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(54) Title: CONTINUOUS DOSING REGIMEN WITH ABT-751

(57) **Abrégé/Abstract:**

Compositions comprising the cancer drug N-2(2-((4-hydroxyphenyl) amino)pyrid-3-yl)-4-methoxybenzenesulfonamide (ABT-751), continuous oral dosing schedule with said drug which binds to the colchicine site of tubulin β -subunits, and methods of treating diseases using continuous dosing schedules are disclosed.



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(54) Title: CONTINUOUS DOSING REGIMEN WITH ABT-751

(57) Abstract: Compositions comprising the cancer drug N-2(2-((4-hydroxyphenyl) amino)pyrid-3-yl)-4-methoxybenzenesulfonamide (ABT-751), continuous oral dosing schedule with said drug which binds to the colchicine site of tubulin β -subunits, and methods of treating diseases using continuous dosing schedules are disclosed.

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CONTINUOUS DOSING REGIMEN WITH ABT-751

5

FIELD OF THE INVENTION

This invention pertains to a composition comprising one or more cancer drugs, continuous oral dosing schedule with drugs which bind to the colchicine site of tubulin β -subunits, and methods of treating diseases using continuous dosing
10 schedules.

BACKGROUND OF THE INVENTION

The efficacy of many commercially-available, parenterally administered tubulin β -subunit binders is compromised by the necessity of intermittent administration due to severity of
15 coincident adverse side effects. There is therefore an existing need in the therapeutic arts for improved treatment of diseases with drugs which bind to tubulin β -subunits.

20

SUMMARY OF THE INVENTION

One embodiment of this invention, therefore, pertains to a continuous oral dosing schedule for treatment of disease in a human with a therapeutically acceptable amount of a drug, or a therapeutically acceptable salt thereof, which binds to
25 tubulin β -subunits, wherein said dosing schedule lasts for at least five days.

Another embodiment pertains to a continuous oral dosing schedule for treatment of disease in a human with a therapeutically acceptable amount of a drug, or a
30 therapeutically acceptable salt thereof, which binds to tubulin β -subunits, wherein said dosing schedule lasts for at least five days and during which the severity of at least one adverse side effect selected from the group consisting of anemia, alopecia, fluid retention, myelosuppression, neuropathy

35 and neutropenia is essentially reduced when compared to the severity of the same side effect coincident with treatment of the substantially same disease with a parenterally administered drug which binds to tubulin β -subunits.

Still another embodiment pertains to a continuous oral dosing schedule for treatment of disease in a human with a therapeutically acceptable amount of a drug which binds to the colchicine site of tubulin β -subunits, or a therapeutically acceptable salt thereof, wherein said dosing schedule lasts for at least five days.

45 Still another embodiment pertains to a continuous oral dosing schedule for treating disease in a human with a therapeutically acceptable amount of a drug, or a therapeutically acceptable salt thereof, which binds to the colchicine site of tubulin β -subunits, wherein said dosing schedule lasts for at least five days and during which the severity of at least one adverse side effect selected from the group consisting of anemia, alopecia, fluid retention, myelosuppression, neuropathy and neutropenia is essentially reduced when compared to the severity of the same side effect coincident with treatment of the substantially same disease with a parenterally administered drug which binds to tubulin β -subunits.

Still another embodiment of this invention, therefore, pertains to a continuous oral dosing schedule for treatment of disease in a human with a therapeutically acceptable amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, or a therapeutically acceptable salt thereof, wherein said dosing schedule lasts for at least five days.

65 Still another embodiment pertains to a continuous oral dosing schedule for treatment of disease in a human with a therapeutically acceptable amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, or a

therapeutically acceptable salt thereof, wherein said dosing
70 schedule lasts for at least five days, and during which the
severity of at least one adverse side effect selected from the
group consisting of anemia, alopecia, fluid retention,
myelosuppression, neuropathy and neutropenia is essentially
reduced when compared to the severity of the same side effect
75 coincident with treatment of the substantially same disease
with a parenterally administered drug which binds to tubulin
 β -subunits.

Still another embodiment pertains to a method for
treatment of disease in a human, said method comprising
80 continuously orally administering, for at least five days, a
therapeutically acceptable amount of a drug, or a
therapeutically acceptable salt thereof, which binds to
tubulin β -subunits.

