20, Asian Lineage Avian Influenza A(H7N9) Virus, Centers for Disease Control and Prevention (CDC), 7 December 2018).

Common symptoms of the influenza virus (also known as the flu) such as fever, headaches and fatigue are the result of large amounts of proinflammatory cytokines and chemokines (such as interferon or tumor necrosis factor) produced from influenza-infected cells. See Eccles R. et al., Lancet Infect Dis 5(11):718-25 (2005); Schmitz N, et al., *Journal of Virology*. **79** (10): 6441–8 (2005). This massive immune response may result in a life-threatening cytokine storm. This effect has been proposed to be the cause of the unusual lethality of both the H5N1 avian influenza, and the 1918 pandemic strain. Cheung CY, et al., *Lancet*. **360** (9348): 1831–37 (2002); Kash JC, et al., *Nature*. **443** (7111): 578–81 (2006). Influenza also appears to trigger programmed cell death (apoptosis) see Spiro SG, et al., Clinical Respiratory Medicine, Elsevier Health Sciences. p. 311 (2012).

Thus, there is an urgent need to develop therapeutically effective agents to treat, inhibit and/or prevent coronavirus-induced pneumonia and acute respiratory distress syndrome and influenza virus induced pneumonia and acute respiratory distress syndrome.

SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

In one example, the present disclosure provides a method for treating, inhibiting, alleviating, or preventing acute respiratory distress syndrome in a mammalian subject infected with coronavirus, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In some examples, the subject is suffering from one or more respiratory symptoms and the method comprises administering to the subject an amount of a MASP-2 inhibitory agent effective to improve at least one respiratory symptom (i.e., improve respiratory function). In one example, the method comprises administering the composition to a subject infected with SARS-CoV-2. In one example, the method comprises administering the composition to a subject suffering from COVID-19, such as a subject

suffering from acute-respiratory distress syndrome (ARDS) associated with COVID-19. In one example, the method comprises administering the composition to a subject infected with SARS-CoV. In one example, the method comprises administering the composition to a subject infected with MERS-CoV. In one example, the subject is identified as having coronavirus (i.e., SARS-CoV-2, SARS-CoV or MERS-CoV) prior to administration of the MASP-2 inhibitory agent. In one example, the MASP-2 inhibitory agent is a MASP-2 antibody or antigen-binding fragment thereof. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent selectively inhibits lectin pathway complement activation without substantially inhibiting C1q-dependent complement activation. In one example, the MASP-2 inhibitory agent is a small molecule, such as a synthetic or semi-synthetic small molecule that inhibits MASP-2-dependent complement activation. In one example, the MASP-2 inhibitory agent is an expression inhibitor of MASP-2. In one example, the MASP-2 inhibitory antibody is a monoclonal antibody, or fragment thereof that specifically binds to human MASP-2. In one example, the MASP-2 inhibitory antibody or fragment thereof is selected from the group consisting of a recombinant antibody, an antibody having reduced effector function, a chimeric antibody, a humanized antibody, and a human antibody. In one example, the MASP-2 inhibitory antibody does not substantially inhibit the classical pathway. In one example, the MASP-2 inhibitory antibody inhibits C3b deposition in 90% human serum (i.e., normal human serum) with an IC_{50} of 30 nM or less. In one example, the MASP-2 inhibitory antibody or antigen-binding fragment thereof, comprises a heavy chain variable region comprising CDR-H1, CDR-H2 and CDR-H3 of the amino acid sequence set forth as SEQ ID NO:67 and a light chain variable region comprising CDR-L1, CDR-L2 and CDR-L3 of the amino acid sequence set forth as SEQ ID NO:69. In one example, the MASP-2 inhibitory antibody or antigen-binding fragment thereof comprises a heavy chain variable region comprising the amino acid sequence set forth as SEQ ID NO:67 and a light chain variable region comprising the amino acid sequence set forth as SEQ ID NO:69.

In another example, the present disclosure provides a method for treating, inhibiting, alleviating, or preventing acute respiratory distress syndrome in a mammalian subject infected with influenza virus, comprising administering to the subject an amount of a

MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In some examples, the subject is suffering from one or more respiratory symptoms and the method comprises administering to the subject an amount of a MASP-2 inhibitory agent effective to improve at least one respiratory symptom (i.e., improve respiratory function). In one example, the subject is infected with an influenza virus selected from the group consisting of influenza virus Type A, influenza virus Type B and influenza virus Type C. In one example, the subject is infected with influenza Type A. In one example, the subject is infected with an influenza Type A serotype selected from the group consisting of H1N1, H2N2, H3N2, H5N1, H7N7, H1N2, H9N2, H7N2, H7N3, H10N7, H7N9 and H6N1. In one example, the subject is identified as having influenza virus prior to administration of the MASP-2 inhibitory agent. In one example, the MASP-2 inhibitory agent is a MASP-2 antibody or antigen-binding fragment thereof. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent selectively inhibits lectin pathway complement activation without substantially inhibiting C1q-dependent complement activation. In one example, the MASP-2 inhibitory agent is a small molecule, such as a synthetic or semi-synthetic small molecule that inhibits MASP-2-dependent complement activation. In one example, the MASP-2 inhibitory agent is an expression inhibitor of MASP-2. In one example, the MASP-2 inhibitory antibody is a monoclonal antibody, or fragment thereof that specifically binds to human MASP-2. In one example, the MASP-2 inhibitory antibody or fragment thereof is selected from the group consisting of a recombinant antibody, an antibody having reduced effector function, a chimeric antibody, a humanized antibody, and a human antibody. In one example, the MASP-2 inhibitory antibody does not substantially inhibit the classical pathway. In one example, the MASP-2 inhibitory antibody inhibits C3b deposition in 90% human serum with an IC_{50} of 30 nM or less. In one example, the MASP-2 inhibitory antibody or antigen-binding fragment thereof, comprises a heavy chain variable region comprising CDR-H1, CDR-H2 and CDR-H3 of the amino acid sequence set forth as SEQ ID NO:67 and a light chain variable region comprising CDR-L1, CDR-L2 and CDR-L3 of the amino acid sequence set forth as SEQ ID NO:69. In one example, the MASP-2 inhibitory antibody or antigen-binding fragment thereof comprises a heavy chain variable region comprising the amino acid sequence set forth as

SEQ ID NO:67 and a light chain variable region comprising the amino acid sequence set forth as SEQ ID NO:69.

In another example, the disclosure provides a method for treating, inhibiting, alleviating or preventing fibrosis in a mammalian subject suffering, or at risk of developing a disease or disorder caused or exacerbated by fibrosis and/or inflammation, such as coronavirus infection, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit fibrosis. In one example, the MASP-2 inhibitory agent is a MASP-2 antibody or fragment thereof. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent selectively inhibits lectin pathway complement activation without substantially inhibiting C1q-dependent complement activation.

In another example, the disclosure provides a method for treating, inhibiting, alleviating, or preventing acute respiratory distress syndrome, pneumonia, or some other pulmonary or other manifestation of coronavirus infection, such as thrombosis, in a mammalian subject infected with coronavirus, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent is a small molecule MASP-2 inhibitory compound.

In another example, the disclosure provides a method for treating a human subject suffering from COVID-19 induced acute respiratory distress syndrome (ARDS) or pneumonia, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In one example, the subject is on a mechanical ventilator (an invasive mechanical ventilator or a non-invasive mechanical ventilator) prior to treatment and the MASP-2 inhibitory agent is administered at a dosage and for a time period sufficient to discontinue the need for mechanical ventilation. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent is a small molecule MASP-2 inhibitory compound.

In another example, the disclosure provides a method for treating, preventing or reducing the severity or coagulation or thrombosis in a human subject infected with SARS-CoV-2 comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to treat, prevent or reduce the severity of coagulation or thrombosis in said subject. In one example, the subject has a D-Dimer level higher than the standard range prior to treatment and the MASP-2 inhibitory agent is administered in an amount and for a time sufficient to reduce the level of D-Dimer in said subject into the normal range of a healthy subject. In one example, the MASP-2 inhibitory agent provides anticoagulation and/or antithrombosis effects without affecting hemostatis. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent is a small molecule MASP-2 inhibitory compound.

In another example, the disclosure provides a method for treating, ameliorating, preventing or reducing the risk of developing one or more COVID-19-related long-term sequelae in a human subject that is currently infected with SARS-CoV-2 or has been infected with SARS-CoV-2, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In one example, the subject is suffering from COVID-19-induced pneumonia or ARDS and the MASP-2 inhibitory agent is administered in an amount effective to improve respiratory function. In one example, the subject has recovered from COVID-19 induced pneumonia or ARDS and the MASP-2 inhibitory agent is administered in an amount to treat or ameliorate one or more long-term sequelae. In one example, the subject is suffering from COVID-19-induced coagulation or thrombosis and the MASP-2 inhibitory agent is administered to the subject in an amount effective to treat, prevent or reduce the severity of coagulation or thrombosis in said subject. In one example, the subject has recovered from COVID-19 induced coagulation or thrombosis and the MASP-2 inhibitory agent is administered in an amount to treat or ameliorate one or more long-term sequelae. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent is a small molecule MASP-2 inhibitory compound.

