USE OF FAK INHIBITOR IN PREPARATION OF DRUG FOR TREATING TUMORS HAVING NRAS MUTATION

FIELD OF THE INVENTION

[0001] The present disclosure belongs to the field of pharmaceutical chemistry, and particularly relates to use of an FAK inhibitor in the manufacture of a medicament for treating tumors having an NRAS mutation.

BACKGROUND OF THE INVENTION

[0002] FAK, also known as protein tyrosine kinase 2 (PTK2), is a non-receptor tyrosine kinase and a key component of the focal adhesion complex. FAK plays an important role in mediating integrin and growth factor signaling to regulate invasion, proliferation and survival of tumor cells. FAK is widely expressed and evolutionarily conserved. Studies in the past 20 years have shown that FAK is overexpressed in a variety of solid tumors, and the expression level is negatively correlated with tumor prognosis. Recent studies have also shown that FAK plays an important role in regulating the tumor microenvironment, which suggests that FAK plays an important role in adaptive resistance to immunotherapy and anti-tumor therapy. Both in vitro and in vivo preclinical studies have shown that blocking FAK has antitumor effects. However, the inhibitory activity of FAK inhibitors against tumors varies widely.

[0003] BI853520 is a FAK inhibitor. In human tumor CDX (Cell line-Derived Xenograft) mice model of 37 different tumors, BI853520 has showed different anti-tumor activities, and its TGI (tumor growth inhibition) span from 0 to 107 %. Inhibiting tumor growth by using BI853520 in a more targeted manner is a technical problem to be solved urgently in this field.

SUMMARY OF THE INVENTION

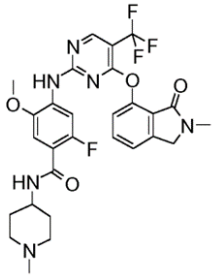
[0004] In one aspect, the present disclosure provides use of a FAK inhibitor in the manufacture of a medicament for treating a tumor having an NRAS mutation.

[0005] Optionally, the FAK inhibitor is BI853520, defactinib, GSK2256098, PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof.

[0006] Alternatively, the FAK inhibitor is BI853520 or a pharmaceutically acceptable salt

thereof, especially BI853520 tartrate.

[0007] The BI 853520 has the following structure:



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[0008] Optionally, the medicament is used in combination with an effective amount of a second therapeutic agent.

[0009] Optionally, the medicament is used in combination with radiotherapy or cell therapy.

[0010] Optionally, the tumor is Hodgkin's lymphoma, non-Hodgkin's lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

[0011] Optionally, the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapy agents.

[0012] Optionally, the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin,

idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab.

[0013] Optionally, the second therapeutic agent is selected from the group consisting of decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, and pembrolizumab.

[0014] Optionally, the second therapeutic agent is docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine.

[0015] Optionally, the second therapeutic agent is cobimetinib.

[0016] In another aspect, the present disclosure also provides a method of treating a tumor having an NRAS mutation comprising administering to an individual an effective amount of a FAK inhibitor.

[0017] Optionally, the FAK inhibitor is BI853520 or defactinib, GSK2256098,

PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof, alternatively, the FAK inhibitor is BI853520 or a pharmaceutically acceptable salt thereof, especially BI853520 tartrate.

[0018] Optionally, the method further comprises administering to the individual an effective amount of a second therapeutic agent.

[0019] Optionally, the method further includes radiotherapy or cell therapy.

[0020] Optionally, the tumor is Hodgkin's lymphoma, non-Hodgkin's lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

[0021] Optionally, the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapy agents.

[0022] Optionally, the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin,

cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab.

[0023] Optionally, the second therapeutic agent is selected from the group consisting of decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, and pembrolizumab.

[0024] Optionally, the second therapeutic agent is docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine.

[0025] Optionally, the second therapeutic agent is cobimetinib.

[0026] Optionally, the second therapeutic agent is administered simultaneously, alternately or sequentially.

[0027] Optionally, the FAK inhibitor and radiotherapy or cell therapy are performed simultaneously, alternately or sequentially.

[0028] In yet another aspect, the present disclosure provides a FAK inhibitor for the treatment of a tumor having an NRAS mutation.

[0029] Optionally, the FAK inhibitor is BI853520, defactinib, GSK2256098, PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof, alternatively, the FAK inhibitor is

BI853520 or a pharmaceutically acceptable salt thereof, especially BI853520 tartrate.

[0030] Optionally, the FAK inhibitor is further used in combination with an effective amount of a second therapeutic agent.

[0031] Optionally, the FAK inhibitor is further used in combination with radiotherapy or cell therapy.

[0032] Optionally, the tumor is Hodgkin's lymphoma, non-Hodgkin's lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

[0033] Optionally, the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapy agents.

[0034] Optionally, the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine,

docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab.

[0035] Optionally, the second therapeutic agent is selected from the group consisting of decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, and pembrolizumab.

[0036] Optionally, the second therapeutic agent is docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine.

[0037] Optionally, the second therapeutic agent is cobimetinib.

Definition

[0038] The following terms and symbols used in this application have the meanings set forth below unless the context dictates otherwise.

[0039] The term “FAK inhibitor” as used herein refers to a potent inhibitor of FAK, which may be suitable for mammals, particularly humans.

[0040] The term “NRAS” as used herein refers to an oncogene that is a member of the RAS oncogene family which also includes two other genes: KRAS and HRAS. These genes play important roles in cell division, cell differentiation and apoptosis.

[0041] The term “NRAS mutation” as used herein means that when a pathogenic mutation occurs in the NRAS gene, the N-Ras protein encoded by it will be in a state of continuous activation, resulting in uncontrolled cell proliferation and tumor formation.

