METHODS OF TREATING PEDIATRIC CANCERS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application Serial Nos. 62/318,041, filed April 4, 2016; 62/323,437, filed April 15, 2016; 62/329,653, filed April 29, 2016; 62/380,773, filed August 29, 2016; and 62/449,366, filed January 23, 2017, each of which is incorporated by reference in its entirety herein.

BACKGROUND

1. FIELD OF THE INVENTION

The present disclosure relates to (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (Formula (**I**)) and to pharmaceutically acceptable salts thereof, for example the hydrogen sulfate salt, a crystalline form of the hydrogen sulfate salt, and further to liquid formulations thereof, which exhibit Trk family protein tyrosine kinase inhibition, and the use of the compound, salts, crystalline forms, and liquid formulations in the treatment of pediatric cancers.

2. DESCRIPTION OF THE RELATED ART

Infantile fibrosarcoma (IFS) is a rare pediatric cancer typically presenting in the first two years of life. Surgical resection can be curative and chemotherapy is active against gross residual disease. However, when recurrences occur, therapeutic options are often limited.

Trk's are the high affinity receptor tyrosine kinases activated by a group of soluble growth factors called neurotrophins (NT). The Trk receptor family has three members – TrkA, TrkB and TrkC. Among the neurotrophins are (i) nerve growth factor (NGF) which activates TrkA, (ii) brain-derived neurotrophic factor (BDNF) and NT-4/5 which activate TrkB and (iii) NT3 which activates TrkC. Trk's are widely expressed in neuronal tissue and are implicated in the maintenance, signaling and survival of neuronal cells (Patapoutian, A. et al., Current Opinion in Neurobiology, 2001, 11, 272-280).

Recent literature has shown that overexpression, activation, amplification and/or mutation of Trk's are associated with many cancers including neuroblastoma (Brodeur, G. M., Nat. Rev. Cancer 2003, 3, 203-216), ovarian cancer (Davidson., B. et al., Clin. Cancer Res. 2003, 9, 2248-2259), breast cancer (Kruettgen et al., Brain Pathology 2006, 16: 304-310), prostate cancer (Dionne et al., Clin. Cancer Res. 1998, 4(8): 1887-1898), pancreatic

cancer (Dang et al., Journal of Gastroenterology and Hepatology 2006, 21(5): 850-858), multiple myeloma (Hu et al., Cancer Genetics and Cytogenetics 2007, 178: 1-10), astrocytoma amd medulloblastoma (Kruettgen et al., Brain Pathology 2006, 16: 304-310), glioma (Hansen et al., Journal of Neurochemistry 2007, 103: 259–275), melanoma (Nakagawara, A. (2001) *Cancer Letters* 169:107-114; Meyer, J. et al. (2007) *Leukemia*, 1–10; Pierottia, M.A. and Greco A., (2006) *Cancer Letters* 232:90–98; Eric Adriaenssens, E. et al. *Cancer Res* (2008) 68:(2) 346-351), thyroid carcinoma (Brzezianska et al., Neuroendocrinology Letters 2007, 28(3), 221-229), lung adenocarcinoma (Perez-Pinera et al., Molecular and Cellular Biochemistry 2007, 295(1&2), 19-26), large cell neuroendocrine tumors (Marchetti et al., Human Mutation 2008, 29(5), 609-616), and colorectal cancer (Bardelli, A., Science 2003, 300, 949). In preclinical models of cancer, Trk inhibitors are efficacious in both inhibiting tumor growth and stopping tumor metastasis. In particular, non-selective small molecule inhibitors of TrkA, TrkB, TrkC and Trk/Fc chimeras were efficacious in both inhibiting tumor growth and stopping tumor metastasis (Nakagawara, A. (2001) *Cancer Letters* 169:107-114; Meyer, J. et al. (2007) *Leukemia*, 1–10; Pierottia, M.A. and Greco A., (2006) *Cancer Letters* 232:90–98; Eric Adriaenssens, E. et al. *Cancer Res* (2008) 68:(2) 346-351). Therefore, an inhibitor of the Trk family of kinases is expected to have utility in the treatment of cancer.

In addition, inhibitors of the Trk/neurotrophin pathway have been demonstrated to be effective in numerous pre-clinical animal models of pain. For example, antagonistic NGF and TrkA antibodies (for example, RN-624) have been shown to be efficacious in inflammatory and neuropathic pain animal models and in human clinical trials (Woolf, C.J. et al. (1994) *Neuroscience* 62,327–331; Zahn, P.K. et al. (2004) *J. Pain* 5, 157–163; McMahon, S. B. et al., (1995) *Nat. Med.* 1, 774–780; Ma, Q. P. and Woolf, C. J. (1997) *Neuroreport* 8, 807–810; Shelton, D. L. et al. (2005) *Pain* 116, 8–16; Delafoy, L. et al. (2003) *Pain* 105, 489–497; Lamb, K. et al. (2003) *Neurogastroenterol. Motil.* 15, 355–361; Jaggar, S. I. et al. (1999) *Br. J. Anaesth.* 83, 442–448). Additionally, recent literature indicates after inflammation, BDNF levels and TrkB signaling is increased in the dorsal root ganglion (Cho, L. *et al.* Brain Research 1997, 749, 358) and several studies have shown antibodies that decrease signaling through the BDNF/TrkB pathway inhibit neuronal hypersensitization and the associated pain (Chang-Qi, L *et al.* Molecular Pain 2008, 4:27).

It has been shown that NGF secreted by tumor cells and tumor invading macrophages directly stimulates TrkA located on peripheral pain fibers. Using various tumor models in both mice and rats it was demonstrated that neutralizing NGF with a monoclonal antibody

inhibits cancer related pain to a degree similar or superior to the highest tolerated dose of morphine. In addition, activation of the BDNF/TrkB pathway has been implicated in numerous studies as a modulator of various types of pain including inflammatory pain (Matayoshi, S., J. Physiol. 2005, 569:685-95), neuropathic pain (Thompson, S.W., Proc. Natl. Acad. Sci. USA 1999, 96:7714-18) and surgical pain (Li, C.-Q. et al., Molecular Pain, 2008, 4(28), 1-11). Because TrkA and TrkB kinases may serve as a mediator of NGF driven biological responses, inhibitors of TrkA and/or other Trk kinases may provide an effective treatment for chronic pain states.

The current treatment regimens for pain conditions utilize several classes of compounds. The opioids (such as morphine) have several drawbacks including emetic, constipatory and negative respiratory effects, as well as the potential for addictions. Non-steroidal anti-inflammatory analgesics (NSAIDs, such as COX-1 or COX-2 types) also have drawbacks including insufficient efficacy in treating severe pain. In addition, COX-1 inhibitors can cause ulcers of the mucosa. Accordingly, there is a continuing need for new and more effective treatments for the relief of pain, especially chronic pain.

In addition, inhibition of the neurotrophin/Trk pathway has been shown to be effective in treatment of pre-clinical models of inflammatory diseases. For example, inhibition of the neurotrophin/Trk pathway has been implicated in preclinical models of inflammatory lung diseases including asthma (Freund-Michel, V; Frossard, N.; *Pharmacology & Therapeutics* (2008), 117(1), 52-76), interstitial cystitis (Hu Vivian Y; et. al. *The Journal of Urology* (2005), 173(3), 1016-21), inflammatory bowel diseases including ulcerative colitis and Crohn's disease (Di Mola, F. F, et. al., Gut (2000), 46(5), 670-678) and inflammatory skin diseases such as atopic dermatitis (Dou, Y.-C.; et. al. *Archives of Dermatological Research* (2006), 298(1), 31-37), eczema and psoriasis (Raychaudhuri, S. P.; et. al. Journal of Investigative Dermatology (2004), 122(3), 812-819).

The neurotrophin/Trk pathway, particularly BDNF/TrkB, has also been implicated in the etiology of neurodegenerative diseases including multiple sclerosis, Parkinson's disease and Alzheimer's disease (Sohrabji, Farida; Lewis, Danielle K. Frontiers in Neuroendocrinology (2006), 27(4), 404-414). Modulation of the neutrophin/Trk pathway may have utility in treatment of these and related diseases.

The TrkA receptor is also thought to be critical to the disease process in the infection of the parasitic infection of Trypanosoma cruzi (Chagas disease) in human hosts (de Melo-Jorge, M. et al. *Cell Host & Microbe* (2007), 1(4), 251-261). Thus, TrkA inhibition may have utility in treating Chagas disease and related protozoan infections.

Trk inhibitors may also find use in treating disease related to an imbalance of the regulation of bone remodeling, such as osteoporosis, rheumatoid arthritis, and bone metastases. Bone metastases are a frequent complication of cancer, occurring in up to 70 percent of patients with advanced breast or prostate cancer and in approximately 15 to 30 percent of patients with carcinoma of the lung, colon, stomach, bladder, uterus, rectum, thyroid, or kidney. Osteolytic metastases can cause severe pain, pathologic fractures, life threatening hypercalcemia, spinal cord compression, and other nerve-compression syndromes. For these reasons, bone metastasis is a serious and costly complication of cancer. Therefore, agents that can induce apoptosis of proliferating osteoblasts would be highly advantageous. Expression of TrkA and TrkC receptors has been observed in the bone forming area in mouse models of bone fracture (K. Asaumi, et al., Bone (2000) 26(6) 625-633). In addition, localization of NGF was observed in almost all bone forming cells (K. Asaumi, et al.). Recently, it was demonstrated that a pan-Trk inhibitor inhibits the tyrosine signaling activated by neurotrophins binding to all three of the Trk receptors in human hFOB osteoblasts (J. Pinski, et al., (2002) 62, 986-989). These data support the rationale for the use of Trk inhibitors for the treatment of bone remodeling diseases, such as bone metastases in cancer patients.

Several classes of small molecule inhibitors of Trk kinases said to be useful for treating pain or cancer are known (*Expert Opin. Ther. Patents* (2009) 19(3)).

International Patent Application Publications WO 2006/115452 and WO 2006/087538 describe several classes of small molecules said to be inhibitors of Trk kinases which could be useful for treating pain or cancer.

Pyrazolo[1,5-a]pyrimidine compounds are known. For example, International Patent Application Publication WO 2008/037477 discloses pyrazolo[1,5-a]pyrimidine compounds bearing an alkyl, aryl or heterocyclic group at the 3-position. These compounds are asserted to be PI3K and/or mTOR Lipid Kinase inhibitors.

PCT Patent Publication No. WO 2008/058126 discloses pyrazolo[1,5-a]pyrimidine compounds bearing a phenyl group at the 3-position. These compounds are asserted to be Pim-kinase inhibitors.

U.S. Patent Publication No. 2006/0094699 discloses pyrazolo[1,5-a]pyrimidine compounds bearing a –C(=O)NH-phenyl, –C(=O)(4-methylpiperidinyl) or –C(=O)NMe(CH_2-trimethylpyrazolyl) group at the 3-position for use in combination therapy with a glucocorticoid receptor agonist.

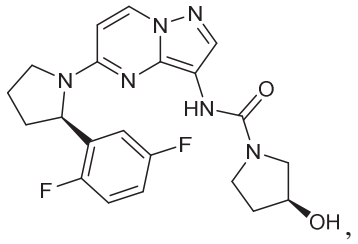
PCT Patent Publication Nos. WO 2010/033941, WO 2010/048314, WO 2011/006074, and WO 2011/146336 disclose compounds which exhibit Trk family protein tyrosine kinase inhibition, and which are useful in the treatment of pain, cancer, inflammation, neurodegenerative diseases and certain infectious diseases.

WO 2010/048314 discloses in Example 14A a hydrogen sulfate salt of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide. WO 2010/048314 does not disclose the particular form of the hydrogen sulfate salt described herein when prepared according to the method of Example 14A in that document. In particular, WO 2010/048314 does not disclose crystalline form (I-HS) as described below.

All documents, including scientific articles, patent publications and applications, and the like, referenced in the present disclosure are hereby incorporated by reference in their entirety.

SUMMARY

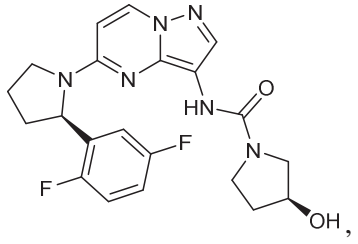
Provided herein are methods of treating a pediatric cancer in a subject in need thereof comprising administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or combinations thereof.

In one aspect, the present disclosure refers to use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or combinations thereof, in the manufacture of a liquid formulation for the treatment of a pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof;

hydroxypropyl-β-cyclodextrin;

sodium citrate; and

a sweetener;

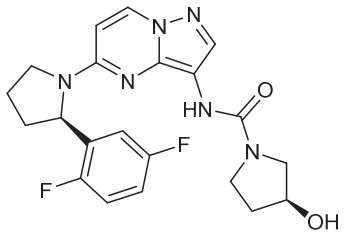
wherein:

the formulation has a pH of 2.5 to 5.5; and

the compound of formula **(I)**, the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

In another aspect, the present disclosure refers to use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof in the manufacture of a liquid formulation for treating a Trk-associated pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

hydroxypropyl-β-cyclodextrin present in an amount from 13 wt.% to 17 wt.%;

sodium citrate dihydrate present in an amount from 0.7 wt.% to 1.5 wt.%;

a sweetener that includes sucrose, glycerin, sorbitol, and flavoring, wherein the sweetener is buffered with citric acid and sodium phosphate, wherein the sweetener is preserved with methylparaben and potassium sorbate, and wherein the sweetener is present in an amount from 45 wt.% to 55 wt.%; and

a bitterness masking agent present in the liquid formulation in an amount from 0.2 wt.% to 0.5 wt.%;

wherein:

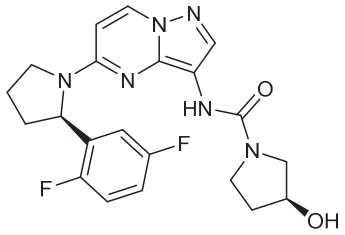
the formulation has a pH of 2.5 to 5.5; and

the compound of formula (I), the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

In yet another aspect, the present disclosure refers to use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof in the

manufacture of a liquid formulation for treating a Trk-associated pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

hydroxypropyl-β-cyclodextrin present in an amount from 13 wt.% to 17 wt.%;

sodium citrate dihydrate present in an amount from 0.7 wt.% to 1.5 wt.%;

a sweetener that includes sucralose; and

a flavoring agent present in an amount from 0.01 wt.% to 0.1 wt.%;

wherein:

the formulation has a pH of 2.5 to 5.5; and

the compound of formula (I), the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

In some examples, the subject is an infant, child, or adolescent. For example, the subject is an infant.

In some examples, the pediatric cancer is a mesenchymal cancer. For example, the mesenchymal cancer can be selected from the group consisting of: pediatric nephroma, congenital fibrosarcoma (CFS), pediatric high-grade glioma (HGG), mesenchymal cancers (infant fibrosarcoma (IF), congenital mesoblastic nephroma, congenital infantile fibrosarcoma (CIFS); pilocytic astrocytoma, brain tumors, pediatic acute leukemia, Ph-like

acute lymphoblastic leukemia, cellular congenital mesoblastic nephroma (CMN); infantile fibrosarcoma, pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), non-brainstem HGGs (NBS-HGGs), anaplastic large cell lymphoma (ALCL), non-Hodgkin's lymphoma (NHL), pediatric papillary thyroid carcinoma, soft tissue sarcoma, spitzoid melanoma, pediatric hemangiopericytoma-like sarcoma, spindle cell sarcoma, NOS with myo/haemangiopericytic growth pattern, lung cancer, advanced pediatric solid tumors, neuroectodermal-derived tumors, pediatric colorectal cancer, adrenal neuroblastoma, and central nervous system tumors.

In some examples, the pediatric cancer is a fibrosarcoma such as infantile fibrosarcoma.

In some examples, the pediatric cancer is a glioma. For example, the pediatric cancer is selected from the group consisting of: pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), and on-brainstem HGGs (NBS-HGGs).

In some examples, the pediatric cancer is an extracranial solid tumor. For example, the pediatric cancer is selected from the group consisting of: neuroblastoma, nephroblastoma (e.g., Wilm's tumor), rhabdomyosarcoma and hepatoblastoma

In some examples, the cancer is mediated by TrkA. In some examples, the cancer is mediated by TrkB. In some examples, the cancer is mediated by TrkC. In some examples, the cancer is mediated by TrkA, TrkB, TrkC, or combinations thereof.

In some examples, surgical resection has failed to inhibit progression of the fibrosarcoma in the subject. In some examples, chemotherapy has failed to inhibit tumor progression in the subject. In some such examples, the chemotherapy comprises administering at least one of vincristine, actinomycin-D, cyclophosphamide, ifosfamide, etoposide, or doxorubicin. For example, the chemotherapy including administering vincristine, actinomycin-D, and cyclophosphamide has failed to inhibit tumor progression in the subject. In some examples, the chemotherapy including administering ifosfamide and doxorubicin has failed to inhibit tumor progression in the subject.

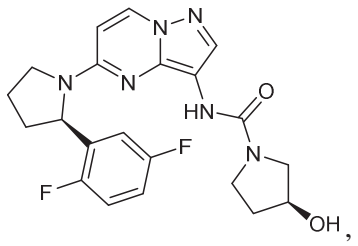
In some examples, the subject has a cancer that is ETV6-NTRK3 fusion positive.

In some examples, the methods provided herein further include performing a morphological diagnosis, molecular testing, or both prior to administering the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof.

Also provided herein is a method of treating an infantile fibrosarcoma, the method comprising administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-

hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:

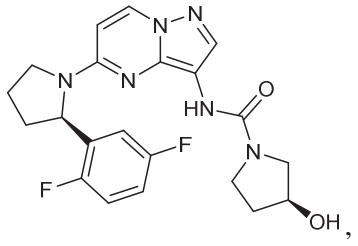


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Disclosed herein is use of a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:

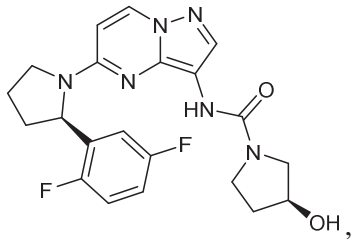


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, in the manufacture of a medicament for the treatment of an infantile fibrosarcoma.

Further provided herein is a method of treating a subject diagnosed or identified as having a Trk-associated pediatric cancer, the method comprising administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:

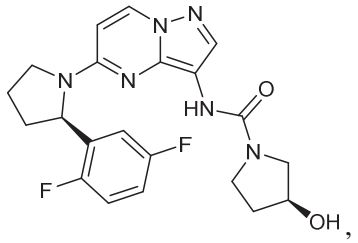


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Disclosed herein is use of a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



(I)

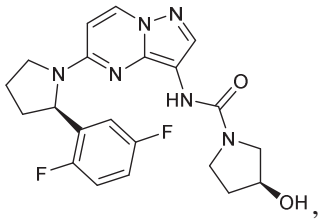
a pharmaceutically acceptable salt thereof, or a combination thereof, in the manufacture of a medicament for the treatment of a subject diagnosed or identified as having a Trk-associated pediatric cancer.

This disclosure also provides a method for treating a pediatric cancer in a subject in need thereof, the method comprising:

(a) determining if the cancer is associated with one or more of overexpression, activation, amplification, and mutation of a Trk kinase; and

(b) if the cancer is determined to be associated with one or more of overexpression, activation, amplification, and mutation of a Trk kinase, administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:

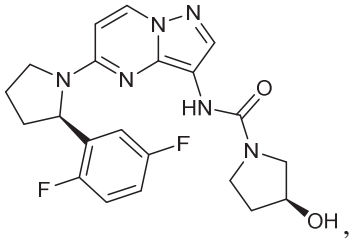


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Disclosed herein is use of a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, in the manufacture of a medicament for the treatment of a pediatric cancer in a subject in need thereof,

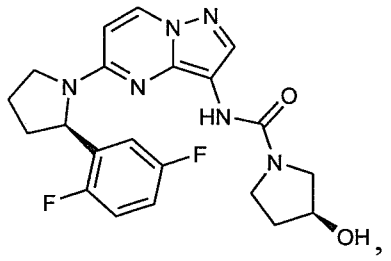
wherein the cancer is determined to be associated with one or more of overexpression, activation, amplification, and mutation of a Trk kinase.

This disclosure also provides a method for treating a pediatric cancer in a subject in need thereof, the method comprising:

(a) identifying the cancer as associated with one or more of overexpression, activation, amplification, and mutation of a Trk kinase; and

(b) administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



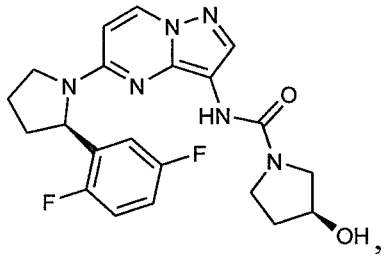
(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Further provided herein are methods for treating a pediatric cancer in a subject in need thereof, the method comprising:

(a) determining if the cancer is mediated by a Trk kinase; and

(b) if the cancer is determined to be mediated by a Trk kinase, administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:

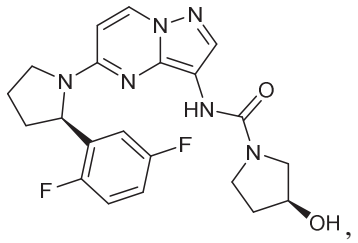


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Disclosed herein is use of a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, in the manufacture of a medicament for the treatment of a pediatric cancer in a subject in need thereof,

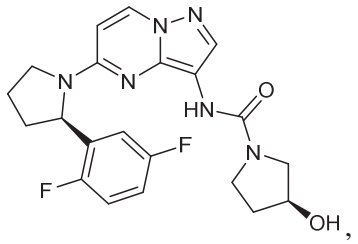
wherein the cancer is determined to be mediated by a Trk kinase.

Further provided herein are methods for treating a pediatric cancer in a subject in need thereof, the method comprising:

(a) identifying the cancer as mediated by a Trk kinase; and

(b) administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



(I)

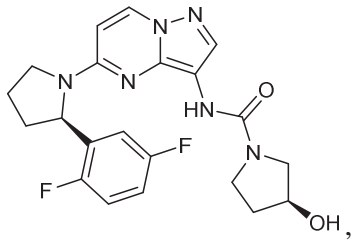
a pharmaceutically acceptable salt thereof, or a combination thereof.

Also provided herein are methods of treating a pediatric subject comprising:

(a) performing an assay on a sample obtained from the subject to determine whether the subject has dysregulation of a NTRK gene, a Trk protein, or expression or level of the same; and

(b) administering to a subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:

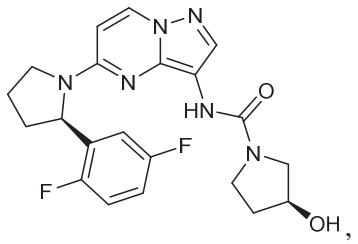


(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

Disclosed herein is use of a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

having the formula **(I)**:



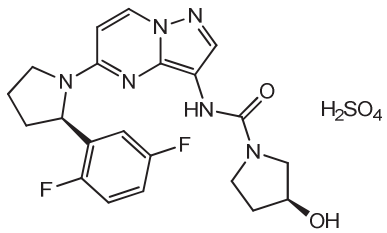
(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, in the manufacture of a medicament for the treatment of a pediatric subject, wherein the subject is determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, based on an assay performed on a sample obtained from the subject to determine whether the subject has dysregulation of a NTRK gene, a Trk protein, or expression or level of the same.

In some examples, the dysregulation of a NTRK gene, a Trk protein, or expression or level of the same is a chromosome translation that results in the translation of a Trk fusion protein. For example,

the Trk fusion protein can be NTRK3-ETV6. In some examples, the dyregulation of a NTRK gene, a Trk protein, or expression or activity of the same is one or more point mutation in the gene.

In some examples provided herein, the compound of formula **(I)** is a pharmaceutically acceptable salt. For example, the compound of formula **(I)** can be a hydrogen sulfate salt. In some examples, the compound of formula **(I)** is provided as a crystalline form. For example, the crystalline form can have the formula **(I-HS)**:



I-HS

In some examples, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, is provided as a liquid formulation.

In some examples, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, is present in the liquid formulation an amount from about 0.5 wt.% to about 7 wt.%. For example, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof can be present in the liquid formulation in an amount of about 1.5 wt.% to about 2.5 wt.%.

In some examples, the compound of formula **(I)**, the pharmaceutically acceptable salt thereof, or the combination thereof, has a concentration of about 5 mg/mL to about 50 mg/mL in the liquid formulation. For example, the compound of formula **(I)**, the pharmaceutically acceptable salt thereof, or the combination thereof, can have a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. In some examples, the compound of formula **(I)**, the pharmaceutically acceptable salt thereof, or the combination thereof, has a concentration of about 20 mg/mL in the liquid formulation.

The solubilizing agent can be selected from the group consisting of a cyclodextrin, a glycol, a glycerol, and combinations thereof. In some examples, the solubilizing agent includes a cyclodextrin. For example, the solubilizing agent can be selected from the group consisting of a β-cyclodextrin derivative, a γ-cyclodextrin, and combinations thereof. In some examples, the solubilizing agent includes a hydroxy alkyl-γ-cyclodextrin. The solubilizing agent can include a β-cyclodextrin selected from the group consisting of a

hydroxy alkyl-β-cyclodextrin, a sulfoalkyl ether-β-cyclodextrin, and combinations thereof. In some examples, the solubilizing agent includes hydroxypropyl-β-cyclodextrin.

In some examples, the solubilizing agent is present in the liquid formulation in an amount of about 5 wt.% to about 35 wt.%. For example, the solubilizing agent can be present in the liquid formulation in an amount of about 13 wt.% to about 17 wt.%.

The liquid formulation can further include a buffer. In some examples, the buffer includes at least one of a citrate buffer, a lactate buffer, a phosphate buffer, a maleate buffer, a tartarate buffer, a succinate buffer, or an acetate buffer. In some examples, the buffer includes at least one of lithium lactate, sodium lactate, potassium lactate, calcium lactate, lithium phosphate, sodium phosphate, potassium phosphate, calcium phosphate, lithium maleate, sodium maleate, potassium maleate, calcium maleate, lithium tartarate, sodium tartarate, potassium tartarate, calcium tartarate, lithium succinate, sodium succinate, potassium succinate, calcium succinate, lithium acetate, sodium acetate, potassium acetate, or calcium acetate. The buffer can be a citrate buffer. The citrate buffer can inlcude at least one of lithium citrate monohydrate, sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, lithium citrate dihydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, lithium citrate trihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, lithium citrate tetrahydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, lithium citrate pentahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, lithium citrate hexahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, lithium citrate heptahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate. In some examples, the buffer includes at least one of sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate.

In some examples, the buffer includes sodium citrate dihydrate.

The buffer can be present in the liquid formulation in an amount of about 0.1 wt.% to about 5 wt.%.

In some examples, the formulation has a pH of about 2 to about 7. For example, the formulation can have a pH of about 3 to about 4. In some examples, the formulation has a pH of about 3.5.

In some examples, the pH of the liquid formulation is adjusted. In some such examples, the formulation includes a base. For example, the base can include one or more of a citrate, a lactate, a phosphate, a maleate, a tartarate, a succinate, an acetate, a carbonate, and a hydroxide. In some examples, the formulation includes at least one of lithium lactate, sodium lactate, potassium lactate, calcium lactate, lithium phosphate, sodium phosphate, potassium phosphate, calcium phosphate, lithium maleate, sodium maleate, potassium maleate, calcium maleate, lithium tartarate, sodium tartarate, potassium tartarate, calcium tartarate, lithium succinate, sodium succinate, potassium succinate, calcium succinate, lithium acetate, sodium acetate, potassium acetate, calcium acetate, sodium carbonate, potassium carbonate, calcium carbonate, sodium bicarbonate, potassium bicarbonate, calcium bicarbonate, sodium hydroxide, potassium hydroxide, calcium hydroxide, or combinations thereof. In some examples, the base includes a citrate. The citrate can include at least one of lithium citrate monohydrate, sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, lithium citrate dihydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, lithium citrate trihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, lithium citrate tetrahydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, lithium citrate pentahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, lithium citrate hexahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, lithium citrate heptahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate. In some examples, the liquid formulation includes at least one of sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate.

