

# Oncology Drugs in the Pipeline

HEM Onc TODAY's annual Oncology Drugs in the Pipeline chart lists agents in phase 2 or phase 3 development for a variety of indications. Clinicians can use this chart as a quick reference to learn about the status of those drugs that may be clinically significant to their practice.

View the chart online at  
[Healio.com/OncologyPipeline](http://Healio.com/OncologyPipeline)

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
117Lu-DOTATATE (Advanced Accelerator Applications)	gastro-entero-pancreatic neuroendocrine tumors (metastatic disease)	phase 3
<sup>90</sup> Y clivatuzumab tetraxetan (Immunomedics)	pancreatic cancer (first-line), prostate cancer (front-line and relapsed) pancreatic cancer (relapsed disease)	phase 2 phase 3
A6 peptide (Angstrom Pharmaceuticals)	chronic lymphocytic leukemia, small lymphocytic leukemia	phase 2
A-dmDT390-bisFv immunotoxin (Resimmune, Angimmune)	cutaneous T-cell lymphoma, melanoma	phase 2
abemaciclib (LY2835219, Eli Lilly)	mantle cell lymphoma breast cancer (metastatic disease)	phase 2 phase 3
abexinostat HCl (Pharmacyclics)	follicular lymphoma, mantle cell lymphoma	phase 2
ABI-009 (AADi)	bladder cancer (nonmuscle-invasive disease)	phase 2
abiraterone acetate (Zytiga, Janssen)	breast cancer prostate cancer (metastatic, castration-resistant, chemotherapy-naive disease)	phase 2 phase 3
abituzumab (EMD Serono)	colorectal cancer	phase 2
ABT-199 (AbbVie)	acute myelogenous leukemia, diffuse large B-cell lymphoma, follicular lymphoma chronic lymphocytic leukemia	phase 2 phase 3
ABT-414 (AbbVie)	glioblastoma (recurrent disease), squamous cell tumors	phase 2
ABT-RTA 408 (AbbVie)	prevention of radiation dermatitis	phase 2
ACP-196 (Acerta Pharma/NIH)	chronic lymphocytic leukemia, mantle cell lymphoma, small lymphocytic leukemia	phase 2
ACP-319 (Acerta Pharma)	acute lymphoblastic leukemia, non-Hodgkin's lymphoma, myeloma (combination therapy)	phase 2
Ad-IL-24 (MultiVir)	head and neck cancers	phase 2
Ad-RTS-IL-12 (ZIOPHARM)	breast cancer	phase 2
ADI-PEG-20 (Polaris Pharmaceuticals)	acute myelogenous leukemia, non-Hodgkin's lymphoma, small cell lung cancer hepatocellular carcinoma	phase 2 phase 3
ado-trastuzumab emtansine (Kadcyla, Genentech)	non-small cell lung cancer breast cancer (first-line HER-2-positive metastatic disease; third-line HER-2-positive metastatic disease), gastric cancer	phase 2 phase 3
<b>READ PERSPECTIVE</b> on this drug from Mateusz Opyrchal, MD, PhD, on page 105.		
AdV-tK (Advantagene)	glioma, pancreatic cancer prostate cancer	phase 2 phase 3
ADX5-HPV (Advaxis)	anal cancer, cervical cancer, head and neck cancers	phase 2
AE37 (Antigen Express)	breast cancer	phase 2
AEB071 (Novartis)	diffuse large B-cell lymphoma (combination therapy), uveal melanoma (combination therapy)	phase 2
afatinib (Gilotrif, Boehringer Ingelheim)	breast cancer, esophageal cancer, gastric cancer, gastroesophageal junction cancer, pancreatic cancer, urothelial cancer head and neck cancers, non-small cell lung cancer	phase 2 phase 3
AFM13 (Affimed Therapeutics)	Hodgkin's lymphoma	phase 2
afuresertib (GlaxoSmithKline)	ovarian cancer	phase 2
AGS-003 (Argos Therapeutics)	renal cell carcinoma (early-stage disease), solid tumors renal cell carcinoma (metastatic disease)	phase 2 phase 3
aldoxorubicin (CytRx)	glioblastoma, Kaposi's sarcoma, small cell lung cancer, soft tissue sarcoma (first-line) soft tissue sarcoma (second-line)	phase 2 phase 3
alectinib (RG7853; Genentech, Roche)	non-small cell lung cancer	phase 3

