COMPOSITION AND METHOD FOR REDUCING NEUTROPENIA

BACKGROUND

Field

[0001] The present invention relates to the field of chemistry and medicine. More particularly, the present invention relates to a method of reducing neutropenia.

Description of the Related Art

[0002] Several cancer therapies can have deleterious side effects. For example, many chemotherapeutic agents have myelosuppressive effects that can cause neutropenia. Similarly, radiation therapy can be a cause of neutropenia. There is a need for therapeutics that can counter the neutropenia caused by cancer therapy.

SUMMARY

[0003] Some embodiments disclosed herein include a method of reducing neutropenia in a subject, comprising administering plinabulin or a pharmaceutically acceptable salt thereof to the subject in need thereof, wherein the neutropenia is induced by administration of a first chemotherapeutic composition comprising one or more chemotherapeutic agents, wherein the chemotherapeutic composition does not comprise docetaxel, or by administration of radiation therapy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 is a graph of neutrophil count 24 hours post dosing of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin.

[0005] Figure 2 is a graph of neutrophil count 48 hours post dosing of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin.

[0006] Figure 3 is a graph of the time course of neutrophil count after administration of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin.

[0007] Figure 4 shows the absolute neutrophil count (ANC) on Day 1 and Day 3 post dosing of cyclophosphamide, the combination of cyclophosphamide and plinabulin, and control groups.

[0008] Figure 5 shows the ANC levels on Day 3 post dosing of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin as expressed as percentage of the ANC of the control group.

[0009] Figure 6 shows the ANC level on Day 3 post dosing of cyclophosphamide and the combination of cyclophosphamide and plinabulin.

[0010] Figure 7 is a graph of the time course of ANC level after administration of naïve, doxorubicin, plinabulin, and the combination of doxorubicin and plinabulin.

[0011] Figure 8 is a graph of the time course of ANC level expressed as a percentage of the ANC level of the naïve group after administration of doxorubicin and the combination of doxorubicin and plinabulin.

[0012] Figure 9 shows the ANC levels on Day 3 post the administration of cisplatin, plinabulin, and the combination of cisplatin and plinabulin.

[0013] Figure 10 shows a dose response curve for plinabulin on cisplatin induced neutropenia with the ANC level change expressed as percentage of the ANC level in cisplatin treatment alone group.

[0014] Figures 11A and 11B show the ANC levels post the administration of control, plinabulin, and the combination of topotecan and plinabulin: Figure 11A shows the ANC levels when 0.25 mg/kg topotecan and 7.5 mg/kg plinabulin were administered; Figure 11B shows the ANC levels when 1 mg/kg topotecan and 3.75 mg/kg plinabulin were administered.

DETAILED DESCRIPTION

[0015] Plinabulin, (3*Z*,6*Z*)-3-Benzylidene-6-{[5-(2-methyl-2-propanyl)-1*H*-imidazol-4-yl]methylene}-2,5-piperazinedione, is a synthetic analog of the natural compound phenylahistin. Plinabulin can be readily prepared according to methods and procedures detailed in U.S. Patents 7,064,201 and 7,919,497, which are incorporated herein by reference in their entireties. Some embodiments relate to the use of Plinabulin or a pharmaceutically effective salt thereof to reduce neutropenia. In some embodiments, the neutropenia is induced by chemotherapy, for example, by administration of drugs that have a myelosuppresive effect. In other embodiments, the neutropenia is induced by radiation therapy.

Definitions

[0016] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this disclosure belongs. All patents, applications, published applications, and other publications are incorporated by reference in their entirety. In the event that there is a plurality of definitions for a term herein, those in this section prevail unless stated otherwise.

[0017] "Subject" as used herein, means a human or a non-human mammal, e.g., a dog, a cat, a mouse, a rat, a cow, a sheep, a pig, a goat, a non-human primate or a bird, e.g., a chicken, as well as any other vertebrate or invertebrate.

[0018] The term "mammal" is used in its usual biological sense. Thus, it specifically includes, but is not limited to, primates, including simians (chimpanzees, apes, monkeys) and humans, cattle, horses, sheep, goats, swine, rabbits, dogs, cats, rodents, rats, mice guinea pigs, or the like.

[0019] An "effective amount" or a "therapeutically effective amount" as used herein refers to an amount of a therapeutic agent that is effective to relieve, to some extent, or to reduce the likelihood of onset of, one or more of the symptoms of a disease or condition, and includes curing a disease or condition.

[0020] "Treat," "treatment," or "treating," as used herein refers to administering a compound or pharmaceutical composition to a subject for prophylactic and/or therapeutic purposes. The term "prophylactic treatment" refers to treating a subject who does not yet exhibit symptoms of a disease or condition, but who is susceptible to, or otherwise at risk of, a particular disease or condition, whereby the treatment reduces the likelihood that the patient will develop the disease or condition. The term "therapeutic treatment" refers to administering treatment to a subject already suffering from a disease or condition.

[0021] The term "pharmaceutically acceptable salt" refers to salts that retain the biological effectiveness and properties of a compound and, which are not biologically or otherwise undesirable for use in a pharmaceutical. In many cases, the compounds disclosed herein are capable of forming acid and/or base salts by virtue of the presence of amino and/or carboxyl groups or groups similar thereto. Pharmaceutically acceptable acid addition salts can be formed with inorganic acids and organic acids. Inorganic acids from which salts can

be derived include, for example, hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid, and the like. Organic acids from which salts can be derived include, for example, acetic acid, propionic acid, glycolic acid, pyruvic acid, oxalic acid, maleic acid, malonic acid, succinic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, p-toluenesulfonic acid, salicylic acid, and the like. Pharmaceutically acceptable salts can also be formed using inorganic and organic bases. Inorganic bases from which salts can be derived include, for example, bases that contain sodium, potassium, lithium, ammonium, calcium, magnesium, iron, zinc, copper, manganese, aluminum, and the like; particularly preferred are the ammonium, potassium, sodium, calcium and magnesium salts. In some embodiments, treatment of the compounds disclosed herein with an inorganic base results in loss of a labile hydrogen from the compound to afford the salt form including an inorganic cation such as Li^+, Na^+, K^+, Mg^{2+} and Ca^{2+} and the like. Organic bases from which salts can be derived include, for example, primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines, basic ion exchange resins, and the like, specifically such as isopropylamine, trimethylamine, diethylamine, triethylamine, tripropylamine, and ethanolamine. Many such salts are known in the art, as described in WO 87/05297, Johnston et al., published September 11, 1987 (incorporated by reference herein in its entirety).

Method of Treatment

[0022] In some embodiments, plinabulin can be effective in ameliorating or treating chemotherapy or radiotherapy related neutropenia (including sever neutropenia such as FN). Patients receiving plinabulin treatment showed less bone pain, lower hospitalization frequency, and lower frequency of grade 4 neutropenia in cycle 1 when compared with other treatment method (e.g., G-CSF). In addition, plinabulin treatment also resulted in minimum or less febrile neutropenia when compared with other treatment methods (e.g., G-CSF).

[0023] In some embodiments, plinabulin can be used together with G-CSF to reduce, ameliorate, or prevent neutropenia caused by a chemotherapeutic composition. Consistent with the benefit of neutropenia prevention, patients receiving plinabulin may require less G-CSF treatment.

[0024] Patients receiving plinabulin treatment are less likely to require chemotherapeutic agent dose reduction. The safety profile of plinabulin is better than other drugs that are used to treat or ameliorate chemotherapeutic agent induced neutropenia (e.g., G-CSF treatment).

[0025] Patients receiving plinabulin treatment can show at least one of the following conditions: 1) lower incidence of Grade 4 neutropenia (absolute neutrophil count [ANC] < 0.5 × 109/L); 2) lower incidence of febrile neutropenia (FN) (ANC <0.5 × 109/L and body temperature ≥ 38.3°C); 3) higher neutrophil count during the treatment cycle; 4) lower incidence of documented infections in Cycles 1 to 4; 5) lower incidence and shorter duration of hospitalizations due to FN during the treatment cycle; 6) better health-related Quality of Life. When compared with the G-CSF treatment (e.g., pegfilgrastim or filgrastim), plinabulin treatment showed lower incidence of antibiotic use, lower incidence of docetaxel dose delay, dose reduction, and/or dose discontinuation, lower Incidence, occurrence, and severity of adverse events (AEs)/serious adverse events (SAEs), lower incidence, occurrence and severity of bone pain, better systemic tolerance (physical examination and safety laboratory assessments).

[0026] Some embodiments relate to a method of reducing or preventing neutropenia induced by one or more chemotherapeutic agents in the first chemotherapeutic composition, the method comprising administering plinabulin to the patient undergoing a chemotherapy treatment. In some embodiments, the neutropenia is induced by one agent in the first chemotherapeutic composition. In some embodiments, the neutropenia is induced by two or more agents in a first chemotherapeutic composition. In some embodiments, the neutropenia is induced by one or more chemotherapeutic agents present in at least one additional chemotherapeutic composition. In some embodiments, the neutropenia is induced by chemotherapeutic agents in the first chemotherapeutic composition and at least one additional chemotherapeutic composition. In some embodiments, the neutropenia is induced by the chemotherapeutic agent in the first chemotherapeutic composition and docetaxel. In some embodiments, the first chemotherapeutic composition does not comprise taxane. In some embodiments, the first chemotherapeutic composition does not comprise docetaxel.

[0027] In some embodiments, plinabulin is useful in preventing, treating, or ameliorating neutrophil reduction arising from a chemotherapy treatment.

[0028] Some embodiments relate to a method of treating a patient being administered one or more chemotherapeutic compositions in an amount sufficient to cause neutropenia, the method comprising: administering plinabulin at a dose effective to alleviate or prevent neutrophil reduction in the patient.

[0029] Some embodiments relate to using plinabulin to relieve the degree of neutropenia and to shorten the severe duration of neutropenia.

[0030] In some embodiments, the absolute neutrophil count (ANC) of the subject prior to administration of plinabulin is less than 500/mm^3. In some embodiments, the ANC of the subject prior to administration of plinabulin is in the range of about 500 to about 1000/mm^3. In some embodiments, the ANC of the subject prior to administration of plinabulin is in the range of about 1000 to about 1500/mm^3. In some embodiments, the ANC of the subject prior to administration of plinabulin is greater than 1500/mm^3.

[0031] In some embodiments, the ANC of the subject show an increase of at least 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 12%, 15%, 17%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99%, 100%, 125%, 150%, or 175%, 200% post the administration of plinabulin. In some embodiments, the ANC of the subject show an increase of less than 10%, 12%, 15%, 17%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99%, 100%, 125%, 150%, or 175%, 200% post the administration of plinabulin. In some embodiments, the ANC of the subject show an increase in the range of about 5% - 40%, 10%-40%, 12.5%-40%, 5% - 50%, 10%-50%, 12.5%-50%, 15%-50%, 17.5%-50%, 20%-50%, 25%-50%, 27.5%-50%, 30%-50%, 5% - 60%, 10%-60%, 12.5%-60%, 15%-60%, 17.5%-60%, 20%-60%, 25%-60%, 27.5%-60%, 30%-60%, 35%-60%, 37.5%-60%, 40%-60%, 45%-70%, or 50%-80% post the administration of plinabulin.

[0032] In some embodiments, the subject has a grade 4 neutropenia induced by the chemotherapy (e.g., the first chemotherapeutic composition) or radiation therapy. In some embodiments, the subject has a grade 3 neutropenia induced by the chemotherapy (e.g., the first chemotherapeutic composition) or radiation therapy. In some embodiments, the subject has a grade 2 neutropenia induced by chemotherapy (e.g., the first chemotherapeutic composition) or radiation therapy. In some embodiments, the subject has a grade 1

neutropenia induced by chemotherapy (e.g., the first chemotherapeutic composition) or radiation therapy.

[0033] Some embodiments relate to treating chemotherapy or radiation therapy induced neutropenia in a subject having advanced or metastatic breast cancer, comprising identifying a patient having advanced or metastatic breast cancer; and administering a pharmaceutically effective amount of plinabulin.

[0034] Some embodiments relate to a method of treating chemotherapy or radiation therapy induced neutropenia in a subject having non-small cell lung cancer, comprising: identifying a patient having non-small cell lung cancer; and administering a pharmaceutically effective amount of plinabulin.

[0035] Some embodiments relate to a method of treating chemotherapy or radiation therapy induced neutropenia in a subject having hormone refractory metastatic prostate cancer, comprising: identifying a patient having hormone refractory metastatic prostate cancer; and administering a pharmaceutically effective amount of plinabulin.

[0036] In some embodiments, the neutropenia is a febrile neutropenia. In some embodiments, the neutropenia is a drug-induced neutropenia. In some embodiments, the neutropenia is a taxane-induced neutropenia. In some embodiments, the neutropenia is induced by cyclophosphamide. In some embodiments, the neutropenia is induced by cisplatin. In some embodiments, the neutropenia is induced by doxorubicin. In some embodiments, the neutropenia is induced by topotecan.