[0042] The term “treating” as used herein refers to the administration of one or more drugs, particularly a FAK inhibitor described herein, especially BI853520 or a pharmaceutically acceptable salt thereof, to an individual with a disease or symptoms of said disease, to cure, alleviate, reduce, alter, remedy, ameliorate, improve or affect the disease or the symptoms of the disease. In some embodiments, the disease is a tumor or cancer. In further embodiments, the disease is a cancer or tumor having an NRAS mutation.

[0043] The term “tumor” as used herein refers to an abnormal lesion formed by abnormally clonal proliferation of cells of local tissues which lose the normal regulation on their growth at the gene level under the action of various tumorigenic factors. Examples include, but are not limited to: Hodgkin’s lymphoma, non-Hodgkin’s lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumors are acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma and cholangiocarcinoma.

[0044] As used herein, the term “individual” refers to mammals and non-mammals. Mammals means any member of the mammalian class including, but not limited to, humans; non-human primates such as chimpanzees and other apes and monkey species; farm animals such as cattle, horses, sheep, goats, and swine; domestic animals such as rabbits, dogs, and cats; laboratory animals including rodents, such as rats, mice, and guinea pigs; and the like. Examples of non-mammals include, but are not limited to, birds, and the like. The term

“individual” does not denote a particular age or sex. In some embodiments, the individual is a human.

[0045] As used herein, the term “pharmaceutically acceptable” means non-toxic, biologically tolerable and suitable for administration to an individual.

[0046] As used herein, the term “pharmaceutically acceptable salt” refers to an acid addition salt of BI853520 that is non-toxic, biologically tolerable and suitable for administration to an individual. The “pharmaceutically acceptable salt” includes, but are not limited to, acid addition salts formed by BI853520 with an inorganic acid, such as hydrochloride, hydrobromide, carbonate, bicarbonate, phosphate, sulfate, sulfite, nitrate, and the like;and acid addition salts formed by BI853520 with an organic acid, such as formate, acetate, malate, maleate, fumarate, tartrate, succinate, citrate, lactate, methanesulfonate, p-toluenesulfonate, 2-hydroxyethanesulfonate, benzoate, salicylate, stearate, and salts with alkane-dicarboxylic acid of formula HOOC-$(CH_2)_n$-COOH (wherein n is 0-4), etc. In some embodiments, the salt is a tartrate salt.

[0047] In addition, a pharmaceutically acceptable acid addition salt may be produced by dissolving the free base in a suitable solvent and treating the solution with an acid, in accordance with conventional procedures for preparing acid addition salts from basic compounds. Those skilled in the art can determine, without undue experimentation, a variety of synthetic methods, which are used to prepare non-toxic pharmaceutically acceptable acid addition salts.

[0048] As used herein, the term “effective amount” refers to an amount sufficient to generally bring about a beneficial effect in an individual. The effective amount of the compounds of the present disclosure may be ascertained by conventional methods (such as modeling, dose escalation studies or clinical trials), and by taking into consideration conventional influencing factors (such as the mode of administration, the pharmacokinetics of the compound, the severity and course of the disease, the individual's medical history, the individual's health status and the individual's response to drugs).

[0049] The term “second therapeutic agent” as used herein refers to one or more drugs used to prevent and/or treat diseases. In some embodiments, the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and

immunotherapeutic agents. In some embodiments, the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab. Optionally, the second therapeutic agent is selected from decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, and pembrolizumab. Optionally, the second therapeutic agent is docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine. Optionally, the second therapeutic agent is cobimetinib.

[0050] In addition, the drug substances from which the second therapeutic agent is selected may be slightly different in names due to different translations, but they still refer to one drug substance, for example: cobimetinib may be translated into Chinese as “卡比替尼” or “考比替尼”.

[0051] The term “inhibition” as used herein refers to a reduction in the baseline activity of a biological activity or process.

[0052] Technical and scientific terms used herein without specific definition have the meaning commonly understood by those skilled in the art to which the invention pertains.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] FIG. 1 shows influence of IL-3 on the antiproliferative effect of BI 853520 in the Ba/F3-$NRAS^{G12D}$ cell line. It illustrates that for BI853520, the IC_{50} was increased from 3.4 to 15 μM after addition of IL-3 in $NRAS^{G12D}$-transfected Ba/F3 cell line (increased by more than 4-fold). GraphPad Prism 6 software and Student’s t-test were used for statistical data analysis. Statistically significant difference threshold was set at P = 0.05.

[0054] FIG. 2 shows changes in body weight. It illustrates that animals in the control group lost 1.9% body weight; animals treated with BI 853520 at 6 mg/kg had a median weight gain of 4.9% (p = 0.9966 compared to the control group); animals treated with 853520 at 12.5 mg/kg had a median weight gain of 5.7% (p = 0.9996 compared to the control group); animals treated with BI 853520 at 25 mg/kg had a median weight gain of 9.4% (p = 1.0000 compared to the control group); and animals treated with BI 853520 at 50 mg/kg had a median weight gain of 8.3% (p = 0.999 compared to the control group).

[0055] FIG. 3 shows HT-1080 tumor growth kinetics. It illustrates that on day 13, the median tumor volume of the control group was 823 mm^3; the median tumor volume of the group treated with BI 853520 at 6 mg/kg was 322 mm^3; the median tumor volume of the group treated with BI 853520 at 12.5 mg/kg was 149 mm^3; the median tumor volume of the group treated with BI 853520 at 25 mg/kg was 15 mm^3; and the median tumor volume of the group treated with BI 853520 at 50 mg/kg was 322 mm^3.

[0056] FIG. 4 shows KYSE-270 tumor growth kinetics, which illustrates the median tumor volume increased from 179 mm^3 to 1032 mm^3 in the control group. Compared to the control

group, the median tumor volume of the group treated with 50 mg/kg BI 853520 per day decreased from 175 mm^3 to 126 mm^3. Treatment with 10 mg/kg paclitaxel once a week had no effect on tumor growth, in which the median tumor volume increased from 190 mm^3 to 1033 mm^3. The combination therapy of 50 mg/kg BI 853520 once a day with 10 mg/kg paclitaxel once a week significantly delayed tumor growth, with the median tumor volume decreased from 173mm^3 to 87mm^3.