Still another embodiment pertains to a method for
85 treatment of disease in a human, said method comprising
continuously orally administering, for at least five days, a
therapeutically acceptable amount of a drug, or a
therapeutically acceptable salt thereof, which binds to
tubulin β -subunits, during which dosing schedule the severity
90 of at least one adverse side effect selected from the group
consisting of anemia, alopecia, fluid retention,
myelosuppression, neuropathy and neutropenia is essentially
reduced when compared with treatment of the substantially same
disease with a parenterally administered drug which binds to
95 tubulin β -subunits.

Still another embodiment pertains to a method for
treatment of disease in a human, said method comprising
continuously orally administering, for a time period of at
least five days, a therapeutically acceptable amount of a
100 drug, or a therapeutically acceptable salt thereof, which
binds to the colchicine site of tubulin β -subunits.

Still another embodiment pertains to a method for treatment of disease in a human, said method comprising continuously orally administering, for at least five days, a
105 therapeutically acceptable amount of a drug, or a therapeutically acceptable salt thereof, which binds to the colchicine site of tubulin β -subunits, during which dosing schedule, the severity of at least one adverse side effect selected from the group consisting of anemia, alopecia, fluid
110 retention, myelosuppression, neuropathy and neutropenia is essentially reduced when compared to the severity of the same side effect coincident with treatment of the substantially same disease with a parenterally administered drug which binds to tubulin β -subunits.

115 Still another embodiment pertains to a method for treatment of disease in a human, said method comprising continuously orally administering, for at least five days, a therapeutically acceptable amount of N-(2-((4-hydroxyphenyl)-amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, or a
120 therapeutically acceptable salt thereof.

Still another embodiment pertains to a method for treatment of disease in a human, said method comprising continuously orally administering, for at least five days, a therapeutically acceptable amount of N-(2-((4-hydroxyphenyl)-
125 amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, or a therapeutically acceptable salt thereof, during which dosing schedule, the severity of at least one adverse side effect selected from the group consisting of anemia, alopecia, fluid retention, myelosuppression, neuropathy and neutropenia is
130 essentially reduced when compared to the severity of the same side effect coincident with treatment of the substantially same disease with a parenterally administered drug which binds to tubulin β -subunits.

Still another embodiment pertains to a composition for
135 immediate gastrointestinal release of N-(2-((4-

hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide comprising a therapeutically effective amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide and an excipient, which composition induces, upon continuous
140 oral ingestion, essentially reduced severity of at least one side effect selected from the group consisting of anemia, alopecia, fluid retention, myelosuppression, neuropathy and neutropenia when compared to the severity of the same side effect coincident with treatment of the substantially
145 same disease with a parenterally administered tubulin β -subunit binder.

Still another embodiment pertains to a pharmaceutical composition having therapeutic synergy comprising N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
150 and at least one cancer drug selected from the group consisting of cisplatin, docetaxel, and 5-fluorouracil.

Still another embodiment pertains to a method of treating cancer in a human comprising administering a therapeutically effective amount of N-(2-((4-hydroxyphenyl)-amino)pyrid-3-yl)-
155 4-methoxybenzenesulfonamide and at least one additional drug selected from the group consisting of cisplatin, docetaxel, and 5-fluorouracil.

DETAILED DESCRIPTION OF THE INVENTION

160 The term "at least five days," as used herein, means the time period over which the drug is administered. In a preferred embodiment for the practice of this invention, at least five days means for the first 7 days of a 21 day schedule, for the first 14 days of a 21 day schedule, for the
165 first 15 days of a 21 day schedule, for the first 21 days of a 28 day schedule, for 5 days then cessation for 5 days then continuation for 5 days then cessation for 5 days, i.e. (5 days on/5 days off) \times 2, and for 7 days then cessation for 7

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days then continuation for 7 days then cessation for 7 days,
170 i.e. (7 days on/7 days off)×2.

The term "colchicine site binder," as used herein, means a tubulin β -subunit binder which binds to the colchicine site of the tubulin β -subunits and thereby inhibits the polymerization of tubulin.