[0037] In some embodiments, the method includes administering one or more additional chemotherapeutic compositions to the subject. In some embodiments, the method includes administering a second chemotherapeutic composition. In some embodiments, the method includes administering a third chemotherapeutic composition. In some embodiments, the method includes administering a fourth chemotherapeutic composition. In some embodiments, the method includes administering a fifth chemotherapeutic composition. In some embodiments, the method includes administering a sixth chemotherapeutic composition. In some embodiments, the method includes administering a seventh chemotherapeutic composition. In some embodiments, the method includes administering an eighth chemotherapeutic composition. In various embodiments, each chemotherapeutic composition can independently comprise one or more chemotherapeutic agents. In some

embodiments, one or more chemotherapeutic compositions may comprise one or more chemotherapeutic agents in common with one or more other chemotherapeutic compositions. In some embodiments, when the chemotherapeutic composition includes two or more agents, each agent in the composition can be administered separately. In some embodiments, when the chemotherapeutic composition includes two or more agents, each agent in the composition can be administered sequentially.

[0038] In some embodiments, the method described herein can include administering a second chemotherapeutic composition. In some embodiments, the second chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the second chemotherapeutic composition can be administered before the administration of plinabulin. In some embodiments, the second chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the second chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the second chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the second chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0039] In some embodiments, the method described herein can include administering a third chemotherapeutic composition. In some embodiments, the third chemotherapeutic composition can be administered prior to the administration of plinabulin. In some embodiments, the third chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the third chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the third chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the third chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the third chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0040] In some embodiments, the method described herein can include administering a fourth chemotherapeutic composition. In some embodiments, the fourth chemotherapeutic composition can be administered prior to the administration of plinabulin.

In some embodiments, the fourth chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the fourth chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the fourth chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the fourth chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the fourth chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0041] In some embodiments, the method described herein can include administering a fifth chemotherapeutic composition. In some embodiments, the fifth chemotherapeutic composition can be administered prior to the administration of plinabulin. In some embodiments, the fifth chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the fifth chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the fifth chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the fifth chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the fifth chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0042] In some embodiments, the method described herein can include administering a sixth chemotherapeutic composition. In some embodiments, the sixth chemotherapeutic composition can be administered prior to the administration of plinabulin. In some embodiments, the sixth chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the sixth chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the sixth chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the sixth chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the sixth chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0043] In some embodiments, the method described herein can include administering a seventh chemotherapeutic composition. In some embodiments, the seventh chemotherapeutic composition can be administered prior to the administration of plinabulin. In some embodiments, the seventh chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the seventh chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the seventh chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the seventh chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the seventh chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0044] In some embodiments, the method described herein can include administering an eighth chemotherapeutic composition. In some embodiments, the eighth chemotherapeutic composition can be administered prior to the administration of plinabulin. In some embodiments, the eighth chemotherapeutic composition can be administered after the administration of plinabulin. In some embodiments, the eighth chemotherapeutic composition can be administered simultaneously with plinabulin. In some embodiments, the eighth chemotherapeutic composition can be administered before the first chemotherapeutic composition. In some embodiments, the eighth chemotherapeutic composition can be administered after the first chemotherapeutic composition. In some embodiments, the eighth chemotherapeutic composition can be administered simultaneously with the first chemotherapeutic composition.

[0045] In some embodiments, the method described herein can include administering plinabulin prior to administration of the first chemotherapeutic composition; and administering the additional one or more chemotherapeutic compositions after administration of the first chemotherapeutic composition. In some embodiments, the method described herein can include administering the first chemotherapeutic composition prior to administration of the plinabulin; and administering the additional one or more chemotherapeutic compositions after administration of the plinabulin. In some embodiments, the method described herein can include administering the first chemotherapeutic composition prior to administration of the additional one or more chemotherapeutic

compositions; and administering the plinabulin after administration of the additional one or more chemotherapeutic agents.

[0046] In some embodiments, the method described herein can include a period of time between administration of each of plinabulin, the first chemotherapeutic composition, and the additional one or more chemotherapeutic compositions is independently selected between about 1 minute and 24 hours.

[0047] In some embodiments, the one or more additional chemotherapeutic compositions (e.g., the second, third, fourth, fifth, sixth, seventh, or eighth chemotherapeutic composition) can independently include one or more agents selected from the group consisting of methotrexate, vinblastine, doxorubicin, cisplatin, MVAC (methotrexate, vinblastine, doxorubicin and cisplatin), docetaxel, trastuzumab, cyclophosphamide, paclitaxel, dose-dense AC followed by T (i.e., doxorubicin, cyclophosphamide, paclitaxel), TAC (docetaxel, doxorubicin, cyclophosphamide), fluorouracil, bleomycin, etoposide, vincristine, procarbazine, prednisone, BEACOPP (bleomycin, etoposide, doxorubicin, cyclophosphamide, vincristine, procarbazine, prednisone), gemcitabine, ifosfamide, carboplatin, ICE (ifosfamide, carboplatin, etoposide), rituximab, RICE (rituximab, ifosfamide, carboplatin, etoposide), CHOP-14 (cyclophosphamide, doxorubicin, vincristine, prednisone), mesna, novantrone, MINE (mesna, ifosfamide, novantrone, etoposide), dexamethasone, cytarabine DHAP (dexamethasone, cisplatin, cytarabine), methylprednisolone, ESHAP (etoposide, methylprednisolone, cisplatin, cytarabine), HyperCVAD and rituximab (cyclophosphamide, vincristine, doxorubicin, dexamethasone, rituximab), dacarbazine, vinblastine, dacarbazine-based combination (dacarbazine, cisplatin, vinblastine), dacarbazine-based combination with IL-2 and interferon alfa (dacarbazine, cisplatin, vinblastine, IL-2, interferon alfa), topotecan, MAID (mesna, doxorubicin, ifosfamine, dacarbazine), VeIP (vinblastine, ifosfamide, cisplatin), VIP (etoposide, ifosfamide, cisplatin), TIP (paclitaxel, ifosfamide, cisplatin), gemcitabine, CMF classic (cyclophosphamide, methotrexate, fluorouracil), AC (doxorubicin, cyclophosphamide), FEC (fluorouracil, epirubicin, cyclophosphamide), TC (docetaxel, cyclophosphamide), cisplatin/topotecan, paclitaxel/cisplatin, irincotecan, FOLFOX (fluorouracil, leucovorin, oxaliplatin), irincotecan/cisplatin, epirubicin/cisplatin/5-fluorouracil, epirubicin/cisplatin/capecitabine, DT-PACE

(dexamethasone/thalidomide/cisplatin/doxorubicin/cyclophosphamide/etoposide), ET-PACE and bortezomib, EPOCH (etoposide, prednisone, vincristine, cyclophosphamide, doxorubicin), GDP (gemcitabine, dexamethasone, cisplatin), GDP and rituximab, FMR (fludarabine, mitoxantrone, rituximab, CHOP and rituximab (cyclophosphamide, doxorubicin, vincristine, prednisone, rituximab), cisplatin/paclitaxel, cisplatin/vinorelbine, cisplatin/docetaxel, ciaplatin/etoposide, carboplatin/paclitaxel, carboplatin/docetaxel, FOLFIRINOX (5-FU/leucovorin, irinotecan and oxaliplatin), cabazitaxel, etoposide/carboplatin, etoposide/cisplatin. In some embodiments, the one or more additional chemotherapeutic compositions (e.g., the second, third, fourth, fifth, sixth, seventh, or eighth chemotherapeutic composition) can independently include one or more agents selected from the group consisting of methotrexate, vinblastine, doxorubicin, cisplatin, docetaxel, trastuzumab, cyclophosphamide, paclitaxel, fluorouracil, bleomycin, etoposide, vincristine, procarbazine, prednisone, gemcitabine, ifosfamide, carboplatin, mesna, novantrone, cytarabine methylprednisolone, rituximab dacarbazine, vinblastine, topotecan, gemcitabine, irincotecan, epirubicin, 5-fluorouracil, capecitabine, bortezomib, and cabazitaxel.

[0048] In some embodiments, the first chemotherapeutic composition can include one or more agents selected from the group consisting of methotrexate, vinblastine, doxorubicin, cisplatin, MVAC (methotrexate, vinblastine, doxorubicin and cisplatin), trastuzumab, cyclophosphamide, dose-dense AC followed by T (i.e., doxorubicin, cyclophosphamide, paclitaxel), fluorouracil, bleomycin, etoposide, vincristine, procarbazine, prednisone, BEACOPP (bleomycin, etoposide, doxorubicin, cyclophosphamide, vincristine, procarbazine, prednisone), gemcitabine, ifosfamide, carboplatin, ICE (ifosfamide, carboplatin, etoposide), rituximab, RICE (rituximab, ifosfamide, carboplatin, etoposide), CHOP-14 (cyclophosphamide, doxorubicin, vincristine, prednisone), mesna, novantrone, MINE (mesna, ifosfamide, novantrone, etoposide), dexamethasone, cytarabine DHAP (dexamethasone, cisplatin, cytarabine), methylprednisolone, ESHAP (etoposide, methylprednisolone, cisplatin, cytarabine), HyperCVAD and rituximab (cyclophosphamide, vincristine, doxorubicin, dexamethasone, rituximab), dacarbazine, vinblastine, dacarbazine-based combination (dacarbazine, cisplatin, vinblastine), dacarbazine-based combination with IL-2 and interferon alfa (dacarbazine, cisplatin, vinblastine, IL-2, interferon alfa), topotecan, MAID (mesna, doxorubicin, ifosfamine, dacarbazine), VeIP (vinblastine, ifosfamide,

cisplatin), VIP (etoposide, ifosfamide, cisplatin), TIP (paclitaxel, ifosfamide, cisplatin). In some embodiments, the gemcitabine, CMF classic (cyclophosphamide, methotrexate, fluorouracil), AC (doxorubicin, cyclophosphamide), FEC (fluorouracil, epirubicin, cyclophosphamide), cisplatin/topotecan, paclitaxel/cisplatin, irincotecan, FOLFOX (fluorouracil, leucovorin, oxaliplatin), irincotecan/cisplatin, epirubicin/cisplatin/5-fluorouracil, epirubicin/cisplatin/capecitabine, DT-PACE (dexamethasone/thalidomide/cisplatin/doxorubicin/cyclophosphamide/etoposide), ET-PACE and bortezomib, EPOCH (etoposide, prednisone, vincristine, cyclophosphamide, doxorubicin), GDP (gemcitabine, dexamethasone, cisplatin), GDP and rituximab, FMR (fludarabine, mitoxantrone, rituximab, CHOP and rituximab (cyclophosphamide, doxorubicin, vincristine, prednisone, rituximab), cisplatin/paclitaxel, cisplatin/vinorelbine, ciaplatin/etoposide, carboplatin/paclitaxel, FOLFIRINOX (5-FU/leucovorin, irinotecan and oxaliplatin), cabazitaxel, etoposide/carboplatin, etoposide/cisplatin. In some embodiments, the first chemotherapeutic compositions can include one or more agents selected from the group consisting of methotrexate, vinblastine, doxorubicin, cisplatin, trastuzumab, cyclophosphamide, fluorouracil, bleomycin, etoposide, vincristine, procarbazine, prednisone, gemcitabine, ifosfamide, carboplatin, mesna, novantrone, cytarabine methylprednisolone, rituximab dacarbazine, vinblastine, topotecan, gemcitabine, irincotecan, epirubicin, 5-fluorouracil, capecitabine, and bortezomib.

[0049] Some embodiments relate to a method of stimulating neutrophil survival, comprising administering plinabulin at a dose in the range of about 1 mg/m^2 to about 50 mg/m^2. In some embodiments, the plinabulin is administered at a dose in the range of about 1-50 mg/m^2 of the body surface area. In some embodiments, the plinabulin is administered at a dose in the range of about 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 1-13, 1-13.75, 1-14, 1-15, 1-16, 1-17, 1-18, 1-19, 1-20, 1-22.5, 1-25, 1-27.5, 1-30, 1.5-2, 1.5-3, 1.5-4, 1.5-5, 1.5-6, 1.5-7, 1.5-8, 1.5-9, 1.5-10, 1.5-11, 1.5-12, 1.5-13, 1.5-13.75, 1.5-14, 1.5-15, 1.5-16, 1.5-17, 1.5-18, 1.5-19, 1.5-20, 1.5-22.5, 1.5-25, 1.5-27.5, 1.5-30, 2.5-2, 2.5-3, 2.5-4, 2.5-5, 2.5-6, 2.5-7, 2.5-8, 2.5-9, 2.5-10, 2.5-11, 2.5-12, 2.5-13, 2.5-13.75, 2.5-14, 2.5-15, 2.5-16, 2.5-17, 2.5-18, 2.5-19, 2.5-20, 2.5-22.5, 2.5-25, 2.5-27.5, 2.5-30, 2.5-7.5, 3-4, 3-5, 3-6, 3-7, 3-8, 3-9, 3-10, 3-11, 3-12, 3-13, 3-13.75, 3-14, 3-15, 3-16, 3-17, 3-18, 3-19, 3-20, 3-22.5, 3-25, 3-27.5, 3-30, 3.5- 6.5, 3.5-13.75, 3.5-15, 2.5-17.5, 4-5, 4-6, 4-7, 4-8, 4-9, 4-10, 4-11, 4-

