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(54) Titre : METHODES DE TRAITEMENT DU SYNDROME DE FUITE VASCULAIRE ET DU CANCER
(54) Title: METHODS FOR TREATING VASCULAR LEAK SYNDROME AND CANCER

(57) Abrégé/Abstract:
Disclosed are methods for treating Vascular Leak Syndrome and preventing cancer metastasis. Further disclosed are methods for treating vascular leakage due to inflammatory diseases, sepsis, cancer or the presence of pathogens.

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(57) **Abstract**: Disclosed are methods for treating Vascular Leak Syndrome and preventing cancer metastasis. Further disclosed are methods for treating vascular leakage due to inflammatory diseases, sepsis, cancer or the presence of pathogens.

METHODS FOR TREATING VASCULAR LEAK SYNDROME AND CANCER

CROSS-REFERENCE TO RELATED APPLICATION

[00001] This application claims priority to U.S. Provisional Application Serial No. 61/546,748 filed October 13, 2011 and to U.S. Provisional Application Serial No. 61/546,697 filed October 13, 2011. The entire content of U.S. Provisional Application Serial No. 61/546,748 and U.S. Provisional Application Serial No. 61/546,697 is incorporated herein by reference.

INCORPORATION BY REFERENCE OF MATERIAL SUBMITTED ELECTRONICALLY

[00002] Incorporated by reference in its entirety is a computer-readable sequence listing submitted concurrently herewith and identified as follows: One 92 KB ASCII (Text) file named "233106-331560_Seq_Listing_ST25," created on October 15, 2012, at 11:52 am.

FIELD

[00003] Methods for treating cancer, preventing metastasis and vascular leak syndrome by administration of a HPTPβ inhibitor.

BACKGROUND

[00004] Vascular leak syndrome (VLS) is characterized by hypotension, peripheral edema and hypoalbuminemia. VLS can occur as a side effect of illness especially illnesses due to pathogens, *inter alia*, viruses and bacteria. Vascular leak complicates the healing process and can itself be a direct result of certain therapies. For example, patients suffering from malignant renal carcinoma are given Interleukin-2 (IL-2) to help boost their immune system. However, this treatment must be withdrawn in many patients due to the onset of severe VLS well before the full course of treatment can be administered. VLS restricts the doses of IL-2 which can be administered to humans and, in some cases, necessitates the cessation of therapy before the therapy is maximally effective.

[00005] VLS is characterized by an increase in vascular permeability accompanied by extravasation of fluids and proteins resulting in interstitial edema and organ failure. Manifestations of VLS include fluid retention, increase in body weight, peripheral edema, pleural and pericardial effusions, ascites, anasarca and, in severe form, signs of pulmonary and cardiovascular failure. Symptoms are highly variable among patients and the causes are poorly understood. Endothelial cell modifications or damage are thought to be important is vascular leak. The pathogenesis of endothelial cell (EC) damage is complex and can involve activation or damage to ECs and leukocytes, release of cytokines and of inflammatory mediators, alteration in cell-cell and cell-matrix adhesion and in cytoskeleton function.

[00006] One of the most frightening aspects of cancer is its ability to spread, or metastasize. Initially, cancer cells are found grouped together thereby forming one or more tumors. After formation of the primary tumor, cancer cells can gain the ability to separate from the original tumor and travel to other areas of the body. Lung cancer cells that take up in the liver and form tumors are still lung cancer cells. Thus, the propensity for one particular form of cancer to metastasize is dependent on many factors, including type of cancer; however, the overall process of how cells begin the process of metastasis is still not completely understood.

[00007] If a single localized tumor is discovered before it has had a chance to metastasize, then the prognosis of patient survival is higher. This is because the tumor can be effectively excised or destroyed by radiation or chemotherapy. There is, therefore, a difference between tumor growth and metastasis of the tumor cells; the first does not always lead to the other. Cancers that have metastasized, however, are difficult to cure because of extent to which they have spread throughout the body.

[00008] In order to metastasize, a cancer cell must break away from its tumor and invade either the circulatory or lymph system. The free cells are then carried to a new location where they establish themselves. Although the body has natural safeguards that prevent cell from surviving after being detached from their natural location, some cancer cells have the ability to overcome these safeguards. Therefore, if metastasis is stopped or significantly reduced, the extent of cancer can be determined and subsequently treated. As such, a follow up treatment to cancer therapy wherein a tumor has been excised or radiation/chemotherapy has been used, would be the treatment of the patient to an anti-metastasizing agent. There is a long felt need for methods of preventing cancer cell metastasis.

[00009] The growth of primary tumors also presents a challenge to treatment. If the growth of a primary tumor goes unchecked, the initial tumor can grow to a size that adversely effects organ function at the primary site and in nearby tissues. Metastasis of the primary tumor are also more likely if the primary tumor's growth is uncontrolled. There is a need for methods of slowing or preventing tumor growth.

[00010] During the course of antiviral and antibacterial infections, patients can develop vascular leak that is induced as result of the initial infection. There is now a long felt need for a method of preventing vascular leak due to viral or bacterial infection, and for providing methods of increasing the survival of humans or other mammals infected with one or more pathogens. In addition, there is a long felt need for a method of preventing vascular leakage due to certain anticancer drugs or other anticancer therapies such that the administration of anticancer drugs or anticancer therapies can be given to humans or other mammals for a longer course of treatment or therapy.

SUMMARY

[00011] The present disclosure provides methods for treating a patient having vascular leak syndrome comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

[00012] Also provided are methods for treating a patient having vascular leak syndrome comprising administering to the patient, a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof, and one or more pharmaceutically acceptable excipient.

[00013] The present disclosure provides for methods of treating vascular leak wherein the patient being treated is suffering from an inflammatory disease or condition, trauma, shock, adult respiratory distress syndrome, acute lung injury, or sepsis comprising administering to the patient, a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

[00014] The present disclosure also provides for methods of treating vascular leak wherein the patient being treated is suffering from an inflammatory disease or condition, trauma, shock, adult respiratory distress syndrome, acute lung injury, or sepsis comprising administering to the patient, a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof, and one or more pharmaceutically acceptable excipient.

[00015] Another method provided by the present disclosure, is a method for determining the course of treatment for a patient suffering from vascular leak syndrome, comprising:
a) administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent; b) monitoring the level of angiopoietin-2 present in the patient during the course of treatment; and c) discontinuing treatment when the angiopoietin-2 level returns to within a normal range.

[00016] A further method provided by the present disclosure is a method for treating cancer in a patient, comprising administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

[00017] A further method provided by the present is a method for treating cancer in a patient, comprising administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof, and a pharmaceutically acceptable excipient.

[00018] Still another method provided by the present disclosure is a method for preventing metastasis in a patient with cancer, by administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

[00019] Still another method provided by the present disclosure is a method for preventing metastasis in a patient with cancer, by administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof, and a pharmaceutically acceptable excipient.

[00020] In the methods of the present disclosure, HPTPβ-ECD binding agents include, but are not limited to antibodies, proteins, peptides, aptamers, peptibodies, adnectins, or nucleic acids, that binds to the extracellular portion of HPTPβ.

BRIEF DESCRIPTION OF THE FIGURES

[00021] **Fig. 1**. The monoclonal antibody R15E6 recognizes endogenous HPTPβ on endothelial Cells. (Panel A) Endothelial cell lysates are immunoprecipitated with a control antibody (Lane 1), with R15E6 (Lane 2), or with a mixture of anti-Tie2 and anti-VEGFR2 antibodies (Lane 3). Immunoprecipitates are resolved by SDS-PAGE, transferred to a PVDF membrane and probed by western blot with a mixture of R15E6, anti-Tie2 and anti-VEGFR2 antibodies. A single major high molecular weight band consistent with HPTPβ is seen with R15E6 (Lane 2), and not with the control antibody (Lane 1), or the mixture of anti-Tie2 and anti-VEGFR2 (Lane 3). (Panel B) Endothelial cells are subjected to FACS analysis with R15E6 (white peak) or a no primary antibody control (black peak). The robust shift in fluorescence indicates that R15E6 binds to HPTPβ on the surface of intact endothelial cells.

[00022] **Fig. 2** The monoclonal antibody R15E6 enhances Tie2 Receptor Activation in HUVECs. Tie2 activation is measured in human endothelial cells as described in Example 4. R15E6 dose dependently enhances both basal and Ang1-induced Tie2 activation.

[00023] **Fig. 3.** Is a graphical representation of the mean area of choroidal neovascularization in C57BL/6 mice 14 days post laser treatment in eyes treated with intravitreal injection of 1μg or 2μg of an anti-VE-PTP extracellular domain antibody in one eye versus similar treatment of the fellow eye with vehicle.

[00024] **Fig. 4.** Shows the mean area (mm^2) of retinal neovascularization in C57BL/6 mice on day P17 after containment in a 75% oxygen atmosphere from P5 to P12 and intravitreal injection of an anti-VE-PTP extracellular domain antibody at P12 when the mice were returned to room air.

[00025] **Fig. 5.** Show representative fluorescent micrographs of mouse retinas in the oxygen-induced retinopathy model after intravitreal injection of vehicle or 2 μg of an anti-VE-PTP extracellular domain antibody.

[00026] **Fig. 6.** Shows the mean area (mm^2) of retinal neovascularization in C57BL/6 mice on day P17 after containment in a 75% oxygen atmosphere from P5 to P12 followed by return to room air on P12 with subcutaneous administration of 1 mg/kg of an anti-VE-PTP extracellular domain antibody on days P12, 14 and 16.

[00027] **Fig. 7.** Shows the mean area (mm^2) of retinal neovascularization in C57BL/6 mice on day P17 after containment in a 75% oxygen atmosphere from P5 to P12 follow by return to room air on P12 with subcutaneous administration of 2 mg/kg of an anti-VE-PTP extracellular domain antibody on days P12, 14 and 16.

DETAILED DESCRIPTION

General Definitions

[00028] In this specification and in the claims that follow, reference will be made to a number of terms, which shall be defined to have the following meanings:

[00029] The term "HPTPβ-ECD binding agent" and "specific binding agent" are used interchangeably herein and refer to a molecule that specifically binds to the extracellular portion of HPTPβ, and variants and derivatives thereof, as defined herein, that inhibits the Tie2 dephosphorylase activity of HPTPβ.

[00030] "Agent" as used herein refers to an "HPTPβ binding agent" or unless otherwise noted.

[00031] "Specifically binds HPTPβ-ECD" refers to the ability of a specific binding agent of the present invention to recognize and bind to an epitope of the extracellular domain of HPTPβ with higher affinity than to other related and/or unrelated molecules. Specific binding agents preferentially bind to HPTPβ in a complex mixture of proteins and/or macromolecules. The specific binding agent is preferably selective for HPTPβ. "Selective" means that the agent has significantly greater activity toward HPTPβ compared with other related and/or unrelated molecules, not that it is completely inactive with regard to other molecules. For example, a selective agent may show 10-fold, 100-fold, or 1000-fold selectivity toward HPTPβ than to other related or unrelated molecules.

[00032] The term "anti-HPTPβ-ECD antibodies" refers to antibodies or antibody fragments that bind to the extracellular domain of HPTPβ. Anti-HPTPβ-ECD antibodies are a type of HPTPβ-ECD binding agent as defined herein.

[00033] The term "VE-PTP" refers to the mouse ortholog of HPTPβ.

[00034] All percentages, ratios and proportions herein are by weight, unless otherwise specified. All temperatures are in degrees Celsius (^{O}C) unless otherwise specified.

[00035] Ranges may be expressed herein as from one particular value to another particular value, the endpoints are included in the range. For example for the range from "1mg to 50mg" includes the specific values 1mg and 50mg. The antecedent "about" indicates that the values are approximate. For example for the range from "about 1mg to about 50mg" indicates that the values are approximate values. Additionally, when such a range is expressed, the range includes the range “from 1mg to 50mg”. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint. For example the range “from 1mg to 50mg”, includes the range “from 30mg to 40mg.”

[00036] As used herein, the term “in combination” refers to the use of more than one prophylactic and/or therapeutic agent. The use of the term “in combination” does not restrict the order in which prophylactic and/or therapeutic agents are administered to a patient. A first prophylactic or therapeutic agent can be administered prior to (e.g., 1 minute, 5 minutes, 15 minutes, 30 minutes, 45 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 12 hours, 24 hours, 48 hours, 72 hours, 96 hours, 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 8 weeks, or 12 weeks before), concomitantly with, or subsequent to (e.g., 1 minute, 5 minutes, 15 minutes, 30 minutes, 45 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 12 hours, 24 hours, 48 hours, 72 hours, 96 hours, 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 8 weeks, or 12 weeks after) the administration of a second prophylactic or therapeutic agent to a patient which had, has, or is susceptible to a disorder. The prophylactic or therapeutic agents are administered to a patient in a sequence and within a time interval such that the agent of the present disclosure can act together with the other agent to provide an increased benefit than if they were administered otherwise. Any additional prophylactic or therapeutic agent can be administered in any order with the other additional prophylactic or therapeutic agents

[00037] “Effective amount” means an amount of an active agent or combination of agents effective to ameliorate or prevent the symptoms, or prolong the survival of the patient being treated. An effective amount may vary according to factors known in the art, such as the disease state, age, sex, and weight of the human or animal being treated. Although particular dosage regimes may be described in examples herein, a person skilled in the art would appreciated that the dosage regime may be altered to provide optimum therapeutic response. For example, several divided doses may be administered daily or the dose may be proportionally reduced as indicated by the exigencies of the therapeutic situation. In addition, the compositions of this disclosure can be administered as frequently as necessary to achieve a therapeutic amount. Determination of a therapeutically effective amount is well within the capabilities of those skilled in the art, especially in light of the detailed disclosure provided herein.

[00038] As used herein the term "inhibit" or "inhibiting" refers to a statistically significant and measurable reduction in activity, preferably a reduction of at least about 10% versus control, more preferably a reduction of about 50% or more, still more preferably a reduction of about 80% or more.

[00039] As used herein the term "increase" or "increasing" refers to a statistically significant and measurable increase in activity, preferably an increase of at least about 10% versus control, more preferably an increase of about 50% or more, still more preferably an increase of about 80% or more.

[00040] "HPTP beta" or "HPTPβ" are used interchangeably herein and are abbreviations for human protein tyrosine phosphatase beta.

[00041] As used herein, "subject" means an individual. Thus, the "subject" can include domesticated animals (e.g., cats, dogs, etc.), livestock (e.g., cattle, horses, pigs, sheep, goats, etc.), laboratory animals (e.g., mouse, rabbit, rat, guinea pig, etc.), and birds. "Patient" can also include a mammal, such as a primate or a human. "Subject" and "patient" are used interchangeably herein. Preferably the subject is a human.

[00042] By "reduce" or other forms of the word, such as "reducing" or "reduction," is meant lowering of an event or characteristic (e.g., vascular leakage). It is understood that this is typically in relation to some standard or expected value, in other words it is relative, but that it is not always necessary for the standard or relative value to be referred to.

[00043] The terms "treatment", "treating", "treat" and the like, refer to obtaining a desired pharmacologic and/or physiologic effect such as mitigating a disease or a disorder in a host and/or reducing, inhibiting, or eliminating a particular characteristic or event associated with a disorder (e.g., vascular leak). Thus, the term "treatment" includes, preventing a disorder from occurring in a host, particularly when the host is predisposed to acquiring the disease, but has not yet been diagnosed with the disease; inhibiting the disorder; and/or alleviating or reversing the disorder. Insofar as the methods of the present invention are directed to preventing disorders, it is understood that the term "prevent" does not require that the disease state be completely thwarted. Rather, as used herein, the term preventing refers to the ability of the skilled artisan to identify a population that is susceptible to disorders, such that administration of the HPTPβ-ECD binding agents of the disclosure may occur prior to onset of a disease. The term does not imply that the disease state is completely avoided.

[00044] As used herein, the term “cancer treatment” means any treatment for cancer known in the art including, but not limited to, chemotherapy and radiation therapy.

[00045] As used herein, the term “cancer treatment” means any treatment for cancer known in the art including, but not limited to, chemotherapy and radiation therapy.

[00046] Throughout the description and claims of this specification the word “comprise” and other forms of the word, such as “comprising” and “comprises,” means including but not limited to, and is not intended to exclude, for example, other additives, components, integers, or steps.

[00047] As used in the description and the appended claims, the singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a composition” includes mixtures of two or more such compositions.

[00048] “Optional” or “optionally” means that the subsequently described event or circumstance can or cannot occur, and that the description includes instances where the event or circumstance occurs and instances where it does not.

[00049] “Specifically binds HPTPβ” refers to the ability of an agent of the present invention to recognize and bind to an epitope of the extracellular domain of HPTPβ with higher affinity than to the other related and/or unrelated molecules. The agent is preferably selective for HPTPβ. “Specific” means that the agent has significantly greater activity toward HPTPβ compared with other related and/or unrelated molecules, not that it is completely inactive with regard to other molecules. For example, a selective agent may show 10-fold, 100-fold, or 1000-fold selectivity toward HPTPβ than to other related or unrelated molecules.

[00050] The term “epitope” refers to any portion of any molecule capable of being recognized by and bound by an agent at one or more of the agent’s antigen binding regions. Epitopes usually consist of distinct surface groupings such as amino acids, sugars, lipids, phosphoryl, or sulfonyl, and, in certain embodiments, may have specific three dimensional structural characteristics, and/or specific charge characteristics. Epitopes as used herein may be conformational or linear.

[00051] "Peptibody" is a molecule comprising an antibody Fc domain attached to at least one peptide. The production of peptibodies is generally described in WO2002/24782.

[00052] "Fragment" refers to a portion of an agent. A fragment may retain the desired biological activity of the agent and may be considered to be an agent itself. For example a truncated protein in which the amino terminus and/or carboxy terminus and/or an internal amino acid residue is deleted is a fragment of the protein and an Fab of an immunoglobulin molecule is a fragment of the immunoglobulin. Such fragments may also be connected to another molecule by way of a direct connection (e.g. a peptide or disulfide bond) or by way of a linker.

[00053] "Protein" is used herein interchangeably with peptide and polypeptide.

[00054] Peptides of the present invention include, but are not limited to amino acid sequences having from about 3 to about 75 amino acids, or from about 5 to about 50 amino acids, or from about 10 to about 25 amino acids. Peptides may be naturally occurring or artificial amino acid sequences.

[00055] A protein of the invention may be obtained by methods well known in the art, for example, using standard direct peptide synthesizing techniques such as via solid-phase synthesis. If the gene sequence is known or can be deduced then the protein may be produced by standard recombinant methods. The proteins may be isolated or purified in a variety of ways known to one skilled in the art. Standard purification methods include precipitation with salts, electrophoretic, chromatographic techniques and the like.

[00056] "Derivatives" include those binding agents that have been chemically modified in some manner distinct from insertion, deletion, or substitution variants. For example, wherein the binding agent is a protein, the carboxyl terminus may be capped with an amino group, such as NH_2.