175 A preferred example of a drug which binds to the colchicine site of tubulin β -subunits for the practice of this invention is N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, also referred to herein as
N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
180 methoxybenzenesulfonamide. The synthesis of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is taught in United States Patent No. 5,292,758, column 23, line 61 to column 24, line 12.

185 The term "cancer," as used herein, means bone marrow dyscrasias, breast (ductal and lobular) cancer, cervical cancer, colon cancer, leukemia, lung (small cell and non-small cell) cancer, lymphoma, melanoma, mouth and tongue cancer, pancreatic cancer, prostate cancer, rectal cancer, renal
190 cancer, sarcoma, stomach cancer, uterine cancer, and cancers resulting from the metastasis of disease from these areas.

The term "continuous," as used herein, means at least once per day without missing a day.

The term "disease," as used herein, means an adverse
195 physiological event. For the practice of this invention, examples of diseases for which drugs which bind to the colchicine site of tubulin β -subunits are useful are gouty arthritis and cancer.

The term "drug," as used herein, means a compound which
200 is suitable for prevention or treatment of disease or inhibition of one or more adverse physiological events.

Examples of parenterally administered drugs include vinca alkaloids (vincristine, vinblastine, and vinorelbine), taxanes (paclitaxel and docetaxel), 5-fluorouracil, cisplatin,
 205 docetaxel, gemcitabine, and colchicine site binders such as colchicine itself which is used to treat gouty arthritis.

The term "essentially reduced," as used herein in reference to severity of an adverse side effect means at least about 50% of the patient population tested did not experience
 210 that side effect at the Grade III or IV level, preferably about 75% of the patient population tested did not experience that side effect at the Grade III or IV level, more preferably about 85% of the patient population tested did not experience that side effect at the Grade III or IV level, even more
 215 preferably, about 95% of the patient population tested did not experience that side effect at the Grade III or IV level, and most preferably, 100% of the patient population tested did not experience that side effect at the Grade III or IV level.

The term "therapeutic synergy," as used herein, means a
 220 combination of two or more drugs having a therapeutic effect greater than the additive effect of each respective drug.

Binding affinities of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, vinblastine, and paclitaxel were evaluated using the competition of [³H]colchicine to
 225 biotinylated bovine brain tubulin in a scintillation proximity assay.

TABLE 1

Inhibition Constants of ABT-751 and Other Tubulin β -Subunit Binders in Binding Experiments with Bovine Brain Tubulin	
Compound	K _i (μ M)
ABT-751	2.60 (n=4)
colchicine	0.78 (n=7)
paclitaxel	>100 (n=4)

vinblastine	>100 (n=4)
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The data in TABLE 1 demonstrate that N-(2-((4-
 230 hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
 displaces [³H]colchicine from the colchicine site of tubulin
 β -subunits and is therefore a colchicine site binder.

The data in TABLE 1 also demonstrate that vinblastine
 and paclitaxel do not displace [³H]colchicine, are therefore
 235 not colchicine-site binders, and therefore must bind to
 tubulin β -subunits sites which are different from the
 colchicine binding site.

N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
 methoxybenzenesulfonamide is a colchicine site binder and
 240 exemplifies drugs which are useful for treatment of diseases
 which may be treated with colchicine-site binders other than
 colchicine itself.

The effectiveness of colchicine-site binders as drugs
 which are useful for treatment of diseases in humans depends
 245 on variables such as the composition comprising the drug, its
 route of administration, the amount of drug administered, and
 the dosing schedule. This invention pertains to an unexpected
 and surprising combination of variables which lead to a
 favorable therapeutic event with a sufficient reduction in the
 250 severity of at least one adverse side effect selected from the
 group consisting of anemia, alopecia, fluid retention,
 myelosuppression, neuropathy and neutropenia as compared to the
 same side effect coincident with treatment of the
 substantially same disease with a parenterally administered
 255 drug which binds to tubulin β -subunits.