12, 4-13, 4-13.75, 4-14, 4-15, 4-16, 4-17, 4-18, 4-19, 4-20, 4-22.5, 4-25, 4-27.5, 4-30, 5-6, 5-7, 5-8, 5-9, 5-10, 5-11, 5-12, 5-13, 5-13.75, 5-14, 5-15, 5-16, 5-17, 5-18, 5-19, 5-20, 5-22.5, 5-25, 5-27.5, 5-30, 6-7, 6-8, 6-9, 6-10, 6-11, 6-12, 6-13, 6-13.75, 6-14, 6-15, 6-16, 6-17, 6-18, 6-19, 6-20, 6-22.5, 6-25, 6-27.5, 6-30, 7-8, 7-9, 7-10, 7-11, 7-12, 7-13, 7-13.75, 7-14, 7-15, 7-16, 7-17, 7-18, 7-19, 7-20, 7-22.5, 7-25, 7-27.5, 7-30, 7.5-12.5, 7.5-13.5, 7.5-15, 8-9, 8-10, 8-11, 8-12, 8-13, 8-13.75, 8-14, 8-15, 8-16, 8-17, 8-18, 8-19, 8-20, 8-22.5, 8-25, 8-27.5, 8-30, 9-10, 9-11, 9-12, 9-13, 9-13.75, 9-14, 9-15, 9-16, 9-17, 9-18, 9-19, 9-20, 9-22.5, 9-25, 9-27.5, 9-30, 10-11, 10-12, 10-13, 10-13.75, 10-14, 10-15, 10-16, 10-17, 10-18, 10-19, 10-20, 10-22.5, 10-25, 10-27.5, 10-30, 11.5-15.5, 12.5-14.5, 7.5-22.5, 8.5-32.5, 9.5-15.5, 15.5-24.5, 5-35, 17.5-22.5, 22.5-32.5, 25-35, 25.5-24.5, 27.5-32.5, 2-20, t 2.5-22.5, or 9.5-21.5 mg/m^2, of the body surface area. In some embodiments, the plinabulin is administered at a dose of about 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, 15, 15.5, 16, 16.5, 17, 17.5, 18, 18.5, 19, 19.5, 20, 20.5, 21, 21.5, 22, 22.5, 23, 23.5, 24, 24.5, 25, 25.5, 26, 26.5, 27, 27.5, 28, 28.5, 29, 29.5, 30, 30.5, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40 mg/m^2 of the body surface area. In some embodiments, the plinabulin is administered at a dose less than about 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, 15, 15.5, 16, 16.5, 17, 17.5, 18, 18.5, 19, 19.5, 20, 20.5, 21, 21.5, 22, 22.5, 23, 23.5, 24, 24.5, 25, 25.5, 26, 26.5, 27, 27.5, 28, 28.5, 29, 29.5, 30, 30.5, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40 mg/m^2 of the body surface area. In some embodiments, the plinabulin is administered at a dose greater than about 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, 15, 15.5, 16, 16.5, 17, 17.5, 18, 18.5, 19, 19.5, 20, 20.5, 21, 21.5, 22, 22.5, 23, 23.5, 24, 24.5, 25, 25.5, 26, 26.5, 27, 27.5, 28, 28.5, 29, 29.5, 30, 30.5, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 mg/m^2 of the body surface area.

[0050] In some embodiments, the plinabulin dose is about 5 mg - 300 mg, 5 mg - 200 mg, 7.5 mg - 200 mg, 10 mg - 100 mg, 15 mg - 100 mg, 20 mg - 100 mg, 30 mg - 100 mg, 40 mg - 100 mg, 10 mg - 80 mg, 15 mg - 80 mg, 20 mg - 80 mg, 30 mg - 80 mg, 40 mg - 80 mg, 10 mg - 60 mg, 15 mg - 60 mg, 20 mg - 60 mg, 30 mg - 60 mg, or about 40 mg - 60 mg. In some embodiments, the plinabulin administered is about 20 mg - 60 mg, 27 mg - 60 mg, 20 mg - 45 mg, or 27 mg - 45 mg. In some embodiments, the plinabulin administered is

about 5 mg-7.5 mg, 5 mg-9 mg, 5 mg-10 mg, 5 mg-12mg, 5mg-14mg, 5mg-15 mg, 5 mg-16 mg, 5 mg-18 mg, 5 mg-20 mg, 5 mg-22 mg, 5 mg-24 mg, 5 mg-26 mg, 5 mg-28mg, 5mg-30mg, 5mg-32mg, 5mg-34mg, 5mg-36mg, 5mg-38mg, 5mg-40mg, 5mg-42mg, 5mg-44mg, 5mg-46mg, 5mg-48mg, 5mg-50mg, 5mg-52mg, 5mg-54mg, 5mg-56mg, 5mg-58mg, 5mg-60mg, 7 mg-7.7 mg, 7 mg-9 mg, 7 mg-10 mg, 7 mg-12mg, 7mg-14mg, 7mg-15 mg, 7 mg-16 mg, 7 mg-18 mg, 7 mg-20 mg, 7 mg-22 mg, 7 mg-24 mg, 7 mg-26 mg, 7 mg-28mg, 7mg-30mg, 7mg-32mg, 7mg-34mg, 7mg-36mg, 7mg-38mg, 7mg-40mg, 7mg-42mg, 7mg-44mg, 7mg-46mg, 7mg-48mg, 7mg-50mg, 7mg-52mg, 7mg-54mg, 7mg-56mg, 7mg-58mg, 7mg-60mg, 9 mg-10 mg, 9 mg-12mg, 9mg-14mg, 9mg-15 mg, 9 mg-16 mg, 9 mg-18 mg, 9 mg-20 mg, 9 mg-22 mg, 9 mg-24 mg, 9 mg-26 mg, 9 mg-28mg, 9mg-30mg, 9mg-32mg, 9mg-34mg, 9mg-36mg, 9mg-38mg, 9mg-40mg, 9mg-42mg, 9mg-44mg, 9mg-46mg, 9mg-48mg, 9mg-50mg, 9mg-52mg, 9mg-54mg, 9mg-56mg, 9mg-58mg, 9mg-60mg, 10 mg-12mg, 10mg-14mg, 10mg-15 mg, 10 mg-16 mg, 10 mg-18 mg, 10 mg-20 mg, 10 mg-22 mg, 10 mg-24 mg, 10 mg-26 mg, 10 mg-28mg, 10mg-30mg, 10mg-32mg, 10mg-34mg, 10mg-36mg, 10mg-38mg, 10mg-40mg, 10mg-42mg, 10mg-44mg, 10mg-46mg, 10mg-48mg, 10mg-50mg, 10mg-52mg, 10mg-54mg, 10mg-56mg, 10mg-58mg, 10mg-60mg, 12mg-14mg, 12mg-15 mg, 12 mg-16 mg, 12 mg-18 mg, 12 mg-20 mg, 12 mg-22 mg, 12 mg-24 mg, 12 mg-26 mg, 12 mg-28mg, 12mg-30mg, 12mg-32mg, 12mg-34mg, 12mg-36mg, 12mg-38mg, 12mg-40mg, 12mg-42mg, 12mg-44mg, 12mg-46mg, 12mg-48mg, 12mg-50mg, 12mg-52mg, 12mg-54mg, 12mg-56mg, 12mg-58mg, 12mg-60mg, 15 mg-16 mg, 15 mg-18 mg, 15 mg-20 mg, 15 mg-22 mg, 15 mg-24 mg, 15 mg-26 mg, 15 mg-28mg, 15mg-30mg, 15mg-32mg, 15mg-34mg, 15mg-36mg, 15mg-38mg, 15mg-40mg, 15mg-42mg, 15mg-44mg, 15mg-46mg, 15mg-48mg, 15mg-50mg, 15mg-52mg, 15mg-54mg, 15mg-56mg, 15mg-58mg, 15mg-60mg, 17 mg-18 mg, 17 mg-20 mg, 17 mg-22 mg, 17 mg-24 mg, 17 mg-26 mg, 17 mg-28mg, 17mg-30mg, 17mg-32mg, 17mg-34mg, 17mg-36mg, 17mg-38mg, 17mg-40mg, 17mg-42mg, 17mg-44mg, 17mg-46mg, 17mg-48mg, 17mg-50mg, 17mg-52mg, 17mg-54mg, 17mg-56mg, 17mg-58mg, 17mg-60mg, 20 mg-22 mg, 20 mg-24 mg, 20 mg-26 mg, 20 mg-28mg, 20mg-30mg, 20mg-32mg, 20mg-34mg, 20mg-36mg, 20mg-38mg, 20mg-40mg, 20mg-42mg, 20mg-44mg, 20mg-46mg, 20mg-48mg, 20mg-50mg, 20mg-52mg, 20mg-54mg, 20mg-56mg, 20mg-58mg, 20mg-60mg, 22 mg-24 mg, 22 mg-26 mg, 22 mg-28mg, 22mg-30mg, 22mg-32mg, 22mg-34mg, 22mg-36mg, 22mg-38mg, 22mg-40mg, 22mg-42mg, 22mg-44mg,

22mg-46mg, 22mg-48mg, 22mg-50mg, 22mg-52mg, 22mg-54mg, 22mg-56mg, 22mg-58mg, 22mg-60mg, 25 mg-26 mg, 25 mg-28mg, 25mg-30mg, 25mg-32mg, 25mg-34mg, 25mg-36mg, 25mg-38mg, 25mg-40mg, 25mg-42mg, 25mg-44mg, 25mg-46mg, 25mg-48mg, 25mg-50mg, 25mg-52mg, 25mg-54mg, 25mg-56mg, 25mg-58mg, 25mg-60mg, 27 mg-28mg, 27mg-30mg, 27mg-32mg, 27mg-34mg, 27mg-36mg, 27mg-38mg, 27mg-40mg, 27mg-42mg, 27mg-44mg, 27mg-46mg, 27mg-48mg, 27mg-50mg, 27mg-52mg, 27mg-54mg, 27mg-56mg, 27mg-58mg, 27mg-60mg, 30mg-32mg, 30mg-34mg, 30mg-36mg, 30mg-38mg, 30mg-40mg, 30mg-42mg, 30mg-44mg, 30mg-46mg, 30mg-48mg, 30mg-50mg, 30mg-52mg, 30mg-54mg, 30mg-56mg, 30mg-58mg, 30mg-60mg, 33mg-34mg, 33mg-36mg, 33mg-38mg, 33mg-40mg, 33mg-42mg, 33mg-44mg, 33mg-46mg, 33mg-48mg, 33mg-50mg, 33mg-52mg, 33mg-54mg, 33mg-56mg, 33mg-58mg, 33mg-60mg, 36mg-38mg, 36mg-40mg, 36mg-42mg, 36mg-44mg, 36mg-46mg, 36mg-48mg, 36mg-50mg, 36mg-52mg, 36mg-54mg, 36mg-56mg, 36mg-58mg, 36mg-60mg, 40mg-42mg, 40mg-44mg, 40mg-46mg, 40mg-48mg, 40mg-50mg, 40mg-52mg, 40mg-54mg, 40mg-56mg, 40mg-58mg, 40mg-60mg, 43mg-46mg, 43mg-48mg, 43mg-50mg, 43mg-52mg, 43mg-54mg, 43mg-56mg, 43mg-58mg, 42mg-60mg, 45mg-48mg, 45mg-50mg, 45mg-52mg, 45mg-54mg, 45mg-56mg, 45mg-58mg, 45mg-60mg, 48mg-50mg, 48mg-52mg, 48mg-54mg, 48mg-56mg, 48mg-58mg, 48mg-60mg, 50mg-52mg, 50mg-54mg, 50mg-56mg, 50mg-58mg, 50mg-60mg, 52mg-54mg, 52mg-56mg, 52mg-58mg, or 52mg-60mg. In some embodiments, the plinabulin dose is greater than about 5 mg, about 10 mg, about 12.5 mg, about 13.5 mg, about 15 mg, about 17.5 mg, about 20 mg, about 22.5 mg, about 25 mg, about 27 mg, about 30 mg, about 40 mg, about 50 mg, about 60 mg, about 70 mg, about 80 mg, about 90 mg, about 100 mg, about 125 mg, about 150mg, or about 200 mg. In some embodiments, the plinabulin dose is about less than about 5 mg, about 10 mg, about 12.5 mg, about 13.5 mg, about 15 mg, about 17.5 mg, about 20 mg, about 22.5 mg, about 25 mg, about 27 mg, about 30 mg, about 40 mg, about 50 mg, about 60 mg, about 70 mg, about 80 mg, about 90 mg, about 100 mg, about 125 mg, about 150mg, or about 200 mg.

[0051] The chemotherapeutic composition or chemotherapeutic agent can be administered in an effective amount suitable for the treatment. In some embodiments, the method described herein comprises administering one or more chemotherapeutic agents (e.g., cisplatin, doxorubicin, cyclophosphamide, topotecan) at a dose in the range of about 40-50 mg/kg in divided doses over 2-5 days. In some embodiments, the method described herein

comprises administering one or more chemotherapeutic agents at a dose in the range of about 10-30, 5-100, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-300, 70-200, 70-100, 70-90, 70-80, 80-300, 80-200, 80-100, 80-90, or 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg/kg over 2-5 days per cycle. In some embodiments, the method described herein comprises administering one or more chemotherapeutic agents at a dose in the range of about 10-15 mg/kg in divided doses over 7-10 days or 3-5 mg/kg twice weekly. In some embodiments, the method described herein comprises administering one or more chemotherapeutic agents at a dose in the range of about 10-30, 5-100, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-300, 70-200, 70-100, 70-90, 70-80, 80-300, 80-200, 80-100, 80-90, or 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg/kg twice weekly. In some embodiments, the method described herein comprises administering one or more chemotherapeutic agents at a dose in the range of about 1-5 mg/kg per day for both initial dose and maintenance dose.

