving G-CSF after allogeneic bone marrow transplantation (see sections 4.8 and 5.1).

Increased hematopoietic activity of the bone marrow in response to growth factor therapy has been associated with transient abnormal bone scans. This should be considered when interpreting bone-imaging results.

Special precautions in patients undergoing PBPC mobilization

Mobilization

There are no prospectively randomized comparisons of the two recommended mobilization methods (Neupogen alone, or in combination with myelosuppressive chemotherapy) within the same patient population. The degree of variation between individual patients and between laboratory assays of $CD34^+$ cells mean that direct comparison between different studies is difficult. It is therefore difficult to recommend an optimum method. The choice of mobilization method should be considered in relation to the overall objectives of treatment for an individual patient.

Prior exposure to cytotoxic agents

Patients who have undergone very extensive prior myelosuppressive therapy may not show sufficient mobilization of PBPC to achieve the recommended minimum yield ($\geq 2.0 \times 10^6$ $CD34^+$ cells/kg) or acceleration of platelet recovery, to the same degree.

Some cytotoxic agents exhibit particular toxicities to the hematopoietic progenitor pool, and may adversely affect progenitor mobilization. Agents such as melphalan, carmustine (BCNU), and carboplatin, when administered over prolonged periods prior to attempts at progenitor mobilization may reduce progenitor yield. However, the administration of melphalan, carboplatin or BCNU together with Neupogen, has been shown to be effective for progenitor mobilization. When a PBPC transplantation is envisaged it is advisable to plan the stem cell mobilization procedure early in the treatment course of the patient. Particular attention should be paid to the number of progenitors mobilized in such patients before the administration of high-dose chemotherapy. If yields are inadequate, as measured by the criteria above, alternative forms of treatment, not requiring progenitor support should be considered.

Assessment of progenitor cell yields

In assessing the number of progenitor cells harvested in patients treated with Neupogen, particular attention should be paid to the method of quantitation. The results of flow cytometric analysis of $CD34^+$ cell numbers vary depending on the precise methodology used and recommendations of numbers based on studies in other laboratories need to be interpreted with caution.

Statistical analysis of the relationship between the number of $CD34^+$ cells re-infused and the rate of platelet recovery after high-dose chemotherapy indicates a complex but continuous relationship.

The recommendation of a minimum yields of $\geq 2.0 \times 10^6$ $CD34^+$ cells/kg is based on published experience resulting in adequate hematologic reconstitution. Yields in excess of this appear to correlate with more rapid recovery, those below with slower recovery.

Special precautions in normal donors undergoing PBPC mobilization

Mobilization of PBPC does not provide a direct clinical benefit to normal donors and should only be considered for the purposes of allogeneic stem cell transplantation.

PBPC mobilization should be considered only in donors who meet normal clinical and laboratory eligibility criteria for stem cell donation with special attention to hematological values and infectious disease.

The safety and efficacy of Neupogen have not been assessed in normal donors < 16 years or > 60 years.

Transient thrombocytopenia (platelets < 100×10^9/l) following filgrastim administration and leukapheresis was observed in 35% of subjects studied. Among these, two cases of platelets < 50×10^9/l were reported and attributed to the leukapheresis procedure.

If more than one leukapheresis is required, particular attention should be paid to donors with platelets < 100×10^9/l prior to leukapheresis; in general apheresis should not be performed if platelets < 75×10^9/l.

Leukapheresis should not be performed in donors who are anticoagulated or who have known defects in hemostasis.

Donors who receive G-CSFs for PBPC mobilization should be monitored until hematological indices return to normal.

Special precautions in recipients of allogeneic PBPCs mobilized with Neupogen

Current data indicate that immunological interactions between the allogeneic PBPC graft and the recipient may be associated with an increased risk of acute and chronic GvHD when compared with bone marrow transplantation.

Special precautions in SCN patients

Neupogen should not be administered to patients with severe congenital neutropenia who develop leukemia or have evidence of leukemic evolution.