M5076 is a transplantable murine reticulum cell sarcoma.
 N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
 methoxybenzenesulfonamide exhibited significant antitumor
 activity in this syngeneic flank tumor model when administered
 260 orally once a day for 5 days. At its approximate MTD of 150

mg/kg for 5 days, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide significantly inhibited tumor growth with T/C (tumor mass of test group divided by tumor mass of control group) and ILS (percent increase in life span) values of 13 and 42%, respectively. In contrast, this model was resistant to paclitaxel. Vincristine and doxorubicin were only marginally active (ILS = 17% and 13% respectively), while this model proved sensitive to cyclophosphamide.

N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide was evaluated against C26 colon tumors grown in the flank of CDF-1 mice. While only marginally active when administered on a 5-day schedule, extended dosing produced a significant antitumor response that was equivalent to that achieved with BCNU at the MTD. Paclitaxel was not efficacious against this tumor.

Apc^{Min} (Min) mice are models for genetically inherited intestinal cancer. These mice carry a dominant germline mutation in the *Apc* tumor suppressor gene that predisposes them to the development of numerous (>50) tumors throughout the intestinal tract.

N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide given orally on a once-a-day schedule for 28 days at 150 mg/kg/day led to a significant reduction in tumor burden in Min mice. The average tumor number for treated mice was 49.8 compared to 73.3 for vehicle controls. Drug treatment was initiated at an age when the tumors were well-established. These results indicate that N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide shows significant *in vivo* activity in a spontaneous model of intestinal tumorigenesis.

(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide as a single agent demonstrated antitumor activity in multiple human tumor xenograft models *in vivo*. In several *in vivo* xenograft models (flank and

295 orthotopic), once-a-day dosing of (2-((4-
hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
demonstrated equal or greater efficacy compared to twice-a-day
dosing. This superior QD efficacy was confirmed in a murine
syngeneic model. Thus, administration of (2-((4-
300 hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
once a day appears to be sufficient to achieve maximal
efficacy. In combination with 5-FU, cisplatin, docetaxel, and
gemcitabine, (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
methoxybenzenesulfonamide demonstrated an increase in
305 antitumor activity in the HT-29 colon, Calu-6 NSCLC, MDA-MB-
468 breast, and MiaPaCa2 pancreatic xenograft models
respectively, compared to single agent alone.

NCI-H460 is a human non-small cell lung carcinoma derived
cell line. It is MDR negative, has wild type p53, and
310 contains an oncogenic K-ras mutation. (2-((4-
hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
showed good efficacy in the NCI-H460 xenograft model. The
mean tumor volume at day 13 was significantly different than
the vehicle control (T/C = 58%). (2-((4-
315 hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
also caused a delay in tumor growth with an ILS value of 32%.
Paclitaxel and vincristine both lacked activity in this assay.

HCT-15 is a human colon carcinoma derived cell line. It
is MDR positive, and expresses both mutant p53 and oncogenic
320 K-ras. The HCT-15 cell line has one of the highest levels of
mdr-1/P-glycoprotein expression of cells from the NCI tumor
cell line panel. Paclitaxel and vincristine, which are both
substrates for P-glycoprotein drug efflux pump, were not
efficacious, while (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
325 methoxybenzenesulfonamide was effective in inhibiting tumor
growth.

Effect of Cytotoxic Agents on the Growth of HCT-15
Human Colon Carcinoma Xenografts

Compound	Dose ^a (mg/kg/d)	Route Schedule	T/C ^b (no. trials)	% ILS ^c
ABT-751	50	PO, QD, days 1-8	50 (2)	34

(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide inhibited the growth of a variety of human tumor xenografts that were allowed to grow into established tumors prior to the initiation of treatment. As summarized below, activity was seen against established tumors derived from colon, breast and lung carcinomas. (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide was also active against a human pancreatic tumor xenograft grown in the orthotopic site.

In vivo Activity of ABT-751 Against Staged and
Orthotopic Human Tumor Xenografts

Cell line	Oral Dose (mg/kg/d)	Schedule	% T/C	% ILS
Tumor Models				
HT-29 colon carcinoma	100	QD, d 10-14, 20-24	28	75
	75	QD, d 10-14, 20-24	43	50
	50	QD, d 1-21	55	36
Calu-6 lung carcinoma	100	QD, d 10-14, 20-24	37	65
	75	QD., d 10-14, 20-24	50	58
	50	QD, d 1-21	54	58
MDA-MB-468	100	QD, d 10-14, 20-24	25	78

breast carcinoma		20-24		
	75	QD, d 10-14, 20-24	33	52
	50	QD, d 1-21	46	41
Orthotopic Tumor Model				
MiaPaCa-2 pancreatic	100	QD, d 1-5, 11-15	56	n.d.
	75	QD, d 1-5, 11-15	79	n.d.
HT-1376 bladder	100	QD, d 1-5, 11-15	63	n.d.
	100	b.i.d., d 1-5, 11-15	86 ^e	n.d.