In another example, the disclosure provides a method for treating, inhibiting, alleviating or preventing acute respiratory distress syndrome, pneumonia or some other pulmonary or other manifestation of influenza virus infection, in a mammalian subject infected with influenza virus, comprising administering to the subject an amount of a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation. In one example, the influenza virus is influenza virus A, influenza virus B or influenza virus C. In one example, the influenza virus A is selected from the group consisting of H1N1, H2N2, H3N2, H5N1, H7N7, H1N2, H9N2, H7N2, H7N3, H10N7, H7N9 and H6N1. In one example, the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6. In one example, the MASP-2 inhibitory agent is a small molecule MASP-2 inhibitory compound.

In one aspect, the present disclosure refers to a use of a composition comprising a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation in the manufacture of a medicament for treating, inhibiting, alleviating or preventing acute respiratory distress syndrome, pneumonia or some other pulmonary manifestation of influenza virus infection, in a mammalian subject infected with influenza virus.

Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a diagram illustrating the genomic structure of human MASP-2;

FIGURE 2A is a schematic diagram illustrating the domain structure of human MASP-2 protein;

FIGURE 2B is a schematic diagram illustrating the domain structure of human MAp19 protein;

FIGURE 3 is a diagram illustrating the murine MASP-2 knockout strategy;

FIGURE 4 is a diagram illustrating the human MASP-2 minigene construct;

FIGURE 5A presents results demonstrating that MASP-2-deficiency leads to the loss of lectin-pathway-mediated C4 activation as measured by lack of C4b deposition on mannan, as described in Example 2;

FIGURE 5B presents results demonstrating that MASP-2-deficiency leads to the loss of lectin-pathway-mediated C4 activation as measured by lack of C4b deposition on zymosan, as described in Example 2;

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Use of a composition comprising a MASP-2 inhibitory agent effective to inhibit MASP-2-dependent complement activation in the manufacture of a medicament for treating, inhibiting, alleviating or preventing acute respiratory distress syndrome, pneumonia or some other pulmonary manifestation of influenza virus infection, in a mammalian subject infected with influenza virus.

2. The use of claim 1, wherein the influenza virus is influenza virus A, influenza virus B or influenza virus C.

3. The use of claim 2, wherein the influenza virus A is selected from the group consisting of H1N1, H2N2, H3N2, H5N1, H7N7, H1N2, H9N2, H7N2, H7N3, H10N7, H7N9 and H6N1.

4. The use of claim 1, wherein the subject has influenza virus prior to administration of the MASP-2 inhibitory agent.

5. The use of claim 1, wherein the MASP-2 inhibitory agent is to be administered in an amount effective to improve respiratory function.

6. The use of claim 1, wherein the MASP-2 inhibitory agent is a MASP-2 antibody or fragment thereof.

7. The use of claim 6, wherein the MASP-2 inhibitory agent is a MASP-2 monoclonal antibody, or fragment thereof that specifically binds to a portion of SEQ ID NO:6.

8. The use of claim 6, wherein the MASP-2 antibody or fragment thereof specifically binds to a polypeptide comprising SEQ ID NO:6 with an affinity of at least 10 times greater than it binds to a different antigen in the complement system.

9. The use of claim 6, wherein the antibody or fragment thereof is selected from the group consisting of a recombinant antibody, an antibody having reduced effector function, a chimeric antibody, a humanized antibody and a human antibody.

10. The use of claim 6, wherein the MASP-2 inhibitory antibody selectively inhibits lectin pathway complement activation without substantially inhibiting C1q-dependent complement activation.

11. The use of claim 6, wherein the MASP-2 inhibitory antibody inhibits C3b deposition in 10% human serum with an IC_{50} of 30 nM or less.

12. The use of claim 6, wherein the MASP-2 inhibitory antibody inhibits C3b deposition in 90% human serum with an IC_{50} of 30 nM or less.

13. The use of claim 6, wherein the MASP-2 inhibitory antibody or antigen-binding fragment thereof comprises a heavy chain variable region comprising CDR-H1, CDR-H2 and CDR-H3 of the amino acid sequence set forth as SEQ ID NO:67 and a light chain variable region comprising CDR-L1, CDR-L2 and CDR-L3 of the amino acid sequence set forth as SEQ ID NO:69.

14. The use of claim 6, wherein the MASP-2 inhibitory antibody or antigen-binding fragment thereof comprises a heavy chain variable region comprising SEQ ID NO:67 and a light chain variable region comprising SEQ ID NO:69.