Blood cell counts

Other blood cell changes occur, including anemia and transient increases in myeloid progenitors, which require close monitoring of cell counts.

Transformation to leukemia or myelodysplastic syndrome

Special care should be taken in the diagnosis of SCNs to distinguish them from other hematopoietic disorders such as aplastic anemia, myelodysplasia, and myeloid leukemia. Complete blood cell counts with differential and platelet counts, and an evaluation of bone marrow morphology and karyotype should be performed prior to treatment.

There was a low frequency (approximately 3%) of myelodysplastic syndromes (MDS) or leukemia in clinical trial patients with SCN treated with Neupogen. This observation has only been made in patients with congenital neutropenia. MDS and leukemias are natural complications of the disease and are of uncertain relation to Neupogen therapy. A subset of approximately 12% of patients who had normal cytogenetic evaluations at baseline were subsequently found to have abnormalities, including monosomy 7, on routine repeat evaluation. It is currently unclear whether long-term treatment of patients with SCN will predispose patients to cytogenetic abnormalities, MDS or leukemic transformation. It is recommended to perform morphologic and cytogenetic bone marrow examinations in patients at regular intervals (approximately every 12 months).

Other special precautions

Causes of transient neutropenia, such as viral infections should be excluded.

Hematuria was common and proteinuria occurred in a small number of patients. Regular urinalysis should be performed to monitor these events.

The safety and efficacy in neonates and patients with autoimmune neutropenia have not been established.

Special precautions in patients with HIV infection

Blood cell counts

Absolute neutrophil count (ANC) should be monitored closely, especially during the first few weeks of Neupogen therapy. Some patients may respond very rapidly and with a considerable increase in neutrophil count to the initial dose of Neupogen. It is recommended that the ANC is measured daily for the first 2-3 days of Neupogen administration. Thereafter, it is recommended that the ANC is measured at least twice per week for the first two weeks and subsequently once per week or once every other week during maintenance therapy. During intermittent dosing with 30 MU (300 µg)/day of Neupogen, there can be wide fluctuations in the patient's ANC over time. In order to determine a patient's trough or nadir ANC, it is recommended that blood samples are taken for ANC measurement immediately prior to any scheduled dosing with Neupogen.

Risk associated with increased doses of myelosuppressive medications

Treatment with Neupogen alone does not preclude thrombocytopenia and anemia due to myelosuppressive medications. As a result of the potential to receive higher doses or a greater number of these medications with Neupogen therapy, the patient may be at higher risk of developing thrombocytopenia and anemia. Regular monitoring of blood counts is recommended (see above).

Infections and malignancies causing myelosuppression

Neutropenia may be due to bone marrow infiltrating opportunistic infections such as *Mycobacterium avium* complex or malignancies such as lymphoma. In patients with known bone marrow infiltrating infections or malignancy, consider appropriate therapy for treatment of the underlying condition, in addition to administration of Neupogen for treatment of neutropenia. The effects of Neupogen on neutropenia due to bone marrow infiltrating infection or malignancy have not been well established.

All patients

The needle cover of the pre-filled syringe may contain dry natural rubber (a derivative of latex), which may cause allergic reactions.

Neupogen contains sorbitol (E420). Patients with hereditary fructose intolerance (HFI) must not be given this medicine unless strictly necessary.

Babies and young children (below 2 years of age) may not yet be diagnosed with hereditary fructose intolerance (HFI). Medicines (containing sorbitol/fructose) given intravenously may be life-threatening and should be contraindicated in this population unless there is an overwhelming clinical need and no alternatives are available.

A detailed history with regard to HFI symptoms has to be taken of each patient prior to being given this medicinal product.

Neupogen contains less than 1 mmol (23 mg) sodium per vial/pre-filled syringe, that is to say essentially 'sodium free'.

In order to improve the traceability of granulocyte-colony stimulating factors (G-CSFs), the trade name of the administered product should be clearly recorded in the patient file.