[0057] FIG. 5 shows changes in body weight. It illustrates that animals in the control group had a 10.3% reduction in the median body weight, and compared to the control group, animals treated with 50 mg/kg BI 853520 daily had a 2.8% increase in the median body weight, animals treated with 10 mg/kg paclitaxel once a week had a 9.7% reduction in the median body weight, and animals treated with the combination therapy of 50 mg/kg BI 853520 once daily with 10 mg/kg paclitaxel once a week had a 3.5% increase in the median body weight.

[0058] FIG. 6 shows GAK tumor growth kinetics. It illustrates that in the GAK model, daily treatment with BI 853520 delayed tumor growth compared to the control group.

[0059] FIG. 7 shows HMVII tumor growth kinetics. It illustrates that in the HMVII model, daily treatment with BI 853520 delayed tumor growth compared to the control group.

DETAILED DESCRIPTION OF THE INVENTION

[0060] The following examples are provided to further illustrate the present disclosure. It should be understood that these examples are only used to illustrate the present disclosure and not to limit the scope of the present disclosure.

[0061] The experimental methods without specific conditions in the following examples can be carried out according to the conventional conditions of this type of reaction or according to the conditions suggested by the manufacturers.

[0062] The experimental materials and reagents used in the following examples can be obtained from commercial sources unless otherwise specified.

[0063] The meanings of the abbreviations used in the examples are as follows:

[0064] ATCC American Type Culture Collection

[0065] CO_2 Carbon dioxide

[0066]	d	Days
[0067]	FCS	Fetal Calf Serum
[0068]	FBS	Fetal Bovine Serum
[0069]	g	Gram
[0070]	kg	Kilograms
[0071]	l	Liter
[0072]	mg	Milligram
[0073]	ml	Milliliter
[0074]	µl	Microliter
[0075]	mM	Millimole
[0076]	mm^3	Cubic millimeter
[0077]	GLP	Good Laboratory Practice
[0078]	h	Hours
[0079]	MCB	Master Cell Bank
[0080]	mean	Arithmetic average
[0081]	MTD	Maximum tolerated dose
[0082]	n	Sample number
[0083]	PBS	Phosphate Buffered Saline
[0084]	RPMI 1640	RPMI 1640 Medium
[0085]	p.o.	peros
[0086]	qd	Daily
[0087]	q7d	Every 7 days (once a week)
[0088]	s.c.	Subcutaneous
[0089]	SD	Standard deviation
[0090]	TGI	Tumor Growth Inhibition
[0091]	WCB	Working Cell Bank
[0092]	V_{rel}	Relative Tumor Volume (relative to Day 1)

Example 1: Correlation between antitumor effect of BI853520 and NRAS

[0093] 1. Materials and method:

[0094] 1.1. DNA construction and retrovirus production

[0095] Retroviral constructs expressing NRAS-G12D, KRAS4A-G12D, KRAS4B-G12D, and NRAS-G12D-C181S as N-terminal GFP fusion proteins were prepared according to a method as described in *Cuiffo B, Ren R. Palmitoylation of oncogenic NRAS is essential for leukemogenesis. Blood., 2010, 115: 3598 - 605,* and *Parikh C, Subrahmanyam R, Ren R. Oncogenic NRAS, KRAS, and HRAS exhibit different leukemogenic potentials in mice. Cancer Res., 2007, 67: 7139 - 46*. Retroviruses were prepared by using Bosc23 cells and the titre determination was performed by the method described in *Parikh C, Subrahmanyam R, Ren R. Oncogenic NRAS, KRAS, and HRAS exhibit different leukemogenic potentials in mice. Cancer Res., 2007, 67: 7139–46.*

[0096] 1.2. Cell culture and retroviral transduction

[0097] The Ba/F3 cell line was obtained from ATCC in 2009, and cultured according to a method described in *Zhang X, Ren R. Bcr-abl efficiently induces a myeloproliferative disease and production of excess interleukin-3 and granulocyte-macrophage colony-stimulating factor in mice: A novel model for chronic myelogenous leukemia. Blood., 1998, 92: 3829–40*. Growth factor-dependent BA/F3 cells were cultured in RPMI 1640 including 10% FBS and supplemented with 15% WEHI-3 conditioned medium or recombinant IL-3 (Roche) as a source of IL-3 at a final concentration of 1 ng/ ml. BA/F3 cells were transduced with retrovirus according to a method as described in *Parikh C, Subrahmanyam R, Ren R. Oncogenic NRAS, KRAS, and HRAS exhibit different leukemogenic potentials in mice. Cancer Res., 2007, 67: 7139–46* and *Fredericks J, Ren R. The role of RAS effectors in BCR/ABL induced chronic myelogenous leukemia. Front Med China., 2013, 7: 452–61*. Upon receipt of the original stock, cells were expanded and frozen at a low passage rate (<3). Frozen cells were thawed and used in this study, with cell passages limited to 15 for all experimental procedures. All cells were tested regularly to ensure freedom and maintenance in a normal state of mycoplasma.

[0098] 1.3. Materials

[0099] BI853520: synthesized according to the method in the patent WO2010058032.