[0052] In some embodiments, the method further comprises administering one or more chemotherapeutic agents (e.g., cisplatin, doxorubicin, cyclophosphamide, topotecan) at a dose in the range of about 10-30, 5-100, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-300, 70-200, 70-100, 70-90, 70-80, 80-300, 80-200, 80-100, 80-90, or 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg/m^2 daily for 5 days per cycle. In some embodiments, the method further comprises administering one or more chemotherapeutic agents at a dose of 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900

or 1000 mg/m^2 per cycle once every 4 weeks. In some embodiments, the method further comprises administering one or more chemotherapeutic agents at a dose of 10-30, 5-100, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-300, 70-200, 70-100, 70-90, 70-80, 80-300, 80-200, 80-100, 80-90, or 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg/m^2 per cycle once every 3 to 4 weeks depending on the extent of prior exposure to radiation therapy and/or prior chemotherapy. In some embodiments, the method further comprises administering one or more chemotherapeutic agents at a dose of 50 mg/m^2 per cycle repeated every 4 weeks. In some embodiments, the method further comprises administering one or more chemotherapeutic agents (e.g., cisplatin) at a dose in the range of about 10-30, 5-100, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-300, 70-200, 70-100, 70-90, 70-80, 80-300, 80-200, 80-100, 80-90, or 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg/m^2 per cycle every 3 weeks or every 4 weeks. In some embodiments, the method further comprises administering one or more chemotherapeutic agents at a dose of 30-70 or 40-60 mg/m^2 per cycle once every 3 weeks or every 4 weeks. In some embodiments, when more than one chemotherapeutic agent is administered to the patient, the dose of each of the chemotherapeutic agent administered can be independently selected from any one of the dose ranges described herein.

[0053] In some embodiments, one or more chemotherapeutic agents are administered at an amount of about 10-30, 5-100, 10-500, 10-400, 10-300, 10-200, 10-100, 10-90, 10-80, 10-70, 10-60, 10-50, 10-40, 10-30, 10-20, 20-500, 20-400, 20-300, 20-200, 20-100, 20-90, 20-80, 20-70, 20-60, 20-50, 20-40, 20-30, 30-500, 30-400, 30-300, 30-200, 30-100, 30-90, 30-80, 30-70, 30-60, 30-50, 30-40, 40-500, 40-400, 40-300, 40-200, 40-100, 40-90, 40-80, 40-70, 40-60, 40-50, 50-500, 50-400, 50-300, 50-200, 50-100, 50-90, 50-80, 50-70, 50-60, 60-500, 60-400, 60-300, 60-200, 60-100, 60-90, 60-80, 60-70, 70-500, 70-400, 70-300, 70-

200, 70-100, 70-90, 70-80, 80-500, 80-400, 80-300, 80-200, 80-100, 80-90, 90-500, 90-400, 90-300, 90-200, 90-100, 100-500, 100-400, 100-300, or 100-200 mg per dose.

[0054] In some embodiments, the plinabulin is administered prior to the administration of the chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered concurrently with the chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered after the chemotherapeutic agent is administered or chemotherapeutic composition.

[0055] In some embodiments, the plinabulin is administered about 1 min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h, 20h, 24h, 30h, 36h, 40h, or 48h after the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered in less than about 1 min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h, 20h, 21h, 22h, 23h, 24h, 30h, 36h, 40h, or 48h after the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered in more than about 1 min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h, 20h, 21h, 22h, 23h, 24h30h, 36h, 40h, or 48h after the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered in about 1min-5min, 1min-10min, 1min-15min, 1min-20min, 1 min-25min, 1 min-30min, 0.25h-0.5h, 0.25-0.75h, 0.25-1h,0.5h-1h, 0.5h-2h, 0.5h-2.5h, 1h-2h, 1h-3h, 1h-5h, 1h-24h, 1min-24h, or 1 min-2h, 1 day- 2days, 1day - 3days, 1 day-4 days, 1 day-5 days, or 1 day-6 days after the administration of a chemotherapeutic agent or chemotherapeutic composition.

[0056] In some embodiments, when plinabulin is administered prior to a chemotherapeutic agent or chemotherapeutic composition administration, the plinabulin is administered about 1min-5min, 1min-10min, 1min-15min, 1min-20min, 1 min-25min, 1 min-30min, 0.25h-0.5h, 0.25-0.75h, 0.25-1h,0.5h-1h, 0.5h-2h, 0.5h-2.5h, 1h-2h, 1h-3h, 1h-5h, 1h-24h, 1min-1h, 1min-2h, 1min-5h, 1min-24h, 1 day- 2days, 1day - 3days, 1 day-4 days, 1 day-5 days, or 1 day-6 days before the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered about 1

min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 30h, 36h, 40h, 48h, 4 days, 5 days, 6 days, or 7 days before the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered in less than about 1 min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h, 20h, 21h, 22h, 23h, 24h, 30h, 36h, 40h, 48h, 4 days, 5 days, 6 days, or 7 days before the administration of a chemotherapeutic agent or chemotherapeutic composition. In some embodiments, the plinabulin is administered in more than about 1 min, 5min, 10 min, 15 min, 20 min, 25 min, 30 min, 1h, 1.5h, 2h, 2.5h, 3h, 4h, 5h, 6h, 7h, 8h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h, 20h, 21h, 22h, 23h, 24h, 30h, 36h, 40h, 48h, 3 days, 4 days, 5 days, 6 days, or 7 days before the administration of a chemotherapeutic agent or chemotherapeutic composition.

[0057] In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin once every 3 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin once every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin two times every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin once every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin twice every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 8, and day 15 of a 21-day treatment cycle. In some embodiments, co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin includes administering the chemotherapeutic agent prior to administering plinabulin. In some embodiments, co-administration of a chemotherapeutic

agent or chemotherapeutic composition and plinabulin includes administering the chemotherapeutic agent after administering plinabulin. In some embodiments, co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin includes administering the chemotherapeutic agent concurrently with plinabulin. The chemotherapeutic composition described in this paragraph can independently be a first, second, third, fourth, fifth, sixth, seventh, or eighth chemotherapeutic composition. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin every day of the week for a week. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin every day of the week for 2 weeks, 3 weeks, or 4 weeks. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1 and day 2 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of the chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 2, and day 3 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of the chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 2, day 3 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of the chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 2, day 3, and day 4 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of the chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 2, day 3, day 4, and day 5 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of the chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 2, day 3, day 4, day 5, and day 6 in weekly treatment. In some embodiments, the treatment schedule includes co-administration of a chemotherapeutic agent or chemotherapeutic composition and plinabulin on day 1, day 3, and day 5 in weekly treatment. In some embodiments, the chemotherapeutic composition used on each administration day can be the same or different. In some embodiments, the chemotherapeutic composition used on the first administration day is

different from the chemotherapeutic composition used on the rest of the administration days. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the second administration day. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the third administration day. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the fourth administration day. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the fifth administration day. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the sixth administration day. In some embodiments, the chemotherapeutic composition used on the first administration day is the same as or different from the chemotherapeutic composition used on the seventh administration day.

[0058] In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition (e.g., the first, the second, the third, the fourth, the fifth, the sixth, the seventh, or the eighth) once every 3 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition once every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition two times every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition once every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition twice every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition three times (e.g., day 1, 2, 3, or day 1, 3, 5) every week in a treatment cycle of 1 week, 2 weeks, 3 weeks,

4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition day 1, day 8, and day 15 of a 21-day treatment cycle. The chemotherapeutic composition described in this paragraph can independently be the first, second, third, fourth, fifth, sixth, seventh, or eighth chemotherapeutic composition. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition every day of the week for a week. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition every day of the week for 2 weeks, 3 weeks, or 4 weeks. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1 in weekly treatment. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1 and day 2 in weekly treatment. In some embodiments the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1, day 2, and day 3 in weekly treatment. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1, day 3, day 5 in weekly treatment. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1, day 2, day 3, and day 4 in weekly treatment. In some embodiments, the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1, day 2, day 3, day 4, and day 5 in weekly treatment. the treatment schedule includes administration of a chemotherapeutic agent or chemotherapeutic composition on day 1, day 2, day 3, day 4, day 5, and day 6 in weekly treatment.

[0059] In some embodiments, the treatment schedule includes administration of plinabulin once every 3 weeks. In some embodiments, the treatment schedule includes administration of plinabulin once every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of plinabulin two times every 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of plinabulin once every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment

schedule includes administration of plinabulin twice every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of plinabulin three times (e.g., day 1, 2, 3, or day 1, 3, 5) every 1 week in a treatment cycle of 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, or 8 weeks. In some embodiments, the treatment schedule includes administration of plinabulin day 1, day 8, and day 15 of a 21-day treatment cycle. The chemotherapeutic composition described in this paragraph can independently be the first, second, third, fourth, fifth, sixth, seventh, or eighth chemotherapeutic composition. In some embodiments, the treatment schedule includes administration of plinabulin every day of the week for a week. In some embodiments, the treatment schedule includes administration of plinabulin every day of the week for 2 weeks, 3 weeks, or 4 weeks. In some embodiments, the treatment schedule includes administration of plinabulin on day 1 in weekly treatment. In some embodiments, the treatment schedule includes administration of plinabulin on day 1 and day 2 in weekly treatment. In some embodiments the treatment schedule includes administration of plinabulin on day 1, day 2, and day 3 in weekly treatment. In some embodiments, the treatment schedule includes administration of plinabulin on day 1, day 3, day 5 in weekly treatment. In some embodiments, the treatment schedule includes administration of plinabulin on day 1, day 2, day 3, and day 4 in weekly treatment. In some embodiments, the treatment schedule includes administration of plinabulin on day 1, day 2, day 3, day 4, and day 5 in weekly treatment. the treatment schedule includes administration of plinabulin on day 1, day 2, day 3, day 4, day 5, and day 6 in weekly treatment.

[0060] The treatment cycle can be repeated as long as the regimen is clinically tolerated. In some embodiments, the treatment cycle for the chemotherapeutic agent and plinabulin is repeated for n times, wherein n is an integer in the range of 2 to 30. In some embodiments, n is 2, 3, 4, 5, 6, 7, 8, 9, or 10. In some embodiments, a new treatment cycle can occur immediately after the completion of the previous treatment cycle. In some embodiments, a new treatment cycle can occur a period of time after the completion of the previous treatment cycle. In some embodiments, a new treatment cycle can occur after 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, or 7 weeks after the completion of the previous treatment cycle.

[0061] In some embodiments, the use of plinabulin can reduce the incidence of Grade 1 or 2 neutropenia by at least about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, or 100%. In some embodiments, the use of plinabulin can reduce the incidence of Grade 3 or 4 neutropenia by at least about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, or 100%. In some embodiments, the use of plinabulin can reduce the incidence of Grade 3 or 4 neutropenia by less than about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, or 100%. In some embodiments, the use of plinabulin can reduce the incidence of Grade 3 or 4 neutropenia in the range of about 5% - 40%, 10%-40%, 12.5%-40%, 5% - 50%, 10%-50%, 12.5%-50%, 15%-50%, 17.5%-50%, 20%-50%, 25%-50%, 27.5%-50%, 30%-50%, 5% - 60%, 10%-60%, 12.5%-60%, 15%-60%, 17.5%-60%, 20%-60%, 25%-60%, 27.5%-60%, 30%-60%, 35%-60%, 37.5%-60%, 40%-60%, 45%-70%, or 50%-80%.

[0062] In some embodiments, the use of plinabulin can be about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, or 500% more effective than the use of G-CSF (e.g., pegfilgrastim) in reducing the incidence of Grade 3 or 4 neutropenia. In some embodiments, the use of plinabulin can be greater than about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, or 500% more effective than the use of G-CSF (e.g., pegfilgrastim) in reducing the incidence of Grade 3 or 4 neutropenia. In some embodiments, the use of plinabulin can be less than about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, or 500% more effective than the use of G-CSF (e.g., pegfilgrastim) in reducing the incidence of Grade 3 or 4 neutropenia. In some embodiments, the use of plinabulin can be greater than about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, 110%, 120%, 130%, 140%,

150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, or 500% more effective than the use of G-CSF (e.g., pegfilgrastim) in reducing the incidence of Grade 3 or 4 neutropenia.

[0063] In some embodiments, the use of plinabulin can reduce the duration of severe neutropenia by about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times. In some embodiments, the use of plinabulin can reduce the duration of severe neutropenia by greater than about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times. In some embodiments, the use of plinabulin can reduce the duration of severe neutropenia by less than about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times. In some embodiments, the use of plinabulin can reduce the duration of severe neutropenia in the range of about 5% -15 times, 20% - 10 times, or 50%-500%.

[0064] In some embodiments, plinabulin can be about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times more effective than G-CSF (e.g., pegfilgrastim) in reducing the duration of severe neutropenia.