4.5 Interaction with other medicinal products and other forms of interaction

The safety and efficacy of Neupogen given on the same day as myelosuppressive cytotoxic chemotherapy have not been definitively established. In view of the sensitivity of rapidly dividing myeloid cells to myelosuppressive cytotoxic chemotherapy, the use of Neupogen is not recommended in the period from 24 hours before to 24 hours after chemotherapy. Preliminary evidence from a small number of patients treated concomitantly with Neupogen and 5-Fluorouracil indicates that the severity of neutropenia may be exacerbated.

Possible interactions with other hematopoietic growth factors and cytokines have not yet been investigated in clinical trials.

Since lithium promotes the release of neutrophils, lithium is likely to potentiate the effect of Neupogen. Although this interaction has not been formally investigated, there is no evidence that such an interaction is harmful.

4.6 Fertility, pregnancy and lactation

Pregnancy

There are no or limited amount of data from the use of filgrastim in pregnant women. Studies in animals have shown reproductive toxicity. An increased incidence of embryo-loss has been observed in rabbits at high multiples of the clinical exposure and in the presence of maternal toxicity (see section 5.3). There are reports in the literature where the transplacental passage of filgrastim in pregnant women has been demonstrated.

Neupogen is not recommended during pregnancy.

Breast-feeding

It is unknown whether filgrastim/metabolites are excreted in human milk. A risk to the newborns/infants cannot be excluded. A decision must be made whether to discontinue breast-feeding or to discontinue/abstain from Neupogen therapy taking into account the benefit of breast-feeding for the child and the benefit of therapy for the woman.

Fertility

Filgrastim did not affect reproductive performance or fertility in male or female rats (see section 5.3).

4.7 Effects on ability to drive and use machines

Neupogen may have a minor influence on the ability to drive and use machines. Dizziness may occur following the administration of Neupogen (see section 4.8).

4.8 Undesirable effects

a. Summary of the safety profile

The most serious adverse reactions that may occur during Neupogen treatment include: anaphylactic reaction, serious pulmonary adverse events (including interstitial pneumonia and ARDS), capillary leak syndrome, severe splenomegaly/splenic rupture, transformation to myelodysplastic syndrome or leukemia in SCN patients, GvHD in patients receiving allogeneic bone marrow transfer or peripheral blood cell progenitor cell transplant and sickle cell crisis in patients with sickle cell disease.

The most commonly reported adverse reactions are pyrexia, musculoskeletal pain (which includes bone pain, back pain, arthralgia, myalgia, pain in extremity, musculoskeletal pain, musculoskeletal chest pain, neck pain), anemia, vomiting, and nausea. In clinical trials in cancer patients musculoskeletal pain was mild or moderate in 10%, and severe in 3% of patients.

b. Tabulated summary of adverse reactions

The data in the table below describe adverse reactions reported from clinical trials and spontaneous reporting. Within each frequency grouping, undesirable effects are presented in order of decreasing seriousness.

MedDRA system organ class	**Adverse reactions**			
	Very common (≥ 1/10)	**Common (≥ 1/100 to < 1/10)**	**Uncommon (≥ 1/1,000 to < 1/100)**	**Rare (≥ 1/10,000 to < 1/1,000)**
Infections and infestations		Sepsis Bronchitis Upper respiratory tract infection Urinary tract infection		
Blood and lymphatic system disorders	Thrombocytopenia Anemia[e]	Splenomegaly[a] Hemoglobin decreased[e]	Leukocytosis[a]	Splenic rupture[a] Sickle cell anemia with crisis
Immune system disorders			Hypersensitivity Drug hypersensitivity[a] Graft versus host disease[b]	Anaphylactic reaction
Metabolism and nutrition disorders		Decreased appetite[e] Blood lactate dehydrogenase increased	Hyperuricemia Blood uric acid increased	Blood glucose decreased Pseudogout[a] (Chondrocalcinosis Pyrophosphate) Fluid volume disturbances
Psychiatric disorders		Insomnia		
Nervous system disorders	Headache[a]	Dizziness Hypoesthesia Paresthesia		
Vascular disorders		Hypertension Hypotension	Veno-occlusive disease[d]	Capillary leak syndrome[a] Aortitis
Respiratory, thoracic and mediastinal disorders		Hemoptysis Dyspnea Cough[a] Oropharyngeal pain[a, e] Epistaxis	Acute respiratory distress syndrome[a] Respiratory failure[a] Pulmonary edema[a] Pulmonary hemorrhage Interstitial lung disease[a] Lung infiltration[a] Hypoxia	
Gastrointestinal disorders	Diarrhea[a, e] Vomiting[a, e] Nausea[a]	Oral pain Constipation[e]		