In some examples, the base includes sodium citrate dihydrate.

In some examples, the formulation includes about 0.1 wt.% to about 5 wt.% of a

base such as citrate (e.g., sodium citrate dihydrate).

The liquid formulation can further include a sweetener. In some examples, the sweetener includes a sugar. The sugar can include sucrose. In some examples, the sweetener includes an intense sweetener. The intense sweetener can include sucralose.

In some examples, the sweetener is present in the liquid formulation in an amount of about 30 wt.% to about 70 wt.%. For example, the sweetener can be present in the liquid formulation in an amount of about 45 wt.% to about 55 wt.%.

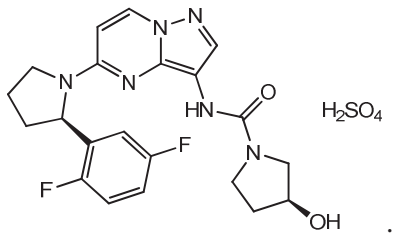
The liquid formulation can further include a bitterness masking agent. In some examples, the bitterness masking agent is present in the liquid formulation in an amount of about 0.01 wt.% to about 2 wt.%. For example, the bitterness masking agent can be present in the liquid formulation in an amount of about 0.2 wt.% to about 0.5 wt.%.

The liquid formulation can further include a flavoring agent. The flavoring agent can include at least one of a natural flavoring agent, a natural fruit flavoring agent, an artificial flavoring agent, an artificial fruit flavoring agent, or a flavor enhancer. In some examples, the flavoring agent is present in the liquid formulation in an amount of about 0.01 wt.% to about 2 wt.%. For example, the flavoring agent can be present in the liquid formulation in an amount of about 0.01 wt.% to about 0.1 wt.%.

In some examples, the liquid formulation further includes a coloring agent.

In some examples, the liquid formulation is prepared from a pharmaceutically acceptable salt of the compound of formula **(I)**. For example, the liquid formulation can be prepared from the hydrogen sulfate salt of the compound of formula **(I)**.

A liquid formulation as provided herein can be prepared from a pharmaceutically acceptable salt of the compound of formula **(I)** such as the hydrogen sulfate salt. In some examples, the liquid formulation is prepared from a crystalline form of the compound of formula **(I)**. For example, the crystalline form can have the formula **(I-HS)**:



I-HS

In some examples, the crystalline form is characterized by having XRPD diffraction peaks (2θ degrees) at 18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some examples, the crystalline form is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2,

18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some examples,the crystalline form is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 18.4±0.2, 19.2±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 23.1±0.2, and 24.0±0.2. In some examples, the crystalline form is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 15.3±0.2, 16.5±0.2, 18.4±0.2, 19.2±0.2, 19.9±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 22.1±0.2, 23.1±0.2, 24.0±0.2. 24.4±0.2, 25.6±0.2, 26.5±0.2, 27.6±0.2, 28.2±0.2, 28.7±0.2, 30.8±0.2, and 38.5±0.2.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent; and

a buffer;

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation.

In some examples, the formulation has a pH of about 3 to about 4. In some examples, the buffer comprises sodium citrate dihydrate.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent; and

a base;

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation.

In some examples, the formulation has a pH of about 3 to about 4. In some examples, the base comprises sodium citrate dihydrate.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent;

a buffer;

a sweetener;

a bitterness masking agent; and

a flavoring agent,

wherein:

the formulation has a pH of about 3 to about 4; and

the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. In some examples, the buffer comprises sodium citrate dihydrate. In some examples, the sweetener comprises sucrose.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent;

a base;

a sweetener;

a bitterness masking agent; and

a flavoring agent,

wherein:

the formulation has a pH of about 3 to about 4; and

the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. In some examples, the base comprises sodium citrate dihydrate. In some examples, the sweetener comprises sucrose.

In some examples, the liquid formulation comprises a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a buffer present in an amount of about 0.1 wt.% to about 5 wt.% ;

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a base present in an amount of about 0.1 wt.% to about 5 wt.% ;

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a

pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a buffer present in an amount of about 0.1 wt.% to about 5 wt.% ;

a sweetener present in an amount of about 30 wt.% to about 70 wt.%;

a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%; and

a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%,

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a base present in an amount of about 0.1 wt.% to about 5 wt.% ;

a sweetener present in an amount of about 30 wt.% to about 70 wt.%;

a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%; and

a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%,

wherein:

the formulation has a pH of about 2.5 to about 5.5; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a buffer comprising sodium citrate dihydrate present in an amount of about 0.1 wt.% to about 5 wt.% ;

a sweetener comprising sucrose present in an amount of about 30 wt.% to about 70 wt.%;

a bitterness masking agent is present in an amount of about 0.2 wt.% to about 0.5 wt.%; and

a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%,

wherein:

the formulation has a pH of about 3 to about 4; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%;

a base comprising sodium citrate dihydrate present in an amount of about 0.1 wt.% to about 5 wt.%;

a sweetener comprising sucrose present in an amount of about 30 wt.% to about 70 wt.%;

a bitterness masking agent is present in an amount of about 0.2 wt.% to about 0.5 wt.%; and

a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%,

wherein:

the formulation has a pH of about 3 to about 4; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation comprises a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof;

a cyclodextrin present in an amount of about 5 wt.% to about 35 wt.%;

sodium citrate dihydrate present in an amount of about 0.1 wt.% to about 5 wt.%;

a sweetener comprising sucrose or a high intensity sweetener present in an amount of about 30 wt.% to about 70 wt.%;

a bitterness masking agent is present in an amount of about 0.2 wt.% to about 0.5 wt.%; and

a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%,

wherein:

the formulation has a pH of about 3 to about 4; and

the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some examples, the liquid formulation is an oral liquid formulation.

In some examples, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, is administered in 28-day cycles. In some examples, the compound is administered in a dosage calculated to be equal to the

exposure of an adult taking the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, at a dose of 100 mg twice a day.

The features and advantages described in this summary and the following detailed description are not all-inclusive. Many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specification, and claims hereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an X-ray powder diffraction (XRPD) pattern of crystalline form (I-HS) prepared according to Example 2.

FIG. 2 illustrates a simultaneous thermogravimetric/differential thermal analyzer (TG/DTA) profile of crystalline form (I-HS) prepared according to Example 2.

FIG. 3 illustrates a differential scanning calorimetry (DSC) profile of crystalline form (I-HS) prepared according to Example 2.

FIGS. 4A and 4B illustrate polarized light microscopy (PLM) images of crystalline form (I-HS) prepared according to Example 2 under (A) unpolarized and (B) polarized light.

FIG. 5 illustrates a dynamic vapor sorption (DVS) isotherm profile of crystalline form (I-HS) prepared according to Example 2.

FIG. 6 illustrates an infrared (IR) spectroscopy profile of crystalline form (I-HS) prepared according to Example 2.

FIG. 7 illustrates an XRPD pattern of the amorphous freebase form of a compound of formula (I).

FIG. 8 illustrates an X-ray powder diffraction (XRPD) pattern of crystalline form (I-HS).

FIG. 9 is pictogram of pediatric solution formulation compounding instructions for the crystalline form (I-HS).

FIG. 10 is set of six MR images showing the brain in neck of the patient diagnosed with infantile fibrosarcoma. (A) and (B) are MR images of the brain and neck showing a 20 mm x 19 mm x 18 mm hyperenhancing mass involving the skull base of the middle cranial fossa, just anterior and inferior to the inner ear structures five weeks following surgical resection. (C) and (D) are MR images of the brain and neck showing a significant interval reduction in the size and enhancement of the mass by more than 90% from baseline at the end of cycle 1 (day 28) where the patient was administered the hydrogen sulfate salt of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-

carboxamide BID. (E) and (F) are MR images of the brain and neck taken at the end of Cycle 2, which confirmed the size reduction and showed continued decrease in enhancement, confirming partial response.

FIG. 11 is a sequence listing for an exemplary wildtype TrkA polypeptide (SEQ ID NO: 1).

FIG. 12 is a sequence listing for an exemplary wildtype TrkA polypeptide (SEQ ID NO: 2).

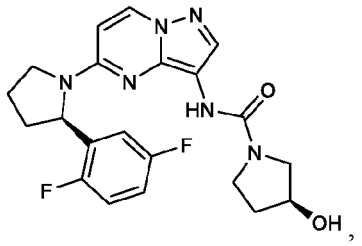
FIG. 13 is a sequence listing for an exemplary wildtype TrkA polypeptide (SEQ ID NO: 3).

DETAILED DESCRIPTION

The present disclosure relates to methods of treating pediatric cancers. The methods include administering (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (formula (I)), pharmaceutically acceptable salts thereof, for example the hydrogen sulfate salt, a crystalline form of the hydrogen sulfate salt, or pharmaceutical compositions including the compound of formula (I), for example liquid formulations including the compound of formula (I).

METHODS OF TREATING A PEDIATRIC CANCER

The present disclosure relates to methods of treating a pediatric cancer in a subject in need thereof. The methods include administering to the subject a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

In some embodiments, a patient is a pediatric patient (i.e., a patient under the age of 21 years at the time of diagnosis or treatment). The term "pediatric" can be further divided into various subpopulations including: neonates (from birth through the first 28 days of life);

infants (29 days of age to less than two years of age); children (two years of age to less than 12 years of age); and adolescents (12 years of age through 21 years of age (up to, but not including, the twenty-second birthday)). See, e.g., Berhman RE, Kliegman R, Arvin AM, Nelson WE. Nelson *Textbook of Pediatrics*, 15th Ed. Philadelphia: W.B. Saunders Company, 1996; Rudolph AM, et al. *Rudolph's Pediatrics*, 21st Ed. New York: McGraw-Hill, 2002; and Avery MD, First LR. *Pediatric Medicine*, 2nd Ed. Baltimore: Williams & Wilkins; 1994.

In some embodiments, the patient is from birth through the first 28 days of life, from 29 days of age to less than two years of age, from two years of age to less than 12 years of age, or 12 years of age through 21 years of age (up to, but not including, the twenty-second birthday). In some embodiments, the patient is from birth through the first 28 days of life, from 29 days of age to less than 1 year of age, from one month of age to less than four months of age, from three months of age to less than seven months of age, from six months of age to less than 1 year of age, from 1 year of age to less than 2 years of age, from 2 years of age to less than 3 years of age, from 2 years of age to less than seven years of age, from 3 years of age to less than 5 years of age, from 5 years of age to less than 10 years of age, from 6 years of age to less than 13 years of age, from 10 years of age to less than 15 years of age, or from 15 years of age to less than 22 years of age.

In some embodiments, the method further includes performing a morphological diagnosis prior to administering the compound of formula (I), or a pharmaceutically acceptable salt thereof, or a combination thereof. The method can further include performing molecular testing prior to administering the compound of formula (I) , or a pharmaceutically acceptable salt thereof, or a combination thereof. In some embodiments, the method includes performing morphological diagnosis and molecular testing prior to administering the compound of formula (I), or a pharmaceutically acceptable salt thereof, or a combination thereof.

Some embodiments include the use of the compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for the treatment of disorders and diseases in a pediatric subject, which can be treated by inhibiting TrkA, TrkB and/or TrkC kinases, such as a TrkA, TrkB and/or TrkC mediated condition, such as one or more conditions described herein, including a Trk-associated cancer, in, e.g., an infant, child, or adolescent. The present disclosure is further directed to pharmaceutical compositions comprising compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof. In some embodiments, the pharmaceutical composition comprises a compound of formula (I), a

pharmaceutically acceptable salt thereof, or a combination thereof and a pharmaceutically acceptable diluent or carrier.

In some embodiments, provided herein is a method for treating a pediatric patient diagnosed with a TRK-associated cancer, comprising administering to the pediatric patient a therapeutically effective amount of the compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof.

The Trk family of neurotrophin receptors, TrkA, TrkB, and TrkC (encoded by the NTRK1, NTRK2, and NTRK3 genes, respectively) and their neurotrophin ligands regulate growth, differentiation and survival of neurons. Dysregulation in a NTRK gene, a Trk protein, or expression or activity, or level of the same, such as translocations involving the NTRK kinase domain, mutations involving the TRK ligand-binding site, amplifications of a NTRK gene, Trk mRNA splice variants, and overexpression of a NTRK gene (e.g., caused by Trk autocrine/paracrine signaling) are described in a diverse number of tumor types and may contribute to tumorigenesis. Translocations in NTRK1, NTRK2, and NTRK3 that lead to the production of constitutively-active TrkA, TrkB, and TrkC fusion proteins are oncogenic and prevalent in a wide array of tumor types.

In some embodiments, the dysregulation in a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes overexpression of a wild-type NTRK1, NTRK2, or NTRK3 gene (e.g., leading to autocrine activation). In some embodiments, the dysregulation in a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes overexpression, activation, amplification, or mutation in a chromosomal segment comprising the NTRK1, NTRK2, or NTKR3 gene or a portion thereof. In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more chromosome translocations or inversions resulting in NTRK1, NTRK2, or NTRK3 gene fusions, respectively. In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, is a result of genetic translocations in which the expressed protein is a fusion protein containing residues from a non-TrkA partner protein and TrkA, a non-TrkB partner protein and TrkB, or a non-TrkC partner protein and TrkC proteins, and include a minimum of a functional TrkA, TrkB, or TrkC kinase domain, respectively.

In some embodiments, a TrkA fusion protein is one of the TrkA fusion proteins shown in Table 10. Additional rearrangements of NTRK were detected in pediatric patients having papillary thyroid carcinomas (Sassolas et al., *Thyroid* 22:17-26, 2012).

Table 10. Exemplary Trk Fusion Proteins and Cancers in Pediatric Subjects

Fusion Protein	Non-Trk Fusion Partner	Pediatric Cancer	References
ETV6-NTRK3	ETS variant gene 6, aka TEL	Pediatric nephroma; Congenital fibrosarcoma (CFS); Pediatric high-grade glioma (HGG); Mesenchymal cancers (infant fibrosarcoma (IF); Congenital mesoblastic nephroma; Congenital infantile fibrosarcoma (CIFS); Pilocytic astrocytoma; brain tumors (glioglastomas); Pediatic acute leukemia; Ph-like Acute Lymphoblastic Leukemia; Cellular Congenital Mesoblastic Nephroma (CMN); Infantile fibrosarcoma; ALK-negative inflammatory myofibroblastic tumors (IMT); Mammary Carcinoma (e.g., Mammary Analogue Secretory Carcinoma, Secretory Breast Carcinoma)	Bouhana et al., AACR 103rd Annual Meeting, 2012, Abstract No. 1798; Bourgeois et al., *Am. J. Surg. Pathol.* 24:937-946, 2000; Wu et al., *Nat. Genet.* 46:444-450, 2014; Tognon et al., *Cancer Cell* 2:367-376, 2002; Euhus et al., *Cancer Cell* 2:347-348, 2002; Sheng et al., *Am. J. Clin. Pathol.* 115:348-355, 2001; Jones et al., *Nat. Genet.* 45:927-932, 2013; Carvalho et al., *Neuro-Oncology* 17:iii1-iii40, 2015, Abstract No. HG-09. Shah et al., *Pediatr. Blood Cancer* 59:179-181, 2012; Eguchi et al., *Med. Pediatr. Oncol.* 37:417, 2001; Prasad et al., Cancer 122:1097-1017, 2016. Roberts et al., *N. Engl. J. Med.* 371:1005-1015, 2014. Alassiri et al., Am J Surg Pathol., 2016 Aug;40(8):1051-61, 2016. Nagasubramanian et al., *Pediatr Blood Cancer.*, Aug;63(8):1468-70, 2016. Hyrcza et al., Vol. 469, Supp. Supplement 1, pp. S17. Abstract Number: OFP-1997-7; 31st International Congress of the International Academy of Pathology and the 28th Congress of the European Society of Pathology, Cologne, Germany. 25-29 September 2016.
RET/NTRK1	RET	Papillary Thyroid Carcinomas	Bongarzone et al., *J. Clin. Endocrinol. Metab.* 81:2006-2009, 1996.
TPM3-NTRK1	TPM3- actin bingind protein	Pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs) and non-brainstem HGGs (NBS-HGGs); Anaplastic large cell	Wu et al., *Nat. Genet.* 46:444-450, 2014; Drexler et al., *Leukemia* 14:1533-1559, 2000; Jones et al., *Nat. Genet.* 45:927-932, 2013; Beimfohr et al., *Int. J. Cancer* 80:842-

		lymphoma (ALCL) and non-Hodgkin's lymphoma (NHL); Pilocytic astrocytoma; pediatric papillary thyroid carcinoma, soft tissue sarcoma; spitzoid melanomal	847, 1999; US 2016/0009785; Doebele et al., *Cancer Discov.* 5:1049-1057, 2015; Wu et al., *Modern Pathol.* 29:359-369, 2016.
BTBD1-NTRK3	Topoisomerase I-interacting protein	Pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs) and non-brainstem HGGs (NBS-HGGs)	Wu et al., *Nat. Genet.* 46:444-450, 2014.
VCL-NTRK2	Actin-binding protein vinculin	Pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs) and non-brainstem HGGs (NBS-HGGs)	Wu et al., Nat. Genet. 46:444-450, 2014.
AGBL4-NTRK2	ATP/GTP binding protein	Pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs) and non-brainstem HGGs (NBS-HGGs)	Wu et al., Nat. Genet. 46:444-450, 2014.
LMNA-NTRK1	Lamin A/C	Congenital infantile fibrosarcoma (CIFS); soft-tissue sarcoma; Paediatric haemangiopericytoma-like sarcoma; Spindle cell sarcoma, NOS with myo/haemangiopericytic growth pattern	Wong et al., *J. Nat. Cancer Inst.* 108(1), 2016; Doebele et al., *Cancer Discov.* 5:1049-1057, 2015; US 2016/0009785; Haller et al., *J. Pathol.* 238:700-710, 2016.
TFG-NTRK1	"Trk-fused gene"	Anaplastic large cell lymphoma (ALCL) and non-Hodgkin's lymphoma (NHL)	Drexler et al., *Leukemia* 14:1533-1559, 2000
QKI-NTRK2	KH domain containing RNA binding	Pilocytic astrocytoma	Jones et al., *Nat. Genet.* 45:927-932, 2013.
NACC2-NTRK2	NACC family member 2	Pilocytic astrocytoma	Jones et al., *Nat. Genet.* 45:927-932, 2013.
TPR-NTRK1	TPR	Pediatic papillary thyroid carcinoma	Beimfohr et al., *Int. J. Cancer* 80:842-847, 1999; Prasad et al., *Cancer* 122:1097-1017, 2016.
RABGA	RABGAP1L		US 2016/0009785

P1L-NTRK1			
MPRIP-NTRK1	MPRIP	E.g., Lung cancer	US 2016/0009785; US 2015/0073036
SQSTM1-NTRK1	SQSTM1	Soft Tissue Sarcoma	Doebele et al., *Cancer Discov.* 5:1049-1057, 2015
EML4-NTRK3	EML4	Advanced Pediatric Solid Tumors; Pediatric Fibrosarcoma	Harris et al., *JAMA Oncol.* Epub. Jan. 28, 2016. Sims et al., Journal of Immunotherapy of Cancer, Vol. 4, Supp. Supplement 1; Abstract Number: P280; 31st Annual Meeting and Associated Programs of the Society for Immunotherapy of Cancer, SITC 2016. National Harbor, MD; 9-13 November 2016.
AFAP1-NTRK2	Actin Filament Associated Protein 1	Pilocytic Astrocytoma With Anaplasia	Lin et al., *Neuro-Oncol*, Vol. 18, Supp. Supplement 3, pp. iii58, Abstract Number: HG-48; 17th International Symposium on Pediatric Neuro-Oncology, ISPNO 2016. Liverpool, UK, 12 Jun 2016- 15 Jun 2016.

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more deletions, insertions, or point mutation(s) in a Trk protein. In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes a deletion of one or more residues from the TrkA protein, resulting in constitutive activity of the Trk kinase domain. In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes at least one point mutation in a NTRK1 gene that results in the production of a TrkA protein that has one or more amino acid substitutions as compared to the wildtype TrkA protein (see, for example, the point mutations listed in Tables 11 and 12). An exemplary wildtype TrkA polypeptide is SEQ ID NO: 1, an exemplary wildtype TrkB polypeptide is SEQ ID NO: 2, and an exemplary TrkC polypeptide is SEQ ID NO: 3.

Table 11. Activating TrkA Point Mutations

Mutation		**Pediatric Cancer**	**Reference**
C6773T, C7232T, C7301T	TrkA	neuroblastoma	Scaruffi et al., *Int. J. Oncol.* 14:935-938, 1999

Table 12. Activating TrkA Point Mutations[A]

Point Mutation	Rationale	Exemplary Isoform in which Mutation is Present (if known)
R33W[B]		NP_001007793.1[F]
A336E	Near NGF Binding Site	Reference TrkA sequence
A337T	Near NGF Binding Site	Reference TrkA sequence
R324Q or R324W	Near NGF Binding Site	Unknown
V420M	Close to Membrane	Reference TrkA sequence
R444Q or R444W	Close to Membrane	Reference TrkA sequence
G517R or G517V	P-Loop	Reference TrkA sequence
K538A	Activating	Reference TrkA sequence
V573M[E]		Reference TrkA sequence
F589L[E]		Reference TrkA sequence
G595R or G667C[D]	Catalytic Domain	Reference TrkA sequence
F598L[E]		Unknown
R649W or R649L	Arginine may stabilize auto-inhibited conformation.	Reference TrkA sequence
R682S	Activation Loop	Reference TrkA sequence
V683G	Activation Loop	Reference TrkA sequence
R702C	Exposed, may form face-to-face disulfide linked dimer	Reference TrkA sequence
Q627X[C], Q597X[C], Q633X[C]		NP_001012331.1[G], NP_001007793.1[F], and Reference TrkA sequence, respectively

[A] Reference TrkA sequence is UniProtKB/Swiss-Prot: P04629.4, and can be found at URL: www.ncbi.nlm.nih.gov/protein/94730402?report=genbank&log$=protalign&blast_rank=0&RID=0 (SEQ ID NO. 1)

[B] Zhang et al., *Blood* 124(21):1682, 2014. Mutation found in T-cell prolymphocytic leukemia.

[C] Park et al., *Proc. Natl. Acad. Sci. U.S.A.* 112(40):12492-12497, 2015. Mutation found in colorectal cancer.

[D] Russo et al., *Cancer Discov.* Jan;6(1):36-44, 2016.

[E] PCT Application No. WO2016196141A1.

[F] www.ncbi.nlm.nih.gov/protein/56118210?report=genbank&log$=protalign&blast_rank=3&RID=0

[G] www.ncbi.nlm.nih.gov/protein/59889558

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes a splice variation in a TrkA mRNA which results in an expressed protein that is an alternatively spliced variant of TrkA having at least one residue deleted (as compared to a wild-type TrkA protein) resulting in constitutive activity of the TrkA kinase domain. In some embodiments, an alternatively spliced form of TrkA with constitutive activity has deletions of exons 8, 9, and 11 resulting in an expressed protein missing residues 192-284 and 393-398 relative to TrkA Isoform 2, has a deletion of

exon 10 in TrkA, or has a deletion in a NTRK1 gene that encodes a TrkA protein with a 75 amino acid deletion in the transmembrane domain (Reuther et al., *Mol. Cell Biol.* 20:8655-8666, 2000).

Cancers identified as having dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, (see references cited herein and also the www.cancer.gov and www.nccn.org websites) include:

(A) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more chromosome translocations or inversions resulting in TrkA fusion proteins, e.g., including:

Cancer	**Standard of Care**
Non-Small Cell Lung Cancer[2]	radiotherapy (e.g., radioiodide therapy, external-beam radiation, or radium 223 therapy), chemotherapeutics as single agents (e.g., afatinib dimaleate, bevacizumab, carboplatin, cetuximab, cisplatin, crizotinib, erlotinib, gefitinib, gemcitabine, methotrexate, paclitaxel, or pemetrexed) or combinations (e.g., carboplatin-paclitaxel, gemcitabine-paclitaxel, or chemoradiation)
Papillary Thyroid Carcinoma[14]	Radiotherapies (e.g., radioiodide therapy or external-beam radiation) and chemotherapeutics (e.g., sorafenib, sunitinib, or pazopanib)
Glioblastoma Multiforme[15]	Chemotherapeutics (e.g., bevacizumab, everolimus, lomustine, or temozolomide)
Colorectal Carcinoma[16]	Chemotherapeutics as single agents (e.g., aflibercept, bevacizumab, capecitabine, cetuximab, fluorouracil, irinotecan, leucovorin, oxaliplatin, panitumumab, or regorafenib) or combinations (e.g., folfox, folfiri, capox, folfiri-bevacizumab, folfiri-cetuximab, or xelox)
Melanoma[12]	Chemotherapeutics (e.g., aldesleukin, dabrafenib, dacarbazine, interferon alfa-2b, ipilimumab, peginterferon alfa-2b, trametinib, or vemurafenib)

(B) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more deletions, insertions, or mutations in the TrkA protein, e.g., including:

Cancer	Standard of care
Acute Myeloid leukemia[17, 18]	Chemotherapeutics as single agents (e.g., arsenic trioxide, cyclophosphamide, cytarabine, daunorubicin, doxorubicin, or vincristine) or combinations (e.g., ADE)
Large Cell Neuroendocrine Carcinoma[19]	Radiotherapy (e.g., radioiodide therapy, external-beam radiation, or radium 223 therapy) and/or chemotherapeutics (e.g., cisplatin, carboplatin, or etoposide)
Neuroblastoma[20]	Chemotherapeutics (e.g., cyclophosphamide, doxorubicin, or vincristine)

(C) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes overexpression of wildtype TrkA (autocrine activation), e.g., including:

Cancer	Standard of care
Prostate Carcinoma[21, 22]	Radiotherapy (e.g., radium 223 therapy) or chemotherapeutics (e.g. abiraterone, cabazitaxel, degarelix, denosumab, docetaxel, enzalutamide, leuprolide, prednisone, or sipuleucel-T)
Neuroblastoma[23]	Chemotherapeutics (e.g., cyclophosphamide, doxorubicin, or vincristine)
Pancreatic Carcinoma[24]	Chemotherapeutics as single agents (e.g., erlotinib, fluorouracil, gemcitabine, or mitomycin C) or combinations (e.g., gemcitabine-oxaliplatin)
Melanoma[25]	Chemotherapeutics (e.g., aldesleukin, dabrafenib, dacarbazine, interferon alfa-2b, ipilimumab, peginterferon alfa-2b, trametinib, or vemurafenib)
Head and Neck Squamous Cell Carcinoma[26]	Radiotherapy and/or chemotherapeutics (e.g., bleomycin, cetuximab, cisplatin, docetaxel, fluorouracil, or methotrexate)
Gastric Carcinoma[27]	Chemotherapeutics (e.g., docetaxel, doxorubucin, fluorouracil, mitomycin C, or trastuzumab)

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes at least one point mutation in a NTRK1 gene that results in the production of a TrkB protein that has one or more amino acid substitutions as compared to the wildtype TrkB protein (see, for example, the point mutations listed in Table 13.