340 (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide also showed antitumor activity against a variety of other human tumor xenografts in nude mice.

Antitumor activity was also seen in tumors derived from
345 gastric, lung, breast, and oral carcinomas.

Antitumor Activity of ABT-751 Against Human Tumor Xenografts			
Tumor Lines	Schedule	Dose (mg/kg/day)	T/C (%)
Gastric Cancer			
H-81	Q5D × 5	300	40
H-111	Q1D × 19	80	36
H-154	Q5D × 5	300	71
SC-2	Q1D × 19	120	28
SC-6	Q5D × 5	500	22
Colorectal Cancer			
H-143	Q5D × 5	300	17
COLO320DM	Q1D × 19	120	42
WiDr	Q1D × 20	100	22
Lung Cancer			

LC-376	Q5D × 5	300	18
LC-6	Q5D × 5	450	31
LC-11	Q1D × 8	150	93
LX-1	Q1D × 20	120	37
Breast Cancer			
H-31	Q1D × 19	80	13
MX-1	Q5D × 5	450	21
Oral Cancer			
KB	Q1D × 20	100	15

(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide was evaluated in 57 cancer subjects in single dose (16 subjects) and 5-day repeated dose regimens (41 subjects). The doses administered in the single dose segment were 80 to 480 mg/m²/day. In the 5-day repeated dose regimen (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide was given at 30 to 240 mg/m²/day for a single cycle. Pharmacokinetic data indicated that (2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide plasma concentrations increased rapidly after dosing. The drug was eliminated with a half-life between 4 and 16 hours. The AUC increased proportionally with dose over the range of 30 to 480 mg/m²/day with no apparent accumulation. Adverse drug reactions from the single dose and 5-day repeated dose segments included nausea and vomiting, diarrhea, epigastric pain, ileus and evidence of peripheral neuropathy. For the single dose segment, the dose limiting toxicity (DLT) was Grade 3 peripheral neuropathy in 1 of 5 subjects at 480 mg/m²/day. In the 5-day repeated dose regimen the dose limiting toxicities were Grade 3 peripheral neuropathy in 1 of 4 subjects at 210 mg/m²/day and Grade 4 intestinal paralysis in 1 of 4 subjects at 210 mg/m²/day and in 1 of 6 subjects at 240 mg/m²/day.

370 In the 7-day QD regimen, the 250 mg QD dose has been
determined to be the MTD, as dose limiting toxicities of
peripheral neuropathy/ileus were reported in 2 of 6 subjects
at the 300 mg QD dose. The MTD of the QD regimen given for 21
days was determined to be 200 mg as dose limiting toxicities
375 of fatigue, anorexia and suspect small bowel obstruction were
observed in 2/3 subjects in the 250 mg dose group.

A review of the safety data demonstrates no significant
myelosuppression, renal or hepatic toxicity reported in any of
the three studies.

380 In accordance with compositions, the tubulin β -subunit
binders of this invention can be administered with or without
an excipient. Excipients include encapsulating materials or
additives such as absorption accelerators, antioxidants,
binders, buffers, coating agents, coloring agents, diluents,
385 disintegrants, emulsifiers, extenders, fillers, flavoring
agents, humectants, lubricants, perfumes, preservatives,
propellants, releasing agents, sterilizing agents, sweeteners,
solubilizers, wetting agents and mixtures thereof. Excipients
for solid dosage forms the tubulin β -subunit binders of this
390 invention to be administered orally include agar, alginic
acid, aluminum hydroxide, benzyl alcohol, benzyl benzoate,
1,3-butylene glycol, castor oil, cellulose, cellulose acetate,
cocoa butter, corn starch, corn oil, cottonseed oil, ethanol,
ethyl cellulose, ethyl laureate, ethyl oleate, gelatin, germ
395 oil, glucose, glycerol, groundnut oil, isopropanol, isotonic
saline, lactose, magnesium hydroxide, magnesium stearate,
malt, olive oil, peanut oil, potassium phosphate salts, potato
starch, propylene glycol, Ringer's solution, talc, tragacanth,
water, safflower oil, sesame oil, sodium carboxymethyl
400 cellulose, sodium lauryl sulfate, sodium phosphate salts,
soybean oil, sucrose, tetrahydrofurfuryl alcohol and mixtures
thereof. Excipients for the tubulin β -subunit binders of this