MedDRA system organ class	Adverse reactions			
	Very common (≥ 1/10)	**Common (≥ 1/100 to < 1/10)**	**Uncommon (≥ 1/1,000 to < 1/100)**	**Rare (≥ 1/10,000 to < 1/1,000)**
Hepatobiliary disorders		Hepatomegaly Blood alkaline phosphatase increased	Aspartate aminotransferase increased Gamma-glutamyl transferase increased	
Skin and subcutaneous tissue disorders	Alopecia[a]	Rash[a] Erythema	Rash maculo-papular	Cutaneous vasculitis[a] Sweets syndrome (acute febrile neutrophilic dermatosis)
Musculoskeletal and connective tissue disorders	Musculoskeletal pain[c]	Muscle spasms	Osteoporosis	Bone density decreased Exacerbation of rheumatoid arthritis
Renal and urinary disorders		Dysuria Hematuria	Proteinuria	Glomerulonephritis Urine abnormality
General disorders and administration site conditions	Fatigue[a] Mucosal inflammation[a] Pyrexia	Chest pain[a] Pain[a] Asthenia[a] Malaise[e] Edema peripheral[e]	Injection site reaction	
Injury, poisoning and procedural complications		Transfusion reaction[e]		

[a] See section c (Description of selected adverse reactions)
[b] There have been reports of GvHD and fatalities in patients after allogeneic bone marrow transplantation (see section c)
[c] Includes bone pain, back pain, arthralgia, myalgia, pain in extremity, musculoskeletal pain, musculoskeletal chest pain, neck pain
[d] Cases were observed in the post-marketing setting in patients undergoing bone marrow transplant or PBPC mobilization
[e] Adverse events with higher incidence in Neupogen patients compared to placebo and associated with the sequelae of the underlying malignancy or cytotoxic chemotherapy

c. Description of selected adverse reactions

Hypersensitivity

Hypersensitivity-type reactions including anaphylaxis, rash, urticaria, angiedema, dyspnea and hypotension occurring on initial or subsequent treatment have been reported in clinical studies and in post-marketing experience. Overall, reports were more common after IV administration. In some cases, symptoms have recurred with rechallenge, suggesting a causal relationship. Neupogen should be permanently discontinued in patients who experience a serious allergic reaction.

Pulmonary adverse events

In clinical studies and the post-marketing setting pulmonary adverse effects including interstitial lung disease, pulmonary edema, and lung infiltration have been reported in some cases with an outcome of respiratory failure or acute respiratory distress syndrome (ARDS), which may be fatal (see section 4.4).

Splenomegaly and splenic rupture

Cases of splenomegaly and splenic rupture have been reported following administration of filgrastim. Some cases of splenic rupture were fatal (see section 4.4).

Capillary leak syndrome

Cases of capillary leak syndrome have been reported with granulocyte-colony stimulating factor use. These have generally occurred in patients with advanced malignant diseases, sepsis, taking multiple chemotherapy medications or undergoing apheresis (see section 4.4).

Cutaneous vasculitis

Cutaneous vasculitis has been reported in patients treated with Neupogen. The mechanism of vasculitis in patients receiving Neupogen is unknown. During long-term use cutaneous vasculitis has been reported in 2% of SCN patients.