Table 13. Activating TrkB Point Mutations[A]

Point Mutation	Rationale	Exemplary Isoform in which Mutation is Present (if known)
A13T[C]		Reference TrkB sequence
E142K[C]		Reference TrkB sequence
R136H[C]		Reference TrkB sequence
V619M[B]		Unknown
F633L[B]		NP_006171.2[D] (Corresponding to position 617 of Reference TrkB sequence)
G639R[B]		NP_006171.2[D] (Corresponding to position 623 of Reference TrkB sequence)
G709C or G709A or G709S[B]		NP_006171.2[D] (Corresponding to position 693 of Reference TrkB sequence)

[A] Reference TrkB sequence is UniProtKB/Swiss-Prot: Q16620.1, and can be found at URL: www.ncbi.nlm.nih.gov/protein/2497560?report=genbank&log$=protalign&blast_rank=0&RID=0 (SEQ ID NO. 2)
[B] PCT Application No. WO2016196141A1.
[C] Bonanno et al., *Journal of Thoracic Oncology*, Vol. 11, No. 4, Supp. Suppl. 1, pp S67. Abstract Number: 28P; 6th European Lung Cancer Conference, ELCC 2016, Geneva, Switzerland.
[D] www.ncbi.nlm.nih.gov/protein/NP_006171.2

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes at least one point mutation in a NTRK1 gene that results in the production of a TrkC protein that has one or more amino acid substitutions as compared to the wildtype TrkC protein (see, for example, the point mutations listed in Table 14.

Table 14. Activating TrkC Point Mutations[A]

Point Mutation	Rationale	Exemplary Isoform in which Mutation is Present (if known)
V603M[C]		NP_001007157.1[D]
F617L[C]		Reference TrkC sequence
G623R[B,C]	Steric Hinderance	Reference TrkC sequence
G696C or G696A or G696S[C]		Reference TrkC sequence

[A] Reference TrkC sequence is UniProtKB/Swiss-Prot: Q16288.2, and can be found at URL: www.ncbi.nlm.nih.gov/protein/1340353357report=genbank&log$=protalign&blast_rank=0&RID=0 (SEQ ID NO. 3)
[B] Drilon et al., Ann Oncol. 2016 May;27(5):920-6. doi: 10.1093/annonc/mdw042. Epub 2016 Feb 15.
[C] PCT Application No. WO2016196141A1.
[D] www.ncbi.nlm.nih.gov/protein/NP_001007157

In some embodiments, a TRK-associated cancer has been identified as having one or more TRK inhibitor resistance mutations (that result in an increased resistance to a TRK inhibitor. Non-limiting examples of TRK inhibitor resistance mutations are listed in Tables 15-17.

Table 15. Exemplary TrkA Resistance Mutations

Amino acid position 517 (e.g., G517R)
Amino acid position 542 (e.g., A542V)
Amino acid position 568 (e.g., Q568x)
Amino acid position 573 (e.g., V573M)
Amino acid position 589 (e.g., F589L, F589C)
Amino acid position 595 (e.g., G595S, G595R[1])
Amino acid position 599 (e.g., D596V)
Amino acid position 600 (e.g., F600L)
Amino acid position 602 (e.g., R602x)
Amino acid position 646 (e.g., F646V)
Amino acid position 656 (e.g., C656Y, C656F)
Amino acid position 657 (e.g., L657V)
Amino acid position 667 (e.g., G667C[1], G667S)
Amino acid position 676 (e.g., Y676S)

[1] Russo et al., Acquired Resistance to the TRK Inhibitor Entrectinib in Colorectal Cancer, Cancer Discov. Jan;6(1):36-44, 2016.

Table 16. Exemplary TrkB Resistance Mutations

Amino acid position 545 (e.g., G545R)
Amino acid position 570 (e.g., A570V)
Amino acid position 596 (e.g., Q596E, Q596P)
Amino acid position 601 (e.g., V601G)
Amino acid position 617 (e.g., F617L, F617C, F617I)
Amino acid position 623 (e.g., G623S, G623R)
Amino acid position 624 (e.g., D624V)
Amino acid position 628 (e.g., F628x)
Amino acid position 630 (e.g., R630K)
Amino acid position 672 (e.g., F672x)
Amino acid position 682 (e.g., C682Y, C682F)
Amino acid position 683 (e.g., L683V)
Amino acid position 693 (e.g., G693S)
Amino acid position 702 (e.g., Y702x)

Table 17. Exemplary TrkC Resistance Mutations

Amino acid position 545 (e.g., G545R)
Amino acid position 570 (e.g., A570V)
Amino acid position 596 (e.g., Q596x)

Amino acid position 601 (e.g., V601)
Amino acid position 617 (e.g., F617x, F617L)
Amino acid position 623 (e.g., G623R[1])
Amino acid position 624 (e.g., D624V)
Amino acid position 628 (e.g., F628x)
Amino acid position 630 (e.g., R630x)
Amino acid position 675 (e.g., F675x)
Amino acid position 685 (e.g., C685Y, C684F)
Amino acid position 686 (e.g., L686V)
Amino acid position 696 (e.g., G696x, G696A)
Amino acid position 705 (e.g., Y705x)

[1] Drilon et al., What hides behind the MASC: clinical response and acquired resistance to entrectinib after ETV6-NTRK3 identification in a mammary analogue secretory carcinoma (MASC), Ann Oncol. 2016 May;27(5):920-6. doi: 10.1093/annonc/mdw042. Epub 2016 Feb 15.

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes a splice variation in a TrkA mRNA which results in an expressed protein that is an alternatively spliced variant of TrkA having at least one residue deleted (as compared to a wild-type TrkA protein) resulting in constitutive activity of the TrkA kinase domain. In some embodiments, an alternatively spliced form of TrkA with constitutive activity is the TrkAIII splice variant and, e.g., is associated with neuroectodermal-derived tumors including Wilm's tumor, neuroblastoma, and medulloblastoma (see, e.g., U.S. Patent Publication No. 2015/0218132).

Overexpression or increased expression of a Trk gene (e.g., as compared to a control non-cancerous cell of the same cell type) is another type of dysregulation of a NTRK gene that is associated with a variety of different pediatric cancers. For example, overexpression of a Trk receptor has been observed in neuroectodermal-derived tumors including Wilm's tumor, neuroblastoma, and medulloblastoma (see, e.g., U.S. Patent Application Publication No. 2015/0218132), overexpression of NTRK2 in pediatric colorectal cancer subjects indicates poor prognosis in subjects (see, e.g., Tanaka et al., *PLoS One* 9:E96410, 2014), overexpression of NTRK2 has been observed in medulloblastoma and neuroblastoma in pediatric subjects (see, e.g., Evans et al., *Clin. Cancer Res.* 5:3592-3602, 1999; Geiger et al., *J. Cancer Res.* 65:7033, 2005). Decreased NTRK1 expression has been detected in bilateral stage IV adrenal neuroblastoma with multiple skin metastases in a neonate (see, e.g., Yanai et al., *J. Pediatr. Surg.* 39:1782-1783, 2004).

In some embodiments, a Trk-associated cancer is advanced solid and primary central nervous system tumors (e.g., advanced solid and primary central nervous system tumors that

are refractory to standard therapy). In some embodiments, the cancer is a solid or central nervous system tumors (e.g., advanced solid or primary central nervous system tumor) that is refractory to standard therapy.

Cancers identified as having dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (see references cited herein and also the www.cancer.gov and www.nccn.org websites) include:

(A) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more chromosome translocations or inversions resulting in Trk fusion proteins;

(B) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes one or more deletions, insertions, or mutations in the Trk protein;

(C) Cancers wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes overexpression of wildtype Trk (e.g., leading to autocrine activation of a Trk);

In some embodiments, the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes a translocation that results in the expression of a TrkA, TrkB, or TrkC fusion protein, e.g., one of the TrkA, TrkB, or TrkC fusion proteins shown in Table 10.

In some embodiments, provided herein is a method for treating a pediatric patient diagnosed with a Trk-associated cancer, comprising administering to the patient a therapeutically effective amount of the compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof. For example, the Trk-associated cancer can be selected from the group consisting of: pediatric nephroma, congenital fibrosarcoma (CFS), pediatric high-grade glioma (HGG), mesenchymal cancers (infant fibrosarcoma (IF), congenital mesoblastic nephroma, congenital infantile fibrosarcoma (CIFS); pilocytic astrocytoma, brain tumors (e.g., glioglastomas), pediatic acute leukemia, Ph-like acute lymphoblastic leukemia, cellular congenital mesoblastic nephroma (CMN); infantile fibrosarcoma, pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), non-brainstem HGGs (NBS-HGGs), anaplastic large cell lymphoma (ALCL), non-Hodgkin's lymphoma (NHL), pediatric papillary thyroid carcinoma, secretory breast cancer, soft tissue sarcoma, spitzoid melanoma, pediatric hemangiopericytoma-like sarcoma, spindle cell sarcoma, NOS with myo/haemangiopericytic growth pattern, advanced pediatric solid tumors, neuroectodermal-derived tumors (e.g., Wilm's tumor, neuroblastoma, and

medulloblastoma), pediatric colorectal cancer, adrenal neuroblastoma, and central nervous system tumors (e.g., advanced solid and primary central nervous system tumors that are refractory to standard therapy).

The pediatric cancer can be a fibrosarcoma. For example, the pediatric cancer can be infantile fibrosarcoma. In some embodiments, the subject is an infant and the fibrosarcoma is infantile fibrosarcoma.

In some embodiments, the pediatric cancer is a myofibroblastic/fibroblastic tumor. The pediatric cancer can be a solid tumor or a primary CNS tumor. The pediatric cancer can also be a congenital mesoblastic nephroma.

In some embodiments, a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof is useful for treating Trk-associated cancers in pediatric patients. For example, the compounds provided herein can be used to treat infantile sarcoma, pediatric glioma, neuroblastoma, congenital mesoblastic nephroma, brain low-grade glioma, and pontine glioma.

In some embodiments, the Trk-associated cancer is a glioma. For example, the Trk-associated cancer is selected from the group consisting of: pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), and on-brainstem HGGs (NBS-HGGs).

In some embodiments, the pediatric cancer is an extracranial solid tumor. For example, the pediatric cancer is selected from the group consisting of: neuroblastoma, nephroblastoma (e.g., Wilm's tumor), rhabdomyosarcoma and hepatoblastoma

In some embodiments, a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof is useful for treating a Trk-associated cancer in combination with one or more additional therapeutic agents or therapies that work by the same or a different mechanism of action.

In some embodiments, the additional therapeutic agent(s) is selected from the group of: receptor tyrosine kinase-targeted therapeutic agents, including cabozantinib, crizotinib, erlotinib, gefitinib, imatinib, lapatinib, nilotinib, pazopanib, pertuzumab, regorafenib, sunitinib, and trastuzumab.

In some embodiments, the additional therapeutic agent(s) is selected from signal transduction pathway inhibitors, including, e.g., Ras-Raf-MEK-ERK pathway inhibitors (e.g., sorafenib, trametinib, or vemurafenib), PI3K-Akt-mTOR-S6K pathway inhibitors (e.g., everolimus, rapamycin, perifosine, or temsirolimus) and modulators of the apoptosis pathway (e.g., obataclax).

In some embodiments, the additional therapeutic agent(s) is selected from the group of: cytotoxic chemotherapeutics, including, e.g., arsenic trioxide, bleomycin, cabazitaxel, capecitabine, carboplatin, cisplatin, cyclophosphamide, cytarabine, dacarbazine, daunorubicin, docetaxel, doxorubicin, etoposide, fluorouracil, gemcitabine, irinotecan, lomustine, methotrexate, mitomycin C, oxaliplatin, paclitaxel, pemetrexed, temozolomide, and vincristine.

In some embodiments, the additional therapeutic agent(s) is selected from the group of angiogenesis-targeted therapies, including e.g., aflibercept and bevacizumab.

In some embodiments, the additional therapeutic agent(s) is selected from the group of immune-targeted agents, e.g., including aldesleukin, ipilimumab, lambrolizumab, nivolumab, and sipuleucel-T.

In some embodiments, the additional therapeutic agent(s) is selected from agents active against the downstream Trk pathway, including, e.g., NGF-targeted biopharmaceuticals, such as NGF antibodies and panTrk inhibitors.

In some embodiments, the additional therapeutic agent or therapy is radiotherapy, including, e.g., radioiodide therapy, external-beam radiation, and radium 223 therapy.

In some embodiments, the additional therapeutic agent(s) includes any one of the above listed therapies or therapeutic agents which are standards of care in cancers wherein the cancer has a dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same.

Methods of detecting dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, include, e.g., detection of NTRK gene translocations, e.g., using Fluorescent In Situ Hybridization (FISH) (e.g., as described in International Application Nos. PCT/US2013/061211 and PCT/US2013/057495, which are incorporated herein by reference).

In some embodiments, provided herein is a method of treating cancer (e.g., a Trk-associated cancer) in a pediatric patient, comprising administering to said patient compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof in combination with at least one additional therapy or therapeutic agent. In some embodiments, the at least one additional therapy or therapeutic agent is selected from radiotherapy (e.g., radioiodide therapy, external-beam radiation, or radium 223 therapy), cytotoxic chemotherapeutics (e.g., arsenic trioxide, bleomycin, cabazitaxel, capecitabine, carboplatin, cisplatin, cyclophosphamide, cytarabine, dacarbazine, daunorubicin, docetaxel, doxorubicin, etoposide, fluorouracil, gemcitabine, irinotecan, lomustine, methotrexate, mitomycin C, oxaliplatin, paclitaxel, pemetrexed, temozolomide, or vincristine), tyrosine kinase targeted-therapeutics

(e.g., afatinib, cabozantinib, cetuximab, crizotinib, dabrafenib, erlotinib, gefitinib, imatinib, lapatinib, nilotinib, pazopanib, panitumumab, pertuzumab, regorafenib, sunitinib, or trastuzumab), apoptosis modulators and signal transduction inhibitors (e.g. everolimus, perifosine, rapamycin, sorafenib, temsirolimus, trametinib, or vemurafenib), immune-targeted therapies (e.g., aldesleukin, interferon alfa-2b, ipilimumab, lambrolizumab, nivolumab, prednisone, or sipuleucel-T) and angiogenesis-targeted therapies (e.g., aflibercept or bevacizumab), wherein the amount of a compound provided herein or a pharmaceutically acceptable salt thereof is, in combination with the additional therapy or therapeutic agent, effective in treating the cancer.

In some embodiments, the additional therapeutic agent is a different Trk inhibitor. In some embodiments, a receptor tyrosine kinase targeted therapeutic is a multikinase inhibitor (e.g., TRK-targeted therapeutic inhibitor) exhibiting TRK inhibition activity. In some embodiments, the TRK-targeted therapeutic inhibitor is selective for a TRK kinase. Exemplary TRK kinase inhibitors can exhibit inhibition activity (IC_{50}) against a TRK kinase of less than about 1000 nM, less than about 500 nM, less than about 200 nM, less than about 100 nM, less than about 50 nM, less than about 25 nM, less than about 10 nM, or less than about 1 nM as measured in an assay as described herein. In some embodiments, a TRK kinase inhibitor can exhibit inhibition activity (IC_{50}) against a TRK kinase of less than about 25 nM, less than about 10 nM, less than about 5 nM, or less than about 1 nM as measured in an assay. For example, a TRK inhibitor assay can be any of those provided in US Patent No. 8,933,084 (e.g., Example A or B).

Non-limiting examples of receptor tyrosine kinase (e.g., Trk) targeted therapeutic agents, include afatinib, cabozantinib, cetuximab, crizotinib, dabrafenib, entrectinib, erlotinib, gefitinib, imatinib, lapatinib, lestaurtinib, nilotinib, pazopanib, panitumumab, pertuzumab, sunitinib, trastuzumab, 1-((3S,4R)-4-(3-fluorophenyl)-1-(2-methoxyethyl)pyrrolidin-3-yl)-3-(4-methyl-3-(2- methylpyrimidin-5-yl)-1 -phenyl- 1H-pyrazol-5-yl)urea, AG 879, AR-772, AR-786, AR-256, AR-618, AZ-23, AZ623, DS-6051, Gö 6976, GNF-5837, GTx-186, GW 441756, LOXO-101, MGCD516, PLX7486, RXDX101, TPX-0005, and TSR-011. Additional Trk targeted therapeutic agents include those described in U.S. Patent No. 8,450,322; 8,513,263; 8,933,084; 8,791,123; 8,946,226; 8,450,322; 8,299,057; and 8,912,194; U.S. Publication No. 2016/0137654; 2015/0166564; 2015/0051222; 2015/0283132; and 2015/0306086; International Publication No. WO 2010/033941; WO 2010/048314; WO 2016/077841; WO 2011/146336; WO 2011/006074; WO 2010/033941; WO 2012/158413; WO 2014078454; WO 2014078417; WO 2014078408; WO 2014078378; WO 2014078372;

WO 2014078331; WO 2014078328; WO 2014078325; WO 2014078323; WO 2014078322; WO 2015175788; WO 2009/013126; WO 2013/174876; WO 2015/124697; WO 2010/058006; WO 2015/017533; WO 2015/112806; WO 2013/183578; and WO 2013/074518, all of which are hereby incorporated by reference in their entireties.

Further examples of Trk inhibitors can be found in U.S. Patent No. 8,637,516, International Publication No. WO 2012/034091, U.S. Patent No. 9,102,671, International Publication No. WO 2012/116217, U.S. Publication No. 2010/0297115, International Publication No. WO 2009/053442, U.S. Patent No. 8,642,035, International Publication No. WO 2009092049, U.S. Patent No. 8,691,221, International Publication No. WO2006131952, all of which are incorporated by reference in their entireties herein. Exemplary Trk inhibitors include GNF-4256, described in *Cancer Chemother. Pharmacol.* 75(1):131-141, 2015; and GNF-5837 (N-[3-[[2,3-dihydro-2-oxo-3-(1H-pyrrol-2-ylmethylene)-1H-indol-6-yl]amino]-4-methylphenyl]-N′-[2-fluoro-5-(trifluoromethyl)phenyl]-urea), described in *ACS Med. Chem. Lett.* 3(2):140-145, 2012, each of which is incorporated by reference in its entirety herein.

Additional examples of Trk inhibitors include those disclosed in U.S. Publication No. 2010/0152219, U.S. Patent No. 8,114,989, and International Publication No. WO 2006/123113, all of which are incorporated by reference in their entireties herein. Exemplary Trk inhibitors include AZ623, described in *Cancer* 117(6):1321-1391, 2011; AZD6918, described in *Cancer Biol. Ther.* 16(3):477-483, 2015; AZ64, described in *Cancer Chemother. Pharmacol.* 70:477-486, 2012; AZ-23 ((S)-5-Chloro-N2-(1-(5-fluoropyridin-2-yl)ethyl)-N4-(5-isopropoxy-1H-pyrazol-3-yl)pyrimidine-2,4-diamine), described in *Mol. Cancer Ther.* 8:1818-1827, 2009; and AZD7451; each of which is incorporated by reference in its entirety.

A Trk inhibitor can include those described in U.S. Patent Nos. 7,615,383; 7,384,632; 6,153,189; 6,027,927; 6,025,166; 5,910,574; 5,877,016; and 5,844,092, each of which is incorporated by reference in its entirety.

Further examples of Trk inhibitors include CEP-751, described in *Int. J. Cancer* 72:672-679, 1997; CT327, described in *Acta Derm. Venereol.* 95:542-548, 2015; compounds described in International Publication No. WO 2012/034095; compounds described in U.S. Patent No. 8,673,347 and International Publication No. WO 2007/022999; compounds described in U.S. Patent No. 8,338,417; compounds described in International Publication No. WO 2016/027754; compounds described in U.S. Patent No. 9,242,977; compounds described in U.S. Publication No. 2016/0000783; sunitinib (N-(2-diethylaminoethyl)-5-[(Z)-(5-fluoro-2-oxo-1H-indol-3-ylidene)methyl]-2,4-dimethyl-1H-pyrrole-3-carboxamide), as described in *PLoS One* 9:e95628, 2014; compounds described in International Publication No. WO

2011/133637; compounds described in U.S. Patent No. 8,637,256; compounds described in *Expert. Opin. Ther. Pat.* 24(7):731-744, 2014; compounds described in *Expert Opin. Ther. Pat.* 19(3):305-319, 2009; (R)-2-phenylpyrrolidine substituted imidazopyridazines, e.g., GNF-8625, (R)-1-(6-(6-(2-(3-fluorophenyl)pyrrolidin-1-yl)imidazo[1,2-b]pyridazin-3-yl)-[2,4'-bipyridin]-2'-yl)piperidin-4-ol as described in ACS Med. Chem. Lett. 6(5):562-567, 2015; GTx-186 and others, as described in *PLoS One* 8(12):e83380, 2013; K252a ((9S-(9α,10β,12α))-2,3,9,10,11,12-hexahydro-10-hydroxy-10-(methoxycarbonyl)-9-methyl-9,12-epoxy-1H-diindolo[1,2,3-fg:3',2',1'-kl]pyrrolo[3,4-i][1,6]benzodiazocin-1-one), as described in *Mol. Cell Biochem.* 339(1-2):201-213, 2010; 4-aminopyrazolylpyrimidines, e.g., AZ-23 (((S)-5-chloro-N2-(1-(5-fluoropyridin-2-yl)ethyl)-N4-(5-isopropoxy-1H-pyrazol-3-yl)pyrimidine-2,4-diamine)), as described in *J. Med. Chem.* 51(15):4672-4684, 2008; PHA-739358 (danusertib), as described in *Mol. Cancer Ther.* 6:3158, 2007; Gö 6976 (5,6,7,13-tetrahydro-13-methyl-5-oxo-12H-indolo[2,3-a]pyrrolo[3,4-c]carbazole-12-propanenitrile), as described in *J. Neurochem.* 72:919-924, 1999; GW441756 ((3Z)-3-[(1-methylindol-3-yl)methylidene]-1H-pyrrolo[3,2-b]pyridin-2-one), as described in *IJAE* 115:117, 2010; milciclib (PHA-848125AC), described in *J. Carcinog.* 12:22, 2013; AG-879 ((2E)-3-[3,5-Bis(1,1-dimethylethyl)-4-hydroxyphenyl]-2-cyano-2-propenethioamide); altiratinib (N-(4-((2-(cyclopropanecarboxamido)pyridin-4-yl)oxy)-2,5-difluorophenyl)-N-(4-fluorophenyl)cyclopropane-1,1-dicarboxamide); cabozantinib (N-(4-((6,7-Dimethoxyquinolin-4-yl)oxy)phenyl)-N'-(4-fluorophenyl)cyclopropane-1,1-dicarboxamide); lestaurtinib ((5S,6S,8R)-6-Hydroxy-6-(hydroxymethyl)-5-methyl-7,8,14,15-tetrahydro-5H-16-oxa-4b,8a,14-triaza-5,8-methanodibenzo[b,h]cycloocta[jkl]cyclopenta[e]-as-indacen-13(6H)-one); dovatinib (4-amino-5-fluoro-3-[6-(4-methylpiperazin-1-yl)-1H-benzimidazol-2-yl]quinolin-2(1H)-one mono 2-hydroxypropanoate hydrate); sitravatinib (N-(3-fluoro-4-((2-(5-(((2-methoxyethyl)amino)methyl)pyridin-2-yl)thieno[3,2-b]pyridin-7-yl)oxy)phenyl)-N-(4-fluorophenyl)cyclopropane-1,1-dicarboxamide); ONO-5390556; regorafenib (4-[4-({[4-Chloro-3-(trifluoromethyl)phenyl]carbamoyl}amino)-3-fluorophenoxy]-N-methylpyridine-2-carboxamide hydrate); and VSR-902A; all of the references above are incorporated by reference in their entireties herein.

The ability of a Trk inhibitor to act as a TrkA, TrkB, and/or Trk C inhibitor may be tested using the assays described in Examples A and B in U.S. Patent No. 8,513,263, which is incorporated herein by reference.

In some embodiments, signal transduction pathway inhibitors include Ras-Raf-MEK-ERK pathway inhibitors (e.g., binimetinib, selumetinib, encorafinib, sorafenib, trametinib, and

vemurafenib), PI3K-Akt-mTOR-S6K pathway inhibitors (e.g. everolimus, rapamycin, perifosine, temsirolimus), and other kinase inhibitors, such as baricitinib, brigatinib, capmatinib, danusertib, ibrutinib, milciclib, quercetin, regorafenib, ruxolitinib, semaxanib, AP32788, BLU285, BLU554, INCB39110, INCB40093, INCB50465, INCB52793, INCB54828, MGCD265, NMS-088, NMS-1286937, PF 477736 ((R)-amino-N-[5,6-dihydro-2-(1-methyl-1H-pyrazol-4-yl)-6-oxo-1Hpyrrolo[4,3,2-ef][2,3]benzodiazepin-8-yl]-cyclohexaneacetamide), PLX3397, PLX7486, PLX8394, PLX9486, PRN1008, PRN1371, RXDX103, RXDX106, RXDX108, and TG101209 (N-tert-butyl-3-(5-methyl-2-(4-(4-methylpiperazin-1-yl)phenylamino)pyrimidin-4- ylamino)benzenesulfonamide).

Non-limiting examples of checkpoint inhibitors include ipilimumab, tremelimumab, nivolumab, pidilizumab, MPDL3208A, MEDI4736, MSB0010718C, BMS-936559, BMS-956559, BMS-935559 (MDX-1105), AMP-224, and pembrolizumab.

In some embodiments, cytotoxic chemotherapeutics are selected from arsenic trioxide, bleomycin, cabazitaxel, capecitabine, carboplatin, cisplatin, cyclophosphamide, cytarabine, dacarbazine, daunorubicin, docetaxel, doxorubicin, etoposide, fluorouracil, gemcitabine, irinotecan, lomustine, methotrexate, mitomycin C, oxaliplatin, paclitaxel, pemetrexed, temozolomide, and vincristine.

Non-limiting examples of angiogenesis-targeted therapies include aflibercept and bevacizumab.

In some embodiments, immune-targeted agents are selected from aldesleukin, interferon alfa-2b, ipilimumab, lambrolizumab, nivolumab, prednisone, and sipuleucel-T.

Non-limiting examples of radiotherapy include radioiodide therapy, external-beam radiation, and radium 223 therapy.

Additional kinase inhibitors include those described in, for example, U.S. Patent No. 7,514,446; 7,863,289; 8,026,247; 8,501,756; 8,552,002; 8,815,901; 8,912,204; 9,260,437; 9,273,051; U.S. Publication No. US 2015/0018336; International Publication No. WO 2007/002325; WO 2007/002433; WO 2008/080001; WO 2008/079906; WO 2008/079903; WO 2008/079909; WO 2008/080015; WO 2009/007748; WO 2009/012283; WO 2009/143018; WO 2009/143024; WO 2009/014637; 2009/152083; WO 2010/111527; WO 2012/109075; WO 2014/194127; WO 2015/112806; WO 2007/110344; WO 2009/071480; WO 2009/118411; WO 2010/031816; WO 2010/145998; WO 2011/092120; WO 2012/101032; WO 2012/139930; WO 2012/143248; WO 2012/152763; WO 2013/014039; WO 2013/102059; WO 2013/050448; WO 2013/050446; WO 2014/019908; WO 2014/072220; WO 2014/184069; and WO 2016/075224, all of which are hereby incorporated

by reference in their entireties.

Further examples of kinase inhibitors include those described in, for example, WO 2016/081450; WO 2016/022569; WO 2016/011141; WO 2016/011144; WO 2016/011147; WO 2015/191667; WO 2012/101029; WO 2012/113774; WO 2015/191666; WO 2015/161277; WO 2015/161274; WO 2015/108992; WO 2015/061572; WO 2015/058129; WO 2015/057873; WO 2015/017528; WO/2015/017533; WO 2014/160521; and WO 2014/011900, each of which is hereby incorporated by reference in its entirety.