invention to be administered ophthalmically or orally in liquid dosage forms include 1,3-butylene glycol, castor oil, corn oil, cottonseed oil, ethanol, fatty acid esters of sorbitan, germ oil, groundnut oil, glycerol, isopropanol, olive oil, polyethylene glycols, propylene glycol, sesame oil, water and mixtures thereof. Excipients for the tubulin β -subunit binders of this invention to be administered osmotically include chlorofluorohydrocarbons, ethanol, water and mixtures thereof. Excipients for the tubulin β -subunit binders of this invention to be administered parenterally include 1,3-butanediol, castor oil, corn oil, cottonseed oil, germ oil, groundnut oil, liposomes, oleic acid, olive oil, peanut oil, Ringer's solution, safflower oil, sesame oil, soybean oil, U.S.P. or isotonic sodium chloride solution, water and mixtures thereof. Excipients for the tubulin β -subunit binders of this invention to be administered rectally or vaginally include cocoa butter, polyethylene glycol, wax and mixtures thereof.

A preferable excipient for the practice of this invention using N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is shown hereinbelow.

Formulation of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide

Ingredient	% w/w	Purpose
ABT-751	30.0	
microcrystalline cellulose NF (Avicel® PH101)	15.8	Filler
lactose monohydrate	28.0	Filler
povidone (USP, K29-32)	8.0	Binder
croscarmellose Na	18.0	Disintegrant

water	sufficient quantity	Binder Liquid
magnesium stearate	0.2	Lubricant

A mixture of microcrystalline cellulose, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, lactose, and croscarmellose were granulated with a solution of povidone in water, dried, and milled. The milled product was blended with magnesium stearate.

The doses herein were made by filling capsules with the appropriate amount of blended product.

In accordance with routes of administration, the tubulin β -subunit binders of this invention may be administered orally, ophthalmically, osmotically, parenterally (subcutaneously, intramuscularly, intrasternally, intravenously), rectally, topically, transdermally, or vaginally. Orally administered solid dosage forms can be administered as capsules, dragees, granules, pills, powders, or tablets. Ophthalmically and orally administered dosage forms may be administered as elixirs, emulsions, microemulsions, suspensions, or syrups. Osmotically and topically administered dosage forms may be administered as creams, gels, inhalants, lotions, ointments, pastes, or powders. Parenterally administered dosage forms may be administered as aqueous or oleaginous suspensions. Rectally and vaginally dosage forms may be administered as creams, gels, lotions, ointments, or pastes.

For the practice of this invention, it is meant to be understood that while administration of drugs which bind to other than the colchicine binding site of tubulin β -subunits are preferentially administered parenterally, oral administration of drugs which bind to the colchicine binding site of tubulin β -subunits is more preferable than parenteral administration of the same drug.

The therapeutically acceptable amounts of the tubulin β -subunit binders of this invention and their dosing schedules
460 depend on the recipient of treatment, the disease being treated and the severity thereof, the composition containing the tubulin β -subunit binder, the time of administration, the route of administration, the potency of the tubulin β -subunit binder, the rate of clearance of the tubulin β -subunit binder,
465 and whether or not another drug is co-administered.

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered orally in a continuous, once daily dose to adult patients having refractory solid tumors, is about 50 mg, about 100 mg, about
470 150 mg, about 200 mg, about 250 mg, or about 300 mg.

Preferably, about 250 mg of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is continuously administered orally once per day (QD) to adult patients having refractory solid tumors for the first 7 days
475 of a 21 day schedule.