[00100] 1.4. Antiproliferative test

[00101] $NRAS^{G12D}$-transfected Ba/F3 (Ba/F3-N) or $KRAS^{G12D}$-transfected Ba/F3 (Ba/F3-N) cells were seeded into 96-well cell culture cluster plate in 100 μL of medium at a density of 5,000 cells per well. BI853520 was diluted 3-fold with RPMI 1640 at 9 points, and added

according to the volume of each well, starting at 10 μmol/L to reach a 3-fold concentration gradient (final solvent concentration <1/1000). PD0325901 was used as a positive control. After 48 hours of incubation, cell viability was measured using CellTiter Glo (Promega). Luminescence was detected using an Envision plate reader (PerkinElmer). The calculation method of Z factor was as described in *Zhang JH, Chung TDY, Oldenburg KR. A simple statistical parameter for use in evaluation and validation of high throughput screening assays. J Biomol Screen., 1999, 4: 67–73*, and the following analysis only used data with Z factor > 0.6. Dose-response curves were fitted based on the relative percentage of viable cells in nonlinear fitness (curve fitting) using GraphPad Prism 6 software (http://www.graphpad.com/scientific-software/prism/). The internal software analysis "non-linear regression (curve fitting)" and the equation "log (inhibitor) vs. slope of response variable" were used for data analysis and IC_{50} calculation.

[00102] 2. Statistical analysis:

[00103] GraphPad Prism 6 software and Student's t-test were used for statistical data analysis. Statistically significant difference threshold was set at P = 0.05.

[00104] 3. Results:

[00105] Ba/F3 is a murine marrow-derived cell line depending on IL-3 for survival and proliferation, and has been successfully used in high-throughput assays for kinase drug discovery. We tested this system with oncogenic RAS and found that oncogenic NRAS ($NRAS^{G12D}$) could convert Ba/F3 cells to being independent on IL-3. FIG. 1 and Table 1 show the antiproliferative effect of BI853520 on Ba/F3-$NRAS^{G12D}$ cell line with IC_{50} value of 3.4 μM. The IC_{50} increased more than 4-fold after the addition of IL-3, indicating that the inhibitory effect was related to NRAS.

[00106] Table 1: Influence of adding IL-3 or not on the antiproliferative effect of BI853520 in Ba/F3-$NRAS^{G12D}$ cell line

Cell line	Compound	IC_{50} (μM)	
		- IL-3	+ IL-3
Ba/F3-$NRAS^{G12D}$	BI853520	3.4	15

Example 2: The effect of BI853520 in a mouse model of human fibrosarcoma (cell line HT-1080)

[00107] 1. Materials and method:

[00108] 1.1. Design of research

[00109] Treatment began when the median tumor volume was between 70-130 mm^3.

[00110] 10 mice in the control group, and 7 mice in the treatment group.

[00111] Oral gavage once daily.

[00112] Control: 0.5% hydroxyethyl cellulose

[00113] BI 853520: 50mg/kg, 25mg/kg, 12.5mg/kg, 6mg/kg,

[00114] Tumor volume was measured 3 times a week and body weight was monitored daily.

[00115] Evaluation of treatment outcome was based on absolute volume of individual tumors.

[00116] Tolerability was assessed based on changes in body weight.

[00117] 1.2. Materials

[00118] BI853520: synthesized according to the method in the patent WO2010058032. The dry powder was suspended in 0.5% hydroxyethyl cellulose to obtain the desired concentration for each assay. The pH of this formulation was 3.5.

[00119] HT-1080 cells: HT-1080 cells carrying NRAS, CDKN2A and IDH1 gene mutations were obtained from ATCC (CRL-121). Cells were grown in T175 tissue culture flasks with DMEM+Glutamax supplemented with 10% heat-inactivated fetal bovine serum as medium. Cells were cultured at 37°C and 5% CO_2 in humidified air.

[00120] Mice: Athymic female BomTac, approximately 6-week-old NMRI-Foxn1^{nu} mice were purchased from Taconic, Denmark. After arriving in the animal room, mice were acclimated to the new environment for at least 3 days before being used for assay. The animals were housed under standard conditions (temperature 21.5±1.5°C and 55±10% humidity) with 5 mice in each group. A standard diet and autoclaved tap water were provided for ad libitum feeding. A Datamars T-IS 8010 FDX-B transponder implanted subcutaneously in the neck region and a LabMax II fixed reader were used to identify each mouse. The cage card showed study number, animal identification number, compound and dose level, route of administration, and dosing schedule for animals throughout the assay.

[00121] 1.3. Random establishment of tumors:

[00122] To establish subcutaneous tumors, HT-1080 cells were harvested by trypsinization, centrifuged, washed and suspended in ice-cold PBS + 1 x 10^8 cells/ml. Then 100 μl of cell suspension containing 1 x 10^7 cells was injected subcutaneously into the right flank of nude mice (1 site per mouse). When tumors were established and reached a diameter of 5-8 mm (7 days after cell injection), mice were randomly assigned to the treatment group and the control group.

[00123] 1.4. Dosing:

[00124] BI853520 was suspended in 0.5% hydroxyethyl cellulose, which was administered intragastrically through gavage needle every day, and the dosage was 10 mL/Kg.

[00125] 1.5. Monitoring tumor growth and side effects:

[00126] Tumor diameters were measured with calipers three times a week (Monday, Wednesday, and Friday). The volume of each tumor [in mm^3] was calculated according to the equation, "tumor volume = length x $diameter^2$ x π/6". To monitor the side effects of the treatment, the mice were checked daily for abnormalities and their body weights were measured daily. Animals were sacrificed at the end of the study (approximately two weeks after the start of treatment). During the study, animals with tumor necrosis or tumors larger than 2000 mm^3 were sacrificed ahead of schedule for ethical reasons.

[00127] 2. Statistical Analysis:

[00128] At the end of the assay on day 13, statistical evaluation of tumor volume and body weight parameters was performed. Absolute tumor volume and percent change in body weight (referenced to initial weight on day 1) were used. A nonparametric approach was used, and the number of observations, median, minimum and maximum values were calculated. For a quick overview of possible treatment effects, the median tumor volume for each treatment group T and the median tumor volume for the control group C were used to calculate the TGI from day 1 to day d:

$$TGI=100 \times [(C_d - C_1) - (T_d-T_1)]/(C_d-C_1)$$

wherein, C_1, T_1 = median tumor volume in control and treatment groups at the start of the assay (day 1).