Yet other additional therapeutic agents include RET inhibitors such as those described, for example, in U.S. Patent Nos. 8,299,057; 8,399,442; 8,937,071; 9,006,256; and 9,035,063; U.S. Publication Nos. 2014/0121239; 2011/0053934; 2011/0301157; 2010/0324065; 2009/0227556; 2009/0130229; 2009/0099167; 2005/0209195; International Publication Nos. WO 2014/184069; WO 2014/072220; WO 2012/053606; WO 2009/017838; WO 2008/031551; WO 2007/136103; WO 2007/087245; WO 2007/057399; WO 2005/051366; and WO 2005/044835; and *J. Med.Chem.* 2012, 55 (10), 4872-4876.

These additional therapeutic agents may be administered with one or more compounds provided herein as part of the same or separate dosage forms, via the same or different routes of administration, and on the same or different administration schedules according to standard pharmaceutical practice known to one skilled in the art.

Also provided herein is (i) a pharmaceutical combination for treating cancer (e.g., a Trk-associated cancer) in a pediatric patient in need thereof, which comprises (a) compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof , (b) an additional therapeutic agent and (c) optionally at least one pharmaceutically acceptable carrier for simultaneous, separate or sequential use for the treatment of a tumor disease, wherein the amounts of the compound or salt thereof and of the additional therapeutic agent are together effective in treating said cancer; (ii) a pharmaceutical composition comprising such a combination; (iii) the use of such a combination for the preparation of a medicament for the treatment of cancer (e.g., a Trk-associated cancer); and (iv) a commercial package or product comprising such a combination as a combined preparation for simultaneous, separate or sequential use; and to a method of treatment of cancer (e.g., Trk-associated cancer) in a pediatric patient in need thereof.

Also provided are methods of treating a pediatric subject identified or diagnosed as having a Trk-associated cancer (e.g., a subject that has been identified or diagnosed as having a Trk-associated cancer through the use of a regulatory agency-approved, e.g., FDA-approved, kit for identifying dysregulation of a NTRK gene, a Trk protein, or expression or activity, or

level of the same, in a pediatric subject or a biopsy sample from the pediatric subject) (e.g., any of the Trk-associated cancers described herein or known in the art) that include administering the pediatric subject a therapeutically effective amount of compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof. Also provided is a the use of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for use in treating a Trk-associated cancer in a pediatric subject identified or diagnosed as having a Trk-associated cancer (e.g., a pediatric subject that has been identified or diagnosed as having a Trk-associated cancer through the use of a regulatory agency-approved, e.g., FDA-approved, kit for identifying dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, in a pediatric subject or a biopsy sample from the pediatric subject) (e.g., any of the Trk-associated cancers described herein or known in the art). Also provided is the use of compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for the manufacture of a medicament for treating a Trk-associated cancer in a pediatric subject identified or diagnosed as having a Trk- associated cancer (e.g., a pediatric subject that has been identified or diagnosed as having a Trk-associated cancer through the use of a regulatory agency-approved, e.g., FDA-approved, kit for identifying dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, in a pediatric subject or a biopsy sample from the pediatric subject) (e.g., any of the Trk-associated cancers described herein or known in the art).

Also provided are methods of treating a pediatric subject (e.g., a pediatric subject suspected of having a Trk-associated cancer, a pediatric subject presenting with one or more symptoms of a Trk-associated cancer, or a pediatric subject having an elevated risk of developing a Trk-associated cancer) that include performing an assay (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, and administering (e.g., specifically or selectively administering) a therapeutically effective amount of compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof to a pediatric subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or levels of the same. Additional assays, non-limiting assays that may be used in these methods are described herein. Additional assays are also known in the art.

In some embodiments provided herein, the sample can be a tissue sample such as a cancer tissue sample, a biopsy sample, a serum sample, a spinal fluid sample, or a urine sample.

Also provided is use of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for use in treating a Trk-associated cancer in a pediatric subject identified or diagnosed as having a Trk-associated cancer through a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, where the presence of dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, identifies that the pediatric subject has a Trk-associated cancer. Also provided is the use of crystalline form (I-HS) or a compound of formula (**I**) or a salt thereof, such as a hydrogen sulfate salt (e.g., see Example 14A of U.S. Patent No. 8,513,263) for the manufacture of a medicament for treating a Trk-associated cancer in a pediatric subject identified or diagnosed as having a Trk-associated cancer through a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, where the presence of dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, identifies that the pediatric subject has a Trk-associated cancer. Some embodiments of any of the methods or uses described herein further include recording in the pediatric subject's clinical record (e.g., a computer readable medium) that the pediatric subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, through the performance of the assay, should be administered a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof.

In some embodiments of any of the methods or uses described herein, the pediatric subject has been identified or diagnosed as having a cancer with dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., as determined using a regulatory agency-approved, e.g., FDA-approved, assay or kit). In some embodiments of any of the methods or uses described herein, the pediatric subject has a tumor that is positive for dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., as determined using a regulatory agency-approved assay or kit). In some embodiments of any of the methods or uses described herein, the pediatric subject can be a subject with a tumor(s) that is positive for dysregulation of a NTRK gene, a Trk protein, or expression or

activity, or level of the same (e.g., identified as positive using a regulatory agency-approved, e.g., FDA-approved, assay or kit). In some embodiments of any of the methods or uses described herein, the pediatric subject can be a subject whose tumors have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or a level of the same (e.g., where the tumor is identified as such using a regulatory agency-approved, e.g., FDA-approved, kit or assay). In some embodiments of any of the methods or uses described herein, the pediatric subject is suspected of having a Trk-associated cancer. In some embodiments of any of the methods or uses described herein, the pediatric subject has a clinical record indicating that the pediatric subject has a tumor that has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (and optionally the clinical record indicates that the pediatric subject should be treated with any of the compositions provided herein).

Also provided are methods of treating a pediatric subject that include administering a therapeutically effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof to a pediatric subject having a clinical record that indicates that the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same. Also provided is the use of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for the manufacture of a medicament for treating a Trk-associated cancer in a pediatric subject having a clinical record that indicates that the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same. Also provided is the use of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for the manufacture of a medicament for treating a Trk-associated cancer in a pediatric subject having a clinical record that indicates that the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same. Some embodiments of these methods and uses can further include: a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, and recording information in a pediatric subject's clinical file (e.g., a computer-readable medium) that the pediatric subject has been identified to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same.

Also provided are methods (e.g., in vitro methods) of selecting a treatment for a pediatric subject that include selecting a treatment including administration of a therapeutically

effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for a pediatric subject identified or diagnosed as having a Trk-associated cancer (e.g., a pediatric subject that has been identified or diagnosed as having a Trk-associated cancer through the use of a regulatory agency-approved, e.g., FDA-approved, kit for identifying dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, in a pediatric subject or a biopsy sample from the pediatric subject) (e.g., any of the Trk-associated cancers described herein or known in the art). Some embodiments can further include administering the selected treatment to the pediatric subject identified or diagnosed as having a Trk-associated cancer. Some embodiments can further include a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the pediatric subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, and identifying or diagnosing a pediatric subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, as having a Trk-associated cancer.

Also provided are methods of selecting a treatment for a pediatric subject that include administration of a therapeutically effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof , wherein the methods include a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, and identifying or diagnosing a pediatric subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, as having a Trk-associated cancer, and selecting a therapeutic treatment including administration of a therapeutically effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof for the pediatric subject identified or diagnosed as having a Trk-associated cancer. Some embodiments further include administering the selected treatment to the pediatric subject identified or diagnosed as having a Trk-associated cancer.

Also provided are methods of selecting a pediatric subject for treatment including administration of a therapeutically effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof that include selecting,

identifying, or diagnosing a pediatric subject having a Trk-associated cancer, and selecting the pediatric subject for treatment including administration of a therapeutically effective amount of a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof. In some embodiments, identifying or diagnosing a pediatric subject as having a Trk-associated cancer can include a step of performing an assay (e.g., an in vitro assay) (e.g., an assay that utilizes next generation sequencing, immunohistochemistry, break apart FISH, or dual-fusion FISH analysis) (e.g., using a regulatory agency-approved, e.g., FDA-approved, kit) on a sample obtained from the pediatric subject to determine whether the subject has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, and identifying or diagnosing a pediatric subject determined to have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, as having a Trk-associated cancer. In some embodiments, the selecting a treatment can be used as part of a clinical study that includes administration of various treatments of a Trk-associated cancer.

In some embodiments of any of the methods or uses described herein, an assay used determine whether the pediatric subject (e.g., an infant, a child, or an adolescent) has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, using a sample (e.g., a biological sample or a biopsy sample (e.g., a paraffin-embedded biopsy sample) from a subject (e.g., a pediatric subject (e.g., an infant, a child, or an adolescent) suspected of having a Trk-associated cancer, a pediatric subject (e.g., an infant, a child, or an adolescent) having one or more symptoms of a Trk-associated cancer, and/or a pediatric subject (e.g., an infant, a child, or an adolescent) that has an increased risk of developing a Trk-associated cancer) can include, for example, next generation sequencing, immunohistochemistry, fluorescence microscopy, break apart FISH analysis, Southern blotting, Western blotting, FACS analysis, Northern blotting, and PCR-based amplification (e.g., RT-PCR). As is well-known in the art, the assays are typically performed, e.g., with at least one labelled nucleic acid probe or at least one labelled antibody or antigen-binding fragment thereof. Assays can utilize other detection methods known in the art for detecting dysregulation of a NTRK gene, a Trk protein, or expression or activity, or levels of the same (see, e.g., the references cited herein).

In some embodiments, the subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) has been identified or diagnosed as having a cancer with dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., as determined using a regulatory agency-approved, e.g., FDA-approved, assay or kit). In some embodiments, the subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) has a tumor that is positive

for dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., as determined using a regulatory agency-approved assay or kit). The subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) can be a subject with a tumor(s) that is positive for dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., identified as positive using a regulatory agency-approved, e.g., FDA-approved, assay or kit). The subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) can be a subject whose tumors have dysregulation of a NTRK gene, a Trk protein, or expression or activity, or a level of the same (e.g., where the tumor is identified as such using a regulatory agency-approved, e.g., FDA-approved, kit or assay). In some embodiments, the subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) is suspected of having a Trk-associated cancer. In some embodiments, the subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) has a clinical record (e.g., a computer-readable medium) indicating that the subject has a tumor that has dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (and optionally the clinical record further indicates that the subject should be treated with any of the compositions provided herein).

In some embodiments, a dose contains, per unit dosage unit, about 2 mg, about 4 mg, about 6 mg, about 8 mg, about 10 mg, about 12 mg, about 14 mg, about 16 mg, about 18 mg, about 20 mg, about 30 mg, about 40 mg, about 50 mg, about 100 mg, about 150 mg, about 200 mg, about 250 mg, about 300 mg, about 400 mg, or about 500 mg of a compound of Formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof. In some embodiments, a unit dosage unit of about 2 mg to about 4 mg is formulated for a one-month old patient. In some embodiments a unit dosage unit of about 6 to about 18 mg (e.g., about 6 mg, about 8 mg, about 10 mg, about 12 mg, about 14 mg, about 16 mg, or about 18 mg) is formulated for a two-month or older infant. The dosages, however, may be varied depending upon the requirement of the patients, the severity of the condition being treated and the compound being employed. In some embodiments, the dosages are administered once daily (QD) or twice daily (BID).

The daily dosage of a compound of Formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof in a liquid formulation as described herein may be varied over a wide range from 1.0 to 10,000 mg per day, or higher, or any range therein. For oral administration, the compositions are preferably provided in the form of tablets containing, 0.01, 0.05, 0.1, 0.5, 1.0, 2.5, 5.0, 10.0, 15.0, 25.0, 50.0, 100, 150, 200, 250 and 500 milligrams of the active ingredient for the symptomatic adjustment of the dosage to the patient to be treated. An effective amount of the drug is ordinarily supplied at a dosage level

of from about 0.1 mg/kg to about 1000 mg/kg of body weight per day, or any range therein. The range can be from about 0.5 to about 500 mg/kg of body weight per day, or any range therein. The range can be from about 1.0 to about 250 mg/kg of body weight per day, or any range therein. The range can be from about 0.1 to about 100 mg/kg of body weight per day, or any range therein. In an example, the range may be from about 0.1 to about 50.0 mg/kg of body weight per day, or any amount or range therein. In another example, the range may be from about 0.1 to about 15.0 mg/kg of body weight per day, or any range therein. In yet another example, the range may be from about 0.5 to about 7.5 mg/kg of body weight per day, or any amount to range therein. A liquid formulation as provided herein may be administered on a regimen of 1 to 4 times per day or in a single daily dose.

Optimal dosages to be administered may be readily determined by those skilled in the art, and will vary with the mode of administration, the strength of the preparation, the mode of administration, and the advancement of the disease condition. In addition, factors associated with the particular patient being treated, including patient age, weight, diet and time of administration, will result in the need to adjust dosages.

In some embodiments, the compounds and formulations provided herein are administered on a continuous 28-day schedule. For example, a single cycle of administration includes 28 days of continuous dosing. Such dosing can be, for example, one daily or twice daily.

One skilled in the art will recognize that, both in vivo and in vitro trials using suitable, known and generally accepted cell and/or animal models are predictive of the ability of a test compound to treat or prevent a given disorder.

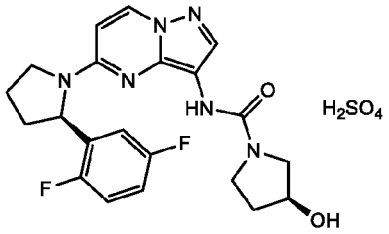
One skilled in the art will further recognize that human clinical trials including first-in-human, dose ranging and efficacy trials, in healthy patients and/or those suffering from a given disorder, may be completed according to methods well known in the clinical and medical arts.

In some embodiments, the methods provided can follow after surgical resection has failed to inhibit progression of the fibrosarcoma in the subject. The methods provided herein can also follow after chemotherapy including administration of at least one of vincristine, actinomycin-D, cyclophosphamide, ifosfamide, etoposide, doxorubicin has failed to inhibit tumor progression in the subject. For example, the methods provided herein can follow after administration of at least one of vincristine, actinomycin-D, and cyclophosphamide has failed to inhibit tumor progression in the subject. The methods provided herein can also follow after administration of at least one of ifosfamide and doxorubicin has failed to inhibit tumor progression in the subject.

METHODS OF TREATING A PEDIATRIC CANCER WITH A CRYSTALLINE FORM OF A COMPOUND OF FORMULA (I)

For the methods of treatment provided herein, a compound of formula **(I)**, or a pharmaceutically acceptable salt thereof, can be provided in a crystalline form.

For example, a crystalline form of the compound of formula **(I)** can include the hydrogen sulfate salt of the compound of formula **(I)** in a stable polymorph form, hereinafter referred to as crystalline form (I-HS), which may be characterized, for example, by its X-ray diffraction pattern.



I-HS

As illustrated in FIG. 1, in some embodiments, the crystalline form (I-HS) can be characterized by its X-ray powder diffraction pattern (XRPD). The XRPD was carried out on a D5000 X-ray diffractometer with a CuKα1, 0.1540562 nm long, fine focus sealed tube source from Siemens by scanning samples between 3 and 40 °2-theta at a step size of 0.0200 °2-theta and a time per step of 1 second. The effective scan speed was 0.0200 °/s with an instrument voltage 40 kV and a current setting of 40 mA. Samples were analyzed using a divergence slit having a size of 2 mm in reflection mode under the following experimental conditions.

In some embodiments, crystalline form (I-HS) has an XRPD pattern with at least the 20 characteristic peaks (2θ degrees ± 0.3), as listed in Table 1.

Table 1. XRPD peaks of crystalline form (I-HS)

Position [°2-θ]	**FWHM [°2-θ]**	**d-spacing [Å]**	**Relative Intensity [%]**
10.63	0.12	8.32	27.44
15.25	0.14	5.81	12.24
16.39	0.13	5.40	13.92
18.37	0.13	4.82	43.65
19.08	0.14	4.65	19.60
19.79	0.11	4.48	9.83
20.15	0.25	4.40	25.09
20.61	0.13	4.31	100.00
21.47	0.21	4.14	24.71

22.01	0.12	4.03	14.45
23.04	0.15	3.86	33.01
23.97	0.12	3.71	38.52
24.35	0.21	3.65	10.05
25.58	0.13	3.48	8.11
26.48	0.17	3.36	9.76
27.50	0.14	3.24	7.70
28.17	0.17	3.16	11.60
28.58	0.19	3.12	10.85
30.77	0.29	2.90	8.48
38.47	0.21	2.34	10.97

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 8 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 15%, as listed in Table 2.

Table 2. XRPD peaks of crystalline form (I-HS)

Position [°2-θ]	FWHM [°2-θ]	d-spacing [Å]	Relative Intensity [%]
10.63	0.12	8.32	27.44
18.37	0.13	4.82	43.65
19.08	0.14	4.65	19.60
20.15	0.25	4.40	25.09
20.61	0.13	4.31	100.00
21.47	0.21	4.14	24.71
23.04	0.15	3.86	33.01
23.97	0.12	3.71	38.52

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 5 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 25%, as listed in Table 3.

Table 3. XRPD peaks of crystalline form (I-HS)

Position [°2-θ]	FWHM [°2-θ]	d-spacing [Å]	Relative Intensity [%]
10.63	0.12	8.32	27.44
18.37	0.13	4.82	43.65
20.61	0.13	4.31	100.00
23.04	0.15	3.86	33.01
23.97	0.12	3.71	38.52

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 4 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 30%, as listed in Table 4.

Table 4. XRPD peaks of crystalline form (I-HS)

Position [°2-θ]	FWHM [°2-θ]	d-spacing [Å]	Relative Intensity [%]
18.37	0.13	4.82	43.65
20.61	0.13	4.31	100.00
23.04	0.15	3.86	33.01
23.97	0.12	3.71	38.52

In certain embodiments, crystalline form (I-HS) has an XRPD pattern that is substantially the same XRPD pattern as shown in Figure 1.

In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 18.4, 20.6, 23.0, and 24.0. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.6, 18.4, 20.6, 23.0, and 24.0. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.6, 18.4, 19.1, 20.2, 20.6, 21.5, 23.0, and 24.0. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.6, 15.3, 16.4, 18.4, 19.1, 19.8, 20.2, 20.6, 21.5, 22.0, 23.0, 24.0, 24.4, 25.6, 26.5, 27.5, 28.2, 28.6, 30.8, and 38.5.

In certain embodiments, crystalline form (I-HS) has an XRPD pattern that is substantially the same XRPD pattern as shown in Figure 8.

In some embodiments, crystalline form (I-HS) has an XRPD pattern with at least the 20 characteristic peaks (2θ degrees ± 0.3), as listed in Table 1.

Table 5. XRPD peaks of crystalline form (I-HS)

Position (°2θ)	**Relative Intensity (%)**
10.76	29.85
15.38	13.22
16.52	16.46
18.50	48.07
19.22	22.92
19.92	16.05
20.26	30.80
20.74	100.00
21.56	23.78

22.16	15.51
23.16	32.52
24.10	33.89
24.50	12.14
25.72	8.89
26.50	10.88
27.62	8.61
28.32	11.44
28.74	10.73
30.92	8.23
38.60	8.88

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 8 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 15%, as listed in Table 6.

Table 6. XRPD peaks of crystalline form (I-HS)

Position (°2θ)	Relative Intensity (%)
10.76	29.85
18.50	48.07
19.22	22.92
20.26	30.80
20.74	100.00
21.56	23.78
23.16	32.52
24.10	33.89

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 5 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 25%, as listed in Table 7.

Table 7. XRPD peaks of crystalline form (I-HS)

Position (°2θ)	Relative Intensity (%)
10.76	29.85
18.50	48.07
20.74	100.00
23.16	32.52
24.10	33.89

In some embodiments, the crystalline form (I-HS) has an XRPD pattern with at least the 4 characteristic peaks (2θ degrees ± 0.3), which comprises peaks having a relative intensity greater than or equal to about 30%, as listed in Table 8.

Table 8. XRPD peaks of crystalline form (I-HS)

Position (°2θ)	Relative Intensity (%)
18.50	48.07
20.74	100.00
23.16	32.52
24.10	33.89

In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 18.5, 20.7, 23.2, and 24.1. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.8, 18.5, 20.7, 23.2, and 24.1. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.8, 18.5, 19.2, 20.3, 20.7, 21.6, 23.2, and 24.1. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at about 10.8, 15.4, 16.5, 18.5, 19.2, 19.9, 20.3, 20.7, 21.6, 22.2, 23.2, 24.1, 24.5, 25.7, 26.5, 27.6, 28.3, 28.7, 30.9, and 38.6.

In some embodiments, given the XRPD patterns provided in FIGs. 1 and 29, crystalline feorm (I-HS) is characterized by having XRPD peaks (2θ degrees) as shown in Table 9.

Table 9. XRPD peaks of crystalline form (I-HS)

FIG. 1	FIG. 29	Difference	Average
10.76	10.63	0.13	10.70
15.38	15.25	0.13	15.32
16.52	16.39	0.13	16.46
18.50	18.37	0.13	18.44
19.22	19.08	0.14	19.15
19.92	19.79	0.13	19.86
20.26	20.15	0.11	20.21
20.74	20.61	0.13	20.68
21.56	21.47	0.09	21.52
22.16	22.01	0.15	22.09
23.16	23.04	0.12	23.10
24.10	23.97	0.13	24.04
24.50	24.35	0.15	24.43
25.72	25.58	0.14	25.65
26.50	26.48	0.02	26.49

27.62	27.50	0.12	27.56
28.32	28.17	0.15	28.25
28.74	28.58	0.16	28.66
30.92	30.77	0.15	30.85
38.60	38.47	0.13	38.54

In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 18.4±0.2, 19.2±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 15.3±0.2, 16.5±0.2, 18.4±0.2, 19.2±0.2, 19.9±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 22.1±0.2, 23.1±0.2, 24.0±0.2. 24.4±0.2, 25.6±0.2, 26.5±0.2, 27.6±0.2, 28.2±0.2, 28.7±0.2, 30.8±0.2, and 38.5±0.2.

It will be understood that the 2-theta values of the X-ray powder diffraction patterns for crystalline form (I-HS) may vary slightly from one instrument to another and also depending on variations in sample preparation and batch to batch variation, and so the values quoted are not to be construed as absolute. It will also be understood that the relative intensities of peaks may vary depending on orientation effects so that the intensities shown in the XRPD trace included herein are illustrative and not intended to be used for absolute comparison. Accordingly, it is to be understood that the phrase "substantially the same XRPD pattern as shown in Figure 1 or Figure 8" means that for comparison purposes, at least 90% of the peaks shown in Figure 1 or Figure 8 are present. It is to be understood that the relative peak positions may vary ± 0.3 degrees from the peak positions shown in Figure 1 or Figure 8. It is to be further understood that for comparison purposes some variability in peak intensities from those shown in Figure 1 and Figure 8 is allowed.

FIG. 2 illustrates a simultaneous thermogravimetric/differential thermal analyzer (TG/DTA) profile of crystalline form (I-HS), according to one embodiment. For the analysis about 5 mg of crystalline form (I-HS) was weighed into an open aluminum pan and loaded into a simultaneous thermogravimetric/differential thermal analyzer (TG/DTA) and held at room temperature. The sample was then heated at a rate of 10° Celsius/min from 25° Celsius to 300° Celsius during which time the change in sample weight was recorded along with any differential thermal events. Nitrogen was used as the purge gas at a flow rate of 100 cm^3/min.

The TG/DAT profile of crystalline form (I-HS) shows an initial weight loss of 0.8% between 27.4° Celsius to 182.4° Celsius, which is followed by 4.9% weight loss in the TG curve between 182.4° Celsius to 225.0° Celsius, also seen as an endotherm in the DTA curve. These weight losses could be decomposition of the material.

FIG. 3 illustrates a differential scanning calorimetry (DSC) profile of crystalline form (I-HS), according to one embodiment. DSC analysis of the sample was performed using a Seiko DSC6200 differential scanning calorimeter (equipped with a cooler). About 5 mg of crystalline form (I-HS) was weighed into an aluminum DSC pan and sealed non-hermetically with a pierced aluminum lid. The sample pan was then loaded into a Seiko DSC6200 (equipped with a cooler), cooled, and held at 25° Celsius. Once a stable heat-flow response was obtained, the sample and reference were heated to 270° Celsius at a scan rate of 10° Celsius/min while monitoring the resulting heat flow response. In some embodiments, crystalline form (I-HS) has a DSC thermogram substantially as shown in Figure 3. As used herein, "substantially as shown in Figure 3" means that the temperatures of the endothermic event shown in Figure 3 can vary by about ± 5 °C.

As shown in FIG. 3, the DSC thermogram of the crystalline form (I-HS) indicates a small endothermic change in the baseline between 122.9° Celsius to 152.8° Celsius, followed by a sharp endotherm that corresponds to the melting of the crystalline form (I-HS) at an onset temperature of melting of 190.8° Celsius, a peak temperature of melting of 197.9° Celsius and a heat of melting of 2.415 mW. The transition following the melting endotherm may be caused by the decomposition of the melted crystalline form (I-HS).

FIGS. 4A and 4B illustrate polarized light microscopy (PLM) images of crystalline form (I-HS) under (A) unpolarized and (B) unpolarized light, according to some embodiments. The presence of crystallinity (birefringence) was determined using an Olympus BX50 polarizing microscope, equipped with a Motic camera and image capture software (Motic Images Plus 2.0). All images were recorded using the 20x objective. The crystalline form (I-HS) exhibits birefringence when examined under polarized light without exhibiting a definite morphology or agglomerates.

FIG. 5 illustrates a dynamic vapor sorption (DVS) isotherm profile of crystalline form (I-HS), according to one embodiment. For the DVS measurement a sample of crystalline form (I-HS) was cycled through changing humidity conditions to determine its hygroscopicity. The sample was analyzed using a Surface Measurement System DVS-1 Dynamic Vapor Sorption System. About 10 mg of crystalline form (I-HS) was placed into a mesh vapor sorption balance pan and loaded into a dynamic vapor sorption balance as part of

the Surface Measurement System. Data was collected in 1 minute intervals. Nitrogen was used as the carrier gas. The sampled crystalline form (I-HS) was subjected to a ramping profile from 20-90% relative humidity (RH) at 10% increments, maintaining the sample at each step until a stable weight had been achieved (99.5% step completion). After completion of the sorption cycle, the sample was dried using the same procedure, but all the way down to 0% RH and finally taken back to the starting point of 20% RH. The weight change during the sorption/desorption cycles were plotted, allowing for the hygroscopic nature of the sample to be determined.

As shown in FIG. 5, crystalline form (I-HS) appears to be non-hygroscopic. A small increase in mass of about 1.7% was observed between 0% and 90% RH during the sorption cycle. In addition, a very small hysteresis was observed between sorption and desorption cycles. The XRPD pattern of crystalline form (I-HS) post DVS analysis (not shown) being similar to its pre-DVS XRPD pattern shown in FIG. 1 or FIG. 29 indicates that no change in the crystalline form (I-HS) occurred during DVS.

FIG. 6 illustrates an infrared (IR) spectroscopy profile of crystalline form (I-HS) for the compound of formula (I), according to one embodiment. IR spectroscopy was carried out on a Bruker ALPHA P spectrometer. Sufficient material of crystalline form (I-HS) was placed onto the center of the plate of the spectrometer with a transmittance spectrum being obtained using a resolution of 4 cm^{-1}, a background scan time of 16 scans, a sample scan time of 16 scans, and collecting data from 4000 cm^{-1} to 400 cm^{-1}. The observed IR spectrum of crystalline form (I-HS) is shown in FIG. 6.

The crystalline form (I-HS) has a number of properties that make it surprisingly superior to the amorphous form of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate (AM(HS)). For example, the crystalline form (I-HS) has properties which contribute to its manufacturability and production of a commercial product. As shown in Example 8, the crystalline form (I-HS) has better flow properties as compared to the amorphous API (AM(HS)) as evidenced by the Carr's and Hausner Index. For example, the crystalline form (I-HS) exhibits a Carr Index value of greater than 20%. In some embodiments, the crystalline form (I-HS) exhibits a Hausner ratio of less than 1.35 (e.g., a value of between about 1.26 to about 1.34). The differences in flow properties can make the development of a solid oral dosage form more difficult for the amorphous API vs. the crystalline API.