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algenpantucel-L (NewLink Genetics)	pancreatic cancer (borderline resectable or locally advanced unresectable)	phase 2
	pancreatic cancer (resected)	phase 3
alisertib (Millennium)	ovarian cancer, small cell lung cancer	phase 2
	peripheral T-cell lymphoma (relapsed or refractory disease)	phase 3
ALT-801 (Altor BioScience)	bladder cancer	phase 2
ALT-803 (Altor BioScience)	bladder cancer, melanoma, myeloma	phase 2
ALT-836 (Altor BioScience)	solid tumors	phase 2
alvocidib (Tolero Pharmaceuticals)	acute myelogenous leukemia (first-line)	phase 2
amatuximab (MORAb-009, Eisai)	mesothelioma	phase 2
AMG 337 (Amgen)	esophageal adenocarcinoma, gastric cancer, gastroesophageal junction adenocarcinoma	phase 2
ANG1005 (Angiochem)	brain metastases, glioma	phase 2
anti-MUC1 AR20.5 mAb (Quest PharmaTech)	pancreatic cancer	phase 2
antineoplaston (Burzynski Research Institute)	glioma	phase 2
antroquinonol (Golden Biotechnology)	non-small cell lung cancer	phase 2
AP26113 (ARIAD)	non-small cell lung cancer	phase 2
AP32788 (ARIAD)	non-small cell lung cancer	phase 2
apatorsen (OGX-427, OncoGenex)	bladder cancer, non-small cell lung cancer, pancreatic cancer, prostate cancer	phase 2
apaziquone (Spectrum)	bladder cancer (nonmuscle-invasive disease)	phase 3
APC100 (Adamis Pharmaceuticals)	prostate cancer	phase 2
AR-42 (Arno Therapeutics)	hematologic malignancies (relapsed/refractory)	phase 2
Archexin (Rexahn)	kidney cancer (metastatic disease)	phase 2
ASP0113 (Astellas/Vical)	cytomegalovirus reactivation in hematopoietic cell transplant recipients	phase 3
ASP2215 (Astellas)	acute myelogenous leukemia (relapsed/refractory)	phase 2
ASP2783 (Astellas)	non-small cell lung cancer	phase 2
asparaginase erwinia chrysanthemi intravenous (Erwinaze, Jazz Pharmaceuticals)	acute lymphoblastic leukemia (patients who develop hypersensitivity to first-line asparaginase therapy)	phase 2
AST-VAC (Asterias Biotherapeutics)	acute myelogenous leukemia	phase 2
ASTX727 (Astex Pharmaceuticals)	myelodysplastic syndrome	phase 2
AT13387 (Astex)	lung cancer, melanoma	phase 2
AT7519 (Astex/Novartis)	multiple myeloma	phase 2
ATL101 (ATLAB Pharma/Weill Cornell Medical College)	prostate cancer (metastatic disease)	phase 2
autologous tumor cell-based vaccine (MVax, AVAX Technologies)	melanoma	phase 3
autologous tumor cell-based vaccine (OVax, AVAX Technologies)	ovarian cancer (relapsed disease)	phase 2
AVX701 (AlphaVax/Duke University)	colorectal cancer (late-stage disease)	phase 2
axitinib (Inlyta, Pfizer)	hepatocellular carcinoma	phase 2
	renal cell carcinoma (adjuvant)	phase 3
AZD1775 (AstraZeneca)	ovarian cancer	phase 2

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AZD2014 (AstraZeneca)	solid tumors	phase 2
AZD4547 (AstraZeneca)	solid tumors	phase 2
AZD5363 (AstraZeneca/Astex)	breast cancer	phase 2
AZD9291 (AstraZeneca)	non-small cell lung cancer	phase 3
BA-003 (Onexo)	hepatocellular carcinoma (second-line)	phase 3
bavituximab (Peregrine Pharmaceuticals)	liver cancer non-small cell lung cancer (second-line)	phase 2 phase 3
BBI503 (Boston Biomedical)	gastrointestinal stromal tumors, hepatobiliary cancer, solid tumors, urologic malignancies	phase 3
BBI608 (Boston Biomedical)	breast cancer, colorectal cancer (combination therapy), melanoma, non-small cell lung cancer, ovarian cancer colorectal cancer (monotherapy), gastric cancer (combination therapy), gastroesophageal cancer (combination therapy)	phase 2 phase 3
belinostat (Beleodaq, Spectrum)	non-small cell lung cancer	phase 2
bendamustine liquid (Treanda, Teva)	mantle cell lymphoma (relapsed or refractory disease) mantle cell lymphoma, non-Hodgkin's lymphoma	phase 2 phase 3
bevacizumab (Avastin; Genentech, Roche)	breast cancer, carcinoid tumors (high risk), glioblastoma, non-small cell lung cancer, ovarian cancer	phase 3
bevacizumab biosimilar (Actavis/Amgen)	non-small cell lung cancer	phase 3
BGJ398 (Novartis)	cholangiocarcinoma (advanced disease), gastrointestinal stromal tumor (combination therapy), glioblastoma, hematologic malignancies, melanoma (combination therapy)	phase 2
BI 81 1283 (Boehringer Ingelheim)	acute myelogenous leukemia	phase 2
BI 836858 (Boehringer Ingelheim)	myelodysplastic syndrome	phase 2
BIND-014 (BIND Therapeutics)	non-small cell lung cancer, prostate cancer	phase 2
binimetinib (MEK162, Array)	fallopian tube cancer, melanoma, ovarian cancer, peritoneal cancer	phase 3
BiovaxID (Biovest International)	follicular non-Hodgkin's lymphoma, mantle cell lymphoma	phase 3
birinapant (TetraLogic Pharmaceuticals)	colorectal cancer, myelodysplastic syndrome, ovarian cancer	phase 2
Bismab-A (Actinium)	acute myelogenous leukemia	phase 2
BL-8040 (BioLineRx)	acute myelogenous leukemia (combination therapy)	phase 2
blinatumomab (Blincyto, Amgen)	acute lymphoblastic leukemia (Philadelphia chromosome-positive and minimal residual disease), diffuse large B-cell lymphoma acute lymphoblastic leukemia	phase 2 phase 3
BNC105 (Bionomics)	renal cell carcinoma	phase 2
bortezomib (Velcade, Millennium)	diffuse large B-cell lymphoma mantle cell lymphoma (front-line)	phase 2 phase 3
bosutinib (Bosulif, Pfizer)	chronic myelogenous leukemia	phase 3
BPX-201 (Bellicum Pharmaceuticals)	prostate cancer (metastatic castration-resistant disease)	phase 2
BPX-501 (Bellicum Pharmaceuticals)	hematopoietic stem cell transplantation	phase 2
brentuximab vedotin (Adcetris, Seattle Genetics)	diffuse large B-cell lymphoma (front-line and relapsed CD30-positive disease), Hodgkin's lymphoma (front-line, patients aged 60 years or older), non-Hodgkin's lymphoma T-cell lymphoma (cutaneous and mature CD30-positive disease), Hodgkin's lymphoma (front-line treatment and posttransplant relapse prevention)	phase 2 phase 3
brigatinib (ARIAD)	non-small cell lung cancer (ALK-positive disease)	phase 2
BT062 (Biotest Pharmaceuticals)	multiple myeloma	phase 2