C_d, T_d = median tumor volume in control and treatment groups at the end of the assay (day 13).

[00129] Each dose of test compound was compared to the control group using a one-sided

descending wilcoxon test, taking reduction in tumor volume as a treatment effect and weight loss as a side effect. The P-values for tumor volume (the efficacy parameter) were compared and adjusted for multiple times according to Bonferroni-Holm, while the P-values for body weight (the tolerance parameter) were not adjusted so as not to overlook possible side effects. Significance level was fixed at α=5%. A p-value (adjusted) of less than 0.05 was considered to show a statistically significant difference between groups, and $0.05 \leq$p-value<0.10 was considered as an indicative difference. Statistical evaluations were performed using the software packages SAS version 9.2 (SAS Institute Inc., Cary, NC, USA) and Proc StatXact version 8.0 (Cytel Software, Cambridge, MA, USA).

[00130] 3. Results:

[00131] 3.1. During the test period, animals in the control group lost 1.9% body weight (FIG. 2, Table 2), and on day 13, their median tumor volume reached 823 mm^3 (FIG. 3, Table 3).

[00132] 3.2. Treatment with BI 853520 at 50 mg/kg once daily resulted in a TGI of 107% (p=0.0002), and tumor shrinkage was observed in all animals (FIG. 3, Table 3). The median body weight of the animals increased by 8.3% (p = 0.999 compared to the control group) (FIG. 2, Table 2).

[00133] 3.3. Treatment with BI 853520 at 25 mg/kg once daily resulted in a TGI of 113% (p = 0.0002) and tumor shrinkage in 6 animals (FIG. 3, Table 3). The median body weight of the animals increased by 9.4% (p = 1.0000 compared to the control group) (FIG. 2, Table 2).

[00134] 3.4. Treatment with BI 853520 at 12.5 mg/kg once daily resulted in a TGI of 94% (p = 0.0002) and tumor shrinkage in 2 animals (FIG. 3, Table 3). The median body weight of the animals increased by 5.7% (p = 0.9996 compared to the control group) (FIG. 2, Table 2).

[00135] 3.5. Treatment with BI 853520 at 6 mg/kg once daily resulted in a TGI of 70% (p = 0.0004) and tumor shrinkage in 1 animal (FIG. 5, Table 3). The median body weight of the animals increased by 4.9% (p = 0.9966 compared to the control group) (FIG. 2, Table 2).

[00136] Table 2: Median weight change at the end of the assay

Dosage (mg/Kg)	Dosing schedule	Median weight change (%)
control group	qd	-1.9
50	qd	+8.3

25	qd	+9.4
12.5	qd	+5.7
6	qd	+4.7

[00137] Table 3: Median tumor volume

Dosage (mg/Kg)	Dosing schedule	Median tumor volume (mm^3)	Tumor shrinkage [X/7]	TGI [%]
control group	qd	823	-	n.a
50	qd	54	7	107
25	qd	15	6	113
12.5	qd	149	2	94
6	qd	322	1	70

[00138] 4. Conclusion:

[00139] In the human HT-1080 fibrosarcoma model, BI 853520 demonstrated statistically significant antitumor activity at all dose levels, and regression was observed in all the treatment groups; reduction in tumor volume was observed in all animals at the highest dose level. In previous studies, the highest daily dose was 100 mg/kg without limiting toxicity. Thus, significant efficacy was obtained at a dose at least 16 times lower than the MTD (6 mg/kg).

Example 3: Antitumor activity of BI 853520 in a subcutaneous xenograft mouse model derived from the human esophageal cancer cell line KYSE-270 in NMRI nude mice

[00140] 1. Materials and Methods

[00141] 1.1. Model: Subcutaneous xenograft of human esophageal cancer cell line KYSE-270 in NMRI nude mice.

[00142] 1.2. Test compound: BI853520: synthesized according to the method in patent WO2010058032.

[00143] 1.3. Cells: KYSE-270 is an esophageal cancer cell line (Public Health England, catalog number: 94072021). Cells were cultured in T175 tissue culture flasks containing 5% CO_2 at 37°C. The medium was RPMI 1640+HAM F12 (1:1) supplemented with 2% FCS and 2

mM Glutamax. Passage was performed three times a week at a ratio of 1:2.

[00144] 1.4. Mice: Mice were 8 to 10 week old female mice (BomTac: NMRI-Foxn1^{nu}) purchased from Taconic, Denmark. Upon arrival in the animal room, the mice were allowed to acclimate for at least 5 days before being used for assay. The animals were housed under standard conditions (temperature: 21.5±1.5°C, humidity: 55+10%), 7 to 10 mice for each group. A standard diet and autoclaved tap water were provided for ad libitum feeding. A subcutaneous microchip implanted under isoflurane anesthesia was used to identify each mouse. The cage card showed study number, animal identification number, compound and dose level, route of administration, and dosing schedule for animals throughout the assay.

[00145] 1.5. Random establishment of tumors: To establish subcutaneous tumors, KYSE-270 cells were harvested by centrifugation, washed and resuspended in PBS + 5% FCS at a concentration of 5 x 10^7 cells/ml. Then 100 µl of cell suspension containing 5×10^6 cells was injected subcutaneously into the right flank of mice (1 site per mouse). When tumors were well established and reached a volume of 94 to 252 mm^3, mice were randomly assigned to the treatment group and the control group (13 days after cell injection).

[00146] 1.6. Administration: BI 853520 was suspended in 0.5% hydroxyethyl cellulose, which was administered intragastrically through gavage needle every day, and the dosage was 10 mL/Kg body weight. Paclitaxel was dissolved in saline (0.9% NaCl), which was administered intravenously in a volume of 10 ml/kg body weight. The suspension of BI853520 could be used for up to 7 days. Paclitaxel solution was stored at 6°C and used for up to 14 days.