The crystalline form (I-HS) also evidenced better stability in an accelerated stability study conducted in an LDPE bag at 40 °C/75% RH for five weeks. While neither the

AM(HS) or crystalline form (I-HS) exhibited a significant changes in chemical impurity levels over the course of the study, the study did reveal that the crystalline form (I-HS) has stable physicochemical properties. The amorphous API, on the other hand, converted into a crystalline form substantially similar to the crystalline form (I-HS) by XRPD, DSC, TGA, KF and polarized light microscopy. Additionally, the amorphous API changed to an agglomerated powder with reduced flow properties over the course of the stability testing. Such changes in the physical properties of the compound, including a change from an amorphous power to a crystalline material and/or an agglomerated powder with reduced flow, on storage would make it nearly impossible to manufacture a solid oral dosage form for patient use based on the amorphous compound. The properties observed for the crystalline form (I-HS), however, are consistent with that desired for a commercial product, including having both a stable physical and chemical structure.

The crystalline form (I-HS), as noted previously, is non-hygroscopic. As used herein, "non-hygroscopic" refers to a compound exhibiting less than a 2% weight gain at 25 °C and 80% RH after 24 to 48 hours (see, e.g., Example 10). The AM(HS) compound, however, was found to deliquesce upon exposure to humidity. Given this tendency, use of the AM(HS) compound would require significant handling precautions during storage and manufacture to prevent this change in form from occurring whereas the crystalline form (I-HS) requires no such precautions during manufacture of the API. This stability to humidity would also be expected to carry over to any solid oral dosage product prepared using the crystalline form (I-HS).

Finally, the crystalline form (I-HS) provides a significantly improved impurity profile versus the amorphous API. The ability to control an impurity profile is important for patient safety, developing a repeatable manufacturing process, and meeting requirements by Regulatory agencies prior to use in humans.

The compounds provided herein, including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (formula (I)) and pharmaceutically acceptable salts thereof, for example the hydrogen sulfate salt, and further a novel crystalline form of the hydrogen sulfate salt (crystalline form (I-HS)), exhibit Trk family protein tyrosine kinase inhibition, and the compound, hydrogen sulfate salt, and crystalline form thereof can be used in the treatment of pain, inflammation, cancer, and certain infectious diseases.

Non-limiting examples of doses of crystalline form (I-HS) or a compound of formula (I) or a salt thereof, such as a hydrogen sulfate salt (e.g., see Example 14A of U.S. Patent No.

8,513,263) that can be administered to a pediatric subject (in any of the methods or uses described herein) are described herein. Non-limiting examples of the frequency of administration of crystalline form (I-HS) or a compound of formula (I) or a salt thereof, such as a hydrogen sulfate salt (e.g., see Example 14A of U.S. Patent No. 8,513,263) to a pediatric subject (that can be used in any of the methods or uses described herein) are described herein.

Also provided herein is a method of treating diseases or medical conditions in a pediatric subject in need thereof, wherein said disease or condition is treatable with an inhibitor of TrkA and/or TrkB (e.g., a Trk-associated cancer), comprising administering to said subject crystalline form (I-HS) or a compound of formula (I) or a a pharmaceutically acceptable salt thereof, such as a hydrogen sulfate salt (e.g., see Example 14A of U.S. Patent No. 8,513,263 in an amount effective to treat or prevent said disorder.

Crystalline form (I-HS) or a compound of formula (I) or a pharmaceutically acceptable salt thereof, such as a hydrogen sulfate salt (e.g., see Example 14A of U.S. Patent No. 8,513,263) can be used in combination with one or more additional drugs that work by the same or a different mechanism of action. Such conjoint treatment may be achieved by way of the simultaneous, sequential or separate administration of the individual components of the treatment. Examples include anti-inflammatory compounds, steroids (e.g., dexamethasone, cortisone and fluticasone), analgesics such as NSAIDs (e.g., aspirin, ibuprofen, indomethacin, and ketoprofen), and opioids (such as morphine), and chemotherapeutic agents.

In the field of medical oncology, it is normal practice to use a combination of different forms of treatment to treat each pediatric patient with cancer. In medical oncology the other component(s) of such conjoint treatment in addition to compositions provided herein may be, for example, surgery, radiotherapy, chemotherapy, signal transduction inhibitors and/or monoclonoal antibodies.

Accordingly, crystalline form (I-HS) may be administered in combination with one or more agents selected from mitotic inhibitors, alkylating agents, anti-metabolites, antisense DNA or RNA, intercalating antibiotics, growth factor inhibitors, signal transduction inhibitors, cell cycle inhibitors, enzyme inhibitors, retinoid receptor modulators, proteasome inhibitors, topoisomerase inhibitors, biological response modifiers, anti-hormones, angiogenesis inhibitors, cytostatic agents anti-androgens, targeted antibodies, HMG-CoA reductase inhibitors, and prenyl-protein transferase inhibitors.

It will be appreciated that crystalline form (I-HS) contains two centers of asymmetry and may therefore be prepared and isolated in a mixture of isomers such as a racemic or

diastereomeric mixture, or in an enantiomerically pure form. Where stereochemistry is specified by a solid wedge or dashed line representing a particular configuration, then that stereoisomer is so specified and defined.

Crystalline form (I-HS) may be administered by any convenient route, e.g. into the gastrointestinal tract (e.g., rectally or orally), the nose, lungs, musculature or vasculature, or transdermally or dermally. Crystalline form (I-HS) may be administered in any convenient administrative form, e.g., tablets, powders, capsules, solutions, dispersions, suspensions, syrups, sprays, suppositories, gels, emulsions, patches etc. Such compositions may contain components conventional in pharmaceutical preparations, e.g. diluents, carriers, pH modifiers, sweeteners, bulking agents, and further active agents. If parenteral administration is desired, the compositions will be sterile and in a solution or suspension form suitable for injection or infusion.

METHODS OF TREATING A PEDIATRIC CANCER WITH A COMPOSITION OF A COMPOUND OF FORMULA (I)

For the methods of treatment provided herein, a compound of formula (I), or a pharmaceutically acceptable salt thereof, can be provided as a pharmaceutical composition.

Pharmaceutical compositions can include a compound of formula (I), or a pharmaceutically acceptable salt thereof, or a combination thereof, and a pharmaceutically acceptable carrier. Pharmaceutical compositions containing a compound of formula (I), or a pharmaceutically acceptable salt thereof, or a combination thereof, as the active ingredient can be prepared by intimately mixing a compound of formula (I), or a pharmaceutically acceptable salt thereof, or a combination thereof, with a pharmaceutical carrier according to conventional pharmaceutical compounding techniques. The carrier may take a wide variety of forms depending upon the desired route of administration (e.g., oral, parenteral). Solid oral preparations may be coated with substances such as sugars or be enteric-coated so as to modulate major site of absorption. For parenteral administration, the carrier will usually consist of sterile water and other ingredients may be added to increase solubility of the compound or to preserve and increase the stability of the solution. Injectable suspensions or solutions may also be prepared utilizing aqueous carriers along with appropriate additives. The liquid formulations provided herein can be administered through a number of different routes including oral administration, intranasal administration, and administration through an enteral feeding or gastrostomy tube (e.g., intra-jejunal tube).

Also provided herein are pharmaceutical compositions comprising a crystalline form (I-HS). To prepare the pharmaceutical compositions provided herein, crystalline form (I-HS) as the active ingredient is intimately admixed with a pharmaceutical carrier according to conventional pharmaceutical compounding techniques, which carrier may take a wide variety of forms depending of the form of preparation desired for administration, e.g., oral or parenteral such as intramuscular. In preparing the compositions in oral dosage form, any of the usual pharmaceutical media may be employed. For solid oral preparations such as, for example, powders, capsules, caplets, gelcaps and tablets, suitable carriers and additives include starches, sugars, diluents, granulating agents, lubricants, binders, disintegrating agents and the like. Suitable binders include, without limitation, starch, gelatin, natural sugars such as glucose or beta-lactose, corn sweeteners, natural and synthetic gums such as acacia, tragacanth or sodium oleate, sodium stearate, magnesium stearate, sodium benzoate, sodium acetate, sodium chloride and the like. Disintegrators include, without limitation, starch, methyl cellulose, agar, bentonite, xanthan gum and the like.

In some embodiments, tablets and capsules may be sugar coated or enteric coated by standard techniques. For parenterals, the carrier can comprise sterile water, through other ingredients, for example, for purposes such as aiding solubility or for preservation, can be included. Injectable suspensions may also be prepared, in which case appropriate liquid carriers, suspending agents and the like may be employed. The pharmaceutical compositions herein can contain, per dosage unit, e.g., tablet, capsule, powder, injection, teaspoonful and the like, an amount of the active ingredient necessary to deliver an effective dose as described above.

The pharmaceutical compositions herein can contain, per unit dosage unit, e.g., tablet, capsule, suspension, solution, sachet for reconstitution, powder, injection, I.V., suppository, sublingual/buccal film, teaspoonful and the like, of from about 0.1-1000 mg or any range therein, and may be given at a dosage of from about 0.01-300 mg/kg/day, or any range therein, preferably from about 0.5-50 mg/kg/day, or any range therein. In some embodiments, the pharmaceutical compositions provided herein contain, per unit dosage unit, about 25 mg to about 500 mg of a compound provided herein (for example, about 25 mg to about 400 mg, about 25 mg to about 300 mg, about 25 mg to about 250 mg, about 25 mg to about 200 mg, about 25 mg to about 150 mg, about 25 mg to about 100 mg, about 25 mg to about 75 mg, about 50 mg to about 500 mg, about 100 mg to about 500 mg, about 150 mg to about 500 mg, about 200 mg to about 500 mg, about 250 mg to about 500 mg, about 300 mg to about 500 mg, about 400 mg to about 500 mg, about 50 to about 200 mg, about 100 to about 250 mg, about

50 to about 150 mg). In some embodiments, the pharmaceutical compositions provided herein contain, per unit dosage unit, about 25 mg, about 50 mg, about 100 mg, about 150 mg, about 200 mg, about 250 mg, about 300 mg, about 400 mg, or about 500 mg of a compound provided herein. The dosages, however, may be varied depending upon the requirement of the patients, the severity of the condition being treated and the compound being employed. In some embodiments, the dosages are administered once daily (QD) or twice daily (BID).

In some embodiments, these compositions are in unit dosage forms such as tablets, pills, capsules, powders, granules, sterile parenteral solutions or suspensions, metered aerosol or liquid sprays, drops, ampoules, autoinjector devices or suppositories; for oral parenteral, intranasal, sublingual or rectal administration, or for administration by inhalation or insufflation. Alternatively, the composition may be presented in a form suitable for once-weekly or once-monthly administration; for example, an insoluble salt of the active compound, such as the decanoate salt, may be adapted to provide a depot preparation for intramuscular injection. For preparing solid compositions such as tablets, a compound of formula **(I)**, a pharmaceutically acceptable salt thereof, crystalline form (I-HS), or a combination thereof, is mixed with a pharmaceutical carrier, e.g. conventional tableting ingredients such as corn starch, lactose, sucrose, sorbitol, talc, stearic acid, magnesium stearate, dicalcium phosphate or gums, and other pharmaceutical diluents, e.g. water, to form a solid preformulation composition containing a homogeneous mixture of the compound of formula (I), a pharmaceutically acceptable salt thereof, crystalline form (I-HS), or a combination thereof. When referring to these preformulation compositions as homogeneous, it is meant that the active ingredient is dispersed evenly throughout the composition so that the composition may be readily subdivided into equally effective dosage forms such as tablets, pills and capsules. This solid preformulation composition is then subdivided into unit dosage forms of the type described above containing from 0.1 to about 1000 mg, or any amount or range thereof, of the active ingredient provided herein. The tablets or pills of the novel composition can be coated or otherwise compounded to provide a dosage form affording the advantage of prolonged action. For example, the tablet or pill can comprise an inner dosage and an outer dosage component, the latter being in the form of an envelope over the former. The two components can be separated by an enteric layer which serves to resist disintegration in the stomach and permits the inner component to pass intact into the duodenum or to be delayed in release. A variety of material can be used for such enteric layers or coatings, such materials including a number of polymeric acids with such materials as shellac, cetyl alcohol and cellulose acetate.

A compound of formula (I), a pharmaceutically acceptable salt thereof, crystalline form (I-HS), or a combination thereof, can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal skin patches well known to those of ordinary skill in that art. To be administered in the form of a transdermal delivery system, the dosage administration will, of course, be continuous rather than intermittent throughout the dosage regimen.

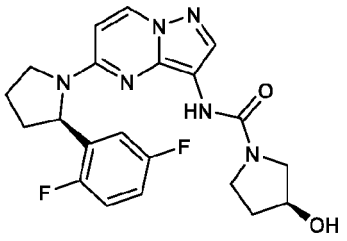
To prepare a pharmaceutical compositions provided herein, a compound of formula (I), a pharmaceutically acceptable salt thereof, crystalline form (I-HS), or a combination thereof as the active ingredient is intimately admixed with a pharmaceutical carrier according to conventional pharmaceutical compounding techniques, which carrier may take a wide variety of forms depending of the form of preparation desired for administration (e.g. oral or parenteral). Suitable pharmaceutically acceptable carriers are well known in the art. Descriptions of some of these pharmaceutically acceptable carriers may be found in *The Handbook of Pharmaceutical Excipients*, published by the American Pharmaceutical Association and the Pharmaceutical Society of Great Britain.

Methods of formulating pharmaceutical compositions have been described in numerous publications such as *Pharmaceutical Dosage Forms: Tablets, Second Edition, Revised and Expanded*, Volumes 1-3, edited by Lieberman et al; *Pharmaceutical Dosage Forms: Parenteral Medications*, Volumes 1-2, edited by Avis et al; and *Pharmaceutical Dosage Forms: Disperse Systems*, Volumes 1-2, edited by Lieberman et al; published by Marcel Dekker, Inc.

METHODS OF TREATING A PEDIATRIC CANCER WITH A LIQUID FORMULATION OF A COMPOUND OF FORMULA (I)

For the methods of treatment provided herein, a compound of formula (I), a pharmaceutically acceptable salt thereof, or combinations thereof can be provided as a liquid formulation.

Provided herein is a liquid formulation including a solubilizing agent and (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof.

In some embodiments, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, can be present in the liquid formulation in an amount from about 0.5 wt.% to about 7 wt.%, about 1 wt.% to about 3 wt.%, or about 1.5 wt.% to about 2.5 wt.%. For example, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof can be present in the liquid formulation in an amount of about 0.5 wt.%, 1 wt.%, 2 wt.%, 3 wt.%, 4 wt.%, 5 wt.%, 6 wt.%, or about 7 wt.%. In some embodiments, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof can be present in the liquid formulation in an amount of about 2 wt.%.

In some embodiments, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof, has a concentration of about 5 mg/mL to about 50 mg/mL, about 15 mg/mL to about 35 mg/mL, or about 20 mg/mL to about 30 mg/mL in the liquid formulation. For example, the compound of formula **(I)**, a pharmaceutically acceptable salt thereof, or a combination thereof can have a concentration of about 5 mg/mL, 10 mg/mL, 15 mg/mL, 20 mg/mL, 25 mg/mL, 30 mg/mL, 35 mg/m, 40 mg/mL, 45 mg/mL, or about 50 mg/mL in the liquid formulation. In some embodiments, the compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof can be present at a concentration of about 20 mg/mL in the liquid formulation.

The formulations provided herein can include a solubilizing agent that functions to increase the solubility of the compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof. A solubilizing agent as provided herein is a polar organic compound having one or more hydroxyl groups. The solubilizing agent is also capable of achieving a higher concentration of the compound of formula (I) (e.g., the free base) in aqueous solution compared to an aqueous phase dissolution of the compound of formula (I) in a similar pH range without the solubilizing agent. The solubilizing agent can include, for example, a cyclodextrin, a glycol, a glycerol, a polyethylene glycol, a self-emulsifying drug delivery system (SEDDS), or a combination thereof.

In some embodiments, the cyclodextrin can include an α-cyclodextrin , β-cyclodextrin

derivative, a δ-cyclodextrin derivative, a γ-cyclodextrin, or a combination derivative thereof. For example, the solubilizing agent can include a cyclodextrin. The solubilizing agent can include a β-cyclodextrin derivative, a γ-cyclodextrin, or a mixture thereof. For example, the solubilizing agent can include a hydroxy alkyl-γ-cyclodextrin. In some embodiments, the solubilizing agent includes a β-cyclodextrin including at least one of a hydroxy alkyl-β-cyclodextrin (e.g., hydroxypropyl-β-cyclodextrin) or a sulfoalkyl ether-β-cyclodextrin (e.g., sulfobutyl ether-β-cyclodextrin). For example, the liquid the solubilizing agent can include hydroxypropyl-β-cyclodextrin. In some embodiments, the cyclodextrin is CAVASOL® W7 HP (hydroxypropyl-β-cyclodextrin). In some embodiments, the cyclodextrin is KLEPTOSE® HP (hydroxypropyl-β-cyclodextrin). In some embodiments, the cyclodextrin is CAVAMAX® W7 (β-cyclodextrin). In some embodiments, the cyclodextrin is CAPTISOL® (sulfoalkyl ether-β-cyclodextrin). In some embodiments, the cyclodextrin is CAVASOL® W7 M (methyll-β-cyclodextrin). In some embodiments, the cyclodextrin is CAVASOL® W8 HP (hydroxypropyl-γ-cyclodextrin). In some embodiments, the cyclodextrin is CAVAMAX® W8 (γ-cyclodextrin). In some embodiments, the cyclodextrin is CAVAMAX® W6 (α-cyclodextrin).

SEDDS are isotropic mixtures of oils, surfactants, solvents and co-solvents/surfactants, that can be used to improve the oral absorption of highly lipophilic drug compounds. See, e.g., Tarate, B. et al., *Recent Patents on Drug Delivery & Formulation* (2014) Vol. 8.

In some embodiments, the poly(ethylene glycol) molecule is a linear polymer. The molecular weight of the linear chain PEG may be between about 1,000 Da and about 100,000 Da. For example, a linear chain PEG used herein can have a molecular weight of about 100,000 Da, 95,000 Da, 90,000 Da, 85,000 Da, 80,000 Da, 75,000 Da, 70,000 Da, 65,000 Da, 60,000 Da, 55,000 Da, 50,000 Da, 45,000 Da, 40,000 Da, 35,000 Da, 30,000 Da, 25,000 Da, 20,000 Da, 15,000 Da, 10,000 Da, 9,000 Da, 8,000 Da, 7,000 Da, 6,000 Da, 5,000 Da, 4,000 Da, 3,000 Da, 2,000 Da, or 1,000 Da. In some embodiments, the molecular weight of the linear chain PEG is between about 1,000 Da and about 50,000 Da. In some embodiments, the molecular weight of the linear chain PEG is between about 1,000 Da and about 40,000 Da. In some embodiments, the molecular weight of the linear chain PEG is between about 5,000 Da and about 40,000 Da. In some embodiments, the molecular weight of the linear chain PEG is between about 5,000 Da and about 20,000 Da.

In some embodiments, the poly(ethylene glycol) molecule is a branched polymer. The molecular weight of the branched chain PEG may be between about 1,000 Da and about

100,000 Da. For example, a branched chain PEG used herein can have a molecular weight of about 100,000 Da, 95,000 Da, 90,000 Da, 85,000 Da, 80,000 Da, 75,000 Da, 70,000 Da, 65,000 Da, 60,000 Da, 55,000 Da, 50,000 Da, 45,000 Da, 40,000 Da, 35,000 Da, 30,000 Da, 25,000 Da, 20,000 Da, 15,000 Da, 10,000 Da, 9,000 Da, 8,000 Da, 7,000 Da, 6,000 Da, 5,000 Da, 4,000 Da, 3,000 Da, 2,000 Da, and 1,000 Da. In some embodiments, the molecular weight of the branched chain PEG is between about 1,000 Da and about 50,000 Da. In some embodiments, the molecular weight of the branched chain PEG is between about 1,000 Da and about 40,000 Da. In some embodiments, the molecular weight of the branched chain PEG is between about 5,000 Da and about 40,000 Da. In some embodiments, the molecular weight of the branched chain PEG is between about 5,000 Da and about 20,000 Da.

In some embodiments, the solubilizing agent can be present in the liquid formulation in an amount of about 5 wt.% to about 35 wt.%, about 10 wt.% to about 25 wt.%, about 10 wt.% to about 20 wt.%, or about 13 wt.% to about 17 wt.%. For example, the solubilizing agent can be present at about 5 wt.%, 7 wt.%, 10 wt.%, 13 wt.%, 15 wt.%, 17 wt.%, 20 wt.%, 23 wt.%, 26 wt.%, 30 wt.% or about 35 wt.%. In some embodiments, the solubilizing agent is present in the liquid formulation in an amount of 15 wt.%.

A buffer can be added to the liquid formulation to adjust the pH of the formulation to a desired pH. In some embodiments, a buffer can be added in an amount to adjust the pH of the formulation to a pH of about 2 to about 7, about 2.5 to about 5.5, or about 3 to about 4. For example, a buffer can be added in an amount to adjust the pH of the formulation to a pH of about 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 6.0, or about 7.0. In some embodiments, a buffer can be added in an amount to adjust the pH of the formulation to a pH of about 3.5. In some embodiments, the buffer includes a citrate buffer, a lactate buffer, a phosphate buffer, a maleate buffer, a tartrate buffer, a suucinate buffer, an acetate buffer, or a combination thereof. In some embodiments, the buffer includes lithium lactate, sodium lactate, potassium lactate, calcium lactate, lithium phosphate, sodium phosphate, potassium phosphate, calcium phosphate, lithium maleate, sodium maleate, potassium maleate, calcium maleate, lithium tartrate, sodium tartrate, potassium tartrate, calcium tartrate, lithium succinate, sodium succinate, potassium succinate, calcium succinate, lithium acetate, sodium acetate, potassium acetate, calcium acetate, or combinations thereof. In some embodiments, the buffer is a citrate buffer. For example, the citrate buffer can include at least one of lithium citrate monohydrate, sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, lithium citrate dihydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, lithium citrate trihydrate, sodium citrate trihydrate, potassium

citrate trihydrate, calcium citrate trihydrate, lithium citrate tetrahydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, lithium citrate pentahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, lithium citrate hexahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, lithium citrate heptahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, calcium citrate heptahydrate, or mixtures thereof. The buffer can include sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate. In some embodiments, the buffer includes sodium citrate dihydrate.

In some embodiments, the buffer is present in the liquid formulation in an amount of about 0.1 wt.% to about 5 wt.%, about 0.3 wt.% to about 4 wt.%, about 0.5 wt.% to about 3.5 wt.%, about 0.6 wt.% to about 3 wt.%, 0.7 wt.% to about 2.5 wt.%, about 0.7 wt.% to about 2.0 wt.%, or about 0.7 wt.% to about 1.5 wt.%. For example, the buffer can be present in the liquid formulation in an amount of about 0.1 wt.%, 0.3 wt.%, 0.5 wt.%, 0.7 wt.%, 0.9 wt.%, 1.1 wt.%, 1.5 wt.%, 2.0 wt.%, 2.5 wt.%, 3.0 wt.%, 3.5 wt.%, 4.0 wt.%, or about 5 wt.%. In some embodiments, the buffer is present in the liquid formulation in an amount of about 0.9 wt.%.

The pH of the liquid formulation can be adjusted to a desired pH. In some embodiments, the pH of the formulation can be adjusted to a pH of about 2 to about 7, about 2.5 to about 5.5, or about 3 to about 4. For example, the pH of the formulation can be adjusted to a pH of about 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 6.0, or about 7.0. In some embodiments, the pH of the formulation is adjusted to a pH of about 3.5. In some such embodiments, where the pH of the liquid formulation is adjusted to a desired pH, the liquid formulation includes a base. In some embodiments, the base is selected from a citrate, a lactate, a phosphate, a maleate, a tartrate, a succinate, an acetate, a carbonate, a hydroxide, or a combination thereof. In some embodiments, the base includes lithium lactate, sodium lactate, potassium lactate, calcium lactate, lithium phosphate, sodium phosphate, potassium phosphate, calcium phosphate, lithium maleate, sodium maleate, potassium maleate, calcium maleate, lithium tartrate, sodium tartrate, potassium tartrate, calcium tartrate, lithium

succinate, sodium succinate, potassium succinate, calcium succinate, lithium acetate, sodium acetate, potassium acetate, calcium acetate, sodium carbonate, potassium carbonate, calcium carbonate, sodium bicarbonate, potassium bicarbonate, calcium bicarbonate, sodium hydroxide, potassium hydroxide, calcium hydroxide, or combinations thereof. In some embodiments, the base includes a citrate. For example, the citrate can include at least one of lithium citrate monohydrate, sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, lithium citrate dihydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, lithium citrate trihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, lithium citrate tetrahydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, lithium citrate pentahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, lithium citrate hexahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, lithium citrate heptahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, calcium citrate heptahydrate, or mixtures thereof. The base can include sodium citrate monohydrate, potassium citrate monohydrate, calcium citrate monohydrate, sodium citrate dihydrate, potassium citrate dihydrate, calcium citrate dihydrate, sodium citrate trihydrate, potassium citrate trihydrate, calcium citrate trihydrate, sodium citrate tetrahydrate, potassium citrate tetrahydrate, calcium citrate tetrahydrate, sodium citrate pentahydrate, potassium citrate pentahydrate, calcium citrate pentahydrate, sodium citrate hexahydrate, potassium citrate hexahydrate, calcium citrate hexahydrate, sodium citrate heptahydrate, potassium citrate heptahydrate, or calcium citrate heptahydrate. In some embodiments, the base includes sodium citrate dihydrate.

In some embodiments, the base is present in the liquid formulation in an amount of about 0.1 wt.% to about 5 wt.%, about 0.3 wt.% to about 4 wt.%, about 0.5 wt.% to about 3.5 wt.%, about 0.6 wt.% to about 3 wt.%, 0.7 wt.% to about 2.5 wt.%, about 0.7 wt.% to about 2.0 wt.%, or about 0.7 wt.% to about 1.5 wt.%. For example, the base can be present in the liquid formulation in an amount of about 0.1 wt.%, 0.3 wt.%, 0.5 wt.%, 0.7 wt.%, 0.9 wt.%, 1.1 wt.%, 1.5 wt.%, 2.0 wt.%, 2.5 wt.%, 3.0 wt.%, 3.5 wt.%, 4.0 wt.%, or about 5 wt.%. In some embodiments, the base is present in the liquid formulation in an amount of about 0.9 wt.%. For example, the citrate is present in the liquid formulation in an amount of about 0.1 wt.% to about 5 wt.%, about 0.3 wt.% to about 4 wt.%, about 0.5 wt.% to about 3.5 wt.%, about 0.6 wt.% to about 3 wt.%, 0.7 wt.% to about 2.5 wt.%, about 0.7 wt.% to about 2.0 wt.%, or about 0.7 wt.% to about 1.5 wt.%. In some embodiments, the citrate can be present in the liquid formulation in an amount of about 0.1 wt.%, 0.3 wt.%, 0.5 wt.%, 0.7 wt.%, 0.9

wt.%, 1.1 wt.%, 1.5 wt.%, 2.0 wt.%, 2.5 wt.%, 3.0 wt.%, 3.5 wt.%, 4.0 wt.%, or about 5 wt.%. For example, the citrate is present in the liquid formulation in an amount of about 0.9 wt.%.

The liquid formulation can have a pH of about 2 to about 8, about 2.5 to about 6, about 3 to about 4, or about 3 to about 4. For example, the liquid formulation can have a pH of about 2, 2.5, 3.0, 3.5, 4.0, 4.5, or about 5. In some embodiments, the formulation can have a pH of about 3.5.