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buparlisib (BKM120, Novartis)	central nervous system lymphoma, cervical cancer (metastatic or locally advanced disease), colorectal cancer (metastatic or advanced RAS wild-type disease), diffuse large B-cell lymphoma, follicular lymphoma, glioblastoma (recurrent disease), head and neck cancers (recurrent or metastatic disease), mantle cell lymphoma, melanoma, non-small cell lung cancer, prostate cancer, thymomas breast cancer	phase 2 phase 3
BVD-523 (BioMed Valley Discoveries)	acute myelogenous leukemia, myelodysplastic syndrome	phase 2
BYL719 (Novartis)	breast cancer, colorectal cancer, esophageal cancer, head and neck cancers, multiple myeloma, non-small cell lung cancer	phase 2
cabazitaxel (Jevtana, Sanofi)	prostate cancer (metastatic)	phase 3
cabozantinib (Cometriq, Exelixis)	hepatocellular carcinoma (late-stage disease), renal cell carcinoma (metastatic disease)	phase 3
cancer vaccine MUC-1 (CVac, Prima BioMed)	ovarian cancer	phase 2
carfilzomib (Kyprolis, Amgen/Onyx)	lung cancer multiple myeloma	phase 2 phase 3
carlecortemcel-L (StemEx, Gamida Cell/Teva)	hematologic malignancies	phase 3
CBL0102 (Cleveland BioLabs/Incuron)	hepatocellular carcinoma	phase 2
CC-486 (Celgene)	acute myelogenous leukemia (post-induction maintenance), myelodysplastic syndrome (lower-risk disease)	phase 3
CEP-32496 (Teva)	colorectal cancer (metastatic disease), melanoma (advanced disease)	phase 2
cerdulatinib (Portola Pharmaceuticals)	chronic lymphocytic leukemia, non-Hodgkin's lymphoma	phase 2
ceritinib (Zykadia, Novartis)	cholangiocarcinoma, hematologic malignancies, non-small cell lung cancer non-small cell lung cancer	phase 2 phase 3
CF102 (Can-Fite BioPharma)	hepatocellular carcinoma	phase 2
CFG920 (Novartis)	prostate cancer (metastatic, castration-resistant disease)	phase 2
CG0070 (Cold Genesys)	bladder cancer	phase 3
CLR457 (Novartis)	solid tumors (advanced)	phase 2
CMD-003 (Cell Medica)	Epstein-Barr virus lymphoma	phase 2
CNDO-109 (Coronado Biosciences)	acute myelogenous leukemia	phase 2
cobimetinib (GDC-0973/RG7421; Genentech, Roche)	breast cancer melanoma	phase 2 phase 3
copanlisib (BAY 80-6946, Bayer)	non-Hodgkin's lymphoma	phase 2
cositecan (Karenitecin, BioNumerik Pharmaceuticals)	ovarian cancer (advanced disease)	phase 2
coxsackievirus A21 (Cavatak, Viralytics)	melanoma	phase 2
CPI-613 (Cornerstone Pharmaceuticals)	lymphoma, pancreatic cancer	phase 2
crenolanib (AROG Pharmaceuticals)	acute myelogenous leukemia (newly diagnosed), gastrointestinal stromal tumors acute myelogenous leukemia (relapsed/refractory disease)	phase 2 phase 3
CRLX101 (Cerulean Pharma)	rectal cancer (late-stage disease)	phase 2
crolibulin (Immune Pharmaceuticals)	solid tumors	phase 2
CRS-207 (Aduro Biotech)	pancreatic cancer (combination treatment)	phase 2
CTL019 (Novartis)	acute lymphoblastic leukemia, non-Hodgkin's lymphoma	phase 2
CTO (Tactical Therapeutics)	glioma	phase 2
custirsen (TV-1011/OGX-011; Teva, OncoGenex)	non-small cell lung cancer, prostate cancer	phase 3
CV-301 (Bavarian Nordic)	bladder cancer, breast cancer, colorectal cancer	phase 2