[00057] In some embodiments one or more molecules are linked together to form the agent. For example antibody fragments may be connected by a linker. In general the chemical structure of the linker is not critical as it serves primarily as a space. In one embodiment the linker is made of amino acids linked together by way of peptide bonds. In another embodiment the linker is a non-peptide linker such as a non-sterically hindering C_1-C_6 alkyl group. In another embodiment the linker is a PEG linker. It will further be appreciated that the linker can be inserted in a number of locations on the molecule.

[00058] Variants of an agent are included within the scope of the present invention. "Variant" or "Variants" as used herein means an agent having a protein or nucleotide sequence which is substantially similar to the protein or nucleotide sequence of the non-variant agent and which shares a similar activity of the non-variant agent. A protein or nucleotide sequence may be altered in various ways to yield a variant encompassed by the present invention, including substitutions, deletions, truncations, insertions and other modifications. Methods for such manipulations are well known in the art. See, for example, Current Protocols in Molecular Biology (and updates) Ausubel et al., Eds (1996), John Wiley and Sons, New York: Methods in Molecular Biology, Vol. 182, In vitro Mutagenesis Protocols, 2nd Edition, Barman Ed. (2002), Humana Press), and the references cited therein. For example, variants include peptides and polypeptides wherein amino acid residues are inserted into, deleted from and/or substituted into the known amino acid sequence for the binding agent. In one embodiment, the substitution of the amino acid is conservative in that it minimally alters the biochemical properties of the variant. In other embodiments, the variant may be an active fragment of a full-length protein, a chemically modified protein, a protein modified by addition of affinity or epitope tags, or fluorescent or other labeling moieties, whether accomplished by *in vivo* or in vitro enzymatic treatment of the protein, by chemical modification, or by the synthesis of the protein using modified amino acids.

[00059] Fusions proteins are also contemplated herein. Using known methods, one of skill in the art would be able to make fusion proteins of the proteins of the invention; that, while different from native form, may be useful. For example, the fusion partner may be a signal (or leader) polypeptide sequence that co-translationally or post-translationally directs transfer of the protein from its site of synthesis to another site (e.g., the yeast alpha-factor leader). Alternatively, it may be added to facilitate purification or identification of the protein of the invention (e.g., poly-His, Flag peptide, or fluorescent proteins).

[00060] Standard techniques may be used for recombinant DNA, oligonucleotide synthesis, and tissue culture and transformation (e.g., electroporation, lipofection). Enzymatic reactions and purification techniques may be performed according to manufacturer's specifications or as commonly accomplished in the art or as described herein. The techniques and procedures are generally performed according to conventional methods known in the art and as described in various general and more specific references that are cited and discussed throughout the present specification. Unless specific definitions are provided, the nomenclature utilized in connection with, and the laboratory procedures and techniques of, analytical chemistry, synthetic organic chemistry, and medicinal and pharmaceutical chemistry described herein are those known and commonly used in the art. Standard techniques may be used for chemical syntheses, chemical analyses, pharmaceutical preparation, formulation, delivery, and treatment of patients.

Sequence Listing

[00061] Table 1.

SEQ ID NO:1	Full length Human HPTPβ nucleotide sequence (X54131)
SEQ ID NO:2	Full length Human HPTPβ amino acid sequence (P23467)
SEQ ID NO:3	Extracellular Portion of Human HPTPβ with $(His)_6$Gly Tag
SEQ ID NO:4	Extracellular Portion of Human HPTPβ
SEQ ID NO:5	Full length mouse VE-PTP nucleotide sequence (AY077755)
SEQ ID NO:6	Full length mouse VE-PTP amino acid sequence (AAL75813)
SEQ ID NO:7	Extracellular portion of mouse VE-PTP amino acid sequence

HPTPβ-ECD binding agents

[00062] Agents useful in the present invention include, but are not limited to, antibodies, proteins, darpins, peptides, aptamers, adnectins, peptibodies, or nucleic acids that bind specifically to the extracellular portion of HPTPβ and inhibit at least one phosphatase activity of HPTPβ. As used herein, "phosphatase activity" includes enzymatic activity and biologic activity where biological activity is measured by assessing Tie2 phosphorylation.

[00063] Agents useful in the present invention further include: antibodies, or antigen binding fragments thereof which bind to the extracellular portion of HPTPβ wherein the antibody or antigen-binding fragment inhibits at least one phosphatase activity of HPTPβ. These agents include monoclonal and polyclonal antibodies. An agent may be a fragment of an antibody, wherein the fragment comprises the heavy and light chain variable regions, or the fragment is an $F(ab')_2$, or the fragment is a dimer or trimer of an Fab, Fv, scFv, or a dia-, tria-, or tetrabody derived from the antibody.

[00064] For example, the agent may be, without limitation, an antibody or antibody fragment that binds the extracellular portion of HPTPβ; or in particular an antibody that binds an FN3 repeat of HPTPβ, or more specifically an antibody that binds the first FN3 repeat of HPTPβ.

[00065] Agents further include: the monoclonal antibody R15E6 which is described in U.S. Pat. No. 7,973,142, which is hereby incorporated in its entirety. (The mouse hybridoma, Balbc spleen cells (B cells) which may be used to produce the antibody are deposited with American Type Culture Collection (ATCC), P.O. Box 1549, Manassas, Va. 20108 USA on 4 May 2006, assigned ATCC No. PTA-7580) (Referred to herein as R15E6)), antibodies having the same or substantially the same biological characteristics of R15E6; antibody fragments of R15E6, wherein the fragment comprises the heavy and light chain variable regions; an F(ab')2 of R15E6; dimers or trimers of an Fab, Fv, scFv; and dia-, tria-, or tetrabodies derived from R15E6.

[00066] In particular, an agent suitable for use in the present invention is an antibody, antibody fragment, variant or derivatives thereof, either alone or in combination with other amino acid sequences, provided by known techniques. Such techniques include, but are not limited to enzymatic cleavage, chemical cleavage, peptide synthesis or recombinant techniques. The invention further embraces derivative agents, e.g. peptibodies.

[00067] Thus, one embodiment of an HPTPβ-ECD binding agent is an antibody, another embodiment is a protein, yet another embodiment is a peptide, and another embodiment is a darpin, another embodiment is an aptamer, another embodiment is a peptibody, still another embodiment is an adnectin, another embodiment is a nucleic acid. In some embodiments the HPTPβ-ECD binding agent is an monoclonal antibody, or is a polyclonal antibody. In particular embodiments, the HPTPβ-ECD binding agent is an antibody fragment that is capable of binding to HPTPβ-ECD. Preferably the HPTPβ-ECD binding agent is an antibody, or an antibody fragment, including but not limited to, an $F(ab')_2$, an Fab, a dimer of an Fab, an Fv, a dimer of an Fv, a scFv, a dimer of a scFv, a dimer an Fab, an Fv, a dimer of an Fv, a scFv, a dimer of a scFv, a trimer of an Fab, a trimer of an Fv, a trimer of a scFv, minibodies, a diabody , a triabody, a tetrabody, a linear antibody, a protein, a peptide, an aptamer, a peptibody, an adnectin, or a nucleic acid, that binds to the extracellular portion of HPTPβ. In certain embodiments the HPTPβ-ECD binding agent is and $F(ab')_2$ of a monoclonal antibody. In some embodiments the HPTPβ-ECD binding agent comprises a plurality of HPTPβ-ECD binding sites, for example where the HPTPβ-ECD binding agent is an intact antibody or an $F(ab')_2$, or a dimer of an Fab, or

a trimer of an Fab. For example, in some embodiments an HPTPβ-ECD binding agent is able to bind to two HPTPβ molecules simultaneously at the same or different epitope, thereby bringing the two HPTPβ molecules into close proximity with one and other. In other embodiments the HPTPβ-ECD binding agent is able to bind to three HPTPβ molecules simultaneously at the same or different epitope, thereby bringing the three HPTPβ molecules into close proximity with one and other. In another embodiment, the HPTPβ-ECD binding agent is the monoclonal antibody produced by hybridoma cell line ATCC No. PTA-7680. In yet another embodiment, the HPTPβ-ECD binding agent is an antigen binding fragment of the monoclonal antibody produced by hybridoma cell line ATCC No. PTA-7680. In still another embodiment, the HPTPβ-ECD binding agent is an antibody having the same or substantially the same biological characteristics the monoclonal antibody produced by hybridoma cell line ATCC No. PTA-7680 or an antigen binding fragment thereof.

[00068] Any of the embodiments of HPTPβ-ECD binding agents disclosed in the present application, may be covalently or non-covalently conjugated to a vehicle. The term "vehicle" refers to a molecule that affects a biological property of an agent. For example, a vehicle may prevent degradation, and/or increase half-life, absorption, reduce toxicity, reduce immunogenicity, or increase biological activity of the agent. Exemplary vehicles include, but are not limited to, Fc domains of immunoglobulins; polymers, for example: polyethylene glycol (PEG), polylysine, dextran; lipids; cholesterol groups (such as a steroid); carbohydrates, dendrimers, oligosaccharides, or peptides that binds to a salvage receptor. In some embodiments the vehicle is polyethylene glycol (PEG), in other embodiments the vehicle is polylysine, in yet other embodiments the vehicle is dextran, in still other embodiments the vehicle is a lipid

[00069] Water soluble polymer attachments, such as polyethylene glycol, polyoxyethylene glycol, or polypropylene glycol, as described U.S. Pat. Nos. 4,640,835, 4,496,689, 4,301,144, 4,670,417, 4,791,192, and 4,179,337, which are incorporated herein in their entirety. Still other useful polymers known in the art include monomethoxy-polyethylene glycol, dextran, cellulose, or other carbohydrate based polymers, poly-(N-vinyl pyrrolidone)-polyethylene glycol, propylene glycol homopolymers, a polypropylene oxide/ethylene oxide co-polymer, polyoxyethylated polyols (e.g., glycerol) and polyvinyl alcohol, as well as mixtures of these polymers. Particularly preferred are peptibodies covalently modified with polyethylene glycol (PEG) subunits. Water soluble polymers may be bonded at specific positions, for example at the amino terminus of the peptibodies, or randomly attached to one or more side chains of the polypeptide. The use of PEG for improving the therapeutic capacity for agents, e.g. peptibodies, and for humanized antibodies in particular, is described in U.S. Pat. No. 6,133,426. The invention also contemplates derivatizing the peptide and/or vehicle portion of the agents. Such derivatives may improve the solubility, absorption, biological half-life, and the like of the agents. The moieties may alternatively eliminate or attenuate any undesirable side-effect of the agents and the like.

[00070] The term "antibody" (Ab) as used herein includes monoclonal antibodies, polyclonal antibodies, multi-specific antibodies (e.g. bispecific antibodies), single chain antibodies, e.g., antibodies from llama and camel, antibody fragments, e.g., variable regions and/or constant region fragments, so long as they exhibit a desired biological activity, e.g., antigen-binding activity. The term "immunoglobulin" (Ig) is used interchangeably with "antibody" herein.

[00071] An “antigen binding fragment” as used herein is a fragment of an agent that binds to a portion of HPTPβ and inhibits at least one phosphatase activity of HPTPβ.

[00072] The basic four-chain antibody unit is a heterotetrameric glycoprotein composed of two identical light (L) chains and two identical heavy (H) chains (an IgM antibody consists of 5 of the basic heterotetramer units along with an additional polypeptide called J chain, and therefore contain 10 antigen binding sites, while secreted IgA antibodies may polymerize to form polyvalent assemblages comprising 2-5 of the basic 4-chain units along with J chain). In the case of IgGs, the four-chain unit is generally about 150 kilo Daltons (kDa). Each L chain is linked to an H chain by one covalent disulfide bond, while the two H chains are linked to each other by one or more disulfide bonds depending on the H chain isotype. Each H and L chain also has regularly spaced intrachain disulfide bridges. Each H chain has at the N-terminus, a variable domain (V_H) followed by three constant domains (C_H) for each of the alpha and gamma chains and four C_H domains for mu and epsilon isotypes. Each L chain has at the N-terminus, a variable domain (V_L) followed by a constant domain (C_L) at its other end. The V_L is aligned with the V_H and the C_L is aligned with the first constant domain of the heavy chain (C_{H1}). Particular amino acid residues are believed to form an interface between the light chain and heavy chain variable domains. The pairing of a V_H and V_L together forms a single antigen-binding site. For the structure and properties of the different classes of antibodies, see, e.g., Basic and Clinical Immunology, 8th edition, Daniel P. Stites, Abba I. Terr and Tristram G. Parslow (eds.), Appleton & Lange, 1994, page 71 and Chapter 6.

[00073] The L chain from any vertebrate species may be assigned to one of two clearly distinct types, called kappa and lambda, based on the amino acid sequences of their constant domains. Depending on the amino acid sequence of the constant domain of their heavy chains (C_H), immunoglobulins may be assigned to different classes or isotypes. There are five classes of immunoglobulins: IgA, IgD, IgE, IgG and IgM, having heavy chains designated alpha, delta, epsilon, gamma and mu, respectively. The gamma and alpha classes are further divided into subclasses on the basis of relatively minor differences in C_H sequence and function, e.g., humans express the following subclasses: IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2.

[00074] Members of the Camelidae family, e.g., llama, camel, and dromedaries, contain a unique type of antibody, that are devoid of light chains, and further lack the C_{H1} domain (Muyldermans, S., Rev. Mol. Biotechnol., 74, 277-302 (2001)). The variable region of these heavy chain antibodies are termed V_{HH} or VHH, and constitute the smallest available intact antigen binding fragment (15 kDa) derived from a functional immunoglobulin.

[00075] The term "variable" refers to the fact that certain segments of the variable domains differ extensively in sequence among antibodies. The V domain mediates antigen binding and defines specificity of a particular antibody for its antigen. However, the variability is not evenly distributed across the 110-amino acid span of the variable domains. Instead, the V regions consist of relatively invariant stretches called framework regions (FR) of 15-30 amino acids separated by shorter regions of extreme variability called "hypervariable regions" that are each 9-12 amino acids long. The variable domains of native heavy and light chains each comprise four FRs, largely adopting a β-sheet configuration, connected by three hypervariable regions, which form loops connecting, and in some cases forming part of, the β-sheet structure. The hypervariable regions in each chain are held together in close proximity by the FRs and, with the hypervariable regions from the other chain, contribute to the formation of the antigen-binding site of antibodies. The constant domains are not involved directly in binding an antibody to an antigen, but exhibit various effector functions, such as participation of the antibody in antibody dependent cellular cytotoxicity (ADCC).

[00076] The term "hypervariable region" when used herein refers to the amino acid residues of an antibody which are responsible for antigen-binding. The hypervariable region generally comprises amino acid residues from a "complementarity determining region" or "CDR" (e.g. around about residues 24-34 (L1), 50-56 (L2) and 89-97 (L3) in the V_L, and around about 1-35

(H1), 50-65 (H2) and 95-102 (H3) in the V_H; Kabat et al., Sequences of Proteins of Immunological Interest, 5th Ed. Public Health Service, National Institutes of Health, Bethesda, Md. (1991)) and/or those residues from a "hypervariable loop".

[00077] The term "monoclonal antibody" as used herein refers to an antibody obtained from a population of substantially homogeneous antibodies, i.e., the individual antibodies comprising the population are identical except for possible naturally occurring mutations that may be present in minor amounts. In contrast to polyclonal antibody preparations which include different antibodies directed against different epitopes, each monoclonal antibody is directed against a single epitope, i.e., a single antigenic determinant. In addition to their specificity, the monoclonal antibodies are advantageous in that they may be synthesized uncontaminated by other antibodies. The modifier "monoclonal" is not to be construed as requiring production of the antibody by any particular method. For example, the monoclonal antibodies useful in the present invention may be prepared by the hybridoma methodology or may be made using recombinant DNA methods in bacterial, eukaryotic animal or plant cells (see, e.g., U.S. Pat. No. 4,816,567). The "monoclonal antibodies" may also be isolated from phage antibody libraries, using the available techniques, e.g., Clackson et al., Nature, Vol. 352, pp. 624-628 (1991).

[00078] The monoclonal antibodies herein include "chimeric" antibodies in which a portion of the heavy and/or light chain is identical with or homologous to corresponding sequences in antibodies derived from a particular species or belonging to a particular antibody class or subclass, while the remainder of the chain(s) is identical with or homologous to corresponding sequences in antibodies derived from another species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they exhibit the desired biological activity (see U.S. Pat. No. 4,816,567; and Morrison et al., Proc. Natl. Acad. Sci. USA, 81, 6851-6855 (1984)).

[00079] An "antibody fragment" comprises a portion of a multimeric antibody, preferably the antigen binding or variable region of the intact antibody. Examples of antibody fragments include Fab, Fab', $F(ab')_2$, dimers and trimers of Fabs, Fv, scFv, minibodies; dia-, tria-, and tetrabodies; linear antibodies (See Hudson et al., Nature Med. 9, 129-134 (2003)).

[00080] "Fv" is the minimum antibody fragment which contains a complete antigen binding site. This fragment consists of a dimer of one heavy- and one light-chain variable region domain in tight, non-covalent association. From the folding of these two domains emanate six hypervariable loops (3 loops each from the H and L chain) that contribute the amino acid residues for antigen binding and confer antigen binding specificity to the antibody. However, even a single variable domain (or half of an Fv comprising only three CDRs specific for an antigen) has the ability to recognize and bind antigen, and are therefore included in the definition of Fv.

[00081] A single-chain variable fragment (scFv) is a fusion protein of the variable regions of the heavy (V_H) and light chains (V_L) of immunoglobulins, connected with a short linker peptide of ten to about 25 amino acids. The linker is usually rich in glycine for flexibility, as well as serine or threonine for solubility, and can either connect the N-terminus of the V_H with the C-terminus of the V_L, or vice versa. This protein retains the specificity of the original immunoglobulin, despite removal of the constant regions and the introduction of the linker.

[00082] Divalent (or bivalent) single-chain variable fragments (di-scFvs, bi-scFvs) can be engineered by linking two scFvs. This can be done by producing a single peptide chain with two V_H and two V_L regions, yielding tandem scFvs. Another possibility is the creation of scFvs with linker peptides that are too short for the two variable regions to fold together (about five amino acids), forcing scFvs to dimerize. This type is known as diabodies. Diabodies have been shown to have dissociation constants up to 40-fold lower than corresponding scFvs, meaning that they have a much higher affinity to their target. Consequently, diabody drugs could be dosed much lower than other therapeutic antibodies and are capable of highly specific targeting of tumors *in vivo*. Still shorter linkers (one or two amino acids) lead to the formation of trimers, so-called triabodies or tribodies. Tetrabodies are known and have been shown to exhibit an even higher affinity to their targets than diabodies.