In some embodiments, plinabulin can be greater than about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times more effective than G-CSF (e.g., pegfilgrastim) in reducing the duration of severe neutropenia. In some embodiments, plinabulin can be less than about 5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%, 30%, 32.5%, 35%, 37.5%, 40%, 42.5%, 45%, 47.5%, 50%, 52.5%, 55%, 57.5%, 60%, 62.5%, 65%, 67.5%, 70%, 72.5%, 75%, 77.5%, 80%, 82.5%, 85%, 87.5%, 90%, 95%, 100%, 110%, 120%, 130%, 140%, 150%, 160%, 170%, 180%, 190%, 200%, 225%, 250%, 275%, 300%, 350% 400%, 450%, 500%, 600%, 700%, 800%, 900%, 10 times, 11 times, 12 times, 13 times, 14 times, 15 times, or 16 times more effective than G-CSF (e.g., pegfilgrastim) in reducing the duration of severe neutropenia. In some embodiments, plinabulin can be in the range of about 5% -15 times, 20% - 10 times, or 50%-500% more effective than G-CSF (e.g., pegfilgrastim) in reducing the duration of severe neutropenia.

[0065] The administration period can be a multi-week treatment cycle as long as the tumor remains under control and the regimen is clinically tolerated. In some embodiments, a single dosage of plinabulin or other therapeutic agent can be administered once a week, and preferably once on each of day 1 and day 8 of a three-week (21 day) treatment cycle. In some embodiments, a single dosage of plinabulin or other therapeutic agent can be administered once a week, twice a week, three times per week, four times per week, five times per week, six times per week, or daily during a one-week, two-week, three-week, four-week, or five-week treatment cycle. The administration can be on the same or different day of each week in the treatment cycle.

[0066] The treatment cycle can be repeated as long as the regimen is clinically tolerated. In some embodiments, the treatment cycle is repeated for n times, wherein n is an integer in the range of 2 to 30. In some embodiments, n is 2, 3, 4, 5, 6, 7, 8, 9, or 10. In some embodiments, a new treatment cycle can occur immediately after the completion of the previous treatment cycle. In some embodiments, a new treatment cycle can occur a period of time after the completion of the previous treatment cycle.

[0067] Administration of the pharmaceutical compositions described herein can be via any of the accepted modes of administration for agents that serve similar utilities including, but not limited to, orally, sublingually, buccally, subcutaneously, intravenously, intranasally, topically, transdermally, intradermally, intraperitoneally, intramuscularly, intrapulmonarilly, vaginally, rectally, intraocularly, or intragastrically (e.g., gastric feeding tube. Oral and parenteral administrations are customary in treating the indications that are the subject of the preferred embodiments.

[0068] Some embodiments relate to a method of reducing neutropenia in a subject, comprising administering plinabulin or a pharmaceutically acceptable salt thereof to a subject in need thereof. In some embodiments, the neutropenia is chemotherapy-induced. In some embodiments, the neutropenia is induced by administration of the first chemotherapeutic composition that is myelosuppresive. The chemotherapeutic composition can include one or more chemotherapeutic agents. In some embodiments, the chemotherapeutic agent is selected from the group consisting of cyclophosphamide, doxorubicin, paclitaxel, carboplatin, cisplatin, irinotecan, topotecan, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel. In some embodiments, the chemotherapeutic agent is selected from the group consisting of phosphamides, rubicins, platins, tecans, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel.

[0069] In some embodiments, the chemotherapeutic agent is selected from the group consisting of phosphamides, rubicins, platins, tecans, taxanes, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing. In some embodiments, the first chemotherapeutic composition can comprises one or more agents selected from the group consisting of phosphamides, rubicins, platins, tecans, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing. In some embodiments, the chemotherapeutic composition (e.g., the second, the third, the fourth, the fifth, the sixth, the seventh, the eighth chemotherapeutic composition) can comprises one or more agents selected from the group consisting of phosphamides, rubicins, platins, tecans, taxanes, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing. In some embodiments, the platin can be one or more selected

from the group consisting of cisplatin, carboplatin, and oxaliplatin, nedaplatin, triplatin tetranitrate, phenanthriplatin, picoplatin, and satraplatin. In some embodiments, the tecan can be topotecan, irinotecan, or combination thereof. In some embodiments, the phosphamides can be cyclophosphamide, ifosamide, or combination thereof. In some embodiments, the taxane can be selected from the group consisting of docetaxel, paclitaxel, cabazitaxel. In some embodiments, the rubicin can be one or more selected from doxorubicin, epirubicin, daunorubicin, and valrubicin.

[0070] In some embodiments, the neutropenia is induced by radiation therapy. Some embodiments include reducing the likelihood of onset of, or reducing the severity of, neutropenia in a subject, comprising administering plinabulin to a subject in need thereof.

[0071] Some embodiments of the foregoing methods comprise administering plinabulin or a pharmaceutically acceptable salt thereof and one or more additional chemotherapeutic agents. In various embodiments, the additional chemotherapeutic agent is selected from the group consisting of cyclophosphamide, doxorubicin, paclitaxel, carboplatin, cisplatin, irinotecan, topotecan, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel. In one embodiment, plinabulin and the one or more additional chemotherapeutic agent are administered simultaneously. In one such embodiment, administration in combination is accomplished by combining the agents in a single dosage form. In another embodiment, the agents are administered sequentially. In one embodiment the agents are administered through the same route, such as orally or intravenously. In another embodiment, the agents are administered through different routes, such as one being administered orally and another being administered i.v. In some embodiments, the time period between administration of one or more agent and administration of the co-administered one or more agent can be about 1 hour, 2 hours, 3 hours, 5 hours, 8 hours, 10 hours, 12 hours, 15 hours, 18 hours, 20 hours, 24 hours, 36 hours, 48 hours, 3 days, 4 days, 5 days, 6 days, 7 days, 10 days, 14 days, 21 days, 28 days, or 30 days. In some embodiments, plinabulin is administered prior to administration of the one or more additional chemotherapeutic agents. In other embodiments, the additional chemotherapeutic agents are administered prior to plinabulin.

[0072] In some embodiments, the method described herein comprises co-administering one or more chemotherapeutic agents and plinabulin. In some embodiments, the method described herein comprises co-administering two chemotherapeutic agents and plinabulin. In some embodiments, the method described herein comprises co-administering three chemotherapeutic agents and plinabulin. In some embodiments, the method described herein comprises co-administering four chemotherapeutic agents and plinabulin.

[0073] In some embodiments, when a second and/or third chemotherapeutic agents are administered with the first chemotherapeutic agent and plinabulin, the second or third chemotherapeutic agent can be administered prior to, after, or concurrently with the coadministration of the first chemotherapeutic agent and plinabulin. In some embodiments, the administration schedule of the second or third chemotherapeutic agent can be different from the first chemotherapeutic agent. In some embodiments, the administration schedule of the second or third chemotherapeutic agent can be the same as the first chemotherapeutic agent.

[0074] In some embodiments, the additional chemotherapeutic agent does not include docetaxel. In some embodiments, the additional chemotherapeutic agent does not include a taxane.

[0075] Some embodiments comprise administering plinabulin or a pharmaceutically acceptable salt thereof and radiation therapy to a subject

[0076] Some embodiments include identifying that a subject is suffering from neutropenia and then administering plinabulin or a pharmaceutically acceptable salt thereof to the subject. Other embodiments include administrating plinabulin or a pharmaceutically acceptable salt thereof to a subject before detection of neutropenia to reduce the incidence or severity thereof. For example, some embodiments include identifying a subject that is at risk for developing neutropenia (e.g., due to myelosuppressive chemotherapy or radiation therapy) but does not yet exhibit neutropenia, and then administering plinabulin or a pharmaceutically acceptable salt thereof to the subject.

[0077] In some embodiments of the foregoing methods, no additional agent that acts to reduce neutropenia are administered. For example, in some embodiments, the methods are practiced without administering a granulocyte-colony stimulating factor (e.g.,

filgrastim). In some embodiments, the methods are practiced without administering any additional active agent beyond the agents recited in above.

[0078] In some of the foregoing embodiments, the subject is a human.

[0079] In some embodiments, the methods described above can be achieved by administering plinabulin and any additional chemotherapeutic agents via any of the accepted modes of administration for agents that serve similar utilities including, but not limited to, orally, sublingually, buccally, subcutaneously, intravenously, intranasally, topically, transdermally, intradermally, intraperitoneally, intramuscularly, intrapulmonarilly, vaginally, rectally, intraocularly, or intragastrically. Oral and parenteral administrations are customary in treating the indications that are the subject of the preferred embodiments.

[0080] The administration period can be a multi-week treatment cycle. In some embodiments, a single dosage of plinabulin or other therapeutic agent can be administered once a week, and preferably once on each of day 1 and day 8 of a three-week (21 day) treatment cycle. In some embodiments, a single dosage of plinabulin or other therapeutic agent can be administered once a week, twice a week, three times per week, four times per week, five times per week, six times per week, or daily during a one-week, two-week, three-week, four-week, or five-week treatment cycle. The administration can be on the same or different day of each week in the treatment cycle.

[0081] The treatment cycle can be repeated as long as the regimen is clinically tolerated. In some embodiments, the treatment cycle is repeated for n times, wherein n is an integer in the range of 2 to 30. In some embodiments, n is 2, 3, 4, 5, 6, 7, 8, 9, or 10. In some embodiments, a new treatment cycle can occur immediately after the completion of the previous treatment cycle. In some embodiments, a new treatment cycle can occur a period of time after the completion of the previous treatment cycle.

Pharmaceutical Compositions

[0082] Some embodiments include pharmaceutical compositions comprising plinabulin or a pharmaceutically effective salt thereof and an additional chemotherapeutic agent. In various embodiments, the additional chemotherapeutic agent is selected from the group consisting of phosphamides, rubicins, platins, tecans, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel. In some embodiments, the additional chemotherapeutic

agent is not taxane. In some embodiments, the additional chemotherapeutic agent is not docetaxel. In various embodiments, the additional chemotherapeutic agent is selected from the group consisting of cyclophosphamide, doxorubicin, carboplatin, cisplatin, topotecan, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel. In various embodiments, the additional chemotherapeutic agent is selected from the group consisting of cyclophosphamide, doxorubicin, paclitaxel, carboplatin, cisplatin, irinotecan, and pharmaceutically acceptable salts thereof, or combinations of two or more of the foregoing, or combinations of one or more of the foregoing and docetaxel. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and doxorubicin or a pharmaceutically effective salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof, doxorubicin or a pharmaceutically effective salt thereof, and docetaxel or a pharmaceutically effective salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and paclitaxel or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and carboplatin or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof, paclitaxel or a pharmaceutically acceptable salt thereof, and carboplatin or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and cisplatin or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and irinotecan or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition comprises plinabulin or a pharmaceutically effective salt thereof and cyclophosphamide or a pharmaceutically acceptable salt thereof. In some embodiments, the pharmaceutical composition does not comprise docetaxel. In some embodiments, the pharmaceutical composition does not comprise a taxane.

[0083] In some embodiments, the pharmaceutical compositions described above do not comprise any additional agent that acts to reduce neutropenia. For example, in some

embodiments, the pharmaceutical compositions do not include a granulocyte-colony stimulating factor (e.g., filgrastim). In some embodiments, the pharmaceutical compositions do not include any additional active agent beyond the agents recited in the compositions above.

[0084] Other embodiments include two or more separate pharmaceutical compositions, one of which comprises plinabulin or a pharmaceutically acceptable salt thereof, and one or more other pharmaceutical compositions that comprise additional chemotherapeutic agents. In various embodiments, the additional chemotherapeutic agent is selected from the group consisting of cyclophosphamide, doxorubicin, paclitaxel, carboplatin, cisplatin, irinotecan, and pharmaceutically acceptable salts thereof.

[0085] In some embodiments, the compositions described above can further include one or more pharmaceutically acceptable diluents. In some embodiments, the pharmaceutically acceptable diluent can include Kolliphor HS-15® (Polyethylene glycol (15)-hydroxystearate, kolliphor). In some embodiments, the pharmaceutically acceptable diluent can include propylene glycol. In some embodiments, the pharmaceutically acceptable diluents can include kolliphor and propylene glycol. In some embodiments, the pharmaceutically acceptable diluents can include kolliphor and propylene glycol, wherein the kolliphor is about 40% by weight and propylene glycol is about 60% by weight based on the total weight of the diluents. In some embodiments, the composition can further include one or more other pharmaceutically acceptable excipients.

[0086] In some embodiments, the compositions described above can further include one or more pharmaceutically acceptable carrier or excipient. The term "pharmaceutically acceptable carrier" or "pharmaceutically acceptable excipient" includes any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents and the like. The use of such media and agents for pharmaceutically active substances is well known in the art. Except insofar as any conventional media or agent is incompatible with the active ingredient, its use in the therapeutic compositions is contemplated. In addition, various adjuvants such as are commonly used in the art may be included. Considerations for the inclusion of various components in pharmaceutical compositions are described, e.g., in Gilman et al. (Eds.)

(1990); Goodman and Gilman's: The Pharmacological Basis of Therapeutics, 8th Ed., Pergamon Press, which is incorporated herein by reference in its entirety.

[0087] Some examples of substances, which can serve as pharmaceutically-acceptable carriers or components thereof, are sugars, such as lactose, glucose and sucrose; starches, such as corn starch and potato starch; cellulose and its derivatives, such as sodium carboxymethyl cellulose, ethyl cellulose, and methyl cellulose; powdered tragacanth; malt; gelatin; talc; solid lubricants, such as stearic acid and magnesium stearate; calcium sulfate; vegetable oils, such as peanut oil, cottonseed oil, sesame oil, olive oil, corn oil and oil of theobroma; polyols such as propylene glycol, glycerin, sorbitol, mannitol, and polyethylene glycol; alginic acid; emulsifiers, such as the TWEENS; wetting agents, such sodium lauryl sulfate; coloring agents; flavoring agents; tableting agents, stabilizers; antioxidants; preservatives; pyrogen-free water; isotonic saline; and phosphate buffer solutions.