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CX-4945 (Senhwa Biosciences)	cholangiocarcinoma	phase 2
CYT-6091 (CytImmune Sciences)	non-small cell lung cancer	phase 2
cytarabine:daunorubicin (CPX-351, Celator)	acute myelogenous leukemia, conditioning prior to hematopoietic stem cell transplantation, myelodysplastic syndrome acute myelogenous leukemia	phase 2 phase 3
dabrafenib (Tafinlar, GlaxoSmithKline)	colorectal cancer, non-small cell lung cancer, rare cancers melanoma (adjuvant therapy, metastatic disease)	phase 2 phase 3
dacomitinib (PF-00299804, Pfizer)	non-small cell lung cancer ( <i>EGFR</i> -mutant disease)	phase 3
dalantercept (Acceleron)	head and neck cancers, renal cell carcinoma	phase 2
daratumumab (Janssen) <b>READ PERSPECTIVE</b> on this drug from Sarah Holstein, MD, PhD, on page 105.	multiple myeloma	phase 3
darbepoetin alfa (Aranesp, Amgen)	myelodysplastic syndrome	phase 3
dasatinib (Sprycel, Bristol-Myers Squibb)	chronic myelogenous leukemia (pediatric)	phase 2
DCVax-L (Northwest Biotherapeutics)	glioblastoma	phase 3
defactinib (VS-6063, Verastem) <b>READ PERSPECTIVE</b> on this drug from James Stevenson, MD, on page 104.	mesothelioma, non-small cell lung cancer ( <i>KRAS</i> -mutant disease)	phase 2
demcizumab (OncoMed Pharmaceuticals)	ovarian cancer	phase 2
dendritic cell vaccine (DCVax-Direct, Northwest Biotherapeutics)	inoperable solid tumors	phase 2
dendritic cell vaccine (DCVax-Prostate, Northwest Biotherapeutics)	prostate cancer (late-stage, hormone-independent disease)	phase 2
denileukin diftitox (Ontak, Eisai)	melanoma	phase 2
denosumab (Xgeva, Amgen)	non-small cell lung cancer prevention of bone metastases in adjuvant breast cancer, prevention of skeletal-related events in multiple myeloma	phase 2 phase 3
DFP-10917 (Delta-Fly Pharmaceuticals)	acute lymphoblastic leukemia, acute myelogenous leukemia	phase 2
DI-Leu 16-IL2 (ALOPEXX Oncology)	non-Hodgkin's lymphoma	phase 2
DKN-01 (HealthCare Pharmaceuticals)	multiple myeloma	phase 2
DM-CHOC-PEN (DEKK-TEC)	brain tumors	phase 2
DN24-02 (Dendreon)	HER-2-positive urothelial carcinoma	phase 2
dorgenmeltucel-L (HyperAcute Melanoma, NewLink Genetics)	melanoma (advanced disease)	phase 2
dovitinib (TKI258, Novartis)	gastric cancer, hematologic malignancies, prostate cancer solid tumors	phase 2 phase 3
doxorubicin liposomal (2B3-101, to-BBB Technologies)	brain metastases, glioma (recurrent disease)	phase 2
doxorubicin liposomal (ThermoDox, Celsion)	breast cancer, colorectal metastases liver cancer, liver metastases	phase 2 phase 3
doxorubicin nanoparticles (BioAlliance Pharma)	liver cancer (second-line)	phase 3
DPV-001 (UbiVac)	non-small cell lung cancer	phase 2
DPX-Survivac (Immunovaccine)	ovarian cancer	phase 2
duvelisib (AbbVie/Infinity)	non-Hodgkin's lymphoma (refractory, indolent disease) chronic lymphocytic leukemia (relapsed/refractory), follicular lymphoma (previously treated)	phase 2 phase 3
E7820 (Eisai)	colorectal cancer	phase 2

## Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
eflornithine (CPP-1X, Cancer Prevention Pharmaceuticals)	neuroblastoma	phase 2
	colorectal cancer	phase 3
EGEN-001 (EGEN)	ovarian cancer (monotherapy)	phase 2
EGF816 (Novartis)	non-small cell lung cancer, solid tumors	phase 2
EGFRvIII CAR (Kite Pharma)	glioblastoma	phase 2
elesclomol (Synta Pharmaceuticals)	ovarian cancer (recurrent, persistent disease)	phase 2
elotuzumab (Bristol-Myers Squibb/AbbVie)	multiple myeloma	phase 3
eltrombopag (Promacta, GlaxoSmithKline)	acute myelogenous leukemia	phase 2
	myelodysplastic syndrome	phase 3
emactuzumab (Roche)	solid tumors	phase 2
encapsulated cell therapy (Rogosin Institute)	colorectal cancer	phase 2
encorafenib (LGX818, Array)	colorectal cancer ( <i>BRAF</i> -mutant metastatic disease), solid tumors ( <i>BRAF</i> -mutant disease)	phase 2
	melanoma ( <i>BRAF</i> -mutant disease)	phase 3
ENMD-2076 (CASI Pharmaceuticals)	breast cancer (locally advanced or metastatic triple-negative disease), fibrolamellar carcinoma (advanced disease), ovarian cancer, soft tissue sarcoma (advanced or metastatic disease)	phase 2
ensituximab (Precision Biologics)	colorectal cancer (advanced disease), pancreatic cancer (advanced disease)	phase 2
entinostat (Syndax Pharmaceuticals)	non-small cell lung cancer, renal cell carcinoma	phase 2
	breast cancer	phase 3
entospletinib (Gilead)	hematologic malignancies	phase 2
enzalutamide (Xtandi; Astellas, Medivation)	breast cancer	phase 2
	prostate cancer	phase 3
EP-100 (Esperance Pharmaceuticals)	hematologic malignancies, solid tumors	phase 2
epratuzumab (Immunomedics)	leukemia, lymphoma	phase 2
EPZ-6438 (Epizyme)	diffuse large B-cell lymphoma, non-Hodgkin's lymphoma	phase 2
ERC-1671 (Eritopoietic Research)	glioblastoma, gliosarcoma	phase 2
eribulin (Halaven, Eisai)	bladder cancer	phase 2
	breast cancer (HER-2-negative disease), non-small cell lung cancer, sarcoma	phase 3
erlotinib (Tarceva, Genentech)	non-small cell lung cancer	phase 3
ERY-ASP (Erytech)	acute lymphoblastic leukemia (young adults)	phase 2
ETBX-011 (Etubics)	colorectal cancer	phase 2
etirinotecan pegol (NKTR-102, Nektar)	colorectal cancer (second-line), glioma (bevacizumab-refractory high-grade disease), non-small cell lung cancer, ovarian cancer (platinum-resistant), small cell lung cancer	phase 2
	breast cancer (metastatic)	phase 3
everolimus (Afinitor, Novartis)	chondrosarcoma, endometrial cancer, glioma, Hodgkin's lymphoma, multiple myeloma, non-Hodgkin's lymphoma, osteosarcoma, ovarian cancer, renal cell carcinoma, testicular germ cell cancer, thyroid cancer	phase 2
	breast cancer, diffuse large B-cell lymphoma, kidney cancer, pancreatic neuroendocrine tumors	phase 3
EZN-2285 (Sigma-Tau Pharmaceuticals)	acute lymphoblastic leukemia	phase 3
FANG vaccine (Gradalis)	colorectal cancer, melanoma, ovarian cancer	phase 2
farletuzumab (MORAb-003, Eisai)	non-small cell lung cancer, ovarian cancer	phase 2
fenretinide intravenous (CerRx)	adult lymphoma, solid tumors	phase 2

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FF-10501 (Boston Strategies/Fujifilm Pharmaceuticals)	hematologic malignancies	phase 2
FG-3019 (Fibrogen)	pancreatic cancer (advanced disease)	phase 2
ficlatuzumab (AVEO)	non-small cell lung cancer	phase 2
filanesib (ARRY-520, Array)	multiple myeloma	phase 2
fosbretabulin (Zybrestat, OXIGENE)	ovarian cancer	phase 2
FPI-01 (Formula Pharmaceuticals)	acute lymphoblastic leukemia, acute myelogenous leukemia	phase 2
GALE-301 (Galena Biopharma)	endometrial cancer, myeloproliferative neoplasm-related thrombocytosis, ovarian cancer	phase 2
galeterone (Tokai Pharmaceuticals)	prostate cancer (metastatic, castration-resistant disease)	phase 2
galunisertib (LY2157299, Eli Lilly)	glioblastoma, glioma, hepatocellular carcinoma, pancreatic cancer (advanced or metastatic unresectable disease)	phase 2
	myelodysplastic syndrome	phase 3
ganetespib (STA-9090, Synta Pharmaceuticals)	breast cancer, fallopian tube cancer, ocular melanoma, ovarian cancer, sarcoma, small cell lung cancer	phase 2
	acute myelogenous leukemia, non-small cell lung cancer	phase 3
GC33 (Chugai Pharmaceutical)	liver cancer (metastatic disease)	phase 2
GI-4000 (GlobelImmune)	non-small cell lung cancer, pancreatic cancer (resected)	phase 2
GI-6207 (GlobelImmune)	medullary thyroid cancer	phase 2
GL-0817 (GliKnik)	squamous cell cancer of the oral cavity	phase 2
glasdegib (PF-04449913, Pfizer)	acute myelogenous leukemia	phase 2
glembatumumab vedotin (CDX-011, Celldex Therapeutics)	breast cancer (triple-negative disease), melanoma (metastatic disease)	phase 2
GL-ONC1 (Genelux)	peritoneal carcinomatosis, solid tumors	phase 2
glufosfamide (Eleison Pharmaceuticals)	pancreatic cancer (metastatic disease, second-line)	phase 3
GO-203-2c (Genus Oncology/Dana-Farber Cancer Institute)	acute myelogenous leukemia (relapsed/refractory)	phase 2
GS-4059 (Gilead)	B-cell malignancies	phase 2
GTx-024/GTx-027 (GTx)	breast cancer	phase 2
GTx-758 (GTx)	prostate cancer (secondary hormone therapy for castration-resistant disease)	phase 2
heat shock protein vaccine (Agenus)	glioma (newly diagnosed and recurrent disease)	phase 2
hRS7-SN-38 (Immunomedics)	solid tumors	phase 2
HS-110 (Viagenpumatucel-L, Heat Biologics)	non-small cell lung cancer	phase 2
HS-410 (Vesigenurtacel-L, Heat Biologics)	bladder cancer	phase 2
HSC835 (Novartis)	hematologic malignancies, single umbilical cord blood transplantation	phase 2
HSV-Tk (MolMed)	acute leukemia (high-risk disease)	phase 3
ibritumomab tiuxetan (Zevalin, CASI Pharmaceuticals)	B-cell lymphomas, follicular lymphoma, mantle cell lymphoma, marginal zone lymphoma, multiple myeloma, non-Hodgkin's lymphoma, posttransplant lymphoproliferative disorder	phase 2
	diffuse large B-cell non-Hodgkin's lymphoma, follicular lymphoma (treatment-naive disease)	phase 3
ibrutinib (Imbruvica; Pharmacyclics, Janssen)	acute lymphoblastic leukemia, acute myelogenous leukemia, multiple myeloma	phase 2
	chronic lymphocytic leukemia, diffuse large B-cell lymphoma, follicular lymphoma, mantle cell lymphoma, marginal zone lymphoma, non-Hodgkin's lymphoma, Waldenström's macroglobulinemia	phase 3
ICT-107 (ImmunoCellular Therapeutics)	glioblastoma (newly diagnosed disease)	phase 3