[00083] The term "humanized antibody" or "human antibody" refers to antibodies which comprise heavy and light chain variable region sequences from a non-human species (e.g., a mouse) but in which at least a portion of the V_H and/or V_L sequence has been altered to be more "human-like", i.e., more similar to human germline variable sequences. One type of humanized antibody is a CDR-grafted antibody, in which human CDR sequences are introduced into non-human V_H and V_L sequences to replace the corresponding nonhuman CDR sequences. Means for making chimeric, CDR-grafted and humanized antibodies are known to those of ordinary skill in the art (see, e.g., U.S. Pat. Nos. 4,816,567 and 5,225,539). One method for making human antibodies employs the use of transgenic animals, such as a transgenic mouse. These transgenic animals contain a substantial portion of the human antibody producing genome inserted into their own genome and the animal's own endogenous antibody production is rendered deficient in the production of antibodies. Methods for making such transgenic animals are known in the art. Such transgenic animals may be made using XenoMouse.RTM. technology or by using a "minilocus" approach. Methods for making XenoMice.RTM. are described in U.S. Pat. Nos. 6,162,963, 6,150,584, 6,114,598 and 6,075,181. Methods for making transgenic animals using the "minilocus" approach are described in U.S. Pat. Nos. 5,545,807, 5,545,806, 5,625,825, and WO 93/12227.

[00084] Humanization of a non-human antibody has become routine in recent years, and is now within the knowledge of one skilled in the art. Several companies provide services to make a humanized antibody, e.g., Xoma, Aries, Medarex, PDL, and Cambridge Antibody Technologies. Humanization protocols are extensively described in technical literature, e.g., Kipriyanov and Le Gall, Molecular Biotechnol., Vol. 26, pp. 39-60 (2004), Humana Press, Totowa, N.J.; Lo, Methods Mol. Biol., Vol. 248, pp. 135-159 (2004), Humana Press, Totowa, N.J.; Wu et al., J. Mol. Biol., 294, pp. 151-162 (1999).

[00085] In certain embodiments, antibodies useful in the present invention may be expressed in cell lines other than hybridoma cell lines. Sequences encoding particular antibodies may be used for transformation of a suitable mammalian host cell by known methods for introducing polynucleotides into a host cell, including, for example packaging the polynucleotide in a virus (or into a viral vector) and transducing a host cell with the virus (or vector), or by transfection procedures known in the art, as exemplified by U.S. Pat. Nos. 4,399,216, 4,912,040, 4,740,461 and 4,959,455. The transformation procedure used may depend upon the host to be transformed. Methods for introduction of heterologous polynucleotides into mammalian cells are known in the art and include; but are not limited to, dextran-mediated transfection, calcium phosphate precipitation, polybrene mediated transfection, protoplast fusion, electroporation, encapsulation of the polynucleotide(s) in liposomes, mixing nucleic acid with positively-charged lipids, and direct microinjection of the DNA into nuclei.

[00086] A nucleic acid molecule encoding the amino acid sequence of a heavy chain constant region, a heavy chain variable region, a light chain constant region, or a light chain variable region of an antibody, or a fragment thereof in a suitable combination if desired, is/are inserted into an appropriate expression vector using standard ligation techniques. The antibody heavy chain or light chain constant region may be appended to the C-terminus of the appropriate variable region and is ligated into an expression vector. The vector is typically selected to be functional in the particular host cell employed (i.e., the vector is compatible with the host cell machinery such that amplification of the gene and/or expression of the gene may occur). For a review of expression vectors, see Methods Enzymol. Vol. 185 (Goeddel, ed.), 1990, Academic Press.

Identification of specific binding agents

[00087] Suitable selective binding agents may be identified using a variety of techniques known in the art. For example candidate agents can be screened for binding to HPTPβ, and screened for activity. Generally the candidate agents will first be screened for binding and those that show selective binding will then be screened to determine ability to inhibit the HPTPβ-mediated dephosphorylation of Tie2. In some cases however the candidate agents may be first screened *in vitro* for activity.

Determination of binding activity

[00088] The selection of a suitable assay for use in identification of a specific binding agent depends on the nature of the candidate agent to be screened. One of skill in the art would be able to choose the appropriate assays for the particular candidate agent.

[00089] For example, where the candidates are antibodies or peptibodies which comprises an Fc moiety, FACS analysis as described in Example 3 B allows the candidate agent to be selected based on its ability to bind to cells which express HPTPβ. The cell may endogenously express HPTPβ or may be genetically engineered to express HPTPβ.

[00090] For other candidate agents such as aptamers, other techniques are known in the art. For example, aptamers which specifically bind to HPTPβ can be selected using a technique known as SELEX (systematic evolution of ligands by exponential enrichment) which selects specific aptamers through repeated rounds of *in vitro* selection.

Determination of inhibitor activity by Western blot

[00091] As exemplified in Example 4, in one suitable assay HUVECs are cultured in serum-free media in the presence or absence of various concentrations of candidate agent and lysates of the cells are prepared, immunoprecipitated with a Tie2 antibody, resolved by polyacrylamide gel electrophoresis and transferred to a PVDF membrane. Membrane-bound immunoprecipitated proteins are then serially western blotted with an antiphosphotyrosine antibody to quantify Tie2 phosphorylation followed by a Tie2 antibody to quantify total Tie2. Tie2 phosphorylation is expressed as the ratio of the anti-phosphotyrosine signal over the total Tie2 signal. Greater levels of the anti-phosphotyrosine signal indicate greater HPTPβ inhibition by the candidate agent.

[00092] Candidate agents that can be screened include, but are not limited to, libraries of known agents, including natural products, such as plant or animal extracts, biologically active molecules including proteins, peptides including but not limited to members of random peptide libraries and combinatorial chemistry derived molecular library made of D- or L-configuration amino acids, antibodies including, but not limited to, polyclonal, monoclonal, chimeric, human, single chain antibodies, Fab, $F(ab)_2$ and Fab expression library fragments and eptiope-binding fragments thereof).

[00093] As used herein "antibody fragments" include, but are not limited, to an $F(ab')_2$, a dimer or trimer of an Fab, Fv, scFv, or a dia-, tria-, or tetrabody derived from an antibody.

[00094] Throughout this application, various publications are referenced. The disclosures of these publications in their entireties are hereby incorporated by reference into this application in order to more fully describe the state of the art.

[00095] The vascular endothelium lines the inside of all blood vessels, forming a non-thrombogenic surface that controls the entry and exit of plasma and white blood cells to and from the bloodstream. The quiescent endothelium has turnover rates of months to years, and proliferates only following angiogenic activation. The loss of endothelial quiescence is a common feature of conditions such as inflammation, atherosclerosis, restenosis, angiogenesis and various types of vasculopathies.

[00096] Vasculogenesis and angiogenesis are down-regulated in the healthy adult and are, except for the organs of the female reproductive system, almost exclusively associated with pathology when angiogenesis is induced by microenvironmental factors such as hypoxia or inflammation. These pathological processes associated with, or induced by, angiogenesis include diseases as diverse as cancer, psoriasis, macular degeneration, diabetic retinopathy, thrombosis, and inflammatory disorders including arthritis and atherosclerosis. However, in certain instances insufficient angiogenesis can lead to diseaeses such as ischemic heart disease and pre-eclampsia.

[00097] The quiescent vascular endothelium forms a tight barrier that controls the passage of plasma and cells from the bloodstream to the underlying tissues. Endothellial cells adhere to each other through junctional transmembrane proteins that are linked to specific intracelllar structural and signaling complexes. The endothelial layer can undergo a transition from the resting state to the active state wherein activation of the endothelium results in the expression of adhesion molecules. This endothelium activation is a prerequisite for initiating angiogensesis, inflammation and inflammation associated diseases.

[00098] Tie-2, a receptor-like tyrosine kinase exclusively expressed in endothelial cells that controls endothelial differentiation. Tie-2 binds and is activated by the stimulatory ligand angiopoeitin-1 (Ang-1) which promotes autophosphorylation of the Tie-2 receptor leading to a cascade of events that results in stabilization of vascular structures by promoting endothelial cell viability and preventing basement membrane dissolution. As such, Tie-2 activation is a method for attenuating leaking vasculature by maintaining a quiescent, intact vascular endothelium. Tie-2 activation is inhibited by Ang-2, which exhibits Ang-1 antagonism by competitively binding to Tie-2 and thus blocking phosphorylation of Tie-2. Elevated levels of Ang-2 have been found to be associated with inflammatory diseases, *inter alia*, sepsis, lupus, inflammatory bowel disease and metastatic diseases such as cancer.

[00099] During periods of high Ang-2 levels, fissures or breaks in the endothelium form which results in vascular leak syndrome. Vascular leak syndrome results in life-threatening effects such as tissue and pulmonary edema. For many disease states elevated Ang-2 levels are clear markers that a disease state or condition exists. Once a disease state has been resolved, the Ang-1/Ang-2 balance returns and the vascular endothelium is stabilized. In conditions wherein the normal balance between Ang-1 and Ang-2 has been disrupted, the disclosed agents have been found to amplify Tie-2 signaling by inhibiting dephosphorylation of phosphorylated Tie-2 via inhibition of Human Protein Tyrosine Phosphatase-β (HPTP-β). In addition, the disclosed agents can be used in varying amounts to increase the Tie-2 signaling in a very controlled manner, and to therefore titrate the level of Tie-2 amplification.

[000100] The present disclosure provides methods for treating a patient having vascular leak syndrome comprising administering to the patient a composition comprising effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. The compositions of the present disclosure may also comprise one or more pharmaceutically acceptable excipients.

[000101] Disclosed herein, are compositions comprising an HPTPβ-ECD binding agent wherein the compositions are useful for treatment of the disclosed conditions, illness, injuries, courses of treatment, cellular treatments and the like.

[000102] In one embodiment, the method comprises treating vascular leak in a patient wherein the patient suffers from an inflammatory disease or condition which comprises administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Another embodiment is a method of treating a patient suffering from a physical trauma comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. In a particular embodiment the trauma is surgical trauma. In one embodiment the method is a method of treating a patient suffering from shock comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent.

[000103] Particular embodiments include post-hemorrhagic shock, or post-traumatic shock or septic shock. The present disclosure also provides for a method of treating a patient suffering from adult respiratory distress syndrome by administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Another embodiment is a method of treating a patient with an acute lung injury comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Cancer metastasis and bacterial and viral infections are covered below.

[000104] In some embodiments an HPTPβ-ECD binding agent is administered prophylactically to stabilize the patient's vasculature prior to an event that places the patient at risk for vascular leak. In one embodiment the HPTPβ-ECD binding agent is administered prophylactically to stabilize the patient's vasculature prior to surgery. Still another embodiment is a method of preventing vascular leak syndrome in a patient wherein an effective amount of an HPTPβ-ECD binding agent is administered to the patient prior to undergoing chemotherapy. Another embodiment is a method of treating a patient at risk of shock comprising administering to the patient an effective amount of an HPTPβ-ECD binding agent.

[000105] The disclosed HPTPβ-ECD binding agents can be used to prevent, abate, minimize, control, and/or lessen tumor metastasis in humans and animals. The disclosed HPTPβ-ECD binding agents can also be used to slow the rate of primary tumor growth. As such, the agents disclosed herein can be administered as part of a combination therapy with one or more drugs or other pharmaceutical agents. When used as part of the combination therapy, the decrease in metastasis and reduction in primary tumor growth afforded by the disclosed agents allows for a more effective and efficient use of any pharmaceutical or drug therapy being used to treat the patient. In addition, control of metastasis by the disclosed agent affords the subject a greater ability to concentrate the disease in one location.

[000106] Thus, one embodiment of the present disclosure is a method of treating cancer in a patient comprising administering a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. Another embodiment is a method of preventing metastasis in a patient suffering from cancer comprising administering a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. Yet another embodiment is a method of minimizing tumor metastasis in a patient suffering from cancer comprising administering a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. Disclosed herein are methods for preventing metastasis of malignant tumors or to reduce the rate of tumor growth. Thus, another embodiment is a method of treating a patient diagnosed with a malignant tumor comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. Another embodiment is a method of preventing metastasis in a patient diagnosed with a malignant tumor comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof. Yet another embodiment is a method of reducing the rate of tumor growth in a patient diagnosed with a tumor comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

[000107] The following are non-limiting examples of cancers that can be treated by the disclosed methods and compositions: leukemia, for example, chronic myelogenous leukemia; acute lymphoblastic leukemia, acute childhood myeloid leukemia; adult acute myeloid leukemia, hairy cell leukemia; lymphoma, for example, Burkitt's lymphoma, Hodgkin's lymphoma, non-Hodgkin's lymphoma, cutaneous t-cell lymphoma, central nervous system lymphoma; astrocytomas, for example, cerebellar astrocytoma, childhood astrocytoma, pilocytic astrocytoma, diffuse astrocytoma, anaplastic astrocytoma, gliomas, oligodendroglioma, cerebral astrocytoma visual pathway glioma and hypothalamic glioma, brain stem glioma, visual pathway, hypothalamic glioma, cerebral astrocytoma/malignant glioma; carcinoma, for example, thymoma carcinoma, thymic carcinoma, squamous cell carcinoma, skin carcinoma, Merkel cell carcinoma, adrenocortical carcinoma, adrenocortical carcinoma, basal cell carcinoma; sarcoma, for example, rhabdomyosarcoma sarcoma, Ewing sarcoma, Kaposi sarcoma, soft tissue sarcoma, uterine sarcoma, osteosarcoma, malignant fibrous histiocytoma of the bone; appendix cancer; extrahepatic bile duct cancer; bladder cancer; bone cancer; salivary gland cancer; brain tumor; childhood central nervous system atypical teratoid/rhabdoid tumor; central nervous system embryonal tumors; craniopharyngioma; ependymoblastoma; ependymoma; medulloblastoma; medulloepithelioma; pineal parenchymal tumors of intermediate differentiation; supratentorial primitive neuroectodermal tumors and pineoblastoma; brain and spinal cord tumors; breast cancer; bronchial tumors; carcinoid tumor; gastrointestinal carcinoid tumor; central nervous system embryonal tumors; cervical cancer; chordoma, childhood; chronic myeloproliferative disorders; colon cancer; colorectal cancer; craniopharyngioma; extragonadal germ cell tumor; testicular germ cell tumor; retinoblastoma; gallbladder cancer; gastric (stomach) cancer; gastrointestinal carcinoid tumor; gastrointestinal stromal tumor (gist); extracranial germ cell tumor; gestational trophoblastic tumor; glioblastoma; head and neck cancer; hepatocellular (liver) cancer; Langerhans cell histiocytosis; hypopharyngeal cancer; islet cell tumors; kidney (renal cell) cancer; laryngeal cancer; lip and oral cavity cancer; liver cancer; non-small cell lung cancer; small-cell lung cancer; mesothelioma; metastatic squamous neck cancer with occult primary; mouth cancer; childhood multiple endocrine neoplasia syndrome; multiple myeloma/plasma cell neoplasm; mycosis fungoides; myelodysplastic syndromes; multiple myeloma; myeloproliferative disorders, chronic; nasal cavity and paranasal sinus cancer; neuroblastoma; oral cancer; oropharyngeal cancer; ovarian cancer, for example, ovarian epithelial cancer, ovarian germ cell tumor, ovarian low malignant potential tumor; pancreatic cancer; islet cell tumors; papillomatosis; thyroid cancer; parathyroid cancer; penile cancer; esophageal cancer; pharyngeal cancer; nasopharyngeal cancer; pheochromocytoma; pineal parenchymal tumors; pituitary tumor; plasma cell neoplasm/multiple myeloma; pleuropulmonary blastoma; prostate cancer; rectal cancer; renal cell (kidney) cancer; renal pelvis and ureter cancer; Sézary syndrome; skin cancer (nonmelanoma); skin cancer (melanoma); intraocular melanoma; malignant melanoma, small intestine cancer; metastatic squamous neck cancer; stomach (gastric) cancer; testicular cancer; throat cancer; transitional cell cancer of the renal pelvis and ureter; gestational trophoblastic tumor; urethral cancer; uterine cancer, endometrial; vaginal cancer; vulvar cancer; Waldenström macroglobulinemia; and Wilms tumor.

[000108] The HPTPβ-ECD binding agents can be administered in combination with one or more chemotherapeutic agent.

[000109] A "chemotherapeutic agent" or "chemotherapeutic compound" is a chemical compound useful in the treatment of cancer. Chemotherapeutic cancer agents that can be used in combination with an HPTPβ-ECD binding agent disclosed herein, include but are not limited to, mitotic inhibitors (vinca alkaloids). These include vincristine, vinblastine, vindesine and Navelbine™ (vinorelbine-5'-noranhydroblastine). In yet other embodiments, chemotherapeutic cancer agents include topoisomerase I inhibitors, such as camptothecin compounds. As used herein, "camptothecin compounds" include Camptosar™ (irinotecan HCL), Hycamtin™ (topotecan HCL) and other compounds derived from camptothecin and its analogues. Another category of chemotherapeutic cancer agents that may be used in the methods and compositions of the present disclosure are podophyllotoxin derivatives, such as etoposide, teniposide and mitopodozide. The present disclosure further encompasses other chemotherapeutic cancer agents known as alkylating agents, which alkylate the genetic material in tumor cells. These include without limitation cisplatin, cyclophosphamide, nitrogen mustard, trimethylene thiophosphoramide, carmustine, busulfan, chlorambucil, belustine, uracil mustard, chlomaphazin and dacarbazine. The present disclosure encompasses antimetabolites as chemotherapeutic agents. Examples of these types of agents include cytosine arabinoside, fluorouracil, methotrexate, mercaptopurine, azathioprime and procarbazine. An additional category of chemotherapeutic cancer agents that may be used in the methods and compositions of the present disclosure include antibiotics. Examples include without limitation doxorubicin, bleomycin, dactinomycin, daunorubicin, mithramycin, mitomycin, mytomycin C and daunomycin. There are numerous liposomal formulations commercially available for these compounds. The present disclosure further encompasses other chemotherapeutic cancer agents including without limitation anti-tumor antibodies, dacarbazine, azacytidine, amsacrine, melphalan, VM-26, ifosfamide, taxol and its derivatives, L-asparaginase, mitoxantrone, IF-2, gemcitabine, erlotinib, doxil, irinortecan and bevacizumab.