[0088] The compositions described herein are preferably provided in unit dosage form. As used herein, a "unit dosage form" is a composition containing an amount of a compound or composition that is suitable for administration to an animal, preferably a mammalian subject, in a single dose, according to good medical practice. The preparation of a single or unit dosage form however, does not imply that the dosage form is administered once per day or once per course of therapy. Such dosage forms are contemplated to be administered once, twice, thrice or more per day and may be administered as infusion over a period of time (e.g., from about 30 minutes to about 2-6 hours), or administered as a continuous infusion, and may be given more than once during a course of therapy, although a single administration is not specifically excluded. The skilled artisan will recognize that the formulation does not specifically contemplate the entire course of therapy and such decisions are left for those skilled in the art of treatment rather than formulation.

[0089] Standard pharmaceutical formulation techniques can be used to make the pharmaceutical compositions described herein, such as those disclosed in Remington's The Science and Practice of Pharmacy, 21st Ed., Lippincott Williams & Wilkins (2005), incorporated herein by reference in its entirety.

[0090] The compositions as described above may be in any of a variety of suitable forms for a variety of routes for administration, for example, for oral, sublingual, buccal, nasal, rectal, topical (including transdermal and intradermal), ocular, intracerebral,

intracranial, intrathecal, intra-arterial, intravenous, intramuscular, or other parental routes of administration. The skilled artisan will appreciate that oral and nasal compositions include compositions that are administered by inhalation, and made using available methodologies. Depending upon the particular route of administration desired, a variety of pharmaceutically-acceptable carriers well-known in the art may be used. Pharmaceutically-acceptable carriers include, for example, solid or liquid fillers, diluents, hydrotropies, surface-active agents, and encapsulating substances. Optional pharmaceutically-active materials may be included, which do not substantially interfere with the activity of the compound or composition. The amount of carrier employed in conjunction with the compound or composition is sufficient to provide a practical quantity of material for administration per unit dose of the compound. Techniques and compositions for making dosage forms useful in the methods described herein are described in the following references, all incorporated by reference herein: Modern Pharmaceutics, 4th Ed., Chapters 9 and 10 (Banker & Rhodes, editors, 2002); Lieberman *et al.*, Pharmaceutical Dosage Forms: Tablets (1989); and Ansel, Introduction to Pharmaceutical Dosage Forms 8th Edition (2004).

[0091] Various oral dosage forms can be used, including such solid forms as tablets, capsules (*e.g.*, liquid gel capsule and solid gel capsule), granules and bulk powders. Tablets can be compressed, tablet triturates, enteric-coated, sugar-coated, film-coated, or multiple-compressed, containing suitable binders, lubricants, diluents, disintegrating agents, coloring agents, flavoring agents, flow-inducing agents, and melting agents. Liquid oral dosage forms include aqueous solutions, emulsions, suspensions, solutions and/or suspensions reconstituted from non-effervescent granules, and effervescent preparations reconstituted from effervescent granules, containing suitable solvents, preservatives, emulsifying agents, suspending agents, diluents, sweeteners, melting agents, coloring agents and flavoring agents.

[0092] The pharmaceutically-acceptable carriers suitable for the preparation of unit dosage forms for peroral administration is well-known in the art. Tablets typically comprise conventional pharmaceutically-compatible adjuvants as inert diluents, such as calcium carbonate, sodium carbonate, mannitol, lactose and cellulose; binders such as starch, gelatin and sucrose; disintegrants such as starch, alginic acid and croscarmelose; lubricants such as magnesium stearate, stearic acid and talc. Glidants such as silicon dioxide can be

used to improve flow characteristics of the powder mixture. Coloring agents, such as the FD&C dyes, can be added for appearance. Sweeteners and flavoring agents, such as aspartame, saccharin, menthol, peppermint, and fruit flavors, are useful adjuvants for chewable tablets. Capsules typically comprise one or more solid diluents disclosed above. The selection of carrier components depends on secondary considerations like taste, cost, and shelf stability, which are not critical, and can be readily made by a person skilled in the art.

[0093] Peroral compositions also include liquid solutions, emulsions, suspensions, and the like. The pharmaceutically-acceptable carriers suitable for preparation of such compositions are well known in the art. Typical components of carriers for syrups, elixirs, emulsions and suspensions include ethanol, glycerol, propylene glycol, polyethylene glycol, liquid sucrose, sorbitol and water. For a suspension, typical suspending agents include methyl cellulose, sodium carboxymethyl cellulose, AVICEL RC-591, tragacanth and sodium alginate; typical wetting agents include lecithin and polysorbate 80; and typical preservatives include methyl paraben and sodium benzoate. Peroral liquid compositions may also contain one or more components such as sweeteners, flavoring agents and colorants disclosed above.

[0094] Such compositions may also be coated by conventional methods, typically with pH or time-dependent coatings, such that the subject composition is released in the gastrointestinal tract in the vicinity of the desired topical application, or at various times to extend the desired action. Such dosage forms typically include, but are not limited to, one or more of cellulose acetate phthalate, polyvinylacetate phthalate, hydroxypropyl methyl cellulose phthalate, ethyl cellulose, Eudragit coatings, waxes and shellac.

[0095] Other compositions useful for attaining systemic delivery of the subject compounds include sublingual, buccal and nasal dosage forms. Such compositions typically comprise one or more of soluble filler substances such as sucrose, sorbitol and mannitol; and binders such as acacia, microcrystalline cellulose, carboxymethyl cellulose and hydroxypropyl methyl cellulose. Glidants, lubricants, sweeteners, colorants, antioxidants and flavoring agents disclosed above may also be included.

[0096] A liquid composition, which is formulated for topical ophthalmic use, is formulated such that it can be administered topically to the eye. The comfort may be maximized as much as possible, although sometimes formulation considerations (e.g. drug

stability) may necessitate less than optimal comfort. In the case that comfort cannot be maximized, the liquid may be formulated such that the liquid is tolerable to the patient for topical ophthalmic use. Additionally, an ophthalmically acceptable liquid may either be packaged for single use, or contain a preservative to prevent contamination over multiple uses.

[0097] For ophthalmic application, solutions or medicaments are often prepared using a physiological saline solution as a major vehicle. Ophthalmic solutions may preferably be maintained at a comfortable pH with an appropriate buffer system. The formulations may also contain conventional, pharmaceutically acceptable preservatives, stabilizers and surfactants.

[0098] Preservatives that may be used in the pharmaceutical compositions disclosed herein include, but are not limited to, benzalkonium chloride, PHMB, chlorobutanol, thimerosal, phenylmercuric, acetate and phenylmercuric nitrate. A useful surfactant is, for example, Tween 80. Likewise, various useful vehicles may be used in the ophthalmic preparations disclosed herein. These vehicles include, but are not limited to, polyvinyl alcohol, povidone, hydroxypropyl methyl cellulose, poloxamers, carboxymethyl cellulose, hydroxyethyl cellulose and purified water.

[0099] Tonicity adjustors may be added as needed or convenient. They include, but are not limited to, salts, particularly sodium chloride, potassium chloride, mannitol and glycerin, or any other suitable ophthalmically acceptable tonicity adjustor.

[0100] Various buffers and means for adjusting pH may be used so long as the resulting preparation is ophthalmically acceptable. For many compositions, the pH will be between 4 and 9. Accordingly, buffers include acetate buffers, citrate buffers, phosphate buffers and borate buffers. Acids or bases may be used to adjust the pH of these formulations as needed.

[0101] Ophthalmically acceptable antioxidants include, but are not limited to, sodium metabisulfite, sodium thiosulfate, acetylcysteine, butylated hydroxyanisole and butylated hydroxytoluene.

[0102] Other excipient components, which may be included in the ophthalmic preparations, are chelating agents. A useful chelating agent is edetate disodium (EDTA), although other chelating agents may also be used in place or in conjunction with it.

[0103] For topical use, creams, ointments, gels, solutions or suspensions, etc., containing the composition disclosed herein are employed. Topical formulations may generally be comprised of a pharmaceutical carrier, co-solvent, emulsifier, penetration enhancer, preservative system, and emollient.

[0104] For intravenous administration, the compositions described herein may be dissolved or dispersed in a pharmaceutically acceptable diluent, such as a saline or dextrose solution. Suitable excipients may be included to achieve the desired pH, including but not limited to NaOH, sodium carbonate, sodium acetate, HCl, and citric acid. In various embodiments, the pH of the final composition ranges from 2 to 8, or preferably from 4 to 7. Antioxidant excipients may include sodium bisulfite, acetone sodium bisulfite, sodium formaldehyde, sulfoxylate, thiourea, and EDTA. Other non-limiting examples of suitable excipients found in the final intravenous composition may include sodium or potassium phosphates, citric acid, tartaric acid, gelatin, and carbohydrates such as dextrose, mannitol, and dextran. Further acceptable excipients are described in Powell, et al., Compendium of Excipients for Parenteral Formulations, *PDA J Pharm Sci and Tech* **1998**, *52* 238-311 and Nema et al., Excipients and Their Role in Approved Injectable Products: Current Usage and Future Directions, *PDA J Pharm Sci and Tech* **2011**, *65* 287-332, both of which are incorporated herein by reference in their entirety. Antimicrobial agents may also be included to achieve a bacteriostatic or fungistatic solution, including but not limited to phenylmercuric nitrate, thimerosal, benzethonium chloride, benzalkonium chloride, phenol, cresol, and chlorobutanol.

[0105] The compositions for intravenous administration may be provided to caregivers in the form of one or more solids that are reconstituted with a suitable diluent such as sterile water, saline or dextrose in water shortly prior to administration. In other embodiments, the compositions are provided in solution ready to administer parenterally. In still other embodiments, the compositions are provided in a solution that is further diluted prior to administration. In embodiments that include administering a combination of a compound described herein and another agent, the combination may be provided to caregivers as a mixture, or the caregivers may mix the two agents prior to administration, or the two agents may be administered separately.

[0106] The actual dose of the active compounds described herein depends on the specific compound, and on the condition to be treated; the selection of the appropriate dose is well within the knowledge of the skilled artisan. In some embodiments, a single dose of Plinabulin or other therapeutic agent may be from about 5 mg/m^2 to about 150 mg/m^2 of body surface area, from about 5 mg/m^2 to about 100 mg/m^2 of body surface area, from about 10 mg/m^2 to about 100 mg/m^2 of body surface area, from about 10 mg/m^2 to about 80 mg/m^2 of body surface area, from about 10 mg/m^2 to about 50 mg/m^2 of body surface area, from about 10 mg/m^2 to about 40 mg/m^2 of body surface area, from about 10 mg/m^2 to about 30 mg/m^2 of body surface area, from about 13.5 mg/m^2 to about 100 mg/m^2 of body surface area, from about 13.5 mg/m^2 to about 80 mg/m^2 of body surface area, from about 13.5 mg/m^2 to about 50 mg/m^2 of body surface area, from about 13.5 mg/m^2 to about 40 mg/m^2 of body surface area, from about 13.5 mg/m^2 to about 30 mg/m^2 of body surface area, from about 15 mg/m^2 to about 80 mg/m^2 of body surface area, from about 15 mg/m^2 to about 50 mg/m^2 of body surface area, or from about 15 mg/m^2 to about 30 mg/m^2 of body surface area. In some embodiments, a single dose of plinabulin or other therapeutic agent may be from about 13.5 mg/m^2 to about 30 mg/m^2 of body surface area. In some embodiments, a single dose of plinabulin or other therapeutic agent may be about 5 mg/m^2, about 10 mg/m^2, about 12.5 mg/m^2, about 13.5 mg/m^2, about 15 mg/m^2, about 17.5 mg/m^2, about 20 mg/m^2, about 22.5 mg/m^2, about 25 mg/m^2, about 27.5 mg/m^2, about 30 mg/m^2, about 40 mg/m^2, about 50 mg/m^2, about 60 mg/m^2, about 70 mg/m^2, about 80 mg/m^2, about 90 mg/m^2, or about 100 mg/m^2, of body surface area.

[0107] In some embodiments, a single dose of plinabulin or other therapeutic agent may be from about 5 mg to about 300 mg, from about 5 mg to about 200 mg, from about 7.5 mg to about 200 mg, from about 10 mg to about 100 mg, from about 15 mg to about 100 mg, from about 20 mg to about 100 mg, from about 30 mg to about 100 mg, from about 40 mg to about 100 mg, from about 10 mg to about 80 mg, from about 15 mg to about 80 mg, from about 20 mg to about 80 mg, from about 30 mg to about 80 mg, from about 40 mg to about 80 mg, from about 10 mg to about 60 mg, from about 15 mg to about 60 mg, from about 20 mg to about 60 mg, from about 30 mg to about 60 mg, or from about 40 mg to about 60 mg, In some embodiments, a single dose of plinabulin or other therapeutic agent may be from about 20 mg to about 60 mg, from about 27 mg to about 60 mg, from about 20

mg to about 45 mg, or from about 27 mg to about 45 mg. In some embodiments, a single dose of plinabulin or other therapeutic agent may be about 5 mg, about 10 mg, about 12.5 mg, about 13.5 mg, about 15 mg, about 17.5 mg, about 20 mg, about 22.5 mg, about 25 mg, about 27 mg, about 30 mg, about 40 mg, about 50 mg, about 60 mg, about 70 mg, about 80 mg, about 90 mg, about 100 mg, about 125 mg, about 150mg, or about 200 mg.