Leukocytosis

Leukocytosis (WBC > 50 × 10^9/l) was observed in 41% of normal donors and transient thrombocytopenia (platelets < 100 × 10^9/l) following filgrastim and leukapheresis was observed in 35% of donors (see section 4.4).

Sweets syndrome

Cases of Sweets syndrome (acute febrile neutrophilic dermatosis) have been reported in patients treated with Neupogen.

Pseudogout (chondrocalcinosis pyrophosphate)

Pseudogout (chondrocalcinosis pyrophosphate) has been reported in patients with cancer treated with Neupogen.

GvHD

There have been reports of GvHD and fatalities in patients receiving G-CSF after allogeneic bone marrow transplantation (see sections 4.4 and 5.1).

d. Pediatric population

Data from clinical studies in pediatric patients indicate that the safety and efficacy of Neupogen are similar in both adults and children receiving cytotoxic chemotherapy suggesting no age-related differences in the pharmacokinetics of filgrastim. The only consistently reported adverse event was musculoskeletal pain, which is no different from the experience in the adult population.

There is insufficient data to further evaluate Neupogen use in pediatric subjects.

e. Other special populations

Geriatric use

No overall differences in safety or effectiveness were observed between subjects over 65 years of age compared to younger adult (> 18 years of age) subjects receiving cytotoxic chemotherapy and clinical experience has not identified differences in the responses between elderly and younger adult patients. There is insufficient data to evaluate Neupogen use in geriatric subjects for other approved Neupogen indications.

Pediatric SCN patients

Cases of decreased bone density and osteoporosis have been reported in pediatric patients with severe chronic neutropenia receiving chronic treatment with Neupogen.

Reporting of suspected adverse reactions

Reporting suspected adverse reactions after authorization of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product.
Any suspected adverse events should be reported to the Ministry of Health according to the National Regulation by using an online form https://sideeffects.health.gov.il

4.9 Overdose

The effects of Neupogen overdosage have not been established. Discontinuation of Neupogen therapy usually results in a 50% decrease in circulating neutrophils within 1 to 2 days, with a return to normal levels in 1 to 7 days.

5. PHARMACOLOGICAL PROPERTIES

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Cytokines, ATC Code: L03AA02

Human G-CSF is a glycoprotein which regulates the production and release of functional neutrophils from the bone marrow. Neupogen containing r-metHuG-CSF (filgrastim) causes marked increases in peripheral blood neutrophil counts within 24 hours, with minor increases in monocytes. In some SCN patients filgrastim can also induce a minor increase in the number of circulating eosinophils and basophils relative to baseline; some of these patients may present with eosinophilia or basophilia already prior to treatment. Elevations of neutrophil counts are dose-dependent at recommended doses. Neutrophils produced in response to filgrastim show normal or enhanced function as demonstrated by tests of chemotactic and phagocytic function. Following termination of filgrastim therapy, circulating neutrophil counts decrease by 50% within 1 to 2 days, and to normal levels within 1 to 7 days.

Use of filgrastim in patients undergoing cytotoxic chemotherapy leads to significant reductions in the incidence, severity and duration of neutropenia and febrile neutropenia. Treatment with filgrastim significantly reduces the durations of febrile neutropenia, antibiotic use and hospitalization after induction chemotherapy for acute myelogenous leukemia or myeloablative therapy followed by bone marrow transplantation. The incidence of fever and documented infections were not reduced in either setting. The duration of fever was not reduced in patients undergoing myeloablative therapy followed by bone marrow transplantation.

Use of filgrastim, either alone, or after chemotherapy, mobilizes hematopoietic progenitor cells into the peripheral blood. These autologous PBPCs may be harvested and infused after high-dose cytotoxic therapy, either in place of, or in addition to bone marrow transplantation. Infusion of PBPC accelerates hematopoietic recovery reducing the duration of risk for hemorrhagic complications and the need for platelet transfusions.