[00147] 1.7. Monitoring tumor growth and side effects: Tumor diameters were measured with calipers three times a week. The volume [mm^3] of each tumor was calculated according to the equation “tumor volume = length x $diameter^2$ x π/6”. To monitor the side effects of the treatment, the mice were checked daily for abnormalities and their body weights were measured three times a week. For ethical reasons, animals with tumors larger than 1.5 cm in diameter, ulcerated tumors, or 20% body weight loss were euthanized.

[00148] 2. Statistical Analysis:

[00149] Statistical assessment of tumor volume and body weight on day 13 was performed. Animal number 1 (control group) was excluded from the statistical evaluation because of weight loss and had to be euthanized early (day 9). Measured tumor volume was used as the

target variable in the statistical analysis. The number of animals and the median, minimum and maximum tumor volumes in each group were calculated. For a quick overview of possible treatment effects, the median tumor volume for each treatment group T and the median tumor volume for the control group C were used to calculate TGI:

$$TGI=100 \times [(C_d - C_1) - (T_d-T_1)]/(C_d-C_1)$$

[00150] wherein, C_1, T_1 = median tumor volume in control and treatment groups at the start of the assay (day 1).

[00151] C_d, T_d= median tumor volume in control and treatment groups at the end of the assay (day 13).

[00152] The wilcoxon test was used for comparison. For body weight, the percent change relative to initial body weight on day 1 was used as the target variable for statistical analysis. The number of animals, and the median, minimum and maximum weight changes in each group were calculated.

[00153] One-sided test to compare all treatment groups with control group was performed for observing:

reduction in tumor volume (inhibition of tumor growth, efficacy parameter) and

reduction in weight changes (weight loss, tolerance parameters).

[00154] Within each subtopic, p-values for the efficacy parameter were compared and adjusted for multiple times according to Bonferroni-Holm. The p-value for the tolerance parameter was kept constant so as not to overlook possible side effects. Significance level was fixed at α=5%. A p-value (adjusted) of less than 0.05 was considered to show a statistically significant difference between groups, and $0.05 \leq$p-value<0.10 was considered as an indicative difference. Statistical evaluations were performed using the SAS software package version 9.4 (SAS Institute Inc., Cary NC, USA).

[00155] 3. Results

[00156] Tumor volume and body weight:

[00157] By day 13, the median tumor volume in the control group increased from 179 mm^3 to 1032 mm^3 (FIG. 4). The median body weight of control animals decreased by 10.3% (FIG. 5, Table 4). On day 9, one animal had to be euthanized due to severe weight loss.

[00158] Daily treatment with 50 mg/kg BI 853520 significantly delayed tumor growth

(median TGI = 106%, p = 0.0003) compared to the control group (FIG. 5, Table 4). On day 13, 6 of 7 tumors had shrunk (Table 4). The median body weight of the animals increased by 2.8%, which was not significantly different from the control group (p = 0.9999) (FIG. 5, Table 4).

[00159] Treatment with 10 mg/kg paclitaxel once a week had no effect on tumor growth (median TGI = 2%, p = 0.3788) compared to the control group (FIG. 4, Table 4). On day 13, none of the animals had tumor shrinkage (Table 4). The median body weight of the animals decreased by 9.7%, which was not significantly different from the control group (p = 0.7320) (FIG. 5, Table 4).

[00160] Combination therapy of BI 853520 at 50 mg/kg once daily and 10 mg/kg paclitaxel once a week significantly delayed tumor growth (median TGI=110%, p=0.0003) compared to the control group (FIG. 4, Table 4). On day 13, all animals had tumor shrinkage (Table 4). The median body weight of the animals increased by 3.5%, which was not significantly different from the control group (p = 1.0000) (FIG. 5, Table 4).

[00161] Table 4: TGI, tumor shrinkage and body weight change in each group (day 13)

Compound	Dosage (Dosing Schedule)	TGI (%)	Tumor shrinkage [x/y]	Change in median weight (%)
Control group	-(qd+q7d)			-10.3
BI853520	50mg/Kg (qd)	106	6/7	+2.8
Paclitaxel	10 mg/Kg (q7d)	2	0/7	-9.7
BI853520+Paclitaxel	50mg/Kg (qd) + 10 mg/Kg (q7d)	110	7/7	3.5

[00162] 4. Conclusion

[00163] In a subcutaneous xenografted model of the human esophageal cancer cell line KYSE-270, statistically significant inhibition of tumor growth was observed in the treatment group with 50 mg/kg BI 853520 and the treatment group with 50 mg/kg BI 853520 in combination with 10 mg/kg paclitaxel, and both were well tolerated.

Example 4: Tumor growth inhibitory effect of BI 853520 on HMVII and GAK CDX models (melanoma models with an NRAS mutation)

[00164] 1. Materials and Methods

[00165] 1.1. Test compound: BI853520, which was synthesized according to the method in the patent WO2010058032. BI853520 was formulated with 0.5% hydroxyethyl cellulose (Ashland).

[00166] 1.2. Cells: The melanoma cell line GAK was purchased from JCRB Cell Bank, and HMVII cells were purchased from Sigma. GAK originated in the inguinal lymph nodes of patients with vaginal melanoma, whereas HMVII originated in primary vaginal melanoma. GAK and HMVII cells were cultured in tissue culture flasks containing 5% CO_2 at 37°C. The media were Ham's F12 containing 10% heat-inactivated FBS and Ham's F10 containing 15% FBS, respectively. All media were supplemented with 100 U/mL penicillin, 100 mg/mL streptomycin, and 2 mM GlutaMAX. All cell culture reagents were purchased from GIBCO.