[0108] In some embodiments, the compositions described herein can be administered or used in combination with other treatments such as radiation or biologic therapies.

[0109] To further illustrate this invention, the following examples are included. The examples should not, of course, be construed as specifically limiting the invention. Variations of these examples within the scope of the claims are within the purview of one skilled in the art and are considered to fall within the scope of the invention as described, and claimed herein. The reader will recognize that the skilled artisan, armed with the present disclosure, and skill in the art is able to prepare and use the invention without exhaustive examples.

EXAMPLES

Example 1

[0110] The effect of plinabulin alone, cyclophosphamide alone, and the combination of plinabulin and cyclophosphamide on neutropenia was evaluated in male Sprague-Dawley rats. Fifteen rats each were placed in 4 treatment groups according to Table 1. The indicated doses were administered through intraperitoneal injection on Day 1 with Administration 2 being given 1 hour following Administration 1.

Table 1. Treatment Groups

Group No.	Treatment	Administration 1	Administration 2
1	Naïve control	-	-
2	Vehicle + Plinabulin	Vehicle 10 ml/kg	Plinabulin 7.5mg/kg (7.5 ml/kg)
3	Cyclophosphamide + Vehicle	Cyclophosphamide 12.5 mg/kg (10 ml/kg)	Vehicle 7.5 ml/kg
4	Cyclophosphamide + Plinabulin	Cyclophosphamide 12.5 mg/kg (10 ml/kg)	Plinabulin 7.5 mg/kg (7.5 ml/kg)

[0111] For treatment groups that included administration of a vehicle, the vehicle consisted of 7.11% Tween 80 (v/v): 25.5% Propylene glycol (v/v): 67.4% D5W (v/v). D5W is 5% dextrose in water for injection. For groups that included administration of plinabulin, plinabulin is first dissolved in the Tween 80 – PG mixture and then diluted with D5W. For groups that included administration of cyclophosphamide, a solution of cyclophosphamide was prepared, on the day of use, by dissolution in sterile water for injection to the desired final concentration.

[0112] The animals were randomized based on body weight and assigned to groups. Before the initiation of dosing, any assigned animals considered unsuitable for use in the study were replaced by alternate animals obtained from the same shipment and maintained under the same environmental conditions.

[0113] PMI Nutrition International Certified Rodent Chow No. 5CR4 was provided *ad libitum* throughout the study, except during designated procedures. The same diet in meal form was provided to individual animals as warranted by clinical signs (e.g., broken/damaged incisors or other health changes).

[0114] Blood was collected by jugular venipuncture for Day -1 bleeds and terminally via abdominal aorta under anesthesia for Day 2 (5 rats per Group i.e. total 20 rats), Day 3 (5 rats per Group i.e. total 20 rats) and Day 10 (5 rats per Group i.e. total 20 rats). After collection, the samples were tested for total and differential cell counts. Five rats per group were terminated on Days 2, 3, and 10. Animals were anesthetized with isoflurane (1-5%) and ~1-2.0mL of blood will be collected via abdominal aorta. After collection, 0.3mL was transferred to EDTA tubes and analyzed for total and differential cell counts. Immediately after blood collection, the animals were euthanized by exsanguination of the abdominal aorta.

[0115] Figure 1 is a graph of neutrophil count 24 hours post dosing of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin (i.e., from the 20 rats that were terminated on Day 2). The results indicate that administration of cyclophosphamide caused a decrease in neutrophil count while the combination of plinabulin and cyclophosphamide maintained the neutrophil count. These results indicate that plinabulin reduced the neutropenia caused by cyclophosphamide ($p=0.0584$). Plinabulin alone did not reduce the neutrophil count.

[0116] Figure 2 is a graph of neutrophil count 48 hours post dosing of cyclophosphamide, plinabulin, or the combination of cyclophosphamide and plinabulin (i.e., from the 20 rats that were terminated on Day 3). These results also indicate that administration of cyclophosphamide caused a decrease in neutrophil count while the combination of plinabulin and cyclophosphamide maintained the neutrophil count. These results indicate that plinabulin reduced the neutropenia caused by cyclophosphamide ($p=0.0494$). Plinabulin alone did not reduce the neutrophil count.

[0117] Figure 3 depicts results from all rats, including the Day -1 bleed as well as the terminations on Days 2, 3, and 10. Again, the results indicate that plinabulin reduced the neutropenia caused by cyclophosphamide.

Example 2

[0118] A study was performed to evaluate the effect of Plinabulin in reducing or treating neutropenia induced by chemotherapeutic agents such as cyclophaphamide. Male Sprague-Dawley rats were first treated with cyclophosphamide, or vehicle saline (control). The control sample contained 7.1% Tween 80 (v/v), 25.5% Propylene glycol (v/v), and 67.4% D5W(5% dextrose in water) (v/v). One hour later, the rats were dosed with Plinabulin or its vehicle following the administration schedule shown in Table 2. Each test group included 15 rats.

Table 2. Treatment Groups

Group No.	Treatment	Administration 1	Administration 2
1	Naïve control	-	-
2	Cyclophosphamide + Vehicle	Cyclophosphamide 12.5mg/kg, (10ml/kg)	Vehicle 7.5ml/kg,
3	Cyclophosphamide + Plinabulin	Cyclophosphamide 12.5mg/kg, (10ml/kg)	Plinabulin 7.5 mg/kg (7.5 ml/kg)
4	Vehicle + Plinabulin	Vehicle (10ml/kg)	Plinabulin 7.5 mg/kg (7.5 ml/kg)

[0119] Blood collection was performed for absolute neutrophil counts in blood samples collected at Day -1 (pre-dose), Day 2 (24h), Day 3 (48h), Day 10 (9 days) and Day

15 (14 days). The absolute neutrophil counts (ANC) measured are listed in Table 3 and shown in Figure 4. Table 4 shows the ANC expressed as percentage of the day -1 base line.

Table 3. ANCs (10^3 Cells/μL) on Day -1 and Day 3 for the treatment groups (Mean ± SD) N= 5 rats per group.

Day	Control	Plinabulin	Cyclophosphamide	Cyclophosphamide + Plinabulin
-1	1.73±0.24	1.69±0.21	1.68±0.19	1.87±0.46
3	1.22±0.22	1.10±0.26	0.48±0.13	1.55±1.03

Table 4. ANCs Expressed as Percent of Baseline (Day -1), with Statistical significance (t-test)

Group	Control	Plinabulin	Cyclophosph.	Cyclophosph. + Plin
ANC % (Day -1)	70.5	65.1	28.5	82.9
P value	0.0034	0.0045	<0.00001	0.5437 NS

[0120] The control group showed some changes from the baseline (Day -1), and this change was compared with the changes in other treatment groups. These were expressed as a percentage of the control level on Day 3. Table 5 and Figure 5 show the ANC levels in each group on Day 3, and the difference between the chemotherapeutic with and without plinabulin treatment is shown in Table 6 and Figure 6.

Table 5. ANC Levels in Each Group on Day 3, Expressed as Percent of Control ANC on Day 3

Group	Control	Plinabulin	Cyclophosphamide	Cyclophosphamide + Plinabulin
% Day 3 Control	100.0	90.2	39.3	127.0
P Value	-	0.889 NS	0.0005	0.39 NS

Table 6. Comparison of ANC Levels of Chemotherapeutic Alone vs. the combination of chemotherapeutic and plinabulin on Day 3

Group	Cyclophosphamide	Cyclophosphamide + Plinabulin

ANC ($10^3/\mu L$)	0.48 ± 0.13	1.55 ± 1.03
P value Chemo vs. Chemo + Plinabulin		0.0494

[0121] As shown in this study, the chemotherapeutic agents, cyclophosphamide respectively induced neutropenia in rats at around 48h after a single intra-peritoneal injection. The administration of plinabulin reversed cyclophosphamide-induced neutropenia and helped increase ANC levels.

Example 3

[0122] A study was performed to evaluate the effect of plinabulin in reducing or treating doxorubicin induced neutropenia. Male Sprague-Dawley rats were first treated with doxorubicin or vehicle saline (control). The control sample included 7.1% Tween 80 (v/v), 25.5% Propylene glycol (v/v), 67.4% D5W (v/v). One hour later, the rats were dosed with Plinabulin or its vehicle following the administration schedule shown in Table 7. Each test group included 6 rats. The doxorubicin was administered intravenously, and plinabulin was administered through intraperitoneal injection.

Table 7. Treatment groups

Group	Treatment	Doxorubicin Dose (mg/kg)	Plinabulin Dose (mg/kg)
A	Naïve Control	-	-
B	Doxorubicin + Vehicle	3	0
C	Plinabulin	-	7.5
D	Doxorubicin + Plinabulin	3	1.75
E	Doxorubicin + Plinabulin	3	3.5
F	Doxorubicin + Plinabulin	3	7.5

[0123] Blood collection was performed for ANC in blood samples collected at Day -1 (pre-dose), Day 2, Day 3, Day 4, Day 5 and Day 8 post single dosing with control, doxorubicin at Day 1 followed by plinabulin, or plinabulin vehicle as control one hour later. The ANC decreased following doxorubicin administration with a duration of at least 8 days. An increase in ANC was noted in all groups 24 hours after doxorubicin. This change rapidly

normalized in control and plinabulin only-treated groups. The ANC in plinabulin only treated rats was not statistically different from naïve animals at any time point. (Table 8, Figure 7)

Table 8. A time course change of ANC ($10^3/\mu L$) levels expressed as Mean ±SD (n)

Day	Naive	Doxorubicin 3.0 mg/kg	Plinabulin 7.5 mg/kg	Doxorubicin + Plinabulin 1.75 mg/kg	Doxorubicin + Plinabulin 3.5 mg/kg	Doxorubicin + Plinabulin 7.5 mg/kg
-1	2.23 ± 0.787 (5)	1.79 ± 0.666 (6)	2.02± 0.378 (6)	2.46 ± 0.792 (6)	2.20 ± 0.645 (6)	2.12 ± 0.582 (6)
2	8.31 ± 1.658 (6)*	4.37 ± 1.985 (6)*,#	5.24 ± 3.429 (6)	4.39 ± 2.802 (6)#	6.01 ± 1.290 (6)*,#	8.93 ± 3.107 (6)*,!
3	1.73 ± 0.474 (6)	0.88 ± 0.156 (6)*,#	1.98 ± 0.792 (6)	1.21 ± 0.930 (6)*	1.25 ± 0.294 (6)*,!	2.10 ± 0.575 (6)!
4	3.31 ± 0.945 (6)*	1.02 ± 0.359 (6)*,#	2.17 ± 1.101 (6)	0.77 ± 0.443 (6)*,#	0.55 ± 0.130 (6)*,#,!	1.35 ± 0.484 (6)*,#
5	3.38 ± 1.207 (6)*	0.65 ± 0.269 (6)*,#	2.13 ± 0.568 (5)	0.85 ± 0.445 (6)*,#	0.52 ± 0.109 (6)*,#	1.06 ± 0.546 (6)*,#
8	3.00 ± 1.566 (6)	0.97 ± 0.248 (6)*,#	3.18 ± 1.304 (5)	1.24 ± 0.644 (6)*,#	1.22 ± 0.239 (6)*,#	1.29 ± 0.606 (5)#

*Statistically Different from Predose ($p<0.05$)
#Statistically Different from Naïve ($p<0.05$)
!Statistically significant from Doxorubicin alone ($p<0.05$)

[0124] As seen in Table 9 and Figure 8, when expressed as percentage of ANC in Naïve animals, the neutropenia effect of doxorubicin was seen within 24 hours after administration and increased in severity until Day 5. Plinabulin (7.5 mg/kg) significantly diminished the effect of doxorubicin on Days 2 and 3 post dose, and ameliorated the doxorubicin-induced neutropenia to a lesser degree on days 5 and 8.

Table 9. ANC level in the treatment groups (7.5 mg/kg), expressed as Percent Naïve Group

Day	Doxorubicin		Doxorubicin + Plinabulin (7.5 mg/kg)		
	% Naïve	p value	% Naïve	p value vs. Naïve	p value vs. Doxorubicin
2	52.6	0.004	107.5	NS	0.0127
3	50.9	0.0019	121.4	NS	0.0005

4	30.8	0.0002	40.8	0.0011	NS
5	19.2	0.0003	31.4	0.0016	NS
8	32.3	0.0106	43.0	0.0489	NS

[0125] When the results were expressed as percent doxorubicin alone, a similar amelioration by plinabulin on doxorubicin-induced neutropenia was observed for the 7.5 mg/kg dose of plinabulin and also for the 3.5 mg/kg dose of plinabulin as shown in Table 10.