Recipients of allogeneic PBPCs mobilized with Neupogen experienced significantly more rapid hematological recovery, leading to a significant decrease in time to unsupported platelet recovery when compared with allogeneic bone marrow transplantation.

One retrospective European study evaluating the use of G-CSF after allogeneic bone marrow transplantation in patients with acute leukemias suggested an increase in the risk of GvHD, treatment-related mortality (TRM) and mortality when G-CSF was administered. In a separate retrospective International study in patients with acute and chronic myelogenous leukemias, no effect on the risk of GvHD, TRM and mortality was seen. A meta-analysis of allogeneic transplant studies, including the results of nine prospective randomized trials, 8 retrospective studies and 1 case-controlled study, did not detect an effect on the risks of acute GvHD, chronic GvHD or early treatment-related mortality.

Relative Risk (95% CI) of GvHD and TRM
Following Treatment with G-CSF after Bone Marrow Transplantation

Publication	Period of Study	N	Acute Grade II-IV GvHD	Chronic GvHD	TRM
Meta-Analysis (2003)	1986-2001[a]	1198	1.08 (0.87, 1.33)	1.02 (0.82, 1.26)	0.70 (0.38, 1.31)
European Retrospective Study (2004)	1992-2002[b]	1789	1.33 (1.08, 1.64)	1.29 (1.02, 1.61)	1.73 (1.30, 2.32)
International Retrospective Study (2006)	1995-2000[b]	2110	1.11 (0.86, 1.42)	1.10 (0.86, 1.39)	1.26 (0.95, 1.67)

[a.] Analysis includes studies involving BM transplant during this period; some studies used GM-CSF
[b.] Analysis includes patients receiving BM transplant during this period

Use of filgrastim for the mobilization of PBPCs in normal donors prior to allogeneic PBPC transplantation

In normal donors, a 10 µg/kg/day dose administered subcutaneously for 4 to 5 consecutive days allows a collection of $\geq 4 \times 10^6$ $CD34^+$ cells/kg recipient body weight in the majority of the donors after two leukapheresis.

Use of filgrastim in patients, children or adults, with SCN (severe congenital, cyclic, and idiopathic neutropenia) induces a sustained increase in absolute neutrophil counts in peripheral blood and a reduction of infection and related events.

Use of filgrastim in patients with HIV infection maintains normal neutrophil counts to allow scheduled dosing of antiviral and/or other myelosuppressive medication. There is no evidence that patients with HIV infection treated with filgrastim show an increase in HIV replication.

As with other hematopoietic growth factors, G-CSF has shown *in vitro* stimulating properties on human endothelial cells.

5.2 Pharmacokinetic properties

Clearance of filgrastim has been shown to follow first-order pharmacokinetics after both subcutaneous and intravenous administration. The serum elimination half-life of filgrastim is approximately 3.5 hours, with a clearance rate of approximately 0.6 ml/min/kg. Continuous infusion with Neupogen over a period of up to 28 days, in patients recovering from autologous bone marrow transplantation, resulted in no evidence of drug accumulation and comparable elimination half-lives. There is a positive linear correlation between the dose and the serum concentration of filgrastim, whether administered intravenously or subcutaneously. Following subcutaneous administration of recommended doses, serum concentrations were maintained above 10 ng/ml for 8 to 16 hours. The volume of distribution in blood is approximately 150 ml/kg.

5.3 Preclinical safety data

Filgrastim was studied in repeated dose toxicity studies up to 1 year in duration which revealed changes attributable to the expected pharmacological actions including increases in leukocytes, myeloid hyperplasia in bone marrow, extramedullary granulopoiesis and splenic enlargement. These changes all reversed after discontinuation of treatment.

Effects of filgrastim on prenatal development have been studied in rats and rabbits. Intravenous (80 µg/kg/day) administration of filgrastim to rabbits during the period of organogenesis was maternally toxic and increased spontaneous abortion, post-implantation loss, and decreased mean live litter size and fetal weight were observed.