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ICT-140 (ImmunoCellular Therapeutics)	ovarian cancer	phase 2
idelalisib (Zydelig, Gilead)	non-Hodgkin's lymphoma (front-line)	phase 2
	chronic lymphocytic leukemia, non-Hodgkin's lymphoma	phase 3
IMA901 (Immatic Biotechnologies)	renal cancer	phase 3
imetelstat (Geron)	myelofibrosis	phase 2
IMO-8400 (Idera Pharmaceuticals)	diffuse large B-cell lymphoma, Waldenström's macroglobulinemia	phase 2
IMMU-132 (Immunomedics)	solid tumors	phase 2
Imprime PGG (Biothera)	chronic lymphocytic leukemia, colorectal cancer (second- and third-line treatment for metastatic disease; third-line treatment for KRAS-mutant metastatic disease), non-Hodgkin's lymphoma	phase 2
	colorectal cancer (third-line treatment for metastatic disease)	phase 3
INCB24360 (Incyte)	colorectal cancer, diffuse large B-cell lymphoma, head and neck cancers, Hodgkin's lymphoma, melanoma, non-Hodgkin's lymphoma, non-small cell lung cancer, ovarian cancer	phase 2
INCB39110 (Incyte)	non-small cell lung cancer, pancreatic cancer	phase 2
INC280 (Incyte/Novartis)	glioblastoma, head and neck squamous cell carcinoma, hepatocellular carcinoma, non-small cell lung cancer, melanoma (combination therapy), papillary renal cell carcinoma	phase 2
indoximod (NewLink Genetics)	breast cancer (metastatic, HER-2-negative disease), prostate cancer (metastatic, castration-resistant disease)	phase 2
ingenol mebutate (Picato, LEO Pharma)	basal cell carcinoma	phase 2
inhaled lipid cisplatin (Eleison Pharmaceuticals)	prevention of pulmonary metastases from osteosarcoma (pediatric)	phase 2
inotuzumab ozogamicin (Pfizer)	acute lymphoblastic leukemia	phase 3
instiladrin (FKD Therapies)	bladder cancer	phase 2
interleukin-12 gene therapy (OncoSec Medical)	cutaneous T-cell lymphoma, melanoma, Merkel cell carcinoma	phase 2
iobenguane I-131 (Azedra, Progenics)	neuroblastoma, neuroendocrine tumors, paraganglioma, pheochromocytoma	phase 2
lomab-B (Actinium)	hematopoietic stem cell transplantation in acute myelogenous leukemia	phase 3
ipatasertib (GDC-0068/RG7440; Genentech, Roche)	breast cancer (triple-negative disease), gastric cancer, prostate cancer	phase 2
IPI-145 (Infinity Pharmaceuticals)	non-Hodgkin's lymphoma	phase 2
	chronic lymphocytic leukemia	phase 3
ipilimumab (Yervoy, Bristol-Myers Squibb)	B-cell lymphoma, cervical cancer, colorectal cancer, Merkel cell carcinoma, pancreatic cancer, small cell lung cancer, uveal melanoma	phase 2
	glioblastoma, melanoma, non-small cell lung cancer, prostate cancer, renal cell carcinoma	phase 3
irinotecan:floxuridine (CPX-1, Celator)	colorectal cancer	phase 2
IRT-102 (TNI Biotech)	pancreatic cancer	phase 2
IRX-2 (IRX Therapeutics)	head and neck cancers	phase 2
IRX4204 (Iovance Therapeutics)	prostate cancer	phase 2
ISIS-EIF4ERx (Isis Pharmaceuticals)	non-small cell lung cancer, prostate cancer (castration-resistant disease)	phase 2
ixazomib (Millennium)	follicular lymphoma (relapsed or refractory disease), multiple myeloma	phase 2
	multiple myeloma (relapsed, refractory disease)	phase 3
JCAR014 (Juno Therapeutics)	acute lymphoblastic leukemia, chronic lymphocytic leukemia (refractory disease), non-Hodgkin's lymphoma	phase 2
JCAR017 (Juno Therapeutics)	acute lymphoblastic leukemia (pediatric)	phase 2
JNJ-26481585 (Janssen)	cutaneous T-cell lymphoma	phase 2
JNJ-42756493 (Janssen/Astex)	urothelial cancer	phase 2