Preferably, about 200 mg of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is continuously administered orally once per day to adult patients having refractory solid tumors for the first 21 days
480 of a 28 day schedule.

Preferably, about 200 mg of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is administered continuously orally once per day to adult patients having breast lung, kidney, or colon cancer, is for
485 the first 21 days of a 28 day dosing schedule.

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered orally in a continuous once per day dose to pediatric patients having refractory solid tumors, may be about 100 mg/mm^2 , about 130
490 mg/mm^2 , about 165 mg/mm^2 , about 200 mg/mm^2 , or about 250 mg/mm^2 .

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered orally in a continuous once per day dose to adult patients having
495 refractory hematologic malignancies, may be about 100 mg/mm², about 125 mg/mm², and about 150 mg/mm².

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered orally in continuous, twice daily (BID) doses to adult patients having
500 refractory solid tumors, may be about 25 mg, about 50 mg, about 75 mg, about 100 mg, about 125 mg, about 150 mg, about 175 mg, about 200 mg, about 250 mg, or about 300 mg.

Preferably, about 175 mg of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide is
505 administered orally twice per day to adult patients having refractory solid tumors for the first 7 days of a 21 day schedule.

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered orally in
510 continuous twice per day doses to adult patients having refractory hematologic malignancies may be about 75 mg/mm², about 100 mg/mm², 125 mg/mm², 150 mg/mm², and 175 mg/mm².

The daily amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide to be administered in
515 continuous twice per day doses to pediatric patients having refractory solid tumors may be about 100 mg/mm² and about 130 mg/mm².

N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide may also be useful in the treatment
520 of disease when used alone or in combination with other therapies. For example, when used for the treatment of cancer, the compounds of the invention may be administered alone or in combination with radiotherapy, hormonal agents, antibodies, antiangiogenics, COX-2 inhibitors, or other

525 chemotherapeutic agents (cytotoxic or cytostatic) such as
cisplatin, 5-fluorouracil, taxotere, docetaxel and
gemcitabine.

Efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
methoxybenzenesulfonamide in combination with other
530 chemotherapeutic drugs was tested in Calu-6 NSCL, MDA-MB-468
breast and HT-29 colon carcinoma xenografts which were grown
in nude mice.

One objective was determination of the efficacy of N-(2-
((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
535 methoxybenzenesulfonamide as a single agent and with cisplatin
in the Calu-6 NSCL flank xenograft model.

Another objective was determination of the efficacy of N-
(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
methoxybenzenesulfonamide as a single agent and with docetaxel
540 in the MDA-MB 468 breast flank xenograft model,

Still another objective was determination of the efficacy
of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
methoxybenzenesulfonamide as a single agent and with
5-fluorouracil in the HT-29 colon flank xenograft model,

545 Still yet another objective was determination of the
efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-
methoxybenzenesulfonamide administered on 2 different
schedules (once per day and twice per day) in the Calu-6 and
HT-29 xenograft model.

550 Following inoculation of tumor cells, tumors were
passaged three times in mice before using the fragments to
generate single cell suspensions. Multiple animals were used
as donors. Single cell suspensions were generated by
homogenizing the minced tumor tissue in RPMI 1640 media. Cell
555 suspensions were washed three times to remove debris and other
foreign materials. Viable cells were counted by trypan blue
exclusion technique using a hemocytometer. Mice were injected

subcutaneously with 0.5 mL of the cell suspension containing 1×10^6 cells.

560 For continuous, 21 day, once per day dosing, 50 mg/kg/day was selected because administration at this dose was essentially without adverse side effects.

For determination of the efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide in
565 the Calu-6 Flank Xenograft model, tumor cells were inoculated subcutaneously into male nude mice on day 0. On day 10, mice bearing established tumors were size matched and grouped at about 233 mm³.

In the Calu-6 xenograft model, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
570 administered as a single agent at 100 and 75 mg/kg/day on a (5 day on/5 day off)×2 cycle dosing schedule demonstrated significant antitumor activity. N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide at
575 50 mg/kg/day administered either on a once per day or twice per day schedule demonstrated similar efficacy. In combination with cisplatin, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide demonstrated greater than additive responses with N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide.
580

For determination of the efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide in the MDA-MB-468 Breast Flank Xenograft model, tumor cells derived from serially passaged tumor fragments were inoculated
585 subcutaneously in female nude mice on day 0. On day 10, mice bearing established tumors were size matched and grouped at about 231 mm³.