A sweetener can be added to the liquid formulation to make it less bitter or palatable, or both. Sweeteners suitable for inclusion in the formulation can include, both natural and artificial sweeteners. In some embodiments, the sweetener is an artificial sweetener and can include intense or high-intensity sweeteners. Intense sweeteners are commonly used as sugar substitutes or sugar alternatives as they are many times sweeter than sugar but contribute only a few to no calories when added to food. Exemplary intense sweeteners include sorbitol, sucrose, saccharins such as sodium saccharin, cyclamates such as sodium cyclamates, aspartame, sucralose, thaumatin, and acesulfam K. In some embodiments, the sweetener is a natural sugar. For example, sugars such as monosaccharides, disaccharides and polysaccharides can be used in the liquid formulations provided herein. The sugars can include xylose, ribose, glucose, mannose, galactose, fructose, dextrose, sucrose, maltose, partially hydrolyzed starch or corn syrup, and sugar alcohols such as sorbitol, xylitol, mannitol, glycerin, and combination thereof. In some embodiments, the liquid formulation further comprises a sweetener. The sweetener can include a sugar. For example, the sweetener can include sucrose. For example, the sweetener can be ORA-SWEET®, a sweetener that includes purified water, sucrose, glycerin, sorbitol, and flavoring; is buffered with citric acid and sodium phosphate; and is preserved with methylparaben and potassium sorbate. The sweetener can also include an intense sweetener. The intense sweetener can include sucralose. For example, the sweetener can be ORA-SWEET SF®, a sugar free sweetener that includes purified water, glycerin, sorbitol, sodium saccharin, xanthan gum, and flavoring; is buffered with citric acid and sodium citrate; and is preserved with methylparaben (0.03%), potassium sorbate (0.1%), and propylparaben (0.008%).

In some embodiments, the sweetener includes one or more of sucrose, glycerin, sorbitol, and flavoring. In some such embodiments, the sweetener further includes citric acid and sodium phosphate. In some such embodiments, the sweetener can include a preservative, such as methylparaben and potassium sorbate. For example, the sweetener includes sucrose, glycerin, sorbitol, flavoring, citric acid, sodium phosphate, methylparaben, and potassium

sorbate. In some embodiments, the sweetener includes one or more of glycerin, sorbitol, sodium saccharin, xanthan gum, and flavoring. In some such embodiments, the sweetener further includes citric acid and sodium citrate. In some such embodiments, the sweetener includes a preservative, such as methylparaben, potassium sorbate, and propylparaben. For example, the sweetener can include glycerin, sorbitol, sodium saccharin, xanthan gum, flavoring, citric acid and sodium citrate, methylparaben (0.03%), potassium sorbate (0.1%), and propylparaben (0.008%).

In some embodiments, the sweetener is present in the liquid formulation in an amount of about 30 wt.% to about 70 wt.%, about 35 wt.% to about 65 wt.%, about 40 wt.% to about 60 wt.%, or about 45 wt.% to about 55 wt.%. For example, the sweetener can be present in the liquid formulation in an amount of about 30 wt.%, 35 wt.%, 40 wt.%, 45 wt.%, 50 wt.%, 55 wt.%, 60 wt.%, 65 wt.%, or about 70 wt.%. In some embodiments, the sweetener is present in the liquid formulation in an amount of about 50 wt.%.

In some embodiments, the liquid formulation further comprises a bitterness masking agent. The bitterness masking agent can include 231a12 natural masking type flavor (Abelei®), 231a39 natural bitterness masking type flavor (Abelei®), bitterness masking flavor, nat (FONA®), and FINATECH Taste Modifier Flavor, Nat.

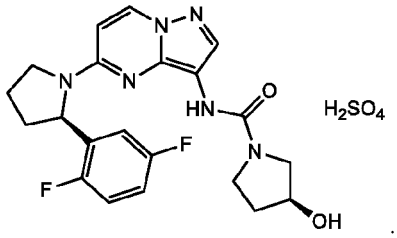
The bitterness masking agent can be present in the liquid formulation in an amount of about 0.01 wt.% to about 2 wt.%, about 0.1 wt.% to about 1.0 wt.%, or about 0.2 wt.% to about 0.5 wt.%. For example, the bitterness masking agent can be present in the liquid formulation in an amount of about 0.01 wt.%, 0.1 wt.%, 0.2 wt.%, 0.3 wt.%, 0.4 wt.%, 0.5 wt.%, 0.7 wt.%, 1.0 wt.%, 1.5 wt.%, or 2.0 wt.%. In some embodiments, the bitterness masking agent is present in the liquid formulation in an amount of about 0.4 wt.%.

A flavoring agent can be included in the liquid formulation so that the final formulation has a substantially non-bitter and palatable taste. The flavoring agent can include at least one of a natural flavoring agent, a natural fruit flavoring agent, an artificial flavoring agent, an artificial fruit flavoring agent, flavor enhancers, or mixtures thereof. Exemplary flavoring agents can be found, for example in US CFR 21 § 172.515 (April 1, 2015), which is incorporated by reference in its entirety. For example, cinnamon, raspberry, orange, maple, butterscotch, glycyrrhiza (licorice) syrup, fruit, berry, vanilla, acacia syrup, coca, chocolate-mint, wild cherry, walnut, eriodictyon, bubblegum, grapefruit, lime, marshmellow, gurana, coffee, peach, lemon, fennel, apricot, honey, mint, wintergreen, and cherry. In some embodiments, the flavoring agent can include a FONATECH® natural taste modifier flavoring agent. The flavoring agent can be present in the liquid formulation in an amount of

about 0.01 wt.% to about 2 wt.%, about 0.01 wt.% to about 0.1 wt.%, or about 0.2 wt.% to about 0.5 wt.%. For example, the flavoring agent can be present in an amount of about 0.01 wt.%, 0.1 wt.%, 0.2 wt.%, 0.3 wt.%, 0.4 wt.%, 0.5 wt.%, 0.7 wt.%, 1.0 wt.%, 1.5 wt.%, or 2.0 wt.%. In some embodiments, the flavoring agent can be present in the liquid formulation in an amount of about 0.5 wt.%.

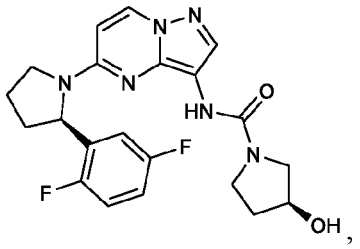
The liquid formulation can also include a coloring agent.

The liquid formulations provided herein can be prepared from a crystalline form of the compound of formula **(I)**. The crystalline form can the formula (I-HS):



I-HS

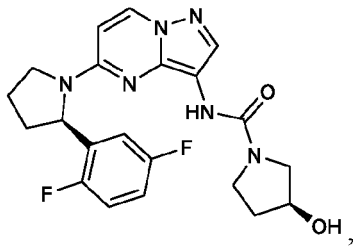
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent and a buffer. In some embodiments, the formulation has a pH of about 2.5 to about 5.5. In some embodiments, the compound of formula **(I)** has a concentration of about 15 mg/mL to about 35 mg/mL. In some embodiments, the formulation has a pH of about 3 to about 4 and the compound of formula **(I)**, or a pharmaceutically acceptable salt thereof, or a combination thereof, is present at a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. The buffer can include sodium citrate dihydrate.

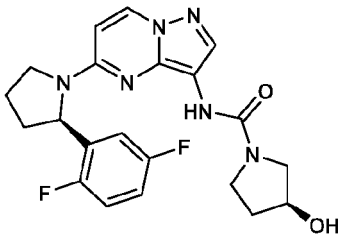
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent and a base. In some embodiments, the formulation has a pH of about 2.5 to about 5.5. In some embodiments, the compound of formula **(I)** has a concentration of about 15 mg/mL to about 35 mg/mL. In some embodiments, the formulation has a pH of about 3 to about 4 and the compound of formula **(I)**, or a pharmaceutically acceptable salt thereof, or a combination thereof, is present at a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. The base can include sodium citrate dihydrate.

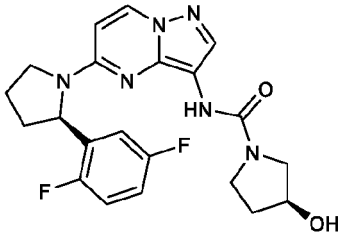
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a buffer, a sweetener, a bitterness masking agent, and a flavoring agent. In some embodiments, the formulation has a pH of about 3 to about 4 and the compound of formula **(I)**, or a pharmaceutically acceptable salt thereof, or a combination thereof, is present at a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. In some embodiments, the buffer includes sodium citrate dihydrate. In some embodiments, the sweetener includes sucrose.

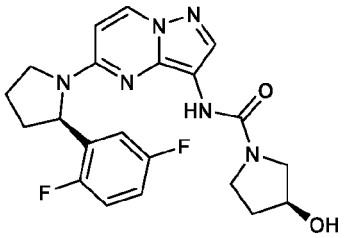
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a base, a sweetener, a bitterness masking agent, and a flavoring agent. In some embodiments, the formulation has a pH of about 3 to about 4 and the compound of formula **(I)**, or a pharmaceutically acceptable salt thereof, or a combination thereof, is present at a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation. In some embodiments, the base includes sodium citrate dihydrate. In some embodiments, the sweetener includes sucrose.

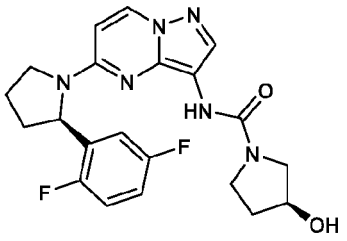
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a buffer, a sweetener, a bitterness masking agent, and flavoring agent, wherein the formulation has a pH of about 3 to about 4.

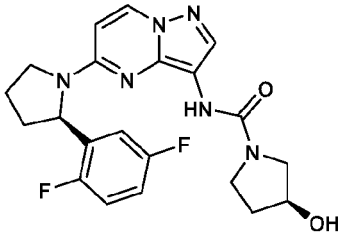
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a base, a sweetener, a bitterness masking agent, and flavoring agent, wherein the formulation has a pH of about 3 to about 4.

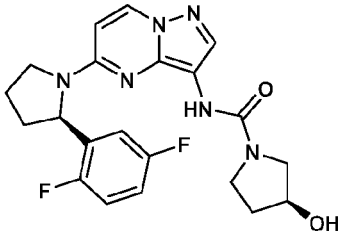
Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a buffer, a sweetener, a bitterness masking agent, and a flavoring agent, wherein the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



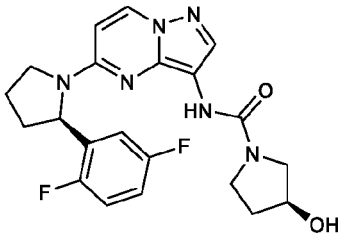
(I)

a pharmaceutically acceptable salt thereof, or a combination thereof, a solubilizing agent, a

base, a sweetener, a bitterness masking agent, and a flavoring agent, wherein the compound of formula (I) has a concentration of about 15 mg/mL to about 35 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

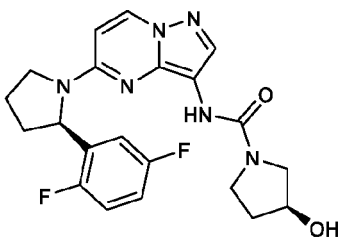
a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%; and

(c) a buffer present in an amount of about 0.1 wt.% to about 5 wt.%. In some embodiments, the buffer comprises sodium citrate dehydrate. In some embodiments, the formulation also includes a sweetener present in an amount of about 30 wt.% to about 70 wt.%. In some embodiments, the sweetener comprises sucrose. In some embodiments, the formulation also includes a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%. In some embodiments, the formulation also includes a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

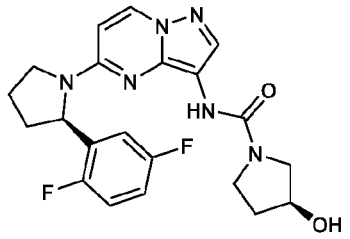
a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) a solubilizing agent present in an amount of about 5 wt.% to about 35 wt.%; and

(c) a base present in an amount of about 0.1 wt.% to about 5 wt.%. In some embodiments, the base comprises sodium citrate dehydrate. In some embodiments, the formulation also includes a sweetener present in an amount of about 30 wt.% to about 70 wt.%. In some embodiments, the sweetener comprises sucrose. In some embodiments, the formulation also includes a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%. In some embodiments, the formulation also includes a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) a solubilizing agent (e.g., a cyclodextrin such as a hydroxypropyl-β-cyclodextrin) present in an amount of about 5 wt.% to about 35 wt.%; and

(c) a buffer (e.g., a citrate buffer such as sodium citrate) present in an amount of about 0.1 wt.% to about 5 wt.%;

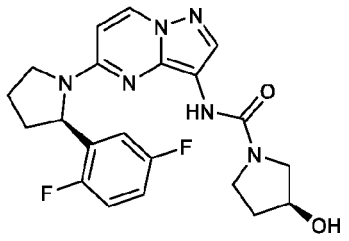
(d) a sweetener (e.g., a sweetener comprising sucrose or an intense sweetener) present in an amount of about 30 wt.% to about 70 wt.%;

(e) a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%.; and

(f) a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) a solubilizing agent (e.g., a cyclodextrin such as a hydroxypropyl-β-cyclodextrin) present in an amount of about 5 wt.% to about 35 wt.%; and

(c) a base (e.g., a citrate such as sodium citrate) present in an amount of about 0.1 wt.% to about 5 wt.%;

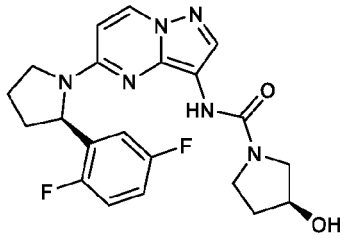
(d) a sweetener (e.g., a sweetener comprising sucrose or an intense sweetener) present in an amount of about 30 wt.% to about 70 wt.%;

(e) a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%.; and

(f) a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) hydroxypropyl-β-cyclodextrin present in an amount of about 5 wt.% to about 35 wt.%; and

(c) a sodium citrate present in an amount of about 0.1 wt.% to about 5 wt.%;

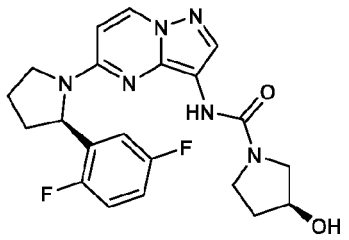
(d) a sucrose or an intense sweetener present in an amount of about 30 wt.% to about 70 wt.%;

(e) a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%.; and

(f) a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

Also provided herein is a liquid formulation including:

(a) (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

(b) hydroxypropyl-β-cyclodextrin present in an amount of about 5 wt.% to about 35 wt.%; and

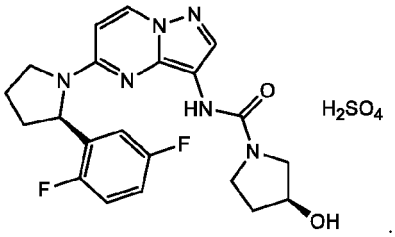
(c) sodium citrate dihydrate present in an amount of about 0.1 wt.% to about 5 wt.%;

(d) a sucrose or an intense sweetener present in an amount of about 30 wt.% to about 70 wt.%;

(e) a bitterness masking agent present in an amount of about 0.2 wt.% to about 0.5 wt.%.; and

(f) a flavoring agent present in an amount of about 0.01 wt.% to about 2 wt.%. In some embodiments, the formulation has a pH of about 3 to about 4. In some embodiments, the compound of formula (I) has a concentration of about 20 mg/mL to about 30 mg/mL in the liquid formulation.

In some embodiments, the liquid formulation is prepared from a pharmaceutically acceptable salt of the compound of formula **(I)**. For example, the pharmaceutically acceptable salt is a hydrogen sulfate salt. In some embodiments, the liquid formulation is prepared from a crystalline form of the compound of formula **(I)**. For example, the crystalline form of the compound of formula **(I)** can have the formula **(I-HS)**:



I-HS

In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 18.4±0.2, 20.7±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 18.4±0.2, 19.2±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 23.1±0.2, and 24.0±0.2. In some embodiments, crystalline form (I-HS) is characterized by having XRPD diffraction peaks (2θ degrees) at 10.7±0.2, 15.3±0.2, 16.5±0.2, 18.4±0.2, 19.2±0.2, 19.9±0.2, 20.2±0.2, 20.7±0.2, 21.5±0.2, 22.1±0.2, 23.1±0.2, 24.0±0.2. 24.4±0.2, 25.6±0.2, 26.5±0.2, 27.6±0.2, 28.2±0.2, 28.7±0.2, 30.8±0.2, and 38.5±0.2.

In some embodiments, the crystalline form (I-HS) has XRPD pattern substantially as shown in Figure 1 or Figure 8.

In some embodiments, the crystalline form exhibits an onset to maximum of about 193 to about 205° Celsius, as measured by differential scanning calorimetry. In some embodiments, the crystalline form (I-HS) exhibits a heat of melting of about 2.415 mW, as measured by differential scanning calorimetry.

Also provided herein is a method of treating cancer in a patient in need thereof. The method includes administering to the patient a therapeutically effective amount of a liquid formulation provided herein.

In some embodiments, the cancer results in dysphagia or difficulty swallowing. For example, the cancer can be a head and neck cancer, a mouth cancer, a throat cancer, or an esophageal cancer. In some embodiments, a patient having cancer develops difficulty swallowing due to one or more of fibrosis in the throat, esophagus, or mouth; infections of the mouth or esophagus (e.g., from radiation therapy or chemotherapy), swelling or narrowing of the throat or esophagus (e.g., from radiation therapy or surgery); physical changes to the mouth, jaws, throat, or esophagus from surgery; muscositis, which is soreness, pain or inflammation in the throat, esophagus, or mouth; xerostomia, commonly referred to as

dry mouth (e.g., from radiation therapy or chemotherapy).

In some embodiments, the patient is an infant, a child, an adolescent, or an elderly patient.

In some embodiments, the patient has a dysphagia. The dysphagia can be an oropharyngeal dysphagia. Oropharyngeal dysphagia can arise due to cancer (e.g., certain cancers and some cancer treatments, such as radiation, can cause difficulty swallowing), neurological disorders (e.g., certain disorders, such as multiple sclerosis, muscular dystrophy and Parkinson's disease, can cause dysphagia), neurological damage (e.g., sudden neurological damage, such as from a stroke or brain or spinal cord injury, that effects one's ability to swallow), and pharyngeal diverticula.

In some embodiments, the patient has a neurological disorders (e.g., certain disorders, such as multiple sclerosis, muscular dystrophy and Parkinson's disease, can cause dysphagia), neurological damage (e.g., sudden neurological damage, such as from a stroke or brain or spinal cord injury, that effects one's ability to swallow), and pharyngeal diverticula.

Also provided herein is a method of treating cancer in a patient in need thereof with dysphagia (e.g., difficulty swallowing). The method includes identifying a patient in need thereof with dysphagia. The method further includes administering to the patient a therapeutically effective amount of a liquid formulation described herein.

In some embodiments, the dysphagia is an oropharyngeal dysphagia.

Also provided herein is a method of treating cancer in a patient in need thereof with dysphagia. The method includes identifying a patient in need thereof with dysphagia. The method further includes determining if the cancer is mediated by a Trk kinase. If the cancer is determined to be mediated by a Trk kinase, administering to the patient a therapeutically effective amount of a liquid formulation described herein.

In some embodiments, the dysphagia is an oropharyngeal dysphagia. Oropharyngeal dysphagia can arise due to cancer (e.g., certain cancers and some cancer treatments, such as radiation, can cause difficulty swallowing), neurological disorders (e.g., certain disorders, such as multiple sclerosis, muscular dystrophy and Parkinson's disease, can cause dysphagia), neurological damage (e.g., sudden neurological damage, such as from a stroke or brain or spinal cord injury, that effects one's ability to swallow), and pharyngeal diverticula.

DEFINITIONS

Where the compound disclosed herein has at least one chiral center, the compounds may accordingly exist as enantiomers. Where the compounds possess two chiral centers, the

compounds may additionally exist as diastereomers. That is, the compound of formula (I), in addition to having the desired configuration designated by the nomenclature "(S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate" (hereinafter referred to as the (S,R) isomer), it may also be present in minor amounts as the isomer (R)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate (hereinafter referred to as the (R,R) isomer) and/or may also be present in minor amounts as the (S)-N-(5-((S)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate (hereinafter referred to as the (S,S) isomer), and/or may be present in minor amounts as the isomer (R)-N-(5-((S)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate" (hereinafter referred to as the (R,S) isomer). It is to be understood that all such isomers and mixtures thereof are encompassed within the scope of the present invention. Preferably, wherein the compound is present as the (S,R) isomer, the (S,R) isomer is present at an excess of greater than or equal to about 80%, more preferably at an excess of greater than or equal to about 90%, more preferably still at an excess of greater than or equal to about 95%, more preferably still at an excess of greater than or equal to about 98%, more preferably at an excess of greater than or equal to about 99%.

As used herein, unless otherwise noted, the term "isolated form" shall mean that the compound is present in a form which is separate from any solid mixture with another compound(s), solvent system or biological environment. In some embodiments, the crystalline form (I-HS) is present as an isolated form.

As used herein, unless otherwise noted, the term “substantially pure form” shall mean that the mole percent of impurities in the isolated compound or crystalline form is less than about 5 mole percent, preferably less than about 2 mole percent, more preferably, less than about 0.5 mole percent, most preferably, less than about 0.1 mole percent. In some embodiments, the crystalline form (I-HS) is present as a substantially pure form.

As used herein, unless otherwise noted, the term “substantially free of other amorphous, polymorph or crystalline form(s)” when used to described crystalline form (I-HS) shall mean that mole percent of other amorphous, polymorph or crystalline form(s) of the isolated base of crystalline form (I-HS) is less than about 5 mole percent, preferably less than about 2 mole percent, more preferably, less than about 0.5 mole percent, most preferably less than about 0.1 mole percent. In some embodiments, the crystalline form (I-HS) is present as a form substantially free of other amorphous, polymorph or crystalline form(s).

The terms "polymorph" and "polymorphic form" refer to different crystalline forms of a single compound. That is, polymorphs are distinct solids sharing the same molecular formula, yet each polymorph may have distinct solid state physical properties. Therefore, a single compound may give rise to a variety of polymorphic forms where each form has different and distinct solid state physical properties, such as different solubility profiles, dissolution rates, melting point temperatures, flowability, and/or different X-ray diffraction peaks. The differences in physical properties may affect pharmaceutical parameters such as storage stability, compressibility and density (which can be important in formulation and product manufacturing), and dissolution rate (which can be an important factor in bioavailability). Techniques for characterizing polymorphic forms include, but are not limited to, X-ray powder diffractometry (XRPD), differential scanning calorimetry (DSC), thermal gravimetric analysis (TGA), single-crystal X-ray diffractometry (XRD), vibrational spectroscopy, e.g., infrared (IR) and Raman spectroscopy, solid-state and solution nuclear magnetic resonance (NMR) spectroscopy, optical microscopy, hot stage optical microscopy, scanning electron microscopy (SEM), electron crystallography and quantitative analysis, particle size analysis (PSA), surface area analysis, solubility measurements, dissolution measurements, elemental analysis and Karl Fischer analysis.

The term "amorphous" means a solid in a solid state that is a non-crystalline state. Amorphous solids are disordered arrangements of molecules and therefore possess no distinguishable crystal lattice or unit cell and consequently have no definable long range ordering. The solid state form of a solid may be determined by polarized light microscopy, X-ray powder diffraction ("XRPD"), differential scanning calorimetry ("DSC"), or other standard techniques known to those of skill in the art.

As used herein, the term "pharmaceutically acceptable salts" refers to salts that retain the desired biological activity of the subject compound and exhibit minimal undesired toxicological effects. These pharmaceutically acceptable salts may be prepared in situ during the final isolation and purification of the compound, or by separately reacting the purified compound in its free acid or free base form with a suitable base or acid, respectively. In some embodiments, pharmaceutically acceptable salts may be preferred over the respective free base or free acid because such salts impart greater stability or solubility to the molecule thereby facilitating formulation into a dosage form. Basic compounds are generally capable of forming pharmaceutically acceptable acid addition salts by treatment with a suitable acid. Suitable acids include pharmaceutically acceptable inorganic acids and pharmaceutically acceptable organic acids. Representative pharmaceutically acceptable acid addition salts

include hydrochloride, hydrobromide, nitrate, methylnitrate, sulfate, bisulfate, sulfamate, phosphate, acetate, hydroxyacetate, phenylacetate, propionate, butyrate, isobutyrate, valerate, maleate, hydroxymaleate, acrylate, fumarate, malate, tartrate, citrate, salicylate, p-aminosalicyclate, glycollate, lactate, heptanoate, phthalate, oxalate, succinate, benzoate, o-acetoxybenzoate, chlorobenzoate, methylbenzoate, dinitrobenzoate, hydroxybenzoate, methoxybenzoate, mandelate, tannate, formate, stearate, ascorbate, palmitate, oleate, pyruvate, pamoate, malonate, laurate, glutarate, glutamate, estolate, methanesulfonate (mesylate), ethanesulfonate (esylate), 2-hydroxyethanesulfonate, benzenesulfonate (besylate), p-aminobenzenesulfonate, p-toluenesulfonate (tosylate),napthalene-2-sulfonate, Ethanedisulfonate, and 2,5-dihydroxybenzoate.

As used herein, unless otherwise noted, the terms "treating," "treatment," and the like, shall include the management and care of a subject or patient (preferably mammal, more preferably human) for the purpose of combating a disease, condition, or disorder and includes the administration of a disclosed compound to alleviate the symptoms or complications, or reduce the rate of progression of the disease, condition, or disorder.

As used herein, unless otherwise noted, the term "prevention" shall include (a) reduction in the frequency of one or more symptoms; (b) reduction in the severity of one or more symptoms; (c) the delay or avoidance of the development of additional symptoms; and/or (d) delay or avoidance of the development of the disorder or condition.

As used herein, the term "Trk-associated cancer" shall be defined to include cancers associated with or having dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., any of types of dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, described herein). Non-limiting examples of a Trk-associated cancer are described herein.

The term "subject" as used herein, refers to an animal, preferably a mammal, most preferably a human, who has been the object of treatment, observation or experiment. In some embodiments, the subject has experienced and/or exhibited at least one symptom of the disease or disorder to be treated and/or prevented. In some embodiments, a patient is a pediatric patient (i.e. a patient under the age of 21 years at the time of diagnosis or treatment). The term "pediatric" can be further divided into various subpopulations including: neonates (from birth through the first 28 days of life); infants (29 days of age to less than two years of age); children (two years of age to less than 12 years of age); and adolescents (12 years of age through 21 years of age (up to, but not including, the twenty-second birthday)). Berhman RE, Kliegman R, Arvin AM, Nelson WE. Nelson *Textbook of Pediatrics*, 15th Ed.

Philadelphia: W.B. Saunders Company, 1996; Rudolph AM, et al. *Rudolph's Pediatrics*, 21st Ed. New York: McGraw-Hill, 2002; and Avery MD, First LR. *Pediatric Medicine*, 2nd Ed. Baltimore: Williams & Wilkins; 1994.

The term "Trk" or "Trk protein" includes any of the Trk proteins described herein (e.g., a TrkA, a TrkB, or a TrkC protein).

The term "NTRK gene" includes any of the NTRK genes described herein (e.g., a NTRK1, a NTRK2, or a NTRK3 gene).