[000110] Other anti-cancer agents that can be used in combination with the disclosed HPTPβ-ECD binding agent include, but are not limited to: acivicin, aclarubicin, acodazole hydrochloride, acronine, adozelesin, aldesleukin, altretamine, ambomycin, ametantrone acetate, aminoglutethimide, anastrozole, anthramycin, asperlin, azacitidine, azetepa, azotomycin, batimastat, benzodepa, bicalutamide, bisantrene hydrochloride, bisnafide dimesylate, bizelesin, bleomycin sulfate, brequinar sodium, bropirimine, cactinomycin, calusterone, caracemide, carbetimer, carboplatin, carubicin hydrochloride, carzelesin, cedefingol, cirolemycin, cladribine, crisnatol mesylate, cytarabine, daunorubicin hydrochloride, decitabine, dexormaplatin, dezaguanine, dezaguanine mesylate, diaziquone, docetaxel, doxorubicin hydrochloride, droloxifene, droloxifene citrate, dromostanolone propionate, duazomycin, edatrexate, eflornithine hydrochloride, elsamitrucin, enloplatin, enpromate, epipropidine, epirubicin hydrochloride, erbulozole, esorubicin hydrochloride, estramustine, estramustine phosphate sodium, etanidazole, etoposide phosphate, etoprine, fadrozole hydrochloride, fazarabine, fenretinide, floxuridine, fludarabine phosphate, flurocitabine, fosquidone, fostriecin sodium, gemcitabine hydrochloride, hydroxyurea, idarubicin hydrochloride, ilmofosine, interleukin 2 (including recombinant interleukin 2, or rIL2), interferon alfa-2a, interferon alfa-2b, interferon alfa-n1, interferon alfa-n3, interferon beta-1a, interferon gamma-1b, iproplatin, irinotecan hydrochloride, lanreotide acetate, letrozole, leuprolide acetate, liarozole hydrochloride, lometrexol sodium, lomustine, losoxantrone hydrochloride, masoprocol, maytansine, mechlorethamine hydrochloride, megestrol acetate, melengestrol acetate, menogaril, methotrexate sodium, metoprine, meturedepa, mitindomide, mitocarcin, mitocromin, mitogillin, mitomalcin, mitosper, mitotane, mitoxantrone hydrochloride, mycophenolic acid, nocodazole, nogalamycin, ormaplatin, oxisuran, paclitaxel, pegaspargase, peliomycin, pentamustine, peplomycin sulfate, perfosfamide, pipobroman, piposulfan, piroxantrone hydrochloride, plicamycin, plomestane, porfimer sodium, porfiromycin, prednimustine, procarbazine hydrochloride, puromycin, puromycin hydrochloride, pyrazofurin, riboprine, rogletimide, safingol, safingol hydrochloride, semustine, simtrazene, sparfosate sodium, sparsomycin, spirogermanium hydrochloride, spiromustine, spiroplatin, streptonigrin, streptozocin, sulofenur, talisomycin, tecogalan sodium, tegafur, teloxantrone hydrochloride, temoporfin, teroxirone, testolactone, thiamiprine, thioguanine, thiotepa, tiazofurin, tirapazamine, toremifene citrate, trestolone acetate, triciribine phosphate, trimetrexate, trimetrexate glucuronate, triptorelin, tubulozole hydrochloride, uredepa, vapreotide, verteporfin, vinblastine sulfate, vincristine sulfate, vindesine sulfate, vinepidine sulfate, vinglycinate sulfate, vinleurosine sulfate, vinorelbine tartrate, vinrosidine sulfate, vinzolidine sulfate, vorozole, zeniplatin, zinostatin, zorubicin hydrochloride. Other anti-cancer drugs include, but are not limited to: 20-epi-1,25 dihydroxyvitamin D3, 5-ethynyluracil, abiraterone, aclarubicin, acylfulvene, adecypenol, adozelesin, aldesleukin, ALL-TK antagonists, altretamine, ambamustine, amidox, amifostine, aminolevulinic acid, amrubicin, amsacrine, anagrelide, anastrozole, andrographolide, angiogenesis inhibitors, antagonist D, antagonist G, antarelix, anti-dorsalizing morphogenetic protein-1, antiandrogen, prostatic carcinoma, antiestrogen, antineoplaston, aphidicolin glycinate, apoptosis gene modulators, apoptosis regulators, apurinic acid, ara-CDP-DL-PTBA, arginine deaminase, asulacrine, atamestane, atrimustine, axinastatin 1, axinastatin 2, axinastatin 3, azasetron, azatoxin, azatyrosine, baccatin III derivatives, balanol, batimastat, BCR/ABL antagonists, benzochlorins, benzoylstaurosporine, beta lactam derivatives, beta-alethine, betaclamycin B, betulinic acid, bFGF inhibitor, bicalutamide, bisantrene, bisaziridinylspermine, bisnafide, bistratene A, bizelesin, breflate, bropirimine, budotitane, buthionine sulfoximine, calcipotriol, calphostin C, canarypox IL-2, capecitabine, carboxamide-amino-triazole, carboxyamidotriazole, CaRest M3, CARN 700, cartilage derived inhibitor, carzelesin, casein kinase inhibitors (ICOS), castanospermine, cecropin B, cetrorelix, chlorlns, chloroquinoxaline sulfonamide, cicaprost, cis-porphyrin, cladribine, clomifene analogues, clotrimazole, collismycin A, collismycin B, combretastatin A4, combretastatin analogue, conagenin, crambescidin 816, crisnatol, cryptophycin 8, cryptophycin A derivatives, curacin A, cyclopentanthraquinones, cycloplatam, cypemycin, cytarabine ocfosfate, cytolytic factor, cytostatin, dacliximab, decitabine, dehydrodidemnin B, deslorelin, dexamethasone, dexifosfamide, dexrazoxane, dexverapamil, diaziquone, didemnin B, didox, diethylnorspermine, dihydro-5-azacytidine, dihydrotaxol, 9-, dioxamycin, diphenyl spiromustine, docetaxel, docosanol, dolasetron, doxifluridine, droloxifene, dronabinol, duocarmycin SA, ebselen, ecomustine, edelfosine, edrecolomab, eflornithine, elemene, emitefur, epirubicin, epristeride, estramustine analogue, estrogen agonists, estrogen antagonists, etanidazole, etoposide phosphate, exemestane, fadrozole, fazarabine, fenretinide, filgrastim, finasteride, flavopiridol, flezelastine, fluasterone, fludarabine, fluorodaunorunicin hydrochloride, forfenimex, formestane, fostriecin, fotemustine, gadolinium texaphyrin, gallium nitrate, galocitabine, ganirelix, gelatinase inhibitors, gemcitabine, glutathione inhibitors, hepsulfam, heregulin, hexamethylene bisacetamide, hypericin, ibandronic acid, idarubicin, idoxifene, idramantone, ilmofosine, ilomastat, imidazoacridones, imiquimod, immunostimulant peptides, insulin-like growth factor-1 receptor inhibitor, interferon agonists, iobenguane, iododoxorubicin, ipomeanol, 4-, iroplact, irsogladine, isobengazole, isohomohalicondrin B, itasetron, jasplakinolide, kahalalide F, lamellarin-N triacetate, lanreotide, leinamycin, lenograstim, lentinan sulfate, leptolstatin, letrozole, leukemia inhibiting factor, leukocyte alpha interferon, leuprolide+estrogen+progesterone, leuprorelin, levamisole, liarozole, linear polyamine analogue, lipophilic disaccharide peptide, lipophilic platinum compounds, lissoclinamide 7, lobaplatin, lombricine, lometrexol, lonidamine, losoxantrone, lovastatin, loxoribine, lurtotecan, lutetium texaphyrin, lysofylline, lytic peptides, maitansine, mannostatin A, marimastat, masoprocol, maspin, matrilysin inhibitors, matrix metalloproteinase inhibitors, menogaril, merbarone, meterelin, methioninase, metoclopramide, MIF inhibitor, mifepristone, miltefosine, mirimostim, mismatched double stranded RNA, mitoguazone, mitolactol, mitomycin analogues, mitonafide, mitotoxin fibroblast growth factor-saporin, mofarotene, molgramostim, monoclonal antibody, human chorionic gonadotrophin, monophosphoryl lipid A+myobacterium cell wall sk, mopidamol, multiple drug resistance gene inhibitor, multiple tumor suppressor 1-based therapy, mustard anticancer agent, mycaperoxide B, mycobacterial cell wall extract, myriaporone, N-acetyldinaline, N-substituted benzamides, nafarelin, nagrestip, naloxone+pentazocine, napavin, naphterpin, nartograstim, nedaplatin, nemorubicin, neridronic acid, neutral endopeptidase, nilutamide, nisamycin, nitric oxide modulators, nitroxide antioxidant, nitrullyn, O6-benzylguanine, octreotide, okicenone, oligonucleotides, onapristone, ondansetron, ondansetron, oracin, oral cytokine inducer, ormaplatin, osaterone, oxaliplatin, oxaunomycin, paclitaxel, paclitaxel analogues, paclitaxel derivatives, palauamine, palmitoylrhizoxin, pamidronic acid, panaxytriol, panomifene, parabactin, pazelliptine, pegaspargase, peldesine, pentosan polysulfate sodium, pentostatin, pentrozole, perflubron, perfosfamide, perillyl alcohol, phenazinomycin, phenylacetate, phosphatase inhibitors, picibanil, pilocarpine hydrochloride, pirarubicin, piritrexim, placetin A, placetin B, plasminogen activator inhibitor, platinum complex, platinum compounds, platinum-triamine complex, porfimer sodium, porfiromycin, prednisone, propyl bis-acridone, prostaglandin J2, proteasome inhibitors, protein A-based immune modulator, protein kinase C inhibitor, protein kinase C inhibitors, microalgal, protein tyrosine phosphatase inhibitors, purine nucleoside phosphorylase inhibitors, purpurins, pyrazoloacridine, pyridoxylated hemoglobin polyoxyethylene conjugate, raf antagonists, raltitrexed, ramosetron, ras farnesyl protein transferase inhibitors, ras inhibitors, ras-GAP inhibitor, retelliptine demethylated, rhenium Re 186 etidronate, rhizoxin, ribozymes, RII retinamide, rogletimide, rohitukine, romurtide, roquinimex, rubiginone B1, ruboxyl, safingol, saintopin, SarCNU, sarcophytol A, sargramostim, Sdi 1 mimetics, semustine, senescence derived inhibitor 1, sense oligonucleotides, signal transduction inhibitors, signal transduction modulators, single chain antigen binding protein, sizofiran, sobuzoxane, sodium borocaptate, sodium phenylacetate, solverol, somatomedin binding protein, sonermin, sparfosic acid, spicamycin D, spiromustine, splenopentin, spongistatin 1, squalamine, stem cell inhibitor, stem-cell division inhibitors, stipiamide, stromelysin inhibitors, sulfinosine, superactive vasoactive intestinal peptide antagonist, suradista, suramin, swainsonine, synthetic glycosaminoglycans, tallimustine, tamoxifen methiodide, tauromustine, tazarotene, tecogalan sodium, tegafur, tellurapyrylium, telomerase inhibitors, temoporfin, temozolomide, tetrachlorodecaoxide, tetrazomine, thaliblastine, thiocoraline, thrombopoietin, thrombopoietin mimetic, thymalfasin, thymopoietin receptor agonist, thymotrinan, thyroid stimulating hormone, tin ethyl etiopurpurin, tirapazamine, titanocene bichloride, topsentin, toremifene, totipotent stem cell factor, translation inhibitors, tretinoin, triacetyluridine, triciribine, trimetrexate, triptorelin, tropisetron, turosteride, tyrosine kinase inhibitors, tyrphostins, UBC inhibitors, ubenimex, urogenital sinus-derived growth inhibitory factor, urokinase receptor antagonists, vapreotide, variolin B, vector system, erythrocyte gene therapy, velaresol, veramine, verdins, verteporfin, vinxaltine, vitaxin, vorozole, zanoterone, zeniplatin, zilascorb, and zinostatin stimalamer. In one embodiment, the anti-cancer drug is 5-fluorouracil or leucovorin.

[000111] Anti-angiogenic agents are also useful in the treatment of cancer. Anti-angiogenic agents are well known to those of skill in the art. Suitable anti-angiogenic agents for use in the methods and compositions of the present disclosure include anti-VEGF antibodies, including humanized and chimeric antibodies, anti-VEGF aptamers and antisense oligonucleotides. Other known inhibitors of angiogenesis include angiostatin, endostatin, interferons, interleukin 1 (including α and β) interleukin 12, retinoic acid, and tissue inhibitors of metalloproteinase-1 and metalloproteinase-2. (TIMP-1 and -2). Small molecules, including topoisomerases such as razoxane, a topoisomerase II inhibitor with anti-angiogenic activity, can also be used.

[000112] One embodiment of the disclosure is a method for treating a patient diagnosed with a carcinoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for treating a patient diagnosed with a carcinoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of a chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and chemotherapeutic agent are administered together or in any order.

[000113] One embodiment of the disclosure is a method for preventing or reducing metastasis in a patient diagnosed with a carcinoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with a carcinoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of a chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and chemotherapeutic agent are administered together or in any order.

[000114] In yet another embodiment of the disclosure is a method for treating a patient diagnosed with a sarcoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for treating a patient diagnosed with a sarcoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of a chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and the chemotherapeutic agent are administered together or in any order.

[000115] Yet another embodiment of the disclosure is a method for preventing or reducing metastasis in a patient diagnosed with a sarcoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with a sarcoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agent are administered together or in any order.

[000116] Yet another embodiment of the disclosure is a method for treating a patient diagnosed with pancreatic cancer, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Still another embodiment is a method for treating a patient diagnosed with pancreatic cancer, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agents, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agents are administered together or in any order.

[000117] Yet another embodiment of the disclosure is a method for preventing or reducing metastasis in a patient diagnosed with pancreatic cancer, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Still another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with pancreatic cancer, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agents are administered together or in any order.

[000118] In some embodiments the chemotherapeutic agent used in the treatment of pancreatic cancer is gemcitabine, or 5-flourouracil, or cisplatin or capecitabine, or oxaliplatin, or mitomycin, or any combination thereof.

[000119] Still another embodiment is a method for treating a patient diagnosed with malignant melanoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for treating a patient diagnosed with metastatic melanoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agents are administered together or in any order.

[000120] Still another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with malignant melanoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with metastatic melanoma, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agents are administered together or in any order.

[000121] In some embodiments the chemotherapeutic agent is used to treat melanoma is cisplatin, or vinblastine, or dacarbazine, or any combination thereof.

[000122] Still another embodiment is a method for treating a patient diagnosed with breast cancer comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for treating a patient diagnosed with breast cancer comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agents are administered together or in any order. Yet another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with breast cancer comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Yet another embodiment is a method for preventing or reducing metastasis in a patient diagnosed with breast cancer comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more chemotherapeutic agent, wherein the HPTPβ-ECD binding agent and one or more chemotherapeutic agent are administered together or in any order. In some embodiments the chemotherapeutic agent is used in the treatment of breast cancer is taxol or an analog of taxol.

[000123] In particular embodiments the HPTPβ-ECD binding agent is administered in combination with IL-2.

IL-2 Induced Vascular Leak: Treatment of Metastatic Cancers

[000124] Immunotherapy is one method of treating cancer. Up-regulation of the body's own immune system is one aspect of immunotherapy. Among the many immune system signaling molecules is interleukin-2 (IL-2) which is instrumental in the body's natural response to microbial infection and in discriminating between foreign (non-self) and self. High-dose interleukin-2 is an FDA approved treatment for patients with metastatic renal cell carcinoma and metastatic melanoma. Although it has been reported that only 23% of those subjects given this therapy show a tumor response, the duration of this response can exceed 10 years (Elias L. et al., "A literature analysis of prognostic factors for response and quality of response of patients with renal cell carcinoma to interleukin-2-based therapy." Oncology, (2001), Vol. 61, pp. 91-101). As such, IL-2 therapy is the only available treatment that offers the potential for cure.

[000125] Gallagher (Gallagher, D.C. et al., "Angiopoietin 2 Is a Potential Mediator of High-Dose Interleukin 2-Induced Vascular Leak" Clin. Cancer Res., (2007), Vol. 13, No. 7, pp. 2115-2120) reports that elevated levels of angiopoietin-2 are found in patients treated with high doses of IL-2 and suggests that overcoming Ang-2 blockade of Tie-2 signaling might be curative for vascular leak syndrome which is a side effect of this therapy.

[000126] IL-2 is known to cause endothelial cell activation, however, with loss of proper barrier function. Amplification of Tie-2 signaling during high dose IL-2 immunotherapy would lead to attenuation of vascular leakage since Tie-2 stimulation promotes endothelial cell stability.

As such, by administering an agent that can amplify Tie-2 signaling, vascular stability can be increased and, hence, the side effects of high IL-2 dosing mitigated. The disclosed HPTPβ-ECD binding agents can amplify Tie-2 signaling under the conditions of low angiopoietin-1 concentrations or when high concentrations of angiopoietin-2 are present as in IL-2 treated patients.

[000127] By amplifying Tie-2 signaling without affecting Ang-2 levels, the use of elevated levels of Ang-2 as a potential pathology marker is retained. For example, a patient suffering from an inflammatory disease such as sepsis will normally have an elevated Ang-2 level that acts to suppress Ang-1 stimulation of Tie-2. This elevated Ang-2 results in edema which is a symptom of vascular leakage. The present methods, by amplifying Tie-2 signaling without affecting the Ang-2 level, provide a method for alleviating the symptoms that are associated with vascular leak while retaining the ability to use Ang-2 levels as a measure of disease progress and resolution.

[000128] As many as 65% of patients receiving this IL-2 therapy will necessarily interrupt or discontinue treatment due to VLS. The major dose-limiting toxicity of interleukin-2 (IL-2) and of immunotoxin (IT) therapies is vascular leak syndrome (VLS). VLS is characterized by an increase in vascular permeability accompanied by extravasation of fluids and proteins resulting in interstitial edema and organ failure. Manifestations of VLS include fluid retention, hypotension, increase in body weight, peripheral edema, pulmonary edema, pleural and pericardial effusions, ascites, anasarca and, in severe form, signs of pulmonary and cardiovascular failure.

[000129] The disclosed HPTPβ-ECD binding agents can be used as an effective therapy to reduce vascular leak caused by treatment with IL-2. Therefore an embodiment of the present invention is a method of treating, reducing or preventing vascular leak in a patient being administered IL-2 wherein the method comprises administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. The HPTPβ-ECD binding agent can be co-administered with IL-2 or administered separately. The IL-2 and the HPTPβ-ECD binding agent may be administered in any order and by any method, for example, intravenously, orally, by patch, subcutaneous injection and the like.

[000130] One embodiment of the present disclosure is a method for treating renal cell carcinoma comprising administering to a patient a composition comprising: a) an effective amount of interleukin-2 such that an immune response is provided; and b) an effective amount of an HPTPβ-ECD binding agent; wherein the interleukin-2 and the HPTPβ-ECD binding agent can be administered together or in any order. Another embodiment disclosed herein is a method for treating renal cell carcinoma comprising administering to a patient a composition comprising: a) a high dose of interleukin-2; and b) an effective amount of an HPTPβ-ECD binding agent.

[000131] Further disclosed is a method for treating metastatic melanoma comprising administering to a patient a series of compositions, wherein the compositions can be administered in any order and at any effective amount, a first composition comprising, a high dose of interleukin-2 and the second composition comprising an effective amount of an HPTPβ-ECD binding agent.

[000132] Still further disclosed is a method for treating renal cell carcinoma comprising administering to a patient a series of compositions, wherein the compositions can be administered in any order and at any effective amount, a first composition comprising a high dose of interleukin-2 and the second composition comprising an effective amount of an HPTPβ-ECD binding agent.

[000133] Disclosed herein is a method for treating metastatic melanoma by administering to a patient in need of treatment a therapy that comprises: a) an effective amount of interleukin-2 such that an immune response is provided; and b) an effective amount of an HPTPβ-ECD binding agent; wherein the interleukin-2 and the HPTPβ-ECD binding agent can be administered together or in any order.