As a single agent, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide at 100 and 75 mg/kg/day for (5
590 days on/5 days off)×2 dosing schedule, as well as 50 mg/kg/day administered daily, demonstrated dose-dependent antitumor

activity in the MDA-MB 468 xenograft model. In combination with docetaxel at 33.3 mg/kg/day, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
595 demonstrated greater than additive responses with the doses of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide tested.

For determination of the efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide in
600 the efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide in the HT-29 Flank Xenograft model, tumor cells derived from serially passaged tumor fragments were inoculated subcutaneously in female nude mice on day 0. On day 10, mice bearing established tumors were size matched
605 and grouped at about 236 mm³.

In the HT-29 colon xenograft model, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide administered as a single agent at 100 and 75 mg/kg/day on a (5 days on/5 days off)×2 dosing schedule demonstrated significant
610 antitumor activity. N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide at 50 mg/kg/day administered either once per day or twice per day demonstrated similar efficacy in this model and confirmed the observation made with the Calu-6 model. In combination with 5-fluorouracil at 30
615 mg/kg/day, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide at the higher doses demonstrated additive responses.

To summarize, the efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide
620 was tested in the Calu-6 NSCL, MDA-MB-468 breast and HT-29 colon xenograft models. As a single agent, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide demonstrated dose-dependent efficacy in all three xenograft models. Efficacy of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-
625 4-methoxybenzenesulfonamide administered once per day and

twice per day was tested in the Calu-6 NSCL and HT-29 colon xenograft models and demonstrated equal efficacy when administered in either once per day or twice per day for 21 days in both models.

630 Accordingly, N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide in combination with cisplatin (Calu-6 NSCLC), docetaxel (MDA-MB-468) or 5-FU (HT-29) showed equal to or greater than additive efficacy compared to single agents alone.

635 To evaluate the pharmacokinetics of representative extended dosing schedules of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide, 43 patients were enrolled. The tumor types studied were colorectal (23), sarcoma (5), mesothelioma (3), salivary gland
640 (2), endometrial (2), unknown (2), hepatoma (1), melanoma (1), renal cell (1), lung (1), ovary (1), and granulosa cell (1). Patients were treated once or twice per day for 21 days with N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide followed by a 7-day period where no
645 drug was received. Doses were escalated by 50 mg/day (25 mg twice per day). Three patients were initially treated at each dose level. If dose-limiting toxicity was observed in cycle one, three more patients were added to that dosing schedule. If additional patients experienced dose-limiting toxicity, on
650 occasion the dose level was expanded to nine patients to further assess tolerability. Response assessment was performed every two cycles.

For 134 patients tested, at doses of about 200 mg QD, 250 mg QD, 300 mg QD, 125 mg BID, 150 mg BID, and 175 mg BID, 16
655 reported anemia, of which 11 were Grades I or II and 5 were Grades (III or IV); 1 reported Grade I or II alopecia; 8 reported Grade I or II neutropenia; and none reported fluid retention, for which Grade I is defined as mild, Grade II is

defined as moderate, Grade III is defined as severe, Grade IV
660 is defined as life threatening.

The foregoing is merely illustrative of the invention and
is not intended to limit the invention to the disclosed
embodiments. Variations and changes obvious to one skilled in
the art are intended to be within the scope and nature of the
665 invention which are defined in the appended claims.

WHAT IS CLAIMED IS:

1. Use of a synergistic therapeutically effective amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide and cisplatin for treatment of non-small cell lung cancer in a human, said N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide being adapted to be continuously orally administered for at least five days.
2. Use of a synergistic therapeutically effective amount of N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide and cisplatin for treatment of non-small cell lung cancer in a human, said N-(2-((4-hydroxyphenyl)amino)pyrid-3-yl)-4-methoxybenzenesulfonamide being adapted to be continuously orally administered for at least (five days on, five days off) x 2.