The term "wildtype" or "wild-type" describes a nucleic acid (e.g., a NTRK gene or a Trk mRNA) or protein (e.g., a Trk protein) that is found in a subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) that does not have a Trk-associated cancer (and optionally also does not have an increased risk of developing a Trk-associated cancer or condition and/or is not suspected of having a Trk-associated cancer or condition) or is found in a cell or tissue from a subject (e.g., a pediatric subject, e.g., an infant, child, or adolescent) that does not have a Trk-associated cancer or condition (and optionally also does not have an increased risk of developing a Trk-associated cancer or condition and/or is not suspected of having a Trk-associated cancer or condition).

The term "regulatory agency" is a country's agency for the approval of the medical use of pharmaceutical agents with the country. For example, a non-limiting example of a regulatory agency is the U.S. Food and Drug Administration (FDA).

The phrase "dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same" is a genetic mutation (e.g., a NTRK gene translocation that results in the expression of a fusion protein, a deletion in a NTRK gene that results in the expression of a Trk protein that includes a deletion of at least one amino acid as compared to the wild-type Trk protein, or a mutation in a NTRK gene that results in the expression of a Trk protein with one or more point mutations, an alternative spliced version of a Trk mRNA that results in a Trk protein that results in the deletion of at least one amino acid in the Trk protein as compared to the wild-type Trk protein), or a NTRK gene duplication that results in overexpression of a Trk protein) or overexpression of a NTRK gene in a cell, that results in a pathogenic increase in the activity of a kinase domain of a Trk protein (e.g., a constitutively active kinase domain of a Trk protein) in a cell. For example, a dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, can be a mutation in a NTRK1, NTRK2, or NTRK3 gene that encodes a Trk protein that is constitutively active or has increased activity as compared to a protein encoded by a NTRK1, NTRK2, or NTRK3 gene that does not include the mutation. For example, a dysregulation of a NTRK gene, a

Trk protein, or expression or activity, or level of the same, can be the result of a gene translocation which results in the expression of a fusion protein that contains a first portion of TrkA, TrkB, or TrkC that includes a functional kinase domain, and a second portion of a partner protein (i.e., that is not TrkA, TrkB, or TrkC). A gene encoding a fusion protein can include, e.g., the following exons of a wild-type NTRK1 gene: exons 10-19, exons 12-19, exons 12-19, exons 13-19, exons 14-19, or exons 15-19. A gene encoding a fusion protein can include, e.g., the following exons of a wild-type NTRK2 gene: exons 12-21, exons 13-21, exons 15-21, exons 16-21, or exons 17-21. A gene encoding a fusion protein can include, e.g., the following exons of a wild-type NTRK3 gene: exons 17-22 or exons 16-22. Non-limiting examples of fusion proteins that are a result of a NTRK gene translocation are described in Table 10.

A dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, can, e.g., include a mutation(s) in a NTRK1, NTRK2, or NTRK3 gene that results in a TrkA, TrkB, or TrkC containing at least one (e.g., two, three, four, or five) point mutations (e.g., one of more of the point mutations listed in Table XX). A dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, can be a mutation in a NTRK1, NTRK2, or NTRK3 gene that results in a deletion of one or more contiguous amino acids (e.g., at least two, at least three, at least four, at least 5, at least 6, at least 7, at least 8, at least 9, at least 10, at least 15, at least 20, at least 30, at least 40, at least 50, at least 60, at least 70, at least 80, at least 90, at least 100, at least 110, at least 120, at least 130, at least 140, at least 150, at least 160, at least 170, at least 180, at least 190, at least 200, at least 210, at least 220, at least 230, at least 240, at least 250, at least 260, at least 270, at least 280, at least 290, at least 300, at least 310, at least 320, at least 330, at least 340, at least 350, at least 360, at least 370, at least 380, at least 390, or at least 400 amino acids) in the TrkA, TrkB, or TrkC protein (except for the deletion of amino acids in the kinase domain of TrkA, TrkB, or TrkC that would result in inactivation of the kinase domain). In some examples, a dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, can include an alternate spliced form of a Trk mRNA, e.g., a TrkAIII spliced variant or an alternative spliced form of a TrkA mRNA that results in the production of a TrkA protein that lacks the amino acids encoded by exon 10. In some examples, a dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, includes an amplification of a NTRK gene (e.g., one, two, three, or four additional copies of the NTRK gene) that can result, e.g., in autocrine or overexpression of a NTRK gene in a cell. The term "overexpression" is a term of art and is used to an increased level of transcription of a gene in

a cell as compared to the level of transcription of the gene in a control cell (e.g., a non-cancerous cell of the same cell type).

The term "Trk-associated cancer or tumor" is a cancer that is associated with dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same (e.g., a cancer that is associated with at least one example (e.g., two, three, four, or five examples) of dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same, described herein).

The term "mammal" as used herein, refers to a warm-blooded animal that has or is at risk of developing a disease described herein and includes, but is not limited to, guinea pigs, dogs, cats, rats, mice, hamsters, and primates, including humans.

The term "therapeutically effective amount" as used herein, means that amount of active compound or pharmaceutical agent that elicits the biological or medicinal response in a tissue system, animal or human that is being sought by a researcher, veterinarian, medical doctor or other clinician, which includes alleviation of the symptoms of the disease or disorder being treated. In particular, a therapeutically effective amount, when administered to a subject in need of such treatment, is sufficient to (i) treat or prevent a particular disease, condition, or disorder which can be treated with an inhibitor of TrkA and/or TrkB, (ii) attenuate, ameliorate, or eliminate one or more symptoms of the particular disease, condition, or disorder, or (iii) prevent or delay the onset of one or more symptoms of the particular disease, condition, or disorder described herein. The amount of crystalline form (I-HS) that will correspond to such a therapeutically effective amount will vary depending upon factors such the disease condition and its severity, the identity (e.g., weight) of the mammal in need of treatment, but can nevertheless be routinely determined by one skilled in the art.

As used herein, the term "composition" is intended to encompass a product comprising the specified ingredients in the specified amounts, as well as any product which results, directly or indirectly, from combinations of the specified ingredients in the specified amounts.

To provide a more concise description, some of the quantitative expressions given herein are not qualified with the term "about." It is understood that whether the term "about" is used explicitly or not, every quantity given herein is meant to refer to the actual given value, and it is also meant to refer to the approximation to such given value that would reasonably be inferred based on the ordinary skill in the art, including approximations due to the experimental and/or measurement conditions for such given value.

In some embodiments, the term "about" is used herein to mean approximately, in the region of, roughly, or around. When the term "about" is used in conjunction with a numerical range, it modifies that range by extending the boundaries above and below the numerical values set forth. In general, the term "about" is used herein to modify a numerical value above and below the stated value by a variance of 10%.

The term "about" preceding one or more peak positions in an X-ray powder diffraction pattern means that all of the peaks of the group which it precedes are reported in terms of angular positions (two theta) with an allowable variability of ± 0.3°. The variability of ± 0.3° is intended to be used when comparing two powder X-ray diffraction patterns. In practice, if a diffraction pattern peak from one pattern is assigned a range of angular positions (two theta) which is the measured peak position ± 0.3° and if those ranges of peak positions overlap, then the two peaks are considered to have the same angular position. For example, if a peak from one pattern is determined to have a position of 11.0°, for comparison purposes the allowable variability allows the peak to be assigned a position in the range of 10.7°-11.3°.

The term “about” preceding a value for DSC, TGA, TG, or DTA, which are reported as degrees Celsius, have an allowable variability of ± 5° C.

To provide a more concise description, some of the quantitative expressions herein are recited as a range from about amount X to about amount Y. It is understood that wherein a range is recited, the range is not limited to the recited upper and lower bounds, but rather includes the full range from about amount X through about amount Y, or any range therein.

One skilled in the art will further recognize that human clinical trials including first-in-human, dose ranging and efficacy trials, in healthy patients and/or those suffering from a given disorder, may be completed according to methods well known in the clinical and medical arts. For example, determining proper dosages for pediatric patients can be determined using known methods, including weight, age, and models such as Simcyp® Pediatric Simulation modeling (CERTARA, Princeton, New Jersey) which can be used to establish a pharmacokinetic approach for dosing that takes into account patient age, ontogeny of the clearance pathways that a compound of formula (I), a pharmaceutically acceptable salt thereof, or a combination thereof, and body surface area (BSA).

Acronyms found in the specification have the following meanings:

ATP	adenosine triphosphate
DI	deionized
EtOH	ethanol

GC	gas chromatography
MOPS	3-(N-morpholino)-propanesulfonic acid
MTBE	methyl *tert*-butyl ether
PDA	photodiode array
RRT	relative retention time
RT	room temperature
THF	tetrahydrofuran
TMB	3,3',5,5'-tetramethylbenzidine

EXAMPLES

The following examples illustrate the invention and are set forth to aid in the understanding of the invention, and are not intended and should not be construed to limit in any way the invention set forth in the claims which follow thereafter.

In the examples described below, unless otherwise indicated all temperatures are set forth in degrees Celsius. Reagents were purchased from commercial suppliers such as Sigma-Aldrich Chemical Company, EMD, JT Baker, or Pharco-Aaper, and were used without further purification unless otherwise indicated. Tetrahydrofuran (THF), heptane and other organic solvents were purchased from commercial suppliers, such as Sigma-Aldrich Chemical Company, ACROS, Alfa-Aesar, Lancaster, TCI, or Maybridge, and used as received.

One skilled in the art will recognize that, where not otherwise specified, the reaction step(s) is performed under suitable conditions, according to known methods, to provide the desired product. One skilled in the art will also recognize that wherein a reaction step as disclosed herein may be carried out in a variety of solvents or solvent systems, said reaction step may also be carried out in a mixture of the suitable solvents or solvent systems. One skilled in the art will recognize that, in the specification and claims as presented herein, wherein a reagent or reagent class/type (e.g. base, solvent, etc.) is recited in more than one step of a process, the individual reagents are independently selected for each reaction step and may be the same of different from each other. For example wherein two steps of a process recite an organic or inorganic base as a reagent, the organic or inorganic base selected for the first step may be the same or different than the organic or inorganic base of the second step.

The reactions set forth below were done generally under a positive pressure of nitrogen (unless otherwise stated) in "ACS grade" solvents, and the reaction flasks were typically fitted with rubber septa for the introduction of substrates and reagents via syringe or addition funnel.

Two reversed-phase high performance liquid chromatography (HPLC) systems were used for in-process monitoring and analysis, using acetonitrile and water/trifluoroacetic acid as mobile phases. One system employed an Agilent Zorbax Extend C18 column at 264 nm, while the other system (hereinafter, "TRK1PM1 HPLC") included a Waters Xbridge Phenyl Column at 268 nm. Unless otherwise specified, the former system was used. The silica for both systems was stirred in a flask with the compound, and then filtered through a polypropylene cloth before being analyzed.

Amorphous freebase form of compound of formula (I): About 1 gram of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide is dissolved in minimum amount of water and cooled to a temperature of about
-26° Celsius followed by drying in the freeze dryer for 24 hours. About 20 mg of the amorphous material obtained from the freeze dryer was weighed in a vial, to which 5 volume aliquots of an appropriate solvent system was added. The mixture was checked for dissolution and if no dissolution was apparent, the mixture was heated to about 40° Celsius and checked again. This procedure was continued until dissolution was observed or until 100 volumes of solvent had been added. The XRPD pattern of the amorphous material obtained from the freeze drying experiment is shown in FIG. 7.

Amorphous hydrogen sulfate salt of compound of formula (I) was prepared as described in Example 14A in WO 2010/048314 (see Example 3). The XRPD patterns of the two different lots of amorphous material prepared by this method are show in FIG. 7.

Also provided herein is a process for the preparation of crystalline form (I-HS). In some embodiments, the process comprises the steps as shown in Scheme 1.

In some embodiments, provided herein is a process for the preparation of crystalline form (I-HS), comprising:

(a) adding concentrated sulfuric acid to a solution of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide in EtOH to form the hydrogen sulfate salt of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide;

(b) adding heptane to the solution in Step (a) to form a slurry;

(c) filtering the slurry to isolate (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate;

(d) mixing said (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate with a 5:95 w/w solution of water/2-butanone;

(e) heating the mixture from step (d) at about 65-70 °C with stirring until the weight percent of ethanol is about 0.5% to form a slurry of the crystalline form of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate; and

(f) isolating the crystalline form of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate by filtration.

In some embodiments, the above method further comprises: (b1) seeding the solution from step (a) with (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate at room temperature and allowing the solution to stir until a slurry forms.

In some embodiments, provided herein is a process for the preparation of crystalline form (I-HS), comprising:

(a) reacting 5-chloro-3-nitropyrazolo[1,5-a]pyrimidine with (*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxysuccinate in the presence of a base to form (R)-5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)-3-nitropyrazolo[1,5-a]pyrimidine;

(b) treating said (*R*)-5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)-3-nitropyrazolo[1,5-a]pyrimidine with Zn and hydrochloric acid to form (*R*)-5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-amine;

(c) treating said (*R*)-5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-amine with a base and phenyl chloroformate to form phenyl (*R*)-(5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)carbamate;

(d) reacting said phenyl (*R*)-(5-(2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)carbamate with (*S*)-pyrrolidin-3-ol to form (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide;

(e) adding sulfuric acid to said (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide form (*S*)-N-(5-((*R*)-

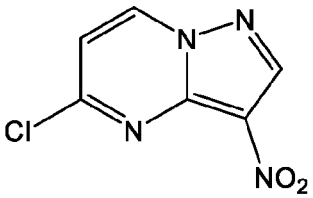
2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate; and

(f) isolating the crystalline form of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate.

In some embodiments of the above step (a), the base is an amine base, such as triethylamine.

In some embodiments of the above step (c), the base is an alkali metal base, such as an alkali metal carbonate, such as potassium carbonate.

Preparation A



Preparation of 5-chloro-3-nitropyrazolo[1,5-a]pyrimidine

Step A – Preparation of sodium pyrazolo[1,5-a]pyrimidin-5-olate: A solution of 1H-pyrazol-5-amine and 1,3-dimethylpyrimidine-2,4(1H,3H)-dione (1.05 equiv.) were charged to a round bottom flask outfitted with a mechanical stirrer, a steam pot, a reflux condenser, a J-Kem temperature probe and an N_2 adaptor for positive N_2 pressure control. Under mechanical stirring the solids were suspended with 4 vol. (4 mL/g) of absolute EtOH under a nitrogen atmosphere, then charged with 2.1 equivalentsof NaOEt (21 wt% solution in EtOH), and followed by line-rinse with 1 vol. (1 mL/g) of absolute EtOH. The slurry was warmed to about 75° Celsius and stirred at gentle reflux until less than 1.5 area % of 1H-pyrazol-5-amine was observed by TRK1PM1 HPLC to follow the progression of the reaction using 20 μL of slurry diluted in 4 mL deionized water and 5 μL injection at 220 nm.

After 1 additional hour, the mixture was charged with 2.5 vol. (2.5 mL/g) of heptane and then refluxed at 70° Celsius for 1 hour. The slurry was then cooled to room temperature overnight. The solid was collected by filtration on a tabletop funnel and polypropylene filter cloth. The reactor was rinsed and charged atop the filter cake with 4 vol. (4 mL/g) of heptane with the cake pulled and the solids being transferred to tared drying trays and oven-dried at 45° Celsius under high vacuum until their weight was constant. Pale yellow solid sodium pyrazolo[1,5-a]-pyrimidin-5-olate was obtained in 93-96% yield (corrected) and larger than 99.5 area% observed by HPLC (1 mg/mL dilution in deionized water, TRK1PM1 at 220 nm).

Step B – Preparation of 3-nitropyrazolo[1,5-a]pyrimidin-5(4H)-one: A tared round bottom flask was charged with sodium pyrazolo[1,5-a]pyrimidin-5-olate that was dissolved at 40-45° Celsius in 3.0 vol. (3.0 mL/g) of deionized water, and then concentrated under high vacuum at 65° Celsius in a water-bath on a rotary evaporator until 2.4 x weight of starting material was observed (1.4 vol/1.4 mL/g deionized water content). Gas chromatography (GC) for residual EtOH (30 μL of solution dissolved in ~ 1 mL MeOH) was performed showing less than 100 ppm with traces of ethyl nitrate fumes being observed below upon later addition of HNO_3. In some cases, the original solution was charged with an additional 1.5 vol. (1.5 mL/g) of DI water, then concentrated under high vacuum at 65° Celsius in a water-bath on a rotary evaporator until 2.4 x weight of starting material was observed (1.4 vol/1.4 mL/g DI water content). Gas chromatograph for residual EtOH (30 μL of solution dissolved in about 1 mL MeOH) was performed showing <<100 ppm of residual EtOH without observing any ethyl nitrate fumes below upon later addition of HNO_3.

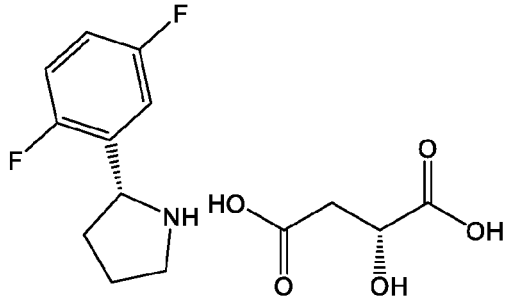
A round bottom vessel outfitted with a mechanical stirrer, a steam pot, a reflux condenser, a J-Kem temperature probe and an N_2 adaptor for positive N_2 pressure control was charged with 3 vol. (3 mL/g, 10 equiv) of >90 wt% HNO_3 and cooled to about 10° Celsius under a nitrogen atmosphere using external ice-water cooling bath under a nitrogen atmosphere. Using a pressure equalizing addition funnel, the HNO_3 solution was charged with the 1.75-1.95 volumes of a deionized water solution of sodium pyrazolo[1,5-a]pyrimidin-5-olate (1.16-1.4 mL DI water/g of sodium pyrazolo[1,5-a]pyrimidin-5-olate) at a rate to maintain 35-40° Celsius internal temperature under cooling. Two azeotropes were observed without any ethyl nitrate fumes. The azeotrope flask, the transfer line (if applicable) and the addition funnel were rinsed with 2 x 0.1 vol. (2 x 0.1 mL/g) deionized water added to the reaction mixture. Once the addition was complete, the temperature was gradually increased to about 45-50° Celsius for about 3 hours with HPLC showing > 99.5 area% conversion of sodium pyrazolo[1,5-a]pyrimidin-5-olate to 3-nitropyrazolo[1,5-a]pyrimidin-5(4H)-one.

Step C – Preparation of 5-chloro-3-nitropyrazolo[1,5-a]pyrimidine: 3-nitropyrazolo[1,5-a]pyrimidin-5(4H)-one was charged to a round bottom flask outfitted with a mechanical stirrer, a heating mantle, a reflux condenser, a J-Kem temperature probe and an N_2 adaptor for positive N_2 pressure control. Under mechanical stirring the solids were suspended with 8 volumes (8 mL/g) of CH_3CN, and then charged with 2,6-lutitine (1.05 equiv) followed by warming the slurry to about 50° Celsius. Using a pressure equalizing

addition funnel, the mixture was dropwise charged with 0.33 equivalents of $POCl_3$. This charge yielded a thick, beige slurry of a trimer that was homogenized while stirring until a semi-mobile mass was observed. An additional 1.67 equivalents of $POCl_3$ was charged to the mixture while allowing the temperature to stabilize, followed by warming the reaction mixture to a gentle reflux (78° Celsius). Some puffing was observed upon warming the mixture that later subsided as the thick slurry got thinner.

The reaction mixture was allowed to reflux until complete dissolution to a dark solution and until HPLC (20 µL diluted in 5 mL of CH_3CN, TRK1PM1 HPLC, 5 µL injection, 268 nm) confirmed that no more trimer (RRT 0.92) was present with less than 0.5 area% of 3-nitropyrazolo[1,5-a]pyrimidin-5(4H)-one (RRT 0.79) being observed by manually removing any interfering and early eluting peaks related to lutidine from the area integration. On a 1.9 kg scale, 0 area% of the trimer, 0.25 area% of 3-nitropyrazolo[1,5-a]pyrimidin-5(4H)-one, and 99.5 area% of 5-chloro-3-nitropyrazolo[1,5-a]pyrimidine was observed after 19 hours of gentle reflux using TRK1PM1 HPLC at 268 nm

Preparation B



Preparation of (*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxysuccinate

Step A – Preparation of *tert*-butyl (4-(2,5-difluorophenyl)-4-oxobutyl)-carbamate: 2-bromo-1,4-difluorobenzene (1.5 eq.) was dissolved in 4 volumes of THF (based on weight of *tert*-butyl 2-oxopyrrolidine-1-carboxylate) and cooled to about 5° Celsius. A solution of 2.0 M iPrMgCl in THF (1.4 eq.) was added over 2 hours to the mixture while maintaining a reaction temperature below 25° Celsius. The solution was allowed to cool to about 5° Celsius and stirred for 1 hour (GC analysis confirmed Grignard formation). A solution of *tert*-butyl 2-oxopyrrolidine-1-carboxylate (1.0 eq.) in 1 volume of THF was added over about 30 min while maintaining a reaction temperature below 25° Celsius. The reaction was stirred at about 5° Celsius for 90 min (*tert*-butyl 2-oxopyrrolidine-1-carboxylate was confirmed to be less than 0.5 area% by HPLC). The reaction was quenched with 5 volumes of 2 M aqueous HCl while maintaining a reaction temperature below 45° Celsius. The reaction was then

transferred to a separatory funnel adding 10 volumes of heptane and removing the aqueous layer. The organic layer was washed with 4 volumes of saturated aqueous NaCl followed by addition of 2 x 1 volume of saturated aqueous NaCl. The organic layer was solvent-switched to heptane (<1%wt THF confirmed by GC) at a distillation temperature of 35-55° Celsius and distillation pressure of 100-200 mm Hg for 2 x 4 volumes of heptane being added with a minimum distillation volume of about 7 volumes. The mixture was then diluted to 10 volumes with heptane while heating to about 55° Celsius yielded a denser solid with the mixture being allowed to cool to room temperature overnight. The slurry was cooled to less than 5° Celsius and filtered through polypropylene filter cloth. The wet cake was washed with 2 x 2 volumes of heptane. The solids were dried under vacuum at 55° Celsius until the weight was constant, yielding *tert*-butyl (4-(2,5-difluorophenyl)-4-oxobutyl)-carbamate as a white solid at about 75% to 85% theoretical yield.

Step B – Preparation of 5-(2,5-difluorophenyl)-3,4-dihydro-2*H*-pyrrole: *tert*-butyl (4-(2,5-difluorophenyl)-4-oxobutyl)-carbamate was dissolved in 5 vol. of toluene with 2.2 eq. of 12M HCl being added observing a mild exotherm and gas evolution. The reaction was heated to 65° Celsius for 12-24 hours and monitored by HPLC. Upon completion the reaction was cooled to less than 15° Celsius with an ice/water bath. The pH was adjusted to about 14 with 3 equivalents of 2M aqueous NaOH (4.7 vol.). The reaction was stirred at room temperature for 1-2 hours. The mixture was transferred to a separatory funnel with toluene. The aqueous layer was removed and the organic layer was washed with 3 volumes of saturated aqueous NaCl. The organic layer was concentrated to an oil and redissolved in 1.5 volumes of heptane. The resulting suspension was filtered through a GF/F filter paper and concentrated to a light yellow oil of 5-(2,5-difluorophenyl)-3,4-dihydro-2*H*-pyrrole with a 90% to 100% theoretical yield.

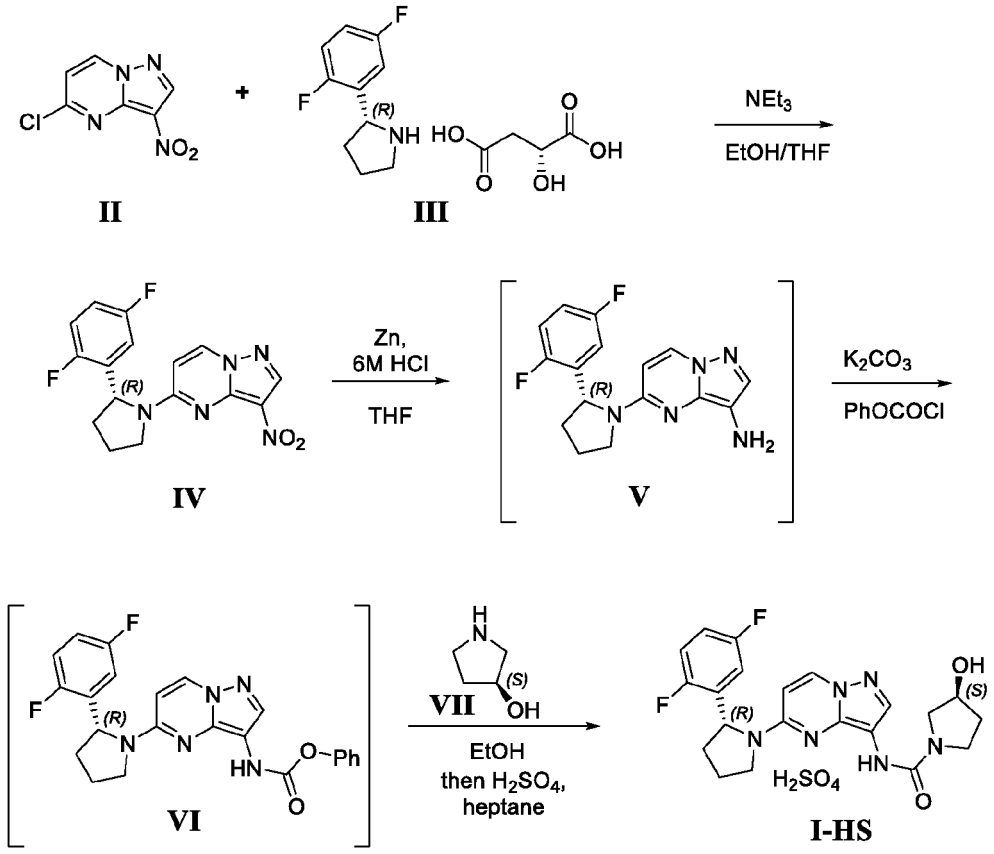
Step C – Preparation of (*R*)-2-(2,5-difluorophenyl)pyrrolidine: Chloro-1,5-cyclooctadiene iridium dimer (0.2 mol%) and (*R*)-2-(2-(diphenylphosphino)phenyl)-4-isopropyl-4,5-dihydrooxazole (0.4 mol%) were suspended in 5 volumes of MTBE (based on 5-(2,5-difluorophenyl)-3,4-dihydro-2*H*-pyrrole) at room temperature. The mixture was stirred for 1 hour and most of the solids dissolved with the solution turning dark red. The catalyst formation was monitored using an HPLC/PDA detector. The reaction was cooled to less than 5° Celsius and 5-(2,5-difluorophenyl)-3,4-dihydro-2*H*-pyrrole (1.0 eq.) was added using a 0.5 volumes of MTBE rinse. Diphenylsilane (1.5 eq.) was added over about 20 minutes while maintaining a reaction temperature below 10° Celsius. The reaction was stirred for 30 minutes below 10° Celsius and then allowed to warm to room temperature. The reaction was

stirred overnight at room temperature. The completion of the reaction was confirmed by HPLC and then cooled to less than 5° Celsius. The reaction was quenched with 5 volumes of 2M aqueous HCl maintaining temperature below 20° Celsius. After 10 minutes the ice/water bath was removed and the reaction temperature was allowed to increase to room temperature while stirring for 2 hours. The mixture was transferred to a separatory funnel with 3 volumes of MTBE. The aqueous layer was washed with 3.5 volumes of MTBE followed by addition of 5 volumes of MTBE to the aqueous layer while adjusting the pH to about 14 by adding 0.75 volumes of aqueous 50% NaOH. The organic layer was washed with 5 volumes of aqueous saturated NaCl, then concentrated to an oil, and diluted with 3 volumes of MTBE. The solution was filtered through a polypropylene filter cloth and rinsed with 1 volume of MTBE. The filtrate was concentrated to an oil of (*R*)-2-(2,5-difluorophenyl)pyrrolidine with a 95% to 100% theoretical yield and with 75-85%ee.