[000134] Also disclosed herein is a method for treating metastatic melanoma by administering to a patient in need of treatment a therapy that comprises: a) an effective amount of interleukin-2 such that an immune response is provided; and b) an effective amount of an HPTPβ-ECD binding agent; wherein the interleukin-2 and the HPTPβ-ECD binding agent can be administered together or in any order.

[000135] Disclosed herein are compositions which can be used to treat patients with cancer, wherein the patient having cancer is treated with one or more cancer agents that induce vascular leak syndrome in the patient. As such, disclosed herein are compositions effective in reducing vascular leak resulting from a cancer treatment, the compositions comprising an effective amount of an HPTPβ-ECD binding agent.

[000136] Another aspect disclosed herein are compositions effective for treating humans or other mammals having a medical condition or disease state wherein the treatment for the medical condition or disease state induces vascular leak syndrome, the composition comprising: a) an effective amount of an HPTPβ-ECD binding agent; and b) one or more pharmaceutical drugs; wherein at least one of the pharmaceutical drugs induces vascular leak syndrome.

[000137] In a further aspect, disclosed herein are compositions comprising: a) an effective amount of an HPTPβ-ECD binding agent; and b) one or more chemotherapeutic agent.

[000138] Also disclosed herein are compositions which can be used to control vascular leakage, the compositions comprising an effective amount of one or more of the agents disclosed herein. Still further disclosed herein are compositions which can be used to treat patients with an inflammatory disease, non-limiting examples of which include sepsis, lupus, and inflammatory bowel disease, the compositions comprising an effective amount of an HPTPβ-ECD binding agents disclosed herein. The HPTPβ-ECD binding agents inhibit the Tie2 dephosphorylase activity of HPTPβ acting as Tie-2 signaling amplifiers.

[000139] Tumor growth is often a multi-step process that starts with the loss of control of cell proliferation. The cancerous cell then begins to divide rapidly, resulting in a microscopically small, spheroid tumor: an *in situ* carcinoma. As the tumor mass grows, the cells will find themselves further and further away from the nearest capillary. Finally the tumor stops growing and reaches a steady state, in which the number of proliferating cells counterbalances the number of dying cells. The restriction in size is caused by the lack of nutrients and oxygen. In tissues, the oxygen diffusion limit corresponds to a distance of 100 μm between the capillary and the cells, which is in the range of 3-5 lines of cells around a single vessel. *In situ* carcinomas may remain dormant and undetected for many years and metastasis are rarely associated with these small (2 to 3 mm^2), avascular tumors.

[000140] When a tumor's growth is stopped due to a lack of nutrients and/or oxygen, this reduction in tumor vasculature also limits the ability of anti-tumor drugs to be delivered to the malignant cells. Moreover, if there is a slight increase in tumor vasculature, this will allow delivery of anti-tumor therapies to the malignant cells without initiating metastasis. As such, the disclosed agents when used to slightly amplify Tie-2 signaling can be used to increase blood flow to the tumor cells without setting off metastasis or uncontrolled tumor cell proliferation while providing a method for delivering anti-cancer drugs to malignant cells.

[000141] Disclosed herein, is a method for treating cancer comprising administering to a patient in need an effective amount of an HPTPβ-ECD binding agent in conjunction with one or more chemotherapeutic compound or immunotherapeutic compound. To "slightly amplify Tie-2 signaling" means that a sufficient amount of a disclosed compound is administered to a patient such that the amount of tumor cell vasculature is increased such that the increased circulation allows for delivery of the anti-tumor compound or therapy without instigating tumor growth wherein the rate of tumor cell growth is less than the rate of tumor cell death. It is recognized that amplifying Tie2 signaling would stabilize the tumor vasculature making it resistant to angiogenic signals reducing tumor angiogenesis and tumor growth while improving tumor blood flow and the delivery of chemotherapeutic agents.

[000142] Angiopoietin-2 is significantly correlated to Gleason Score, metastasis and to cancer specific survival (Lind A.J. et al., "Angiopoietin-2 expression is related to histological grade, vascular density, metastasis and outcome in prostate cancer" Prostate, (2005), Vol. 62, pp. 394-299). Angiopoietin-2 was found to be expressed in prostate cancer bone, liver and lymph node metastasis, but with little to no angiopoietin-1 expression in prostate cancer tumor cells in bone, liver and lymph nodes (Morrissey C. et al., "Differential expression of angiogenesis associated genes in prostate cancer bone, live and lymph node metastasis" Clin. Exp. Metastasis, (2008), Vol. 25, pp. 377-388). As such, monitoring the level of Ang-2 provides a method for evaluating the presence of prostate cancer and the spread of prostate cancer cells throughout the body due to vascular leakage.

[000143] Thus, another embodiment of the disclosure is a method of evaluating efficacy of treatment comprising monitoring the Ang-2 level of the patient while the patient is undergoing treatment.

Vasculature Stabilization in Diseases Caused by Pathogens

[000144] Disclosed herein is a method for preventing or treating vascular leak syndrome caused by one or more pathogens, comprising administering to a human or other mammal in need of treatment an effective amount of one or more HPTPβ-ECD binding agent.

[000145] One embodiment is a method for treating vascular leak syndrome caused by one or more pathogens, comprising administering to a human or other mammal in need of treatment a composition comprising: a) an effective amount of one or more compounds effective against a

pathogen present in the human or mammal; and b) an effective amount of an HPTPβ-ECD binding agent; wherein the one or more compounds effective against a pathogen and the HPTPβ-ECD binding agent can be administered together or in any order.

[000146] Further disclosed is a method for preventing vascular leak syndrome in a human or other mammal diagnosed with a pathogen infection that can produce vascular leak syndrome in a human or mammal, comprising administering to a human or mammal a composition comprising: a) an effective amount of one or more compounds effective against a pathogen present in the human or mammal; and b) an effective amount of one or more HPTPβ-ECD binding agent; wherein the one or more compounds effective against a pathogen and the one or more HPTPβ-ECD binding agent can be administered together or in any order.

[000147] The following are non-limiting examples of viruses, bacteria and other pathogens where virulence can be controlled by mitigating the degree of vascular leak that is induced by the organism. *Staphylococcus aureus*, *Bacillus anthracis*, *Pseudomonas*, *Streptococcus pyogenes*, and dengue virus.

[000148] One embodiment is a method for treating vascular leak syndrome in a patient suffering from a bacterial infection by administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Further disclosed is a method for preventing vascular leak syndrome in a human or other mammal diagnosed with a bacterial infection.

[000149] Thus one embodiment of the present disclosure is a method of treating a patient suffering from a bacterial infection by administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. In particular embodiments the bacterial infection is a *Bacillus anthracis* infection. In other embodiments the bacterial infection is a *Pseudomonas* infection. In yet other embodiments the bacterial infection is a *Streptococcus pyogenes* infection.

[000150] One embodiment is a method for treating vascular leak syndrome in a patient suffering from a viral infection by administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. Further disclosed is a method for preventing vascular leak syndrome in a human or other mammal diagnosed with a viral infection.

[000151] Another embodiment is a method of treating a patient suffering from a viral infection by administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent. In particular embodiments the viral infection is a dengue virus infection.

[000152] The HPTPβ-ECD binding agent may be administered in combination with one or more antibacterial or antiviral agent wherein the HPTPβ-ECD binding agent and the antiviral or antibacterial agents can be administered together or in any order. Thus, an embodiment of the present disclosure is a method of treating a patient suffering from a bacterial infection comprising administering: a) an HPTPβ-ECD binding agent; and b) one or more antibacterial agents, wherein the HPTPβ-ECD binding agent and antibacterial agent can be administered together or in any order. Another embodiment of the present disclosure is a method of treating a patient suffering from a viral infection comprising administering: a) an HPTPβ-ECD binding agent; and b) one or more antiviral agents wherein the HPTPβ-ECD binding agent and antiviral agent can be administered together or in any order.

[000153] Another method provided by the present disclosure, is a method for determining the course of treatment for a patient suffering from vascular leak syndrome, comprising:
a) administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent; b) monitoring the level of angiopoietin-2 present in the patient during the course of treatment; and c) discontinuing treatment when the angiopoietin-2 level returns to within a normal range.

[000154] A further aspect relates to methods of treating vascular leak in a patient infected with anthrax comprising administering a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more antibacterial agents effective against anthrax, wherein the HPTPβ-ECD binding agent and the antibacterial agents effective against anthrax are administered together or in any order.

[000155] Yet another aspect relates to methods of treating vascular leak in a patient infected with a virus comprising administering a composition comprising an effective amount of an HPTPβ-ECD binding agent in combination with an effective amount of one or more antiviral agents, wherein the HPTPβ-ECD binding agent and the antiviral agent are administered together or in any order.

[000156] Increased amplification of Tie-2 signaling using the disclosed agents provides a method for stabilizing vasculature without the need to affect Ang-1 and/or Ang-2 levels. Disclosed herein are methods for stabilizing vasculature, comprising administering to a patient an effective amount of an HPTPβ-ECD binding agents.

[000157] Because the disclosed agents can amplify Tie-2 signaling without increasing the amount of Ang-2, monitoring the amount of Ang-2 in blood serum of a patient while administering to a patient an HPTPβ-ECD binding agent, serves as a method for determining the course of various illnesses or disease states associated with vascular leak syndrome, for example, sepsis as a result of infection. As such, disclosed is a method for stabilizing vasculature in a patient suffering from an inflammatory disease wherein the level of angiopoietin-2 is elevated, comprising: a) administering to a patient an effective amount of an HPTPβ-ECD binding agent; b) monitoring the level of angiopoietin-2 present in the patient; and c) discontinuing treatment when the angiopoietin-2 level returns to a normal range.

[000158] What is meant herein by "normal angiopoietin-2 level" is an amount of Ang-2 in blood serum of from about 1 ng/mL to about 2 ng/mL. Alternatively, the level of Ang-2 can be determined for an individual suffering from a disease state, for example, severe sepsis and the level of Ang-2 can be monitored until the amount of Ang-2 in the patient's serum drop to a level that is nearer the normal range. In this case, the co-administration of a drug can be continued or discontinued.

[000159] Therefore, disclosed herein is a method for stabilizing the vasculature of a patient during a course of treatment, comprising: a) co-administering to a patient an effective amount of an HPTPβ-ECD binding agent and one or more drugs as a treatment; b) monitoring the level of angiopoietin-2 present in the patient; and c) discontinuing the administration of the one or more drugs, and selecting one or more other drugs for use as a treatment if the level of serum angiopoetin-2 does not decrease.

[000160] The HPTPβ-ECD binding agent, while stabilizing the vasculature of a patient such that a course of treatment against a pathogen can be sustained, can also be used to stabilize a patient during a period wherein an effective treatment against a pathogen is being determined. That is, the HPTPβ-ECD binding agents by themselves can have a beneficial effect on the outcome of diseases caused by pathogens by reducing vascular leak and its complications.

[000161] Any of the foregoing compositions comprising an HPTPβ-ECD binding agent are suitable for use in the manufacture of a medicament for treatment of any of the diseases or disorder described above. In addition, any of the foregoing compositions comprising an HPTPβ-ECD binding agent are suitable for use in treating any of the diseases or disorder described above.

***In Vivo* Vascular Leak**

[000162] The Miles assay (**Miles, A. A. and E. M. Miles** (1952) Vascular reactions to histamine, histamine-liberator and leukotaxine in the skin of guinea-pigs. J. Physiol., Vol. 118, pp. 228-257 incorporated herein by reference in its entirety) can be used to directly investigate and quantify lethal toxin, as well as edema toxin (ET [PA plus EF])-mediated vascular leakage in the mouse model. The following is a modified Miles assay as described by Gozes Y. et al., Anthrax Lethal Toxin Induces Ketotifen-Sensitive Intradermal Vascular Leakage in Certain Inbred Mice Infect. Immun., 2006 February, Vol. 74, No. 2, pp. 1266–1272 incorporated herein by reference in its entirety, that can be used to evaluate the disclosed HPTPβ-ECD binding agents for their ability to prevent vascular leakage in humans and animals exposed to anthrax.

[000163] Highly pure PA, LF, and mutant LF E687C are purified as previously described (**Varughese M. et al.,** (1998) Internalization of a *Bacillus anthracis* protective antigen-c-Myc fusion protein mediated by cell surface anti-c-Myc antibodies. Mol. Med. **4:**87-95 included herein by reference in its entirety). Doses of ET or LT refer to the amount of each component (i.e., 100 μg LT is 100 μg PA plus 100 μg of LF). All drugs except for azelastine can be purchased from Sigma Aldrich (St. Louis, MO); azelastine can be purchased from LKT Laboratories (St. Paul, MN). LT is an abbreviation for lethal toxin; PA is an abbreviation for protective antigen; LF is an abbreviation for lethal factor; and EP is an abbreviation for edema factor.

Animals.

[000164] BALB/cJ, DBA/2J, C3H/HeJ, C3H/HeOuJ, WBB6F1/J-Kit^{W}/Kit$^{W\text{-}v}$, and colony-matched wild-type homozygous control mice can be purchased from The Jackson Laboratory (Bar Harbor, ME). BALB/c nude, C57BL/6J nude, and C3H hairless (C3.Cg/*TifBomTac-hr*) mice can be purchased from Taconic Farms (Germantown, NY). C3H nude mice can be purchased from The National Cancer Institute Animal Production Area (Frederick, MD). Mice are used when they are 8 to 12 weeks old. Except for C3H hairless and nude animals, all mice are shaved

24 hours prior to intradermal (i.d.) injections. In order to assess the susceptibility to systemic LT, mice are injected intraperitoneally (i.p.) with 100 µg LT and observed over 5 days for signs of malaise or death. Fischer 344 rats can be purchased from Taconic Farms (Germantown, NY) and used at weights of 150 to 180 g. Rats are injected intravenously (i.v.) in the tail vein with 12 µg LT, with or without 250 µg of the mast cell stabilizer drug ketotifen and monitored for the exact time to death.

Miles Assay.

[000165] The Miles assay uses i.v. injection of Evans blue dye (which binds to endogenous serum albumin) as a tracer to assay macromolecular leakage from peripheral vessels after i.d. injection of test substances. Nude mice and normal shaved mice are injected i.v. with 200 µl of 0.1% Evans blue dye (Sigma Chemical Co., St. Louis, MO). After 10 min, 30 µl of test toxin or control samples (PA only, LF only, EF only, or phosphate-buffered saline) are injected i.d. in both left and right flanks, as well as at single or dual dorsal sites. To quantify the extents of leakage, equally sized (1.0- to 1.5-cm diameter) skin regions surrounding i.d. injection sites are removed 60 min after injection and placed in formamide (1 ml) at 41°C for 48 h, allowing for dye extraction. The A_{620} of samples is read, and the extent of leakage is calculated by comparison with phosphate-buffered saline-, PA-, or LF-treated controls.

[000166] In experiments wherein the effectiveness of the HPTPβ-ECD binding agents are tested for LT-mediated leakage, mice are injected i.v. with Evans blue as described above, and the test agent introduced systemically through i.p. injection 10 min after dye injection. LT was introduced by i.d. injection 30 min after the injection of Evans blue. In another embodiment, the agent to be tested can be introduced locally by i.d. injection and LT injected in the same site after 10 min.

Cytotoxicity Experiments.

[000167] MC/9 mast cells can be obtained from ATCC (Manassas, VA) and grown in Dulbecco's modified Eagle's medium supplemented with l-glutamine (2 mM), 2-mercaptoethanol (0.05 mM), Rat T-STIM (BD Biosciences-Discovery Labware, Bedford, MA) (10%), and fetal bovine serum (FBS, 10% final concentration; Invitrogen-GIBCO BRL, Gaithersburg, MD). Cells are then seeded at a density of 10^4/well in 96-well plates prior to treatment with various LT concentrations or PA-only controls. After 6, 12, and 24 hours, viability is assessed using Promega's CellTiter 96 AQ_{ueous} One Solution cell proliferation assay (Promega, Madison, WI) per the manufacturer's protocol. Alternatively, toxicity assays can be performed in medium provided with all supplements except FBS (serum-free medium). In other embodiments, pooled human umbilical vein endothelial cells (HUVECs) at third to fifth passage can be obtained from Cambrex Corp. (Cambrex, Walkersville, MD) and grown in an EGM-MV Bulletkit (Cambrex, Walkersville, MD) in flasks pretreated with endothelial cell attachment factor (Sigma, St. Louis, MO). For cytotoxicity experiments, cells are typically seeded in 96-well plates in an EGM-MV Bulletkit. On the day of assays, this medium is then replaced with M199 medium (Sigma, St. Louis, MO) supplemented with 10% FBS or human serum (Sigma, St. Louis, MO), and cells are reseeded in 96-well plates at a density of 2×10^3/0.1 ml/well and treated with various concentrations of LT in triplicate. Cell viability is typically assessed as for MC/9 cells at 24, 48 and 72 hour time points.

HUVEC Permeability Assay

[000168] HUVEC monolayers can be effectively cultured on Transwell-Clear cell culture inserts (6.5-mm diameter, 0.4-μm pore size; Corning-Costar, Acton, MA) in 24-well plates, creating a two-chamber culturing system consisting of a luminal compartment (inside the insert) and a subluminal compartment (the tissue culture plate well). Prior to seeding cells, the inserts are coated with endothelial cell attachment factor (Sigma, St. Louis, MO). Pre-warmed CS-C medium (Sigma, St. Louis, MO) containing 10% iron-supplemented calf serum and 1% endothelial cell growth factor (Sigma, St. Louis, MO) is added to wells prior to insert placement. A HUVEC cell suspension (200 μL of 5×10^5 cells/ml) is then added to each insert. Cells are cultured at 37 °C in 5% CO_2 for up to 21 days to ensure proper formation of a monolayer. For testing barrier function, medium can be changed to RPMI supplemented with 10% FBS or to RPMI without serum. To assess barrier function, horseradish peroxidase enzyme (Sigma, St. Louis, MO) is added to the inserts (10 μg/well). LT (1 μg/mL) or control treatments of PA alone (1 μg/mL) or LF alone (1 μg/mL) are added to duplicate wells, and every hour (for 12 hours), a sample of 10 μL was taken from the subluminal compartment and tested for the enzymatic activity of horseradish peroxidase by adding 100 μL substrate [2′,2′-azino-bis(3-ethylbenzthizolin 6-sulfonic acid)] (A-3219; Sigma, St. Louis, MO) and reading at 405 nm.

Anthrax Combination Therapy

[000169] Increased stabilization of vascular tissue can increase the effectiveness of known antimicrobials against anthrax infection. As such, HPTPβ-ECD binding agents can be evaluated as a combination therapy for the treatment of anthrax. The following describes a series of assays that can be used to determine the effectiveness of an HPTPβ-ECD binding agent as one part of a combination therapy useful for treating anthrax infections.