**READ PERSPECTIVE**  
on this drug from Andrew J. Armstrong, MD, ScM, FACP, on page 105.



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JNJ56021927/ARN-509 (Janssen)	prostate cancer	phase 3
JTCR016 (Juno Therapeutics)	acute myelogenous leukemia	phase 2
JZP-416 (Jazz Pharmaceuticals)	acute lymphoblastic leukemia	phase 2
KB004 (KaloBios Pharmaceuticals)	acute myelogenous leukemia, myelodysplastic syndrome, myelofibrosis	phase 2
KD018 (Kadmon Pharmaceuticals)	colorectal cancer, liver cancer	phase 2
KD019 (Kadmon Pharmaceuticals)	breast cancer	phase 2
KD032 (Kadmon Pharmaceuticals)	non-small cell lung cancer, pancreatic cancer	phase 2
KTE-C19 CAR (Kite Pharma)	diffuse large B-cell lymphoma (refractory disease), mediastinal B-cell lymphoma (refractory disease), non-Hodgkin's lymphoma, transformed follicular lymphoma (refractory disease)	phase 2
labetuzumab-SN-38 (Immunomedics)	colorectal cancer	phase 2
LCL161 (Novartis)	myelofibrosis, multiple myeloma	phase 2
LEE011 (Astex/Novartis)	breast cancer, hematologic malignancies, liposarcoma, melanoma (combination treatment), non-small cell lung cancer, teratoma	phase 2
	breast cancer	phase 3
lenalidomide (Revlimid, Celgene)	diffuse large B-cell lymphoma (ABC subtype, first-line), indolent lymphoma (relapsed, refractory)	phase 2
	chronic lymphocytic leukemia (maintenance, second-line), diffuse large B-cell lymphoma, follicular lymphoma (front-line), multiple myeloma (maintenance), myelodysplastic syndrome (non-deletion 5q)	phase 3
lenvatinib (E7080, Eisai)	endometrial cancer, melanoma, non-small cell lung cancer, renal cell carcinoma	phase 2
	hepatocellular carcinoma	phase 3
leukocyte interleukin injection (Multikine, CEL-SCI)	head and neck cancers (first-line)	phase 3
LGH447 (Novartis)	multiple myeloma	phase 2
lifastuzumab vedotin (DNIB0600A/RG7599; Genentech, Roche)	ovarian cancer	phase 2
lintuzumab Ac-225 (Actinium)	acute myelogenous leukemia	phase 2
lipegfilgrastim (Teva)	non-Hodgkin's lymphoma	phase 3
LJM716 (Novartis)	esophageal squamous cell carcinoma	phase 2
lucitanib (Clovis)	breast cancer, lung cancer	phase 2
luspatercept (ACE-536, Celgene)	myelodysplastic syndrome	phase 2
LY2228820 (Eli Lilly)	breast cancer, glioblastoma, ovarian cancer (recurrent disease)	phase 2
LY2510924 (Eli Lilly)	renal cell carcinoma (metastatic disease), small cell lung cancer (extensive-stage disease)	phase 2
LY2606368 (Eli Lilly)	breast cancer, ovarian cancer	phase 2
LY2801653 (Eli Lilly)	cancer	phase 2
LY2874455 (Eli Lilly)	cancer	phase 2
LY2875358 (Eli Lilly)	gastric cancer (advanced disease)	phase 2
LY2940680 (Eli Lilly)	small cell lung cancer	phase 2
MAGE-A3 (GlaxoSmithKline)	bladder cancer	phase 2
	melanoma, non-small cell lung cancer	phase 3
margetuximab (MacroGenics)	breast cancer, gastroesophageal cancer	phase 2
marizomib intravenous (Triphase Accelerator)	multiple myeloma	phase 2
masitinib (AB Science USA)	gastrointestinal stromal tumor (late-stage disease, first-line), pancreatic cancer (metastatic disease)	phase 3

## Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
MB07133 (Ligand/Chiva)	hepatocellular carcinoma	phase 3
MEDI4736 (AstraZeneca/MedImmune)	solid tumors non-small cell lung cancer	phase 2 phase 3
MEDI-551 (AstraZeneca/MedImmune)	chronic lymphocytic leukemia, diffuse large B-cell lymphoma	phase 2
MEDI-573 (AstraZeneca/MedImmune)	breast cancer	phase 2
melapuldencel-T (NeoStem Oncology)	melanoma	phase 2
melphalan intravenous (Captisol-enabled melphalan, Spectrum)	myeloma	phase 2
MGCD265 (Mirati Therapeutics)	non-small cell lung cancer, solid tumors	phase 2
milatuzumab-doxorubicin (Immunomedics)	chronic lymphocytic leukemia, non-Hodgkin's lymphoma	phase 2
miliciclib (Nerviano Medical Sciences)	malignant thymoma	phase 2
mipsagargin (G-202, GenSpera)	glioblastoma, prostate cancer liver cancer	phase 2 phase 3
MK-2206 (Merck)	breast cancer, colorectal cancer, diffuse large B-cell lymphoma, non-small cell lung cancer	phase 2
MK-8628 (Merck)	cancer	phase 2
MLN0128 (Millennium)	breast cancer (metastatic disease)	phase 2
MLN0264 (Millennium)	gastroesophageal junction adenocarcinoma, pancreatic cancer, stomach cancer	phase 2
MLN2480 (Sunesis/Millennium)	melanoma, solid tumors	phase 2
MM-111 (Merrimack)	gastric cancer (second-line)	phase 2
MM-121 (Merrimack)	breast cancer, non-small cell lung cancer, ovarian cancer	phase 2
MM-302 (Merrimack)	breast cancer (advanced HER-2-positive disease)	phase 2
MM-398 (Merrimack)	colorectal cancer, glioma, pancreatic cancer	phase 3
mocetinostat (Mirati Therapeutics)	bladder cancer, diffuse large B-cell lymphoma, myelodysplastic syndrome	phase 2
mogamulizumab (Kyowa Hakko Pharma)	adult T-cell leukemia, adult T-cell lymphoma cutaneous T-cell lymphoma	phase 2 phase 3
momelotinib (Gilead)	pancreatic cancer myelofibrosis	phase 2 phase 3
MOR208 (MorphoSys)	acute lymphoblastic leukemia, chronic lymphocytic leukemia, non-Hodgkin's lymphoma	phase 2
MORAb-003 (Eisai/Morphotek)	non-small cell lung cancer ovarian cancer (platinum-sensitive disease)	phase 2 phase 3
MORAb-004 (Eisai)	colorectal cancer, melanoma, sarcoma	phase 2
MORAb-009 (Eisai/Morphotek)	mesothelioma	phase 2
moxetumomab pasudotox (AstraZeneca/MedImmune)	acute lymphoblastic leukemia hairy cell leukemia	phase 2 phase 3
MPDL3280A (Genentech)	non-small cell lung cancer (metastatic), renal cell carcinoma (combination regimen), urothelial bladder cancer (metastatic) non-small cell lung cancer (second-line), urothelial bladder cancer (second-line)	phase 2 phase 3
MSB 0010445 (EMD Serono)	melanoma	phase 2
MSB 0010718C (EMD Serono)	Merkel cell carcinoma	phase 2
MSC1936369B (Merck Serono)	ovarian cancer (combination regimen)	phase 2
MVA-BN-PRO (Bavarian Nordic)	prostate cancer (hormone-refractory disease)	phase 2
MVI-816 (Madison Vaccines)	prostate cancer	phase 2

# Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
mycobacterium cell wall-DNA complex (Bioniche Life Sciences)	nonmuscle-invasive bladder cancer (refractory disease)	phase 2
NC-6004 (NanoCarrier)	non-small cell lung cancer	phase 2
necitumumab (Lilly)	non-small cell lung cancer	phase 3
necuparanib (Momenta Pharmaceuticals)	pancreatic cancer	phase 2
nelipepimut-S (NeuVax, Galena Biopharma)	breast cancer (node-positive or node-negative HER-2-positive disease), gastric cancer	phase 2
	breast cancer (node-positive, HER-2-positive disease)	phase 3
neratinib (PB272, Puma Biotechnology)	HER-mutated non-small cell lung cancer, HER-mutated solid tumors	phase 2
	breast cancer	phase 3
NiCord (Gamida Cell)	hematologic malignancies	phase 2
nilotinib (Tasigna, Novartis)	chronic myelogenous leukemia	phase 3
nimotuzumab (Daiichi-Sankyo)	cervical cancer, hypopharyngeal cancer, oropharyngeal cancer, rectal cancer	phase 2
	esophageal squamous cell carcinoma, gastric cancer, gastroesophageal junction cancer, head and neck cancer, nasopharyngeal carcinoma	phase 3
nintedanib (Vargatef, Boehringer Ingelheim)	breast cancer, cervical cancer, esophagogastric adenocarcinoma, glioblastoma, mesothelioma, thyroid cancer	phase 2
	colorectal cancer, non-small cell lung cancer, ovarian cancer