[00167] Both HMVII and GAK cell lines carried an NRAS mutation at the Q61 position. HMVII ($NRAS^{Q61K}$) and GAK ($NRAS^{Q61L}$).

[00168] 1.3. Mice: 4-week-old female balb/c nude mice (purchased from Beijing Vital River Laboratory Animal Technology Co., Ltd.). After arriving in the animal room, the mice were allowed to acclimate to the new environment for at least 2 weeks before being used for assay. The animals were housed under standard conditions (temperature: 21.5±1.5℃, humidity: 55±10%).A Standard diet and autoclaved tap water were provided ad libitum. All animal care and experimental procedures were performed in accordance with the animal care ethics guidelines approved by the Medical Ethics Committee of Beijing Cancer Hospital and Research Institute.

[00169] 1.4. Random establishment of tumors:

[00170] To establish subcutaneous tumors, HMVII and GAK cells were harvested by trypsinization, centrifuged, washed and resuspended in ice-cold PBS+5% FCS. Then 100 μl of the cell suspension containing 5×10^6 cells was injected subcutaneously into the right flank of nude mice (1 site per mouse). When tumors were well established and reached a median volume of approximately 400-600 mm^3, mice were randomly assigned to the treatment group and the control group.

[00171] 1.5. Administration: BI 853520 was formulated in 0.5% hydroxyethyl cellulose, which was intragastrically administered through gavage needle every day, and the dosage was

10 mL/Kg body weight.

[00172] 1.6. Monitoring tumor growth:

[00173] Tumor diameters were measured twice a week with calipers. The volume [mm^3] of each tumor was calculated according to the equation "tumor volume = length x $diameter^2$ x $\pi/6$". Animals were sacrificed at the end of the study (approximately two weeks after the start of treatment). During the study, animals with necrotic tumors or tumors exceeding 2000 mm^3 in size were sacrificed for ethical reasons.

[00174] 2. Statistical Analysis:

[00175] Tumor volumes were statistically assessed at the end of the assay. For tumor volume, relative values were used.

[00176] The number of observations, and the median, minimum and maximum tumor volumes were calculated. For a quick overview of possible treatment effects, the following metrics were calculated:

Relative tumor volume: (T/C)

$$T/C = 100 * \frac{T_d}{C_d} \quad ;$$

TGI from day 1 to day d:

$$TGI=100 \text{ x } [(C_d - C_1) - (T_d-T_1)]/(C_d-C_1)$$

[00177] wherein, C_1, T_1 = mean relative tumor volume in control and treatment groups at the start of the assay (day 1);

C_d, T_d= mean relative tumor volume in control and treatment groups at the end of the assay (day d).

[00178] Statistical evaluation was performed using the Student's t-test function in Microsoft Excel, using two-tailed distribution and two-sample equal variance type.

[00179] The significance level was fixed at α=5%. A p-value (adjusted) of less than 0.05 was considered to show a significant difference between treatment groups, and $0.05 \leq$p-value<0.10 was considered as an indicative difference.

[00180] 3. Results

[00181] In the GAK model, daily treatment with BI 853520 delayed tumor growth (median TGI = 80%, p = 0.03) compared to the control group (FIG. 6, Table 5).

[00182] In the HMVII model, daily treatment with BI 853520 delayed tumor growth (median TGI = 60%, p = 0.17) compared to the control group (FIG. 7, Table 5).

[00183] Table 5: Mean tumor volume, mean TGI and P-value based on relative tumor volume on day 14

Group	**Cell line**	**Scheme**	**Mean tumor volume [mm^3]**	**Mean TGI**	**P**
A	HMVII	0.5 % hydroxyethyl cellulose	1237±733 (n=3)	-	-
B	HMVII	BI853520 50 mg/kg (during the 1st week) 25 mg/kg (during the 2nd week)	671±606 (n=4)	60%	0.17
C	GAK	0.5 % hydroxyethyl cellulose	1387±1180 (n=3)	-	-
D	GAK	BI853520 50 mg/kg (during the 1st week) 25 mg/kg (during the 2nd week)	548±144 (n=3)	80%	0.03

[00184] 4. Conclusion

[00185] BI853520 can inhibit tumor growth in CDX models of HMVII and GAK (two melanoma models with an NRAS mutation).

[00186] All references mentioned herein are incorporated by reference in their entirety, as if each were individually listed. It should be understood that after reading the disclosure of the present invention, those skilled in the art can make various changes or modifications to the present invention, and these equivalent forms also fall within the scope defined by the appended claims of the present application.

CLAIMS

WHAT IS CLAIMED IS:

1. Use of a FAK inhibitor in the manufacture of a medicament for treating a tumor having an NRAS mutation.

2. The use of claim 1, wherein the FAK inhibitor is BI853520, defactinib, GSK2256098, PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof, alternatively, the FAK inhibitor is BI853520 or a pharmaceutically acceptable salt thereof, especially BI853520 tartrate.

3. The use of any one of claims 1-2, wherein the medicament is used in combination with an effective amount of a second therapeutic agent.

4. The use of any one of claims 1-3, wherein the medicament is used in combination with radiotherapy or cell therapy.

5. The use of any one of claims 1-4, wherein the tumor is Hodgkin’s lymphoma, non-Hodgkin’s lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

6. The use of claim 3, wherein the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapeutic agents.

7. The use of claim 3, wherein the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab; further selected from decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, or pembrolizumab; even further selected from docetaxel, liposomal doxorubicin,

cobimetinib, pembrolizumab, or decitabine; still further selected from cobimetinib.

8. A method of treating tumors having an NRAS mutation comprising administering to an individual an effective amount of a FAK inhibitor.

9. The method of claim 8, wherein the FAK inhibitor is BI853520, defactinib, GSK2256098, PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof, alternatively, the FAK inhibitor is BI853520 or a pharmaceutically acceptable salt thereof, especially BI853520 tartrate.