Table 10. ANC levels in the treatment groups, expressed as percent of the doxorubicin treated group

Day	Doxorubicin + Plinabulin 1.75 mg/kg		Doxorubicin + Plinabulin 3.5 mg/kg		Doxorubicin + Plinabulin 7.5 mg/kg	
	% Dox Alone	p value	% Dox Alone	p value	% Dox Alone	p value
2	100.5	NS	137.6	NS	204.3	0.0127
3	137.5	NS	142.0	0.0219	238.6	0.0005
4	75	NS	53.9	NS	132.0	NS
5	130.8	NS	80.0	NS	163.0	NS
8	127.8	NS	125.8	NS	133.0	NS

[0126] The doxorubicin induced a long-lasting neutropenia in the rat, when it was administered at a dose of 3.0 mg/kg. Plinabulin significantly reduced the doxorubicin-induced neutropenia as doses of 3.5 and 7.5 mg/kg IP, when administered one hour after doxorubicin.

Example 4

[0127] A study was performed to evaluate the effect of Plinabulin in reducing or treating cis-platin induced neutropenia. Male Sprague-Dawley rats were first treated with cis-platin or vehicle saline (control). The control sample included 7.1% Tween 80 (v/v), 25.5% Propylene glycol (v/v), 67.4% D5W (v/v). One hour later, the rats were dosed with Plinabulin or its vehicle following the administration schedule shown in Table 11. Each test group included 6 rats.

Table 11. Treatment groups

Group	Treatment	Administration 1	Administration 2

a	Naïve control	-	-
b	Cis-platin + Vehicle	Cisplatin 6.5 mg/kg, (10ml/kg)	Vehicle (TI), 7.5ml/kg, Single, 1h post cis-platin
c	Vehicle + Plinabulin	Vehicle (for cis-platin), 10ml/kg	Plinabulin 4.9 mg/kg (4.9 ml/kg)
d	Cis-platin + Plinabulin	Cisplatin 6.5 mg/kg, (10ml/kg)	Plinabulin 1.14 mg/kg (1.14 ml/kg)
e	Cis-platin + Plinabulin	Cisplatin 6.5 mg/kg, (10ml/kg)	Plinabulin 4.9 mg/kg (4.9 ml/kg)
f	Vehicle + Plinabulin	Vehicle (for cis-platin), 10ml/kg	Plinabulin 7.5 mg/kg (7.5 ml/kg)
g	Cis-Platin + Plinabulin	Cisplatin 6.5 mg/kg, (10ml/kg)	Plinabulin 7.5 mg/kg (7.5 ml/kg)

[0128] Blood collection was performed for ANC in blood samples collected at Day -1 (pre-dose), Day 2, Day 3, Day 4, and Day 5 post single dosing with control, cisplatin at Day 1 followed by plinabulin, or plinabulin vehicle as control one hour later. The ANC decreased following cisplatin administration. Table 12 shows the ANC of the different treatment groups at predose and Day 3.

Table 12. ANCs (10^3 Cells/μL) at Predose and Day 3 (Cisplatin ANC nadir) for the treatment groups

Day	-1	3
Control	1.69± 0.41	1.46± 0.28
Cisplatin	2.03± 0.81	0.93± 0.28
Plinabulin 4.9 mg/kg	1.98± 0.47	2.42± 0.73
Plinabulin 7.5 mg/kg	2.12± 0.25	4.55± 1.41
Cisplatin + Plinabulin	2.03±	1.35±

1.14 mg/kg	0.60	0.38
Cisplatin + Plinabulin 2.3 mg/kg	2.07± 0.71	1.70± 0.63
Cisplatin + Plinabulin 4.9 mg/kg	2.04± 0.45	2.81± 1.24
Cisplatin + Plinabulin 7.5 mg/kg	1.55± 0.24	2.08± 0.55

[0129] Table 13 shows the ANC levels on Day 3 after treatment expressed as percentage of the baseline (Day -1 pretreatment)

Table 13. Day 3 ANCs Expressed as Percent of Baseline (Day -1), with Statistical significance (t-test)

Group	Control	Cisplatin	Plinabulin 4.9 mg/kg	Plinabulin 7.5 mg/kg	Cisplatin + Plinabulin 1.14 mg/kg	Cisplatin + Plinabulin 2.3 mg/kg	Cisplatin + Plinabulin 4.9 mg/kg	Cisplatin + Plinabulin 7.5 mg/kg
% of Day -1	86.4	45.8	122.2	214.6	66.5	84.2	137.7	134.2
P value based on ANC levels	0.2933 NS	0.0101	0.2391 NS	0.0014	0.0417	0.3525 NS	0.1837 NS	0.0521 NS

[0130] The ANC levels in the Control Group were not significantly different between predose and Day 3, and a direct comparison can be made between groups. Cisplatin at 6.5 mg/kg in the rat induced a statistically significant neutropenia on Day 3 post dosing. Plinabulin at 4.9 mg/kg did not change ANC levels. When plinabulin (2.3 mg/kg, 4.9 mg/kg and 7.5 mg/kg) was administered one hour post cisplatin, the ANC levels were not significantly different from the predose levels. Table 14 shows the ANC levels on Day 3 for various test groups. Figure 9 shows the ANC levels on day 3 for the cisplatin alone group and

the cis-platin and plinabulin combination groups. Figure 10 shows the dose-response curve for plinabulin on cis-platin induced neutropenia in the rat, with the ANC data expressed as percentage of the ANC levels measured in the cis-platin only treatment group. When the ANC levels in the cis-platin and plinabulin combination dosed groups were expressed as the percent of ANC in the cis-platin alone group (Day 3), plinabulin exhibited a dose-response effect in decreasing the neutropenia observed in the cis-platin alone group.

Table 14. Effect of plinabulin on ANC Levels in the treatment groups, expressed as % of the cis-platin only treatment group.

Comparison	Cis-platin vs. Cis + Plinabulin 1.14	Cis-platin vs. Cis + Plinabulin 2.3	Cis-platin vs. Cis + Plinabulin 4.9	Cis-platin vs. Cis + Plinabulin 7.5
ANC % of Cis-platin alone group (Day 3)	145.2	182.8	302.2	223.7
P value	0.0548 NS	0.212	0.0047	0.0011

[0131] At a dose of 6.5 mg/kg IP, cis-platin induced a statistically significant neutropenia. As shown in the study, plinabulin, in a dose-dependent manner, significantly reduced the cis-platin induced neutropenia.

Example 5

[0132] A study was performed to evaluate the effect of Plinabulin in reducing or treating topotecan induced neutropenia. The control sample contained 7.1% Tween 80 (v/v), 25.5% Propylene glycol (v/v), and 67.4% D5W(5% dextrose in water) (v/v). Topotecan (0.25 or 1.0 mg/kg IV) was administered to adult male Sprague-Dawley rats on Days 1, 3 and 5. Topotecan was administered by intravenous infusion over a period of 30 minutes using a syringe infusion pump and sterile disposable syringes at a dose volume of 10mL/kg.

[0133] Plinabulin (3.75 mg/kg, IP) was dosed 1 hour post topotecan following each topotecan dose. Plinabulin (7.5 mg/kg IP) was dosed 1 hour after the topotecan dose (0.25 mg/kg) on Day 1 only.

[0134] Blood collection was performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples collected on day 3 were analyzed for total and differential blood cell counts.

[0135] Figures 11A and 11B illustrate the change of ANC levels post the administration of control, plinabulin, and the combination of topotecan and plinabulin. As

shown in Figures 11A and 11B, the topotecan induced a long-lasting neutropenia in the rat, when it was administered at a dose of 1 or 0.25 mg/kg. Plinabulin significantly reduced the topotecan-induced neutropenia as doses of 3.75 and 7.5 mg/kg IP, when administered one hour after topotecan.

Example 6

[0136] A study can be performed to evaluate the effect of Plinabulin in reducing or treating a test chemotherapeutic agent-induced neutropenia. An effective amount of the test chemotherapeutic agent is administered to a test subject (e.g., adult male Sprague-Dawley rats) on Days 1, 3 and 5. Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the test chemotherapeutic agent is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

Example 7

[0137] A study can be performed to evaluate the effect of Plinabulin in reducing or treating a tecan compound induced neutropenia. An effective amount of the tecan compound is administered to a test subject (e.g., adult male Sprague-Dawley rats). Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the tecan compound is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

Example 8

[0138] A study can be performed to evaluate the effect of Plinabulin in reducing or treating a platin compound induced neutropenia. An effective amount of the platin compound is administered to a test subject (e.g., adult male Sprague-Dawley rats) on Days 1, 3 and 5. Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the platin compound is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

Example 9

[0139] A study can be performed to evaluate the effect of Plinabulin in reducing or treating a phosphamide compound induced neutropenia. An effective amount of the phosphamide compound is administered to a test subject (e.g., adult male Sprague-Dawley rats) on Days 1, 3 and 5. Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the phosphamide compound is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

Example 10

[0140] A study can be performed to evaluate the effect of Plinabulin in reducing or treating a rubicin compound induced neutropenia. An effective amount of the rubicin compound is administered to a test subject (e.g., adult male Sprague-Dawley rats) on Days 1, 3 and 5. Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the rubicin compound is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

Example 11

[0141] A study can be performed to evaluate the effect of Plinabulin in reducing or treating radiation therapy induced neutropenia. A radiation therapy is administered to a test subject (e.g., adult male Sprague-Dawley rats) on days 1, 3 and 5. Plinabulin in the range of about 3.75 mg/kg to 40 mg/kg is dosed after the radiation is administered to the test subject. Blood collection is performed Days -2, 0, 2, 4, 6, 7, 8, 9, 10 for the pilot and Days -2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 15 for the main study. Blood samples are analyzed for total and differential blood cell counts.

WHAT IS CLAIMED IS:

1. A method of reducing neutropenia in a subject, comprising administering plinabulin or a pharmaceutically acceptable salt thereof to the subject in need thereof, wherein the neutropenia is induced by administration of a first chemotherapeutic composition comprising one or more chemotherapeutic agents, wherein the chemotherapeutic composition does not comprise docetaxel, or by administration of radiation therapy.

2. The method of claim 1, wherein the first chemotherapeutic composition does not comprise a taxane.

3. The method of claim 1 or 2, comprising administering one or more additional chemotherapeutic compositions to the subject.

4. The method of any one of claims 1 to 3, wherein the first chemotherapeutic composition comprises a single chemotherapeutic agent.

5. The method of any one of claims 1 to 3, wherein the first chemotherapeutic composition comprises two or more chemotherapeutic agents.

6. The method of any one of claims 1 to 4, wherein the first chemotherapeutic composition comprises one or more agents selected from the group consisting of cyclophosphamide, ifosamide, cisplatin, carboplatin, oxaliplatin, nedaplatin, triplatin tetranitrate, phenanthriplatin, picoplatin, satraplatin, topotecan, irinotecan, doxorubicin, epirubicin, daunorubicin, valrubicin, and pharmaceutically acceptable salts thereof.

7. The method of any one of claims 3 to 6, wherein the at least one of the one or more additional chemotherapeutic compositions comprises docetaxel.

8. The method of any one of claims 3 to 7, wherein at least one of the one or more additional chemotherapeutic compositions comprises one or more taxanes selected from the group consisting of docetaxel, paclitaxel, and cabazitaxel.

9. The method of any one of claims 1-8, wherein the first chemotherapeutic composition comprises cyclophosphamide.

10. The method of any one of claims 1-9, wherein the first chemotherapeutic composition comprises cisplatin.

11. The method of any one of claims 1-10, wherein the first chemotherapeutic composition comprises doxorubicin.

12. The method of any one of claims 1-11, wherein the first chemotherapeutic composition comprises topotecan.

13. The method of any one of claims 1-12, comprising administering plinabulin prior to administering the first chemotherapeutic composition.

14. The method of claim 13, wherein the plinabulin is administered in the range of about 1 minute to 24 hours prior to administration of the first chemotherapeutic composition.

15. The method of any one of claims 1-12, comprising administering plinabulin after administering the first chemotherapeutic composition.

16. The method of claim 15, wherein the plinabulin is administered in the range of about 1 minute to 24 hours after administration of the first chemotherapeutic composition.

17. The method of any one of claims 1-12, wherein the plinabulin and the first chemotherapeutic composition are administered substantially simultaneously.

18. The method of any one of claims 3, 7, or 8, comprising:

administering plinabulin prior to administration of the first chemotherapeutic composition; and

administering the additional one or more chemotherapeutic compositions after administration of the first chemotherapeutic composition.

19. The method of any one of claims 3, 7, or 8, comprising:

administering the first chemotherapeutic composition prior to administration of the plinabulin; and

administering the additional one or more chemotherapeutic compositions after administration of the plinabulin.

20. The method of any one of claims 3, 7, or 8, comprising:

administering the first chemotherapeutic composition prior to administration of the additional one or more chemotherapeutic compositions; and

administering the plinabulin after administration of the additional one or more chemotherapeutic agents.

21. The method of any one of claims 18-20, wherein a period of time between administration of each of plinabulin, the first chemotherapeutic composition, and the additional one or more chemotherapeutic compositions is independently selected between about 1 minute and 24 hours.

22. The method of any one of claims 1-21 comprising administering radiation therapy to the subject.

23. The method of any one of claims 1-22, comprising identifying the subject as suffering from neutropenia.

24. The method of any one of claims 1-23, wherein the neutropenia induced by the first chemotherapeutic composition is a grade 3 or 4 neutropenia.

25. The method of any one of claims 1-24, comprising identifying the subject as being at risk for developing neutropenia.

26. The method of any one of claims 1-25, wherein said reducing neutropenia comprises reducing the likelihood of onset of, or reducing the severity of, neutropenia in the subject.