[000170] LF has been found to cleave mitogen-activated protein kinase kinases (MAPKK), disrupts signal transduction, and leads to macrophage lysis. As such, in addition to the Miles Assay, the following cell-based and peptide cleavage assay can be used to confirm the potency of the HPTPβ-ECD binding agents to inhibit the effect of LT activity. For the following assay, MAPKKide can be purchased from List Biological Laboratories (Campbell, CA. Fluorinated peptide substrate is available from Anaspec (San Jose, CA).

***In Vivo* Assays**

[000171] One week before beginning an evaluation of a combination course of treatment for anthrax, test agents (200 mg each) are dissolved in 800 μL of DMSO and stored at -20 °C. Immediately before injection, each test agent is diluted in PBS, resulting in a final concentration of 0.5 mg/mL in 2% DMSO. Test animal are challenged on day 0 with 2 x 10^7 spores per mouse in PBS through i.p. injection. Treatment was started 24 hours after challenge. One example of a suitable treatment regimen is the combination of ciprofloxacin (50 mg/kg) and an HPTPβ-ECD binding agent (5 mg/kg). A control sample of untreated animals, ciprofloxacin alone, a disclosed agent alone and ciprofloxacin in combination with a disclosed agent are given to the animals and they are monitored twice per day until day 14 after injection.

[000172] Ciprofloxacin and the agent to be tested can be conveniently administered through parenteral injection with a volume of 200 μL for each once per day for 10 days. All surviving animals are sacrificed on day 14. Sick animals that appear moribund (i.e., exhibiting a severely reduced or absent activity or locomotion level, an unresponsiveness to external stimuli, or an inability to obtain readily available food or water, along with any of the following accompanying signs: ruffled haircoat, hunched posture, inability to maintain normal body temperature, signs of hypothermia, respiratory distress, or other severely debilitating condition) should be sacrificed on the same day these symptoms are manifested.

Modulation of Bacterium-Induced Vascular Leak

[000173] Pathogenic bacteria are known to cause vascular leak. This induced vascular leakage inhibits the ability of antimicrobials and other pharmaceuticals from targeting the invading microorganism. As such, HPTPβ-ECD binding agents can be used alone or in combination with other pharmaceutical ingredients to boost the host immune system by preventing excess vascular leakage that occurs as a result of a bacterial infection.

[000174] The following describe tests and assays that can be used to determine the effectiveness of an HPTPβ-ECD binding agent, either alone, or a combination therapy.

[000175] *Staphylococcus aureus* (*S.* aureus) is a major pathogen of gram-positive septic shock and is associated with consumption of plasma kininogen. The effect of an HPTPβ-ECD binding agent on *S. aureus* induced vascular leakage activity can be determined by measuring the activity of these agents with respect to two cysteine proteinases that are secreted by *S. aureus*. Proteolytically active staphopain A (ScpA) induces vascular leakage in a bradykinin (BK) B_2-receptor–dependent manner in guinea pig skin. This effect is augmented by staphopain B (SspB), which, by itself, had no vascular leakage activity. ScpA also produces vascular leakage activity from human plasma.

[000176] An important pathophysiologic mechanism of septic shock is hypovolemic hypotension that is caused by plasma leakage into the extravascular space. It has been found that ScpA induced vascular leakage at a concentration as low as 20 nM within 5 minute after injection into the guinea pig skin—with the reaction being augmented by coexisting SspB indicating that vascular leakage induction by these proteinases occurs efficiently *in vivo* (Imamura T. et al., Induction of vascular leakage through release of bradykinin and a novel kinin by cysteine proteinases from *Staphylococcus aureus* (2005) J. Experimental Medicine, Vol. 201, No. 10, pp. 1669-1676).

Vascular Leakage Assay.

[000177] Animals can be evaluated for vascular leakage using the following procedure. 100 μL of a 1% solution of Evans blue dye (Sigma Aldrich) in saline is injected into the tail vein. Thirty minutes later, mice are sacrificed and perfused with saline via the right ventricle to remove intravascular Evans blue. Lungs are excised and extracted in 1 mL of formamide at 55 °C overnight. Evans blue content is determined as OD_{620} minus OD_{500} of the formamide extract.

[000178] The agents disclosed herein can be used as a single pharmaceutical therapy to reduce the severity of influenza by mediating the effects of vascular leak caused by viruses, and, hence, allowing the body's own immune system to affect greater resistance to these pathogens. The following assays can be used to determine the effect of an HPTPβ-ECD binding agent to inhibit viral severity because of improved vascular integrity.

[000179] The disclosed assays can use inhibition of viral plaques, viral cytopathic effect (CPE), and viral hemagglutitin.

Proteolytic Sensitivity Assay

[000180] An HPTPβ-ECD binding agent can be determined to bind to hemagglutinin and thereby destabilize the protein assembly. The following procedure can be used to determine the increase in destabilization and therefore the increased sensitivity of hemagglutinin to proteolytic attack caused by an HPTPβ-ECD binding agent. At the fusion conformation, HA becomes more sensitive to protease digestion. This property can be used to verify if a fusion inhibitor interacts with HA (Luo G. et al., "Molecular mechanism underlying the action of a novel fusion inhibitor of influenza A virus." J. Virol., (1997), Vol. 71, No. 5, pp. 4062-4070). Thus, an HPTPβ-ECD binding agent, due to the control of vascular leakage, can be evaluated for its ability to indirectly effect HA digestion by enhancing the body's immune response.

[000181] The purified trimer of hemagglutinin ectodomain is incubated with the agent to be tested at a concentration of 5 μM. The trimers are subjected to trypsin digestion at pH 7.0 and pH 5.0 with controls of untreated HA and HA treated with DMSO which is the solvent used to dissolve the test agent. For the pH 5.0 sample, the HA trimers are treated with a pH 5.0 buffer for 15 minutes and neutralized to pH 7.0. Trypsin (20 ng) is added to the sample in 10 μL and the digestion allowed to proceed for 1 hour at 37 °C, The amount of HA present is assessed by a western blot gel electrophoresis using anti-HA (H3) antisera. Samples containing effective inhibitors will provide an increase in digestion of HA by trypsin.

[000182] In addition, combination therapies can provide a method for treating influenza by providing an antiviral medication together with an agent that prevents the severity of vascular leakage due to influenza viruses.

[000183] An antiviral compound, for example, oseltamivir, can be used for an *in vivo* evaluation of the disclosed combination therapy and to evaluate the effectiveness of an HPTPβ-ECD binding agent. The drug combination is administered in a single dose to mice infected with the influenza A/NWS/ (H1N1) virus. In some instances, infection of the animals will include multiple passage of the virus through their lungs. One convenient protocol involves administering 20 mg/kg per day twice daily for 5 days beginning 4 hours prior to virus exposure. The animals are then challenged with different concentrations of virus, ranging 10-fold from 10^{-2} ($10^{5.75}$ cell culture 50 % infectious doses ($CCID_{50}$) per mL). Four mice in each group are sacrificed on day 6 and their lungs removed, assigned a consolidation score ranging from 0 (normal) to 4 (maximal plum coloration), weighted, homogenized, the homogenates centrifuged at 2000 x g for 10 minutes, and varying 10-fold dilutions of the supernatant assayed for virus titer in MDCK cells using CPE produced after a 96-hour incubation at 37 °C as endpoint.

[000184] The serum taken from mice on day 6 is assayed for a_1-AG using single radial immunodiffusion kites. Eight additional mice in each group are continually observed daily for death for 21 days, and their arterial oxygen saturation (SaO_2) values determined by pulse oximetery (Sidwell R. et al., (1992) Utilization of pulse oximetry for the study of the inhibitory effects of antiviral agents on influenza virus in mice. Antimicrob. Agents Chemother. **36**, 473-476) on day 3, when SaO_2 decline usually begins to occur, through day 11, when the values are seen to decline to the maximum degree of the animals otherwise die.

Inhibition of Protein Tyrosine Phosphatase beta in a Cell

[000185] Disclosed herein are methods for inhibiting protein tyrosine phosphatase beta (HPTP-β) activity in a cell, comprising contacting a cell with an effective amount of an HPTPβ-ECD binding agents. The cell can be contacted *in vivo*, *ex vivo*, or *in vitro.*

Administration

[000186] Depending on the nature of the particular agent, agents of the present disclosure can be administered to humans and other animal, parenterally, (e.g., by intravenous or intraperitoneal injection), subcutaneously, orally, topically, rectally, buccally, as an oral or nasal spray.

[000187] The HPTPβ-ECD binding agents of the disclosure are preferably formulated in dosage unit form for ease of administration and uniformity of dosage. The expression "dose" or "dosage unit form" as used herein refers to a physically discrete unit of agent appropriate for the patient to be treated. It will be understood, however, that the total daily usage of the HPTPβ-ECD binding agents and compositions of the present invention will be decided by the attending physician within the scope of sound medical judgment.

Dosing

[000188] Effective dosages and schedules for administering the HPTPβ-ECD binding agent may be determined empirically, and making such determinations is within the skill in the art. Those skilled in the art will understand that the dosage of the agent that must be administered will vary depending on, for example, the subject which will receive the agent, the route of administration, the particular type of agent used and other drugs being administered to the subject. For example, guidance in selecting appropriate doses for antibodies is found in the literature on therapeutic uses of antibodies, e.g., Handbook of Monoclonal Antibodies, Ferrone et al., eds., Noges Publications, Park Ridge, N.J., (1985) ch. 22 and pp. 303-357; Smith et al., Antibodies in Human Diagnosis and Therapy, Haber et al., eds., Raven Press, New York (1977) pp. 365-389. A typical dose of the agent used alone might range from about 0.01 mg/kg to up to 500 mg/kg of body weight or more per day, or from about 0.01 mg/kg to about 50 mg/kg, or from 0.1 mg/kg to about 50 mg/kg, or from about 0.1 mg/kg to up to about 10 mg/kg, or from about 0.2 mg/kg to about 1 mg/kg, or from about 1mg/kg to about depending on the factors mentioned above.

[000189] The dosing schedules for administration of an HPTPβ-ECD binding agent include, but are not limited to, once daily, three-times weekly, twice weekly, once weekly, three times, twice monthly, once monthly and once every other month.

Formulations

[000190] In one aspect of the present invention, pharmaceutically acceptable compositions are provided, wherein these compositions comprise any of the agents as described herein, and a pharmaceutically acceptable carrier and, in addition, can include other pharmaceutical agents, adjuvants or diluents. For example, pharmaceutical compositions can also include one or more additional active ingredients such as antimicrobial agents, anti-inflammatory agents, anesthetics and the like.

[000191] The formulation may vary depending on the mode of administration. The pharmaceutical compositions can be in the form of solid, semi-solid or liquid dosage forms, such as, for example, tablets, suppositories, pills, capsules, powders, liquids, suspensions, lotions, creams, gels, or the like, preferably in unit dosage form suitable for single administration of a precise dosage.

[000192] For the purposes of the present disclosure the term "excipient" and "carrier" are used interchangeably throughout the description of the present disclosure and said terms are defined herein as, "ingredients which are used in the practice of formulating a safe and effective pharmaceutical composition." The formulator will understand that excipients are used primarily to serve in delivering a safe, stable and functional pharmaceutical, serving not only as part of the overall vehicle for delivery but also as a means for achieving effective absorption by the recipient of the active ingredient. An excipient may fill a role as simple and direct as being an inert filler, or an excipient as used herein may be part of a pH stabilizing system or coating to insure delivery of the ingredients.

[000193] "Pharmaceutically acceptable" means a material that is not biologically or otherwise undesirable, i.e., the material may be administered to a patient without causing any undesirable biological effects or interacting in a deleterious manner with any of the other components of the pharmaceutical formulation in which it is contained. The carrier would naturally be selected to minimize any degradation of the active ingredient and to minimize any adverse side effects in the patient, as would be well known to one of skill in the art. See Remington's Pharmaceutical Sciences, 18th ed., Gennaro, AR. Ed., Mack Publishing, Easton Pa. (1990), which discloses typical carriers and conventional methods of preparing pharmaceutical compositions that can be used in conjunction with the preparation of formulations of the agents described herein. It will be apparent to those persons skilled in the art that certain carriers can be more preferable depending upon, for instance, the route of administration and concentration of composition being administered.

[000194] For solid compositions, conventional nontoxic solid carriers include, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharin, talc, cellulose, glucose, sucrose, magnesium carbonate and the like. Liquid pharmaceutically administrable compositions can, for example, be prepared by dissolving, dispersing, etc., an active agent as described herein and optional pharmaceutical adjuvants in an excipient, such as, for example, water, saline aqueous dextrose, glycerol, ethanol and the like, to thereby form a solution or suspension. If desired, the pharmaceutical composition to be administered can also contain minor amounts of nontoxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like, for example, sodium acetate, sorbitan monolaurate, triethanolamine sodium acetate, triethanolamine oleate, etc. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art.

[000195] The disclosed agents can also be present in liquids, emulsions, or suspensions for delivery of active therapeutic agents. Liquid pharmaceutically administrable compositions can, for example, be prepared by dissolving, dispersing, etc., an active agent as described herein and optional pharmaceutical adjuvants in an excipient, such as, for example, water, saline aqueous dextrose, glycerol, ethanol and the like, to thereby form a solution or suspension. If desired, the pharmaceutical composition to be administered can also contain minor amounts of nontoxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like, for example, sodium acetate, sorbitan monolaurate, triethanolamine sodium acetate, triethanolamine oleate, etc. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for example see Remington's Pharmaceutical Sciences, 18th ed., Gennaro, AR. Ed., Mack Publishing, Easton Pa. (1990).

[000196] Injectable preparations, for example, sterile injectable aqueous or oleaginous suspensions may be formulated according to the known art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution, suspension or emulsion in a nontoxic parenterally acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution, U.S.P. and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil can be employed including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid are used in the preparation of injectables.

[000197] The injectable formulations can be sterilized, for example, by filtration through a bacterial-retaining filter, or by incorporating sterilizing agents in the form of sterile solid compositions which can be dissolved or dispersed in sterile water or other sterile injectable medium prior to use.

[000198] The disclosed agents can also be present in liquids, emulsions, or suspensions for delivery of active therapeutic agents in aerosol form to cavities of the body such as the nose, throat, or bronchial passages. The ratio of agents to the other compounding agents in these preparations will vary as the dosage form requires.

[000199] Depending on the intended mode of administration, the pharmaceutical compositions can be in the form of solid, semi-solid or liquid dosage forms, such as, for example, tablets, suppositories, pills, capsules, powders, liquids, suspensions, lotions, creams, gels, or the like, preferably in unit dosage form suitable for single administration of a precise dosage. The compositions will include, as noted above, an effective amount of the agents in combination with a pharmaceutically acceptable carrier and, in addition, can include other medicinal agents, pharmaceutical agents, carriers, adjuvants, diluents, etc.

[000200] When the agents are to be delivered into a mammal other than a human, the mammal can be a non-human primate, horse, pig, rabbit, dog, sheep, goat, cow, cat, guinea pig, or rodent. The terms human and mammal do not denote a particular age or sex. Thus, adult and newborn subjects, as well as fetuses, whether male or female, are intended to be covered. A patient, subject, human or mammal refers to a subject afflicted with a disease or disorder. The term "patient" includes human and veterinary subjects.

KITS

[000201] Also disclosed are kits comprising the agents be delivered into a human, mammal, or cell. The kits can comprise one or more packaged unit doses of a composition comprising an HPTPβ-ECD binding agent to be delivered into a human, mammal, or cell. The kit optionally includes directions for using the components of the kit. The agents can be packaged as a sterile formulation, and the hermetically sealed container is designed to preserve sterility of the formulation until use.

EXAMPLES

EXAMPLE 1

Production of the HPTPβ Extracellular Domain Protein

[000202] Full length HPTPβ cDNA (SEQ ID NO:1) is cloned from a human placental library according to the manufacturer's (Origene) instructions. A cDNA encoding the entire soluble extracellular domain (ECD) of HPTPβ is cloned by PCR from the full length cDNA coding for amino acids 1-1621 with an added c-terminal His-His-His-His-His-His-Gly (6His-Gly) (SEQ ID NO:3). The resulting cDNA is cloned into mammalian expression vectors for transient (pShuttle-CMV) or stable (pcDNA3.1(-)) expression in HEK293 cells. To obtain purified HPTPβ ECD (βED), HEK293 cells transfected with a βECD expression vector are incubated in OptiMEM-serum free (Gibco) for 24 hours under normal growth conditions. The conditioned media is then recovered, centrifuged to remove debris, and 1 mL of washed Ni-NTA agarose (Qiagen) (500 µL packed material) is added to each 10µL of cleared media and allowed to rock overnight at 4° C.

On the following day, the mixture is loaded into a column and washed with 20 bed volumes of 50 mM NaH_2PO_4, 300 mM NaCl, 20 mM imidazole, pH 8. The purified HPTPβ extracellular domain protein (SEQ ID NO:4) is then eluted with 200 µL/elution in 50 mM NaH_2PO_4, 300 mM NaCl, 250 mM Imidazole, pH 8. Fractions are analyzed for protein content using reducing-denaturing SDS-polyacrylimide gel electrophoresis and detected by silver stain (Invitrogen) and confirmed by mass spectrometry.

EXAMPLE 2

[000203] Purified HPTPβ extracellular domain protein is produced, for example by the procedure described in Example 1. For production of the HPTPβ extracellular domain immunogen, the purified HPTPβ extracellular domain-6-His protein is conjugated to porcine thyroglobulin (Sigma) using EDC coupling chemistry (Hockfield, S. et al., (1993) Cold Spring Habor Laboratory Press., Vol. 1 pp. 111-201, Immunocytochemistry). The resulting HPTPβ extracellular domain-thyroglobulin conjugate is dialyzed against PBS, pH 7.4. Adult Balb/c mice are then immunized subcutaneously with the conjugate (100-200 µg) and complete Freund's adjuvant in a 1:1 mixture. After 2-3 weeks, the mice are injected intraperitoneally or subcutaneously with incomplete Freund's adjuvant and the conjugate in a 1:1 mixture. The injection is repeated at 4-6 weeks. Sera are collected from mice 7 days post-third-injection and assayed for immunoreactivity to HPTPβ extracellular domain antigen by ELISA and western blotting. Mice that display a good response to the antigen are boosted by a single intra-spleen injection with 50 µl of purified HPTPβ extracellular domain protein mixed 1:1 with Alum hydroxide using a 31 gauge extra long needle (Goding, J. W., (1996) Monoclonal Antibodies: Principles and Practices. Third Edition, Academic Press Limited. p.145). Briefly, mice are anesthetized with 2.5% avertin, and a 1 centimeter incision is created on the skin and left oblique body wall. The antigen mixture is administered by inserting the needle from the posterior portion to the anterior portion of the spleen in a longitudinal injection. The body wall is sutured and the skin is sealed with two small metal clips. Mice are monitored for safe recovery. Four days after surgery the mouse spleen is removed and single cell suspensions are made for fusion with mouse myeloma cells for the creation of hybridoma cell lines (Spitz, M., (1986) Methods In Enzymology, Vol. 121. Eds. John J, Lagone and Helen Van Vunakis. pp. 33-41 (Academic Press, New York, NY)). Resulting hybridomas are cultured in Dulbeccos modified media (Gibco) supplemented with 15 % fetal calf serum (Hyclone) and hypoxathine, aminopterin and thymidine.