10. The method of any one of claims 8-9, further comprising administering to the individual an effective amount of a second therapeutic agent.

11. The method of any one of claims 8-10, further comprising radiotherapy or cell therapy.

12. The method of claim 8, wherein the tumor is Hodgkin's lymphoma, non-Hodgkin's lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma, ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

13. The method of claim 10, wherein the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapeutic agents.

14. The method of claim 10, wherein the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab; further selected from decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, or pembrolizumab; even further selected from docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine; still further selected from cobimetinib.

15. The method of claim 10, wherein the FAK inhibitor and the second therapeutic agent are administered simultaneously, alternately or sequentially.

16. The method of claim 11, wherein the FAK inhibitor and radiotherapy or cell therapy are performed simultaneously, alternately or sequentially.

17. A FAK inhibitor for the treatment of a tumor having an NRAS mutation.

18. The FAK inhibitor of claim 17, wherein the FAK inhibitor is BI853520, defactinib, GSK2256098, PF-00562271, VS-4718 or a pharmaceutically acceptable salt thereof, alternatively, the FAK inhibitor is BI853520 or a pharmaceutically acceptable salt thereof, especially BI853520 tartrate.

19. The FAK inhibitor of any one of claims 17-18, which is further used in combination with an effective amount of a second therapeutic agent.

20. The FAK inhibitor of any one of claims 17-19, which is further used in combination with radiotherapy or cell therapy.

21. The FAK inhibitor of claim 17, wherein the tumor is Hodgkin’s lymphoma, non-Hodgkin’s lymphoma, non-small cell lung cancer, small cell lung cancer, hepatocellular carcinoma, cholangiocarcinoma, myelodysplastic syndrome, acute lymphoblastic leukemia, acute myeloid leukemia, chronic myeloid leukemia, thyroid cancer, glioma, colon cancer, rectal cancer, colorectal cancer, ovarian cancer, bladder cancer, prostate cancer, breast cancer, liposarcoma, fibrosarcoma, rhabdomyosarcoma, leiomyosarcoma, angiosarcoma, neuroblastoma, renal cell carcinoma, head and neck cancer, stomach cancer, esophageal cancer, gastroesophageal junction cancer, thymic cancer, pancreatic cancer, endometrial cancer, cervical cancer, melanoma, skin cancer, germ cell carcinoma, nasopharyngeal carcinoma, oropharyngeal carcinoma or laryngeal carcinoma; further the tumor is acute myeloid leukemia, melanoma, thyroid carcinoma, colorectal carcinoma, esophageal carcinoma, hepatocellular carcinoma,

ovarian carcinoma, fibrosarcoma or cholangiocarcinoma.

22. The FAK inhibitor of claim 19, wherein the second therapeutic agent is one or more selected from chemotherapeutic agents, targeted therapeutic agents and immunotherapeutic agents.

23. The FAK inhibitor of claim 19, wherein the second therapeutic agent is one or more selected from the group consisting of nimustine, carmustine, lomustine, temozolomide, cyclophosphamide, isocyclophosphamide, glyfosfin, doxifluridine, Furtulon, fluorouraeil, mercaptopurine, azathioprine, tioguanine, floxuridine, tegafur, gemcitabine, decitabine, carmofur, hydroxyurea, methotrexate, UFT, capecitabine, ancitabine, thiotepa, actinomycin D, adriamycin, liposomal doxorubicin, daunorubicin, epirubicin, mitomycin, pingyangmycin, pirarubicin, valrubicin, idarubicin, irinotecan, harringtonine, camptothecin, hydroxycamptothecine, topotecan, vinorelbine (navelbine), taxol, taxotere, hycamtin, vinblastine, vincristine, vindesine, vindesine sulfate, vincaleukoblastine, teniposide, etoposide, elemene, atamestane, anastrozole, aminoglutethimide, letrozole, formestane, megestrol, tamoxifen, asparaginase, carboplatin, cisplatin, dacarbazine, oxaliplatin, eloxatin, eloxatin“可铂奥沙”, mitoxantrone, procarbazine, docetaxel, gefitinib, erlotinib, icotinib, afatinib, osimertinib, crizotinib, ceritinib, alectinib, lapatinib, everolimus, palbociclib, ribociclib, apatinib, regorafenib, sorafenib, sunitinib, temsirolimus, lenvatinib, pazopanib, alectinib“阿雷替尼”, axitinib, cabozantinib, trametinib, binimetinib, vemurafenib, dabrafenib, cobimetinib“卡比替尼”, vandetanib, bortezomib, palbociclib, lenalidomide, ixazomib, imatinib, dasatinib, bosutinib, ponatinib, ibrutinib, idelalisib, belinostat, romidepsin, vorinostat, olaparib, niraparib, denosumab, vismodegib, sonidegib, rucaparib, brigatinib, bicalutamide, enzalutamide, abiraterone, abemaciclib, apalutamide, aflibercept, azacitidine, bleomycin, chlorambucil, cytarabine, asparaginase“天冬酰胺酶”, epothilone, fludarabine, flutamide, mechlorethamine, paclitaxel, pemetrexed, raltitrexed, necitumumab, bevacizumab, ramucirumab, Ado-trastuzumab, pertuzumab, cetuximab, panitumumab, alirocumab, durvalumab, nimotuzumab, daratumumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, durvalumab, nivolumab, and pembrolizumab; further selected

from decitabine, gemcitabine, cisplatin, carboplatin, oxaliplatin, adriamycin, liposomal doxorubicin, taxol, docetaxel, trametinib, binimetinib, cobimetinib, durvalumab, atezolizumab, sintilimab, toripalimab, camrelizumab, tislelizumab, nivolumab, or pembrolizumab; even further selected from docetaxel, liposomal doxorubicin, cobimetinib, pembrolizumab, or decitabine; still further selected from cobimetinib.