Step D – Preparation of (*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxy-succinate: (*R*)-2-(2,5-difluorophenyl)pyrrolidine (1.0 eq.) was transferred to a round bottom flask charged with 15 volumes (corrected for potency) of EtOH (200 prf). D-malic acid (1.05 eq.) was added and the mixture was heated to 65° Celsius. The solids all dissolved at about 64° Celsius. The solution was allowed to cool to RT. At about 55° Celsius the solution was seeded with (*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxy-succinate (about 50 mg, >97%ee) and stirred at room temperature overnight. The suspension was then filtered through a polypropylene filter cloth and washed with 2 x 1 volumes of EtOH (200 prf). The solids were dried under vacuum at 55° Celsius, yielding (*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxy-succinate with a 75% to 90% theoretical yield and with >96%ee.

Referring to **Scheme 1**, suitable bases include tertiary amine bases, such as triethylamine, and K_2CO_3. Suitable solvents include ethanol, heptane and tetrahydrofuran (THF). The reaction is conveniently performed at temperatures between 5° Celsius and 50° Celsius. The reaction progress was generally monitored by HPLC TRK1PM1.

Scheme 1



Compounds **II** (5-chloro-3-nitropyrazolo[1,5-a]pyrimidine) and **III** ((*R*)-2-(2,5-difluorophenyl)pyrrolidine (*R*)-2-hydroxysuccinate, 1.05 eq.) were charged to a round bottom flask outfitted with a mechanical stirrer, a J-Kem temperature probe and an N_2 adaptor for positive N_2 pressure control. A solution of 4:1 EtOH:THF (10 mL/g of compound **II**) was added and followed by addition of triethylamine (NEt_3, 3.50 eq.) via addition funnel with the temperature reaching about 40° Celsius during addition. Once the addition was complete, the reaction mixture was heated to 50° Celsius and stirred for 0.5-3 hours to yield compound **IV**.

To a round bottom flask equipped with a mechanical stirrer, a J-Kem temperature probe, and an N_2 inlet compound **IV** was added and followed by addition of tetrahydrofuran (10 mL/g of compound **IV**). The solution was cooled to less than 5° Celsius in an ice bath, and Zn (9-10 eq.) was added. 6M HCl (9-10 eq.) was then added dropwise at such a rate to keep the temperature below 30° Celsius (for 1 kg scale the addition took about 1.5 hours). Once the exotherm subsided, the reaction was allowed to warm to room temperature and was stirred for 30-60 min until compound **IV** was not detected by HPLC. At this time, a solution of potassium carbonate (K_2CO_3, 2.0 eq.) in water (5 mL/g of compound **IV**) was added all at once and followed by rapid dropwise addition of phenyl chloroformate (PhOCOCl, 1.2 eq.).

Gas evolution (CO_2) was observed during both of the above additions, and the temperature increased to about 30° Celsius after adding phenyl chloroformate. The carbamate formation was stirred at room temperature for 30-90 min. HPLC analysis immediately followed to run to ensure less than 1 area% for the amine being present and high yield of compound **VI** in the solution.

To the above solution amine **VII** ((*S*)-pyrrolidin-3-ol, 1.1 eq. based on theoretical yield for compound **VI**) and EtOH (10mL/g of compound **VI**) was added. Compound **VII** was added before or at the same time as EtOH to avoid ethyl carbamate impurities from forming. The above EtOH solution was concentrated to a minimum volume (4-5mL/g) using the batch concentrator under reduced pressure (THF levels should be <5% by GC), and EtOH (10mL/g of compound **VI**) was back-added to give a total of 10mL/g. The reaction was then heated at 50° Celsius for 9-19 hours or until HPLC shows that compound **VI** is less than 0.5 area%. The reaction was then cooled to room temperature, and sulfuric acid (H_2SO_4, 1.0 eq. to compound **VI**) was added via addition funnel to yield compound **I-HS** with the temperature usually exotherming at about 30° Celsius.

Example 1

Preparation of Crystalline Form (I-HS) (Method 1)

(*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (0.500 g, 1.17 mmol) was dissolved in EtOH (2.5 mL) and cooled to about 5° Celsius. Concentrated sulfuric acid (0.0636 mL, 1.17 mmol) was added to the cooled solution and stirred for about 10 min, while warming to room temperature. Methyl *tert*-butyl ether (MTBE) (2 mL) was slowly added to the mixture, resulting in the product gumming out. EtOH (2.5 mL) was then added to the mixture and heated to about reflux until all solids were dissolved. Upon cooling to room temperature and stirring for about 1 hour, some solids formed. After cooling to about 5° Celsius, the solids were filtered and washed with MTBE. After filtration and drying at air for about 15 minutes, (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate was isolated as a solid.

Example 2

Preparation of Crystalline Form (I-HS) (Method 2)

Concentrated sulfuric acid (392 mL) was added to a solution of 3031 g of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-

hydroxypyrrolidine-1-carboxamide in 18322 mL EtOH to form the hydrogen sulfate salt. The solution was seeded with 2 g of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate and the solution was stirred at room temperature for at least 2 hours to form a slurry of the hydrogen sulfate salt. Heptane (20888 g) was added and the slurry was stirred at room temperature for at least 60 min. The slurry was filtered and the filter cake was washed with 1:1 heptane/EtOH. The solids were then dried under vacuum at ambient temperature (oven temperature set at 15° Celsius).

The dried hydrogen sulfate salt (6389 g from 4 combined lots) was added to a 5:95 w/w solution of water/2-butanone (total weight 41652 g). The mixture was heated at about 68° Celsius with stirring until the weight percent of ethanol was about 0.5%, during which time a slurry formed. The slurry was filtered, and the filter cake was washed with a 5:95 w/w solution of water/2-butanone. The solids were then dried under vacuum at ambient temperature (oven temperature set at 15° Celsius) to provide the crystalline form of (*S*)-N-(5-((*R*)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrogen sulfate.

Example 3

Preparation of Amorphous Form AM(HS)

To a solution of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (9.40 g, 21.94 mmol) in MeOH (220 mL) was slowly added sulfuric acid (0.1 M in MeOH, 219.4 mL, 21.94 mmol) at ambient temperature under rapid stirring. After 30 minutes, the reaction was first concentrated by rotary evaporator to near dryness, then on high vacuum for 48 h to provide amorphous form of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide sulfate (11.37 g, 21.59 mmol, 98.43 % yield). LCMS (apci m/z 429.1, M+H).

Example 4

Preparation of Crystalline HCl Salt of Formula (I)

A mixture of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (0.554 g, 1.29 mmol) in EtOH (6 mL, 200 proof) and MTBE (10 mL) was heated to 50 °C while stirring to obtain a solution, followed by addition of hydrogen chloride (conc.) (0.108 mL, 1.29 mmol) in one portion.

The reaction mixture was then allowed to cool to ambient temperature first, then cooled to about 5 °C in an ice-water bath with stirring to induce crystallization. The suspension was stirred for 4 h in the ice-water bath before it was vacuum-filtered, with the filter cake rinsed with MTBE and dried under vacuum at 55°C to constant weight, yielding crystalline (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrochloride (0.534 g, 89% yield). LCMS (apci m/z 429.2, M+H).

Preparation of Crystalline HBr Salt of Formula (I)

A mixture of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (0.505 g, 1.18 mmol) in EtOH (6 mL, 200 proof) and MTBE (10 mL) was heated to 50 °C while stirring to obtain a solution, followed by addition of hydrogen bromide (33% aq.) (0.213 mL, 1.18 mmol) in one portion. The reaction mixture was heated to reflux to obtain a mostly clear solution with small amount of oily residue on glass wall of reaction vessel. Upon cooled to ambient temperature, precipitation appeared and the oily residue solidified. The mixture was heated to 50 °C again, then allowed to cool to room temperature and stirred for overnight. The suspension was vacuum-filtered, with the filter cake rinsed with MTBE and dried under vacuum at 55°C to constant weight, yielding crystalline (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide hydrobromide (0.51 g, 85% yield). LCMS (apci m/z 429.3, M+H).

Preparation of Crystalline Mesylate Salt of Formula (I)

A mixture of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (0.532 g, 1.24 mmol) in EtOH (2.7 mL, 200 proof) and MTBE (5.3 mL) was heated to 50 °C while stirring to obtain a solution, followed by addition of methanesulfonic acid (0.076 mL, 1.24 mmol) in one portion. The reaction mixture was heated to reflux to obtain a mostly clear solution with small amount of particulates. Upon cooled to ambient temperature, precipitation appeared along with some oily residue. Additional EtOH (0.5 mL, 200-proof) and methanesulfonic acid (0.010 mL) were added to obtain a solution. The reaction mixture was heated to 50 °C again, then allowed to cool to room temperature and stirred for 1 h. The suspension was vacuum-filtered, with the filter cake rinsed with MTBE and dried under vacuum at 55°C to constant weight, yielding crystalline (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-

a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide methanesulfonate (0.51 g, 78% yield). LCMS (apci m/z 429.4, M+H).

Preparation of Crystalline Camsylate Salt of formula (I)

A mixture of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide (0.500 g, 1.17 mmol) and S-(+)-camphorsulfonic acid (0.271 g, 1.17 mmol) in EtOH (3 mL, 200 proof) and MTBE (5 mL) was heated to reflux while stirring to obtain a solution. Upon cooled to ambient temperature, precipitation appeared. The suspension was stirred at room temperature for overnight, then vacuum-filtered, with the filter cake rinsed with MTBE and dried under vacuum at 55°C to constant weight, yielding crystalline (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide ((1S,4R)-7,7-dimethyl-2-oxobicyclo[2.2.1]heptan-1-yl)methanesulfonate .

Example 5

Infantile fibrosarcoma with NTRK3-ETV6 fusion successfully treated with a liquid formulation of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

Materials and Methods

A multicenter pediatric phase 1 dose-escalation study in patients with advanced solid or primary CNS tumors was initiated in December 2015 (ClinicalTrials.gov Identifier: NCT02637687) to evaluate the safety and tolerability of Compound I-HS (i.e., the hydrogen sulfate salt of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide). Eligibility criteria included age 1-21 years regardless of the presence of a known TRK alteration, as well as those patients aged 1 month of age or greater with a known NTRK fusion and a diagnosis of infantile fibrosarcoma or congential mesoblastic nephroma. An oral liquid formulation of Compound I-HS was developed for patients unable to swallow capsules. SIMCYP® Pediatric Simulation modeling (CERTARA, Princeton, New Jersey) was utilized to establish a pharmacokinetic approach for dosing that takes into account patient age, ontogeny of the clearance pathways that eliminate Compound I-HS, and body surface area (BSA). The pediatric dose selected for the initial cohort was predicted to equal the exposure achieved in adult patients taking a dose of 100 mg BID, the recommended Phase 2 adult dose. Cycles are measured in 28-day increments with continuous dosing. Response assessments by appropriate imaging

modalities are scheduled every eight weeks. Patients continue on therapy until evidence of disease progression or intolerable toxicity.

A kit was provided that included a sealed graduated amber bottle containing 7.6 g of Compound I-HS; a sealed bottle containing 51 g CAVASOL® W7 HP Pharma; a sealed bottle containing 500 g trisodium citrate dihydrate; a sealed bottle containing 100 mL sterile water; a sealed pint (~473 mL) bottle of ORA-Sweet® SF; a funnel; a 28-mm press-in bottle adaptor; a box containing 56 units of 1-mL single use dosing syringes; a box containing 56 units of 5-mL single use dosing syringes; a drug product label indicating the concentration of Compound I-HS (20 mg/mL); and compounding instructions.

A liquid solution was prepared as shown in Figure 9. First, the seal (cap) was removed from the bottle containing CAVASOL® W7 HP Pharma. Next, using the funnel, the contents of the 100 mL bottle of sterile water to were added to the bottle containing CAVASOL® W7 HP Pharma. The bottle with its cap was then closed and the bottle containing CAVASOL® W7 HP Pharma and sterile water was shaken until all of the CAVASOL® W7 HP was dissolved. Ten minutes was allowed to pass for full dissolution of the CAVASOL® W7 HP Pharma. The bottom and sides of the bottle were inspected to make sure all CAVASOL® W7 HP Pharma dissolved and was not clumped on the bottom or clinging to the sides. Next, the bottle was allowed to stand without agitation for approximately five minutes to allow the bubbles created from dissolved CAVASOL® W7 HP Pharma to dissipate. The seal (cap) from the graduated bottle containing Compound I-HS was then removed. Using the same funnel from earlier, the CAVASOL® W7 HP Pharma solution was added to the graduated bottle containing Compound I-HS. The bottle was capped and shaken by hand until dissolved. Bubbles were allowed to come to surface and a clear red solution resulted. Using the same funnel from earleir, q.s. to 300 mL with the supplied ORA-Sweet® SF. The graduated bottle was capped and gently inverted 10 times to mix the ORA-Sweet® SF with the Compound I-HS /CAVASOL® W7 HP solution while being careful not to introduce too many bubbles into the formulation. Next, 3.5 g trisodium citrate dihydrate from the provided container of Trisodium Citrate Dihydrate was weighed and added, using the second funnel in the kit, to the liquid formulation and, subsequently, the bottle was capped and the bottle was inverted ten times. The bubbles were allowed to rise to the top and the contents of the bottle were inspected to make sure all of the trisodium citrate dihydrate was fully dissolved; if it was not, the bottle was inverted an additional 10 times. Subsequently, the cap on the graduated bottle was removed and the provided 28-mm press-in bottle adaptor (syringe adaptor) was inserted in the bottle. The bottle was then closed by

securely placing the cap on the bottle. The liquid formulation was then administered the desired amount of Compound I-HS using a 1mL or 5mL syringe, depending on patient dosing regimen.

Results

An otherwise healthy female was born with a large, vascular, right-sided neck mass extending to the face that was initially diagnosed and treated as a Rapidly Involuting Congenital Hemangioma. At 6 months of age, the mass grew rapidly and surgical excision/debulking revealed the diagnosis of IFS confirmed by an ETV6 translocation by fluorescent in situ hybridization (FISH). Within the first 7 days post-operatively, the tumor rapidly progressed, encroaching the oral cavity. Chemotherapy with vincristine, actinomycin-D and cyclophosphamide was initiated but the patient experienced disease progression during cycle 1. A new chemotherapy regimen comprised of ifosfamide and doxorubicin (ID) was started concurrently with debulking surgery and a tracheostomy was placed-for oropharyngeal obstruction. Two additional courses of ID and four courses of ifosfamide and etoposide had minimal impact on the tumor. The tumor progressed to involve the base of skull, mastoids and cervical vasculature. Gross surgical resection was performed in October 2015 by a team of multidisciplinary surgeons but clear surgical margins could not be achieved.

Five weeks following surgical resection, an MR of the brain and neck showed a 20mm x 19 mm x 18 mm hyperenhancing mass involving the skull base of the middle cranial fossa, just anterior and inferior to the inner ear structures (see Figure 10A and Figure 10B). Further chemotherapy was determined to be futile due to lack of response to all standard regimens. Repeat surgical resection was deemed not possible. Therapeutic radiotherapy was possible, but based on the age of the patient and location of the disease, it was expected to produce devastating long-term sequelae.

In December 2015, at the age of 16 months, the patient enrolled on the Phase 1 pediatric study of the oral, selective TRK inhibitor Compound I-HS. The parents noted improved engagement and playfulness throughout cycle 1. At the end of cycle 1 (day 28), an MR of the brain and neck showed a significant interval reduction in the size and enhancement of the mass by more than 90% from baseline (see Figure 10C and Figure 10D). Repeat scans at the end of Cycle 2 confirmed the size reduction and showed continued decrease in enhancement, confirming partial response (see Figure 10E and Figure 10F). During the first two cycles, the patient experienced fever and PCR-confirmed influenza A (considered not related) but no adverse events related to Compound I-HS.

Example 6

A liquid formulations of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide

A liquid formulation of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide was prepared with the components listed in Table 16.

Table 16. A liquid formulations of (S)-N-(5-((R)-2-(2,5-difluorophenyl)-pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide.

Material Name	% Weight (a)	Total Formulation Weight in grams (b)	Theoretical Quantity Required (a x b) /100	Amount per bottle[1]
Compound I-HS API	2.05%	171,648	3,518.8 grams[1][2]	1.47 g
Purified Water, USP	33.55%		57,587.9 grams	24.01 g
KLEPTOSE® HPB Parenteral Grade EP, USP	14.55%		24,974.8 grams	10.48 g
ORA-SWEET®	48.51%		83,266.4 grams	34.93 g
Sodium Citrate, Dihydrate, Granular, USP (Spectrum)	0.94%		1,613.5 grams (1,694.2 grams)[3]	0.68 g
231a12 Natural Masking Type Flavor (Abelei)	0.10%		171.6 grams	0.07 g
231a39 Natural Bitterness Masking Type Flavor (Abelei)	0.20%		343.3 grams	0.14 g
Bitterness Masking Flavor, Nat (FONA - Liquid)	0.05%		85.8 grams	0.04 g
FONATECH® Taste Modifier Flavor, Nat	0.05%		85.8 grams	0.04 g

(1) Includes an API correction factor of 0.8137. Calculation: Free base molecular weight/salt formula weight = 428.44/526.51. Density of the liquid formulation is 1.2 mg/mL.

*(2) Label claim =3,518.8 grams Salt Form API x 0.8137 / 171,648 grams total formulation * 1.2 g/mL density * 1,000 mg/g.*

(3) Includes an additional 5% of the total amount of Sodium Citrate added to the formulation for pH adjustment, as needed.

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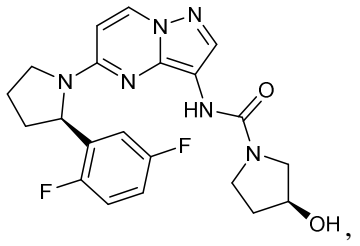
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What is claimed:

1. Use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or combinations thereof, in the manufacture of a liquid formulation for the treatment of a pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof;

hydroxypropyl-β-cyclodextrin;

sodium citrate; and

a sweetener;

wherein:

the formulation has a pH of 2.5 to 5.5; and

the compound of formula **(I)**, the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

2. The use of claim 1, wherein the subject is an infant, child, or adolescent.

3. The use of claim 1, wherein the subject is an infant.

4. The use of any one of claims 1-3, wherein the pediatric cancer is a mesenchymal cancer.

5. The use of claim 4, wherein the mesenchymal cancer is selected from the group consisting of: pediatric nephroma, congenital fibrosarcoma (CFS), pediatric high-grade glioma (HGG), infant fibrosarcoma (IF), congenital mesoblastic nephroma, congenital infantile fibrosarcoma (CIFS); pilocytic astrocytoma, brain tumors, pediatic acute leukemia,

Ph-like acute lymphoblastic leukemia, cellular congenital mesoblastic nephroma (CMN); infantile fibrosarcoma, pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), non-brainstem HGGs (NBS-HGGs), anaplastic large cell lymphoma (ALCL), non-Hodgkin's lymphoma (NHL), pediatric papillary thyroid carcinoma, soft tissue sarcoma, spitzoid melanoma, pediatric hemangiopericytoma-like sarcoma, spindle cell sarcoma, NOS with myo/haemangiopericytic growth pattern, lung cancer, advanced pediatric solid tumors, neuroectodermal-derived tumors, pediatric colorectal cancer, adrenal neuroblastoma, and central nervous system tumors.

6. The use of any one of claims 1-3, wherein the pediatric cancer is a fibrosarcoma.

7. The use of any one of claims 1-3, wherein the pediatric cancer is infantile fibrosarcoma.

8. The use of any one of claims 1-7, wherein the compound of formula **(I)** is a pharmaceutically acceptable salt.

9. The use of any one of claims 1-8, wherein the compound of formula **(I)** is a hydrogen sulfate salt.

10. The use of any one of claims 1-9, wherein the hydroxypropyl-β-cyclodextrin is present in an amount of 13 wt.% to 17 wt.%.

11. The use of any one of claims 1-10, wherein hydroxypropyl-β-cyclodextrin is present in an amount of about 15 wt.%.

12. The use of any one of claims 1-11, wherein the sodium citrate comprises at least one of sodium citrate monohydrate and sodium citrate dihydrate.

13. The use of any one of claims 1-12, wherein the sodium citrate comprises sodium citrate dihydrate.

14. The use of any one of claims 12 or 13, wherein the sodium citrate dihydrate is present in the liquid formulation in an amount of 0.1 wt.% to 5 wt.%.

15. The use of any one of claims 12-14, wherein sodium citrate dihydrate is present in the liquid formulation in an amount of about 1.1 wt.%

16. The use of any one of claims 1-15, wherein the sweetener comprises sucrose, glycerin, sorbitol, and flavoring.

17. The use of claim 16, wherein the sweetener further includes citric acid and sodium phosphate.

18. The use of claim 17, wherein the sweetener further includes methylparaben and potassium sorbate.

19. The use of any one of claims 16-18, wherein the sweetener is present in an amount of 45 wt.% to 55 wt.%.

20. The use of any one of claims 16-19, wherein the sweetener is present in the liquid formulation in an amount of about 50 wt.%.

21. The use of any one of claims 16-20, wherein the liquid formulation further comprises a bitterness masking agent.

22. The use of claim 21, wherein the bitterness masking agent is present in an amount of 0.2 wt.% to 0.5 wt.%.

23. The use of any one of claims 21 or 22, wherein the bitterness masking agent is present in the liquid formulation in an amount of about 0.4 wt.%.

24. The use of any one of claims 1-15, wherein the sweetener includes sucralose.

25. The use of claim 24, wherein the formulation further comprises a flavoring agent.

26. The use of claim 25, wherein the flavoring agent comprises a natural berry flavoring agent.

27. The use of any one of claims 24 or 25, wherein the flavoring agent is present in an amount of 0.01 wt.% to 0.1 wt.%.

28. The use of any one of claims 1-27, wherein the pediatric cancer is associated with or having a dysregulation of a NTRK gene, a Trk protein, or expression, or activity, or level of the same.

29. The use of claim 28, wherein the dysregulation of a NTRK gene, a Trk protein, or expression, or activity, or level of the same is a chromosome translocation that results in the translation of a Trk fusion protein.

30. The use of claim 29, wherein the Trk fusion protein is selected from the group consisting of ETV6-NTRK3, RET/NTRK1, TPM3-NTRK1, BTBD1-NTRK3, VCL-NTRK2, AGBL4-NTRK2, LMNA-NTRK1, TFG-NTRK1, QKI-NTRK2, NACC2-NTRK2, TPR-NTRK1, RABGAP1L-NTRK1, MPRIP-NTRK1, SQSTM1-NTRK1, EML4-NTRK3, and AFAP1-NTRK2.

31. The use of claim 29, wherein the Trk fusion protein is ETV6-NTRK3.

32. The use of claim 28, wherein the dysregulation of a NTRK gene, a Trk protein, or expression or activity, or level of the same is one or more point mutations in the gene.

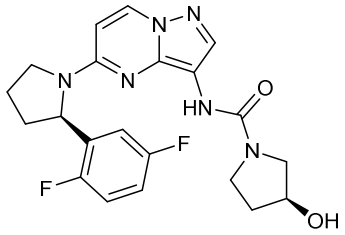
33. The use of claim 32, wherein the one or more point mutations in the gene results in translation of a TrkA protein having one or more amino acid substitutions selected from the group consisting of C6773T, C7232T, C7301T, R33W, A336E, A337T, R324Q, R324W, V420M, R444Q, R444W, G517R, G517V, K538A, V573M, F589L, G595R, G667C, F598L, R649W, R649L, R682S, V683G, R702C, Q627X, Q597X, and Q633X.

34. The use of claim 32, wherein the one or more point mutations in the gene results in translation of a TrkB protein having one or more amino acid substitutions selected from the group consisting of A13T, E142K, R136H, V619M, F633L, G639R, G709C, G709A, and G709S.

35. The use of claim 32, wherein the one or more point mutations in the gene results in translation of a TrkC protein having one or more amino acid substitutions selected from the group consisting of V603M, F617L, G623R, G696C, G696A, and G696S.

36. Use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof in the manufacture of a liquid formulation for treating a Trk-associated pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

hydroxypropyl-β-cyclodextrin present in an amount from 13 wt.% to 17 wt.%;

sodium citrate dihydrate present in an amount from 0.7 wt.% to 1.5 wt.%;

a sweetener that includes sucrose, glycerin, sorbitol, and flavoring, wherein the sweetener is buffered with citric acid and sodium phosphate, wherein the sweetener is preserved with methylparaben and potassium sorbate, and wherein the sweetener is present in an amount from 45 wt.% to 55 wt.%; and

a bitterness masking agent present in the liquid formulation in an amount from 0.2 wt.% to 0.5 wt.%;

wherein:

the formulation has a pH of 2.5 to 5.5; and

the compound of formula (I), the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

37. The use of claim 36, wherein the Trk-associated pediatric cancer is selected from the

group consisting of: congenital mesoblastic nephroma, Ph-like acute lymphoblastic leukemia, infantile fibrosarcoma, pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), pediatric papillary thyroid carcinoma, soft tissue sarcoma, and spindle cell sarcoma.

38. The use of any one of claims 36 or 37, wherein hydroxypropyl-β-cyclodextrin is present in the liquid formulation in an amount of about 15 wt.%.

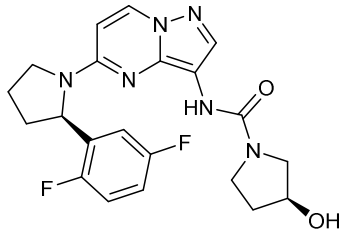
39. The use of any one of claims 36-38, wherein sodium citrate dihydrate is present in the liquid formulation in an amount of about 1.1 wt.%.

40. The use of any one of claims 36-39, wherein the sweetener is present in the liquid formulation in an amount of about 50 wt.%.

41. The use of any one of claims 36-40, wherein the bitterness masking agent is present in the liquid formulation in an amount of about 0.4 wt.%.

42. Use of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide, a pharmaceutically acceptable salt thereof, or combinations thereof in the manufacture of a liquid formulation for treating a Trk-associated pediatric cancer in a subject in need thereof, wherein the liquid formulation comprises:

a therapeutically effective amount of (S)-N-(5-((R)-2-(2,5-difluorophenyl)pyrrolidin-1-yl)-pyrazolo[1,5-a]pyrimidin-3-yl)-3-hydroxypyrrolidine-1-carboxamide having the formula **(I)**:



(I)

a pharmaceutically acceptable salt thereof, or a combination thereof;

hydroxypropyl-β-cyclodextrin present in an amount from 13 wt.% to 17 wt.%;

sodium citrate dihydrate present in an amount from 0.7 wt.% to 1.5 wt.%;

a sweetener that includes sucralose; and

a flavoring agent present in an amount from 0.01 wt.% to 0.1 wt.%;

wherein:

the formulation has a pH of 2.5 to 5.5; and

the compound of formula (I), the pharmaceutically acceptable salt thereof, or the combination thereof has a concentration of 20 mg/mL to 30 mg/mL in the liquid formulation.

43. The use of claim 42, wherein the Trk-associated pediatric cancer is selected from the group consisting of: congenital mesoblastic nephroma, Ph-like acute lymphoblastic leukemia, infantile fibrosarcoma, pediatric high-grade glioma (HGG), diffuse intrinsic pontine gliomas (DIPGs), pediatric papillary thyroid carcinoma, soft tissue sarcoma, and spindle cell sarcoma.

44. The use of any one of claims 42 or 43, wherein hydroxypropyl-β-cyclodextrin is present in the liquid formulation in an amount of about 15 wt.%.

45. The use of any one of claims 42-44, wherein sodium citrate dihydrate is present in the liquid formulation in an amount of about 1.1 wt.%.