[000204] Screening for positive hybridomas begins 8 days after the fusion and continues for 15 days. Hybridomas producing anti-HPTPβ extracellular domain antibodies are identified by ELISA on two sets of 96-well plates: one coated with the histidine tagged-HPTPβ extracellular domain and another one coated with a histidine-tagged bacterial MurA protein as a negative control. The secondary antibody is a donkey anti-mouse IgG labeled with horseradish peroxidase (HRP) (Jackson Immunoresearch). Immunoreactivity is monitored in wells using color development initiated by ABTS tablets dissolved in TBS buffer, pH 7.5. The individual HRP reaction mixtures are terminated by adding 100 microliters of 1% SDS and reading absorbance at 405 nm with a spectrophotometer. Hybridomas producing antibodies that interact with HPTPβ extracellular domain-6His, and not with the murA-6His protein are used for further analysis. Limiting dilutions (0.8 cells per well) are performed twice on positive clones in 96 well plates, with clonality defined as having greater than 99% of the wells with positive reactivity. Isotypes of antibodies are determined using the iso-strip technology (Roche). To obtain purified antibody for further evaluation, tissue culture supernatants are affinity purified using a protein A or a protein G column.

[000205] Five monoclonal antibodies immunoreactive to HPTPβ–ECD protein were isolated and given the following nomenclature, R15E6, R12A7, R3A2, R11C3, R15G2 and R5A8. Based on its reaction with theHPTPβ–ECD protein in ELISA and in western blots, R15E6 was selected for further study.

EXAMPLE 3

The monoclonal antibody R15E6

[000206] The monoclonal antibody R15E6 was identified and characterized as described in Example 2 of the present application and in U.S. Pat. No. 7,973,142; the procedure and results are summarized below.

A. R15E6 binds endogenous HPTPβ as demonstrated by demonstrated by immunoprecipitation.

[000207] Materials: Human umbilical vein endothelial cells (HUVECs), EGM media, and trypsin neutralizing solution from Cambrex; OPTIMEM I (Gibco), bovine serum albumin (BSA; Santa Cruz), phosphate buffered saline (PBS; Gibco), Growth Factors including Angiopoietin 1 (Ang1), vascular endothelial growth factor (VEGF) and fibroblast growth factor (FGF) (R&D Systems), Tie2 monoclonal antibody (Duke University/P&GP), VEGF receptor 2 (VEGFR2) polyclonal antibody (Whitaker et. al), protein A/G agarose (Santa Cruz), Tris-Glycine pre-cast gel electrophoresis/transfer system (6-8%) (Invitrogen), PVDF membranes (Invitrogen), lysis buffer (20 mm Tris-HCl, 137 mm NaCl, 10% glycerol, 1% triton-X-100, 2 mM EDTA, 1 mM NaOH, 1 mM NaF, 1 mM PMSF, 1 μg/ml leupeptin, 1 μg/ml pepstatin).

[000208] Method: HUVECs are pre-treated for 30 min with antibody (in OPTIMEM) or OPTIMEM I alone. After removal of pre-treatment, cells are treated with Ang1 (100 ng/ml) for 6 minutes in PBS+0.2% BSA and lysed in lysis buffer. Lysates are run directly on a Tris-Glycine gel or immunoprecipitated with 2-5 μg/ml Tie-2 antibody or 10 μg/ml R15E6 antibody and protein A/G agarose. Immunoprecipitated samples are rinsed once with lysis buffer and boiled for 5 min in 1 x times sample buffer. Samples are resolved on a Tris-Glycine gel, transferred to a PVDF membrane, and detected by western blot using the indicated antibodies (pTYR Ab (PY99, Santa Cruz), Tie-2, VEGFR2 and/or R15E6).

[000209] Results: By IP/western blotting, R15E6 recognizes a major, high molecular weight band consistent with the size of HPTPβ (**Figure 1**, Panel A, Lane 2). The less intense, lower molecular weight bands likely represent less glycosylated precursor forms of HPTPβ. An immunoprecipitation (IP) with control, non-immune IgG shows no bands in the molecular weight range of HPTPβ (**Fig. 1**, Panel A, Lane 1), and a combined Tie2/VEGFR2 IP shows bands of the expected molecular weight (**Fig. 1**, Panel A, Lane 3). This result demonstrates that R15E6 recognizes and is specific for HPTPβ.

B. R15E6 Binds Endogenous HPTPβ as Demonstrated by FACS Analysis

[000210] Materials: HUVECs, EGM media, and trypsin neutralizing solution from Cambrex; Secondary Alexfluor 488-tagged antibody from Molecular Probes; Hanks balanced salt solution (Gibco); FACSCAN flow cytometer and CellQuest software from Becton Dickenson.

[000211] Method: HUVECs are trypsinized, treated with trypsin neutralizing solution and rinsed with HBSS. R15E6 antibody (0.6 μg) is added to 250,000 cells in 50μl of HBSS and incubated on ice for 20 minutes. Cells are rinsed with 1 ml HBSS followed by adding 2 μg of fluorescent-conjugated secondary antibody for 20 minutes on ice. Cells are rinsed and resuspended in 1 ml HBSS then analyzed on the FACSCAN flow cytometer with CellQuest software. Control cells are treated with fluorescent-conjugated secondary antibody only.

[000212] Results: By FACS analysis, intact HUVECs, R15E6 causes a robust shift (>90% of cells) in the fluorescence signal compared to the secondary antibody alone (**Fig. 1, Panel B**). This result indicates that R15E6 binds to endogenous HPTPβ presented on the surface of intact endothelial cells.

EXAMPLE 4

R15E6 Enhances Tie2 Activation

[000213] R15E6 enhances Tie2 phosphorylation in the absence and presence of the angiopoietin 1 (Ang1), the Tie2 ligand.

[000214] Methods: HUVECs are cultured in serum free media as described above in the presence or absence of various concentrations of R15E6 and with or without added Ang1. Lysates are prepared, immunoprecipitated with a Tie2 antibody, resolved by polyacrylamide gel electrophoresis and transferred to a PVDF membrane. Membrane-bound immunoprecipitated proteins are then serially western blotted with an antiphosphotyrosine antibody to quantify Tie2 phosphorylation followed by a Tie2 antibody to quantify total Tie2. Tie2 phosphorylation is expressed as the ratio of the antiphosphotyrosine signal over the total Tie2 signal.

[000215] Results: R15E6 enhances Tie2 phosphorylation both in the absence and presence of Ang1 (**Fig. 2**). This result indicates that binding of R15E6 to HPTPβ on the surface of endothelial cells modulates its biological function resulting in enhanced activation of Tie2 in the absence or presence of ligand.

EXAMPLE 5

Generation of anti-VE-PTP extracellular domain antibodies

A. Production of mouse VE-PTP extracellular domain protein (VE-PTP-ECD)

[000216] VE-PTP –ECD may be produced by any suitable method. Such methods are well known in the art. For example, VE-PTP –ECD can be produced using a method similar to

Example 1 of the present disclosure where VE-PTP-ECD cDNA is used in place of cDNA encoding HPTPβ-ECD. SEQ ID NO:7 provides a nucleotide sequence that encodes VE-PTP-ECD. SEQ ID NO:8 provides the amino acid sequence of VE-PTP-ECD.

B. Generation of antibodies to VE-PTP ECD

[000217] Anti-VE-PTP antibodies are readily generated by methods that are well known in the art. For example, anti VE-PTP antibodies can be generated using the method of Example 2 of the present disclosure by substituting VE-PTP-ECD for the HPTPβ extracellular domain and immunizing rats with the resulting protein. The rat anti-mouse VE-PTP antibody used in the present studies was kindly provided by Dr. D. Vestweber (mAb 109). The antibody was generated as described in Baumer S. et al., Blood, 2006, Vol. 107, pp. 4754-4762. Briefly, the antibody was generated by immunizing rats with a VE-PTP-Fc fusion protein. Immunization, hybridoma-fusion, and screening were conducted as described in Gotsch U., et al., J Cell Sci., 1997, Vol. 110, pp. 583-588 and Bosse R. and Vestweber D., Eur J Immunol., 1994, Vol. 24, pp. 3019-3024.

[000218] The fusion protein was constructed such that the first 8 fibronectin type III-like repeats ending with the amino acid proline at position 732 of VE-PTP were fused in frame with the Fc part of human IgG1 (starting with amino acid proline at position 239). This construct cloned into pcDNA3 (Invitrogen) was stably transfected into CHO cells, and the fusion protein was purified by protein A Sepharose affinity purification.

EXAMPLE 6

Intravitreal injections of an anti- VE-PTP ECD antibody

[000219] Laser-induced Choroidal Neovascularization Model: The choroidal neovascularization model is considered to represent a model of neovascular age-related macular degeneration. Choroidal NV was generated as previously described. See Tobe T, et al., Am. J. Pathol., 1998, Vol. 153, pp. 1641-1646. Adult C57BL/6 mice had laser-induced rupture of Bruch's membrane in three locations in each eye and were then given 1 μL intravitreal injections of 1 or 2 μg of a rat anti-mouse VE-PTP-ECD antibody (IgG2a), in one eye and vehicle (5% dextrose) in the fellow eye. These treatments were repeated on day 7. Fourteen days after laser, the mice were perfused with fluorescein-labeled dextran (2×10^6 average MW, Sigma, St. Louis, MO) and the extent of neovascularization was assessed in choroidal flat mounts by fluorescence microscopy. The area of CNV at each Bruch's membrane rupture site was measured by image analysis by an observer masked with respect to treatment group. The area of CNV is the average of the three rupture sites in one eye. As shown in Fig. 3, treatment with the VE-PTP-ECD antibody significantly reduced choroidal neovascularization at both 1 and 2 μg doses versus treatment with vehicle control.

Example 7

Oxygen-Induced Ischemic Retinopathy

[000220] The oxygen-induced ischemic retinopathy model is considered to represent a model of proliferative diabetic retinopathy. Ischemic retinopathy was produced in C57BL/6 mice by a method described by Smith, L.E.H., et al. Oxygen-induced retinopathy in the mouse. Invest. Ophthalmol. Vis. Sci. 35, 101-111 (1994).

[000221] C57BL/6 mice at postnatal day 7 (P7) and their mothers were placed in an airtight chamber and exposed to hyperoxia (75 ± 3% oxygen) for five days. Oxygen was continuously monitored with a PROOX model 110 oxygen controller (Reming Bioinstruments Co., Redfield, NY). On P12, mice were returned to room air and under a dissecting microscope, a Harvard Pump Microinjection System and pulled glass pipettes were used to deliver a 1 μl intravitreal injection of 1 or 2 μg of a VE-PTP-ECD antibody was made in one eye and vehicle was injected in the fellow eye. At P17, the area of NV on the surface of the retina was measured at P17 as previously described. See Shen J, et al., Invest. Ophthalmol. Vis. Sci., 2007, Vol. 48, pp. 4335-4341. Briefly, mice were given an intraocular injection of 1 μl containing 0.5 μg rat anti-mouse PECAM antibody (Pharmingen, San Jose, CA). Twelve hours later, the mice were euthanized, the eyes fixed in 10% formalin. The retinas were dissected, incubated for 40 minutes in 1:500 goat anti-rat IgG conjugated with Alexa488 (Invitrogen, Carlsbad, CA), washed, and whole mounted. An observer masked with respect to treatment group examined the slides with a Nikon Fluorescence microscope and measured the area of NV per retina by computerized image analysis using ImagePro Plus software (Media Cybernetics, Silver Spring, MD). Fig. 4 shows that treatment with the VE-PTP-ECD antibody significantly reduced retinal neovascularization at both 1 and 2 μg doses versus treatment with vehicle control. Fig. 5 shows representative retinal whole mounts from a mouse treated with vehicle versus a mouse treated with 2 μg of the VE-PTP-ECD antibody.

Example 8

Subcutaneous injection of a VE-PTP-ECD antibody

[000222] The oxygen-induced ischemic retinopathy model was conducted as described in Example 7 (containment in a 75% oxygen atmosphere from P5 to P12) for intravitreal dosing except that the VE-PTP-ECD antibody (1 mg/kg) was dosed subcutaneously at P12 when the mice were returned to room air and again on days P14 and P16 (three total doses). Neovascularization was assessed as described above on day (P17). Fig. 6 shows that subcutaneous dosing of the VE-PTP-ECD antibody reduces the area of retinal neovascularization.

Example 9

[000223] The experiment described in Example 8 was repeated at a subcutaneous dose of 2 mg/kg. (Fig. 7)

[000224] While a number of embodiments of this disclosure are described, it is apparent that the basic examples may be altered to provide other embodiments that utilize or encompass the HPTPβ-ECD binding agent, methods and processes of this invention. The embodiments and examples are for illustrative purposes and are not to be interpreted as limiting the disclosure, but rather, the appended claims define the scope of this invention.

CLAIMS

1. A method for treating a patient having vascular leak syndrome comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

2. The method of claim 1, wherein the composition further comprises one or more pharmaceutically acceptable excipient.

3. The method according to claim 1 or claim 2, wherein the patient is suffering from an inflammatory disease or condition, trauma, shock, adult respiratory distress syndrome, acute lung injury, or sepsis.

4. The method according to claim 1 or claim 2, wherein the patient is suffering from an inflammatory disease or condition.

5. The method according to claim 1 or claim 2, wherein the patient is undergoing a treatment for cancer.

6. The method according to claim 5, wherein the cancer is renal cell carcinoma, malignant melanoma, medulloblastoma, ependymoma, ogliodendroglioma, pilocytic astrocytoma, diffuse astrocytoma, anaplastic astrocytoma, or glioblastoma.

7. A method for stabilizing the vasculature of a patient in need thereof, comprising administering to the patient a composition comprising an effective amount of an HPTPβ-ECD binding agent or a pharmaceutically acceptable salt thereof.

8. The method of claim 7, wherein the composition further comprises one or more pharmaceutically acceptable excipient.

9. The method according to claim 7 or claim 8, wherein the HPTPβ-ECD binding agent is administered to the patient prior to the onset of, or during the course of treatment with IL-2.

10. The method according to claim 7 or claim 8, wherein the HPTPβ-ECD binding agent is administered to the patient prior to the onset of, or during the course of a cancer treatment.

11. The method according to claim 10, wherein the cancer is renal cell carcinoma or malignant melanoma, medulloblastoma, ependymoma, ogliodendroglioma, pilocytic astrocytoma, diffuse astrocytoma, anaplastic astrocytoma, or glioblastoma.

12. The method according to claim 10 or claim 11, wherein the cancer treatment comprises administering to the patient an effective amount of IL-2.

13. The method according to claim 7 or claim 8, wherein the patient is infected with a pathogen.

14. The method according to claim 13, wherein the pathogen is a bacterium, a virus, a yeast, a fungus, or a protozoa.

15. The method according any one of claims 1 to 14, further comprising administering to the patient an effective amount of an antibacterial agent, an antiviral agent, an anti-fungal agent, or combination thereof.

16. A method for determining the course of treatment for a patient suffering from vascular leak syndrome, comprising:

a) administering to a patient a composition comprising an effective amount of an HPTPβ-ECD binding agent;

b) monitoring the level of angiopoietin-2 present in the patient during the course of treatment; and

c) discontinuing treatment when the angiopoietin-2 level returns to within a normal range.

17. A method for treating cancer in a patient, comprising administering to a patient a composition comprising an effective amount of a specific binding agent or a pharmaceutically acceptable salt thereof.

18. The method of claim 17, wherein the composition comprises one or more pharmaceutically acceptable excipient.

19. A method for preventing metastasis in a patient with cancer, by administering to a patient a composition comprising a composition comprising an effective amount of a specific binding agent or a pharmaceutically acceptable salt thereof.

20. The method of claim 19, wherein the composition further comprises one or more pharmaceutically acceptable excipient.

21. The method according to any one of claims 17 to 20, further comprising administration of one or more chemotherapeutic agents.

22. The method according to claim 21, wherein the chemotherapeutic agent is chosen from taxol, IL-2, gemcitabine, erlotinib, doxil, irinortecan and bevacizumab.

23. The method according to any one of claims 17 to 22, wherein the cancer is renal cell carcinoma or malignant melanoma, medulloblastoma, ependymoma, ogliodendroglioma, pilocytic astrocytoma, diffuse astrocytoma, anaplastic astrocytoma, or glioblastoma.

24. A method according to any of claims 1 to 23, wherein the HPTPβ-ECD binding agent is an antibody, a protein, a peptide, an aptamer, a peptibody, an adnectin, or a nucleic acid, that binds to the extracellular portion of HPTPβ.

25. A method according to any of claims 1 to 23, wherein the HPTPβ-ECD binding agent is a monoclonal antibody or a polyclonal antibody or an antigen binding fragment thereof.

26. A method according claim 25, wherein the HPTPβ-ECD binding agent is a monoclonal antibody or an antigen binding fragment thereof.

27. The method according to claim 26, wherein the HPTPβ-ECD binding agent is: the monoclonal antibody produced by hybridoma cell line ATCC No. PTA-7680 or an antigen binding fragment thereof.

28. The method according to claim 24, wherein the HPTPβ-ECD binding agent is an antibody having the same or substantially the same biological characteristics the monoclonal antibody produced by hybridoma cell line ATCC No. PTA-7680 or an antigen binding fragment thereof.

29. A method according to any one of claims 25 to 28, wherein the HPTPβ-ECD binding agent is an antigen binding fragment wherein the antigen binding fragment is a: $F(ab')_2$, Fab, dimer of an Fab, Fv, dimer of an Fv, or dimer of a scFv.

30. The method according to any one of claims 25 to 26, wherein the HPTPβ-ECD binding agent is an antigen binding fragment wherein the antigen binding fragment is an $F(ab')_2$, dimer of an Fab, dimer of an Fv, or dimer of a scFv.

31. The method according to any one of claims 25 to 28, wherein the antigen binding fragment is an Fab, Fv, or a scFv.

32. The method according claim 24, wherein the HPTPβ-ECD binding agent is a protein, a peptide, an aptamer, a peptibody, an adnectin, or a nucleic acid.

33. The method according to any of claims 1 to 32, wherein the dose of the HPTPβ-ECD binding agent or pharmaceutically acceptable salt thereof, administered to the patient is from about 0.01 mg/kg to about 500 mg/kg by weight of the patient.

34. The method according to any of claims 1 to 32, wherein the dose of the HPTPβ-ECD binding agent or pharmaceutically acceptable salt thereof administered to the patient is from about 0.1 mg/kg to about 10 mg/kg by weight of the patient.

35. The method according to claim 33 or claim 34, wherein the dose is administered once daily, three-times weekly, twice weekly, once weekly, three times monthly, twice monthly, once monthly, or once every other month.

36. The method according to any one of claims 1 to 35, wherein the HPTPβ-ECD binding agent is conjugated to a vehicle.

37. The method according to claim 36, wherein the vehicle is PEG.

38. The method according to any one of claims 1 to 37, wherein the HPTPβ-ECD binding agent is administered by intraocular injection.