Based on reported data for another filgrastim product similar to Neupogen, comparable findings plus increased fetal malformations were observed at 100 µg/kg/day, a maternally toxic dose which corresponded

to a systemic exposure of approximately 50-90 times the exposures observed in patients treated with the clinical dose of 5 µg/kg/day. The no observed adverse effect level for embryo-fetal toxicity in this study was 10 µg/kg/day, which corresponded to a systemic exposure of approximately 3-5 times the exposures observed in patients treated with the clinical dose.

In pregnant rats, no maternal or fetal toxicity was observed at doses up to 575 µg/kg/day. Offspring of rats administered filgrastim during the peri-natal and lactation periods, exhibited a delay in external differentiation and growth retardation (≥ 20 µg/kg/day) and slightly reduced survival rate (100 µg/kg/day).

Filgrastim had no observed effect on the fertility of male or female rats.

6. PHARMACEUTICAL PARTICULARS

6.1 List of excipients

Glacial acetic acid
Sodium hydroxide (1N) ad pH 4
Sorbitol
Polysorbate 80
Water for Injections

6.2 Incompatibilities

Neupogen should not be diluted with saline solutions.

Diluted filgrastim may be adsorbed to glass and plastic materials.

This medicinal product must not be mixed with other products except those mentioned in section 6.6.

6.3 Shelf life

The expiry date of the product is indicated on the packaging materials.

Chemical and physical in-use stability of the diluted solution for infusion has been demonstrated for 24 hours at 2°C to 8°C. From a microbiological point of view, the product should be used immediately. If not used immediately, in-use storage times and conditions prior to use are the responsibility of the user and would normally not be longer than 24 hours at 2°C to 8°C, unless dilution has taken place in controlled and validated aseptic conditions.

6.4 Special precautions for storage

Store at 2°C to 8°C.

For storage conditions after dilution of the medicinal product, see section 6.3.

Keep the container in the outer carton in order to protect from light.

Do not freeze.

6.5 Nature and contents of container

Neupogen 30 MU vials

Package containing five vials of 1 ml Neupogen solution for injection.
The vials are made from type I glass with rubber stoppers.

Neupogen 30 MU and 48 MU pre-filled syringes

Package containing one or five pre-filled syringe(s) of 0.5 ml Neupogen solution for injection.

The pre-filled syringes are made from type I glass and have a permanently attached stainless steel needle in the tip. The needle cover of the pre-filled syringe contains dry natural rubber (a derivative of latex) or synthetic rubber. See section 4.4.

Not all pack sizes may be marketed.

6.6 Special precautions for disposal and other handling

If required, Neupogen may be diluted in 5% glucose.

Dilution to a final concentration less than 0.2 MU (2 µg) per ml is not recommended at any time.

The solution should be visually inspected prior to use. Only clear solutions without particles should be used.

For patients treated with filgrastim diluted to concentrations below 1.5 MU (15 µg) per ml, human serum albumin (HSA) should be added to a final concentration of 2 mg/ml.

Example: In a final injection volume of 20 ml, total doses of filgrastim less than 30 MU (300 µg) should be given with 0.2 ml of 20% human albumin solution Ph. Eur. added.

Neupogen contains no preservative. In view of the possible risk of microbial contamination, Neupogen pre-filled syringes and vials are for single use only.

When diluted in 5% glucose solution, Neupogen is compatible with glass and a variety of plastics including PVC, polyolefin (a co-polymer of polypropylene and polyethylene) and polypropylene.

Any unused medicinal product or waste material should be disposed of in accordance with local requirements.

7. MANUFACTURER

Amgen Europe B.V.
Minervum 7061
4817 ZK Breda
The Netherlands

8. LICENSE HOLDER

Amgen Europe B.V.
P.O. BOX 53313
Tel - Aviv

9. LICENSE NUMBERS

Neupogen 30 MU Vials 058 31 27318
Neupogen 30 MU PFS 117 22 29875
Neupogen 48 MU PFS 117 21 29876

Revised in July 2023 according to MoHs guidelines.