39. The method according to any one of claims 1 to 37, wherein the HPTPβ-ECD binding agent is administered by subcutaneous injection.

40. The method according to any one of claims 1 to 37, wherein the HPTPβ-ECD binding agent is administered by intravenous injection.

Application number / Numéro de demande: 2850830

Figures:

Pages: 5

Unscannable items received with this application
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Replacement Sheet
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Fig. 1

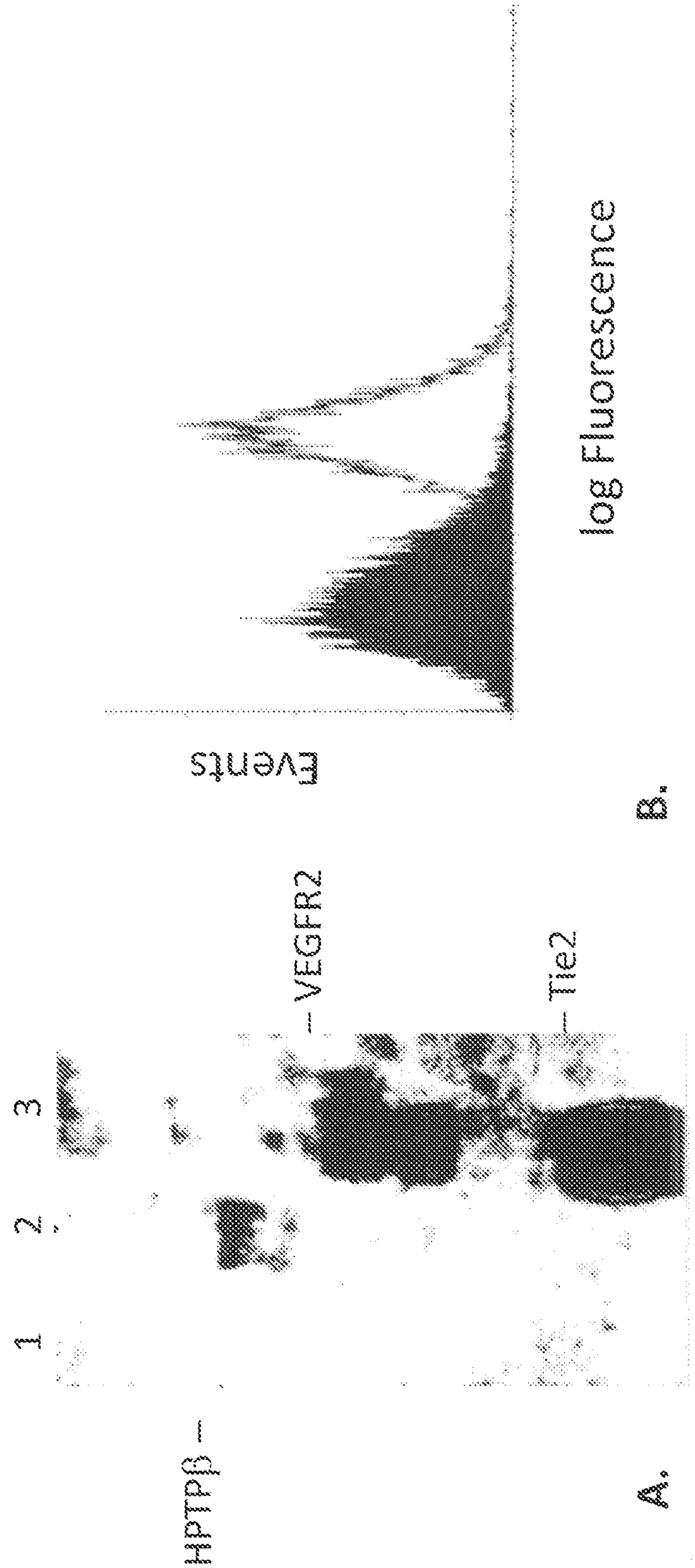

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Fig. 2

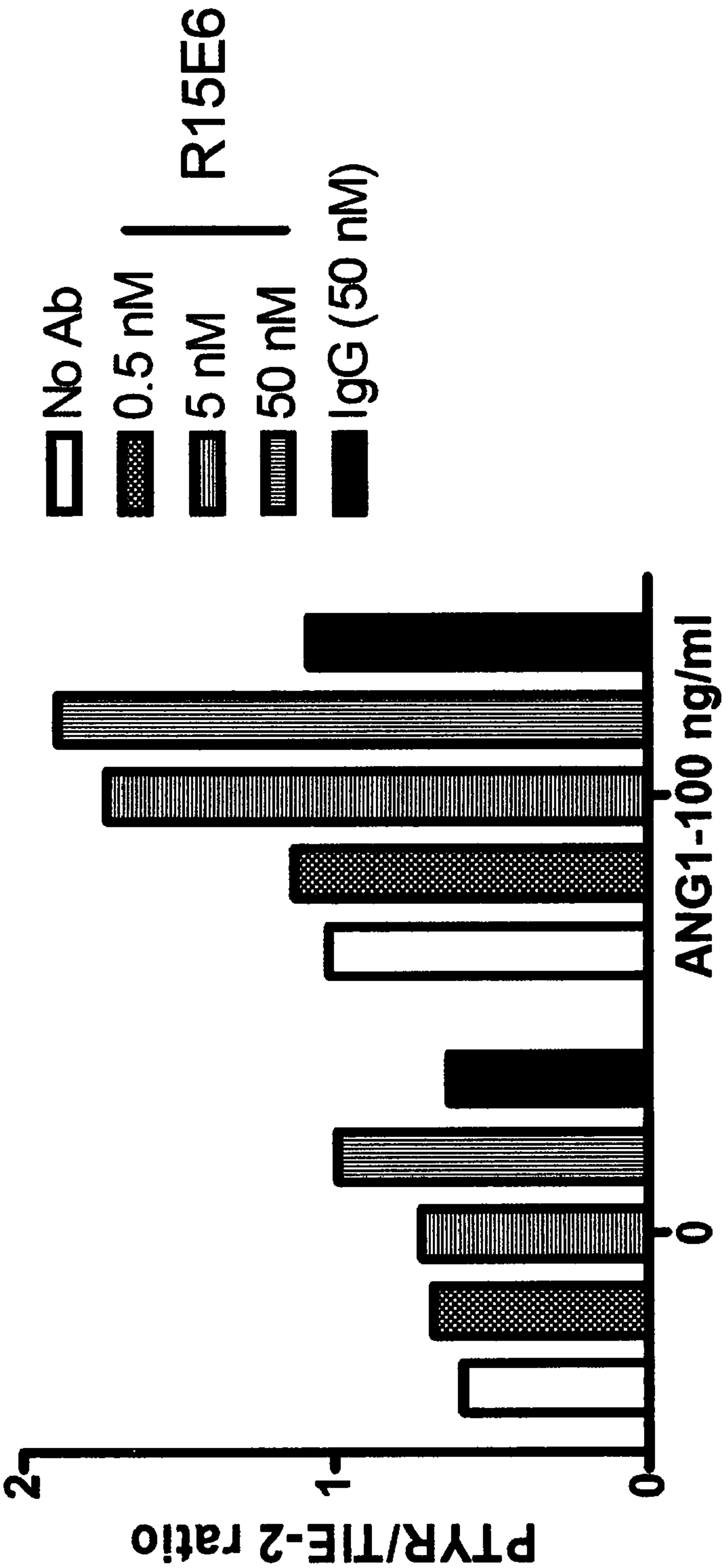

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Fig. 3

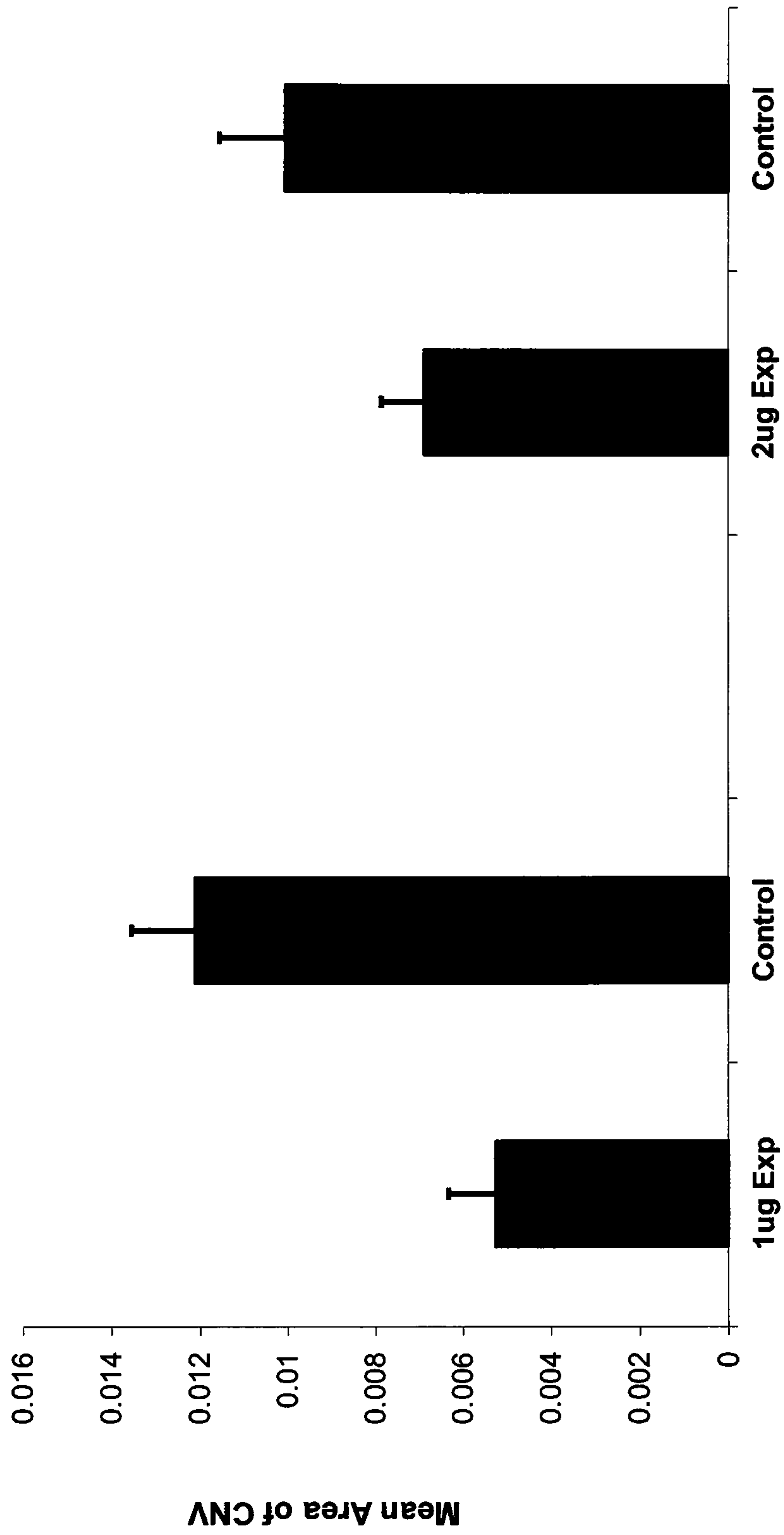

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Fig. 4

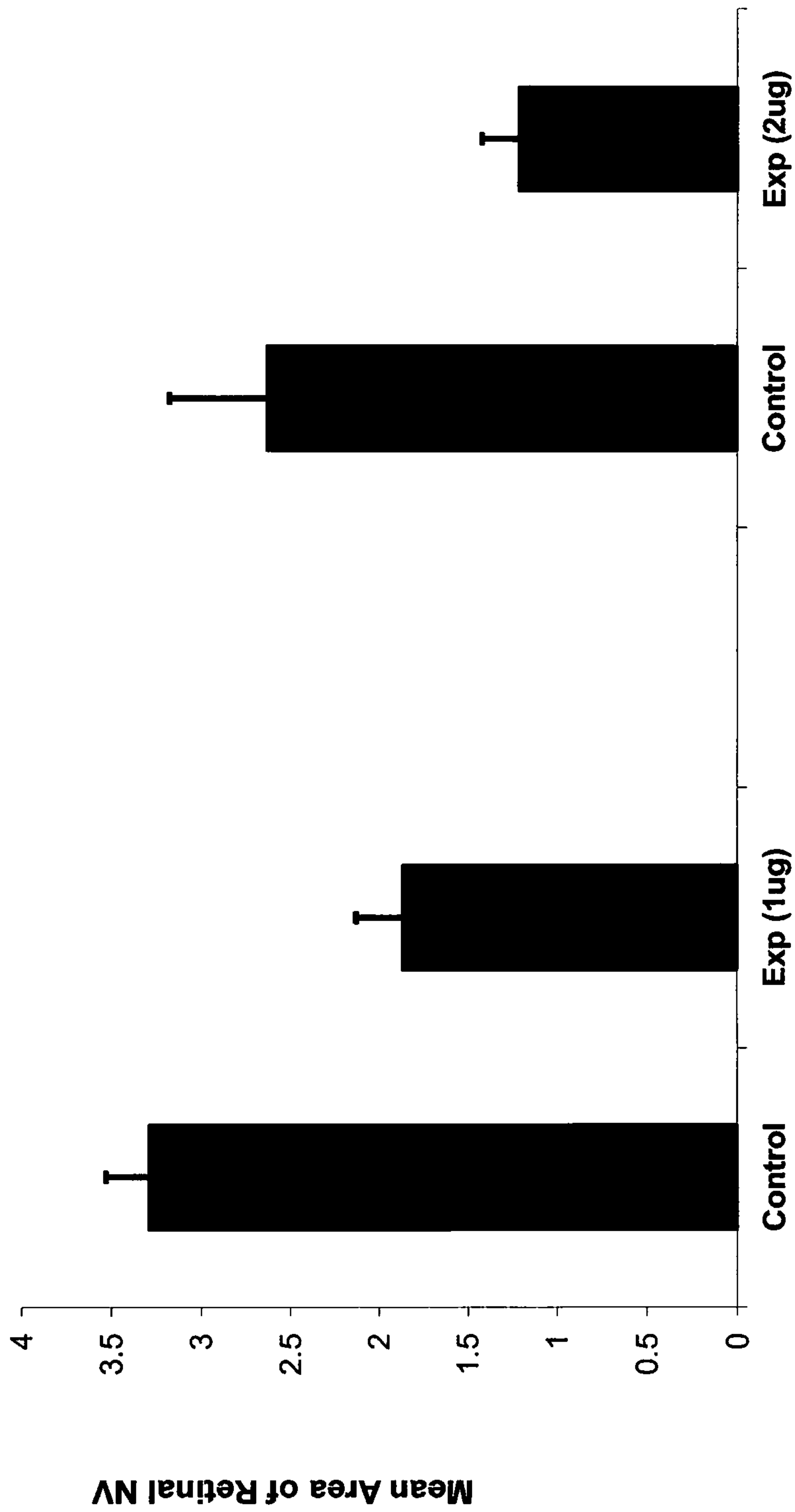

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Fig. 6

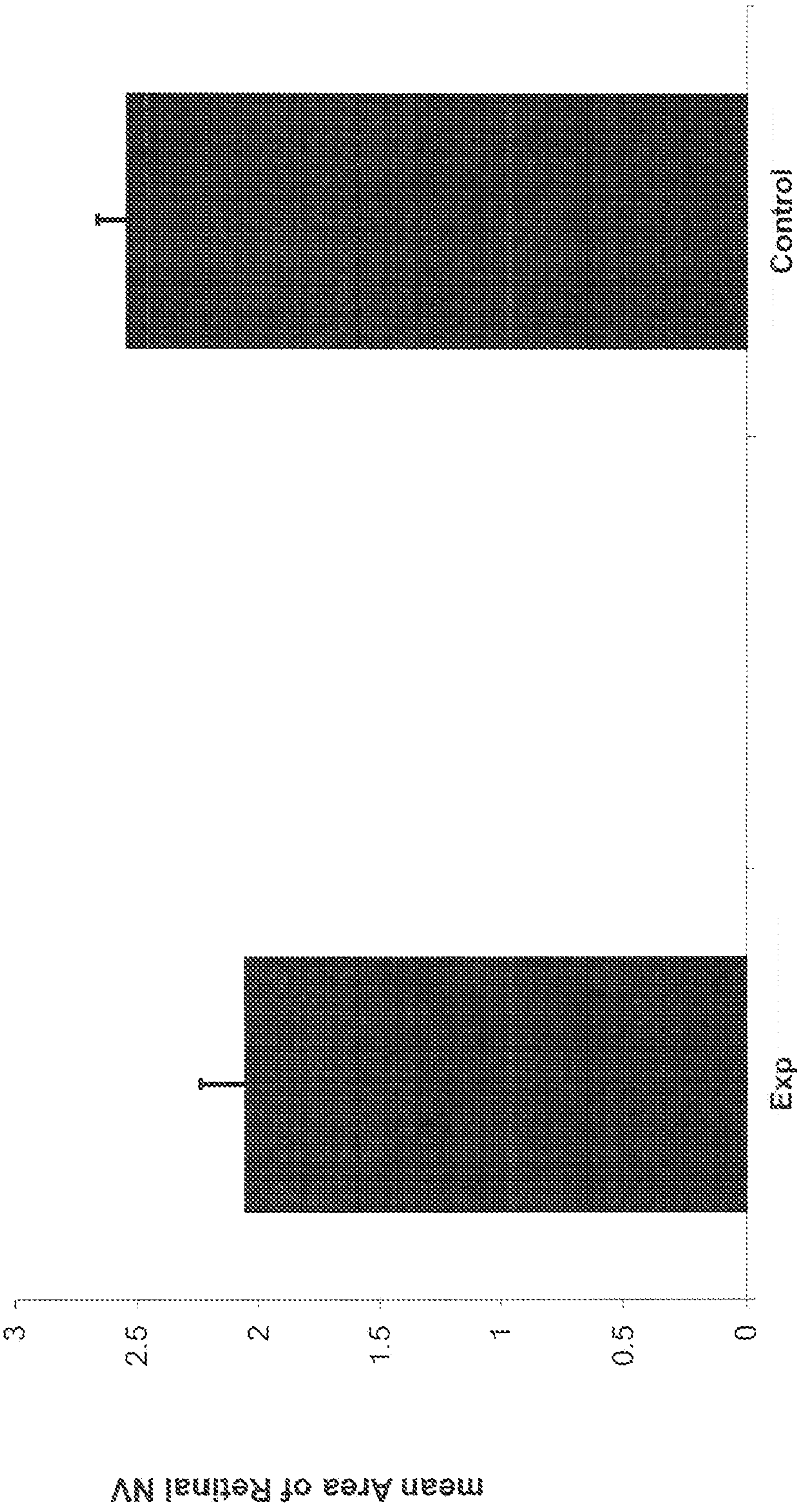

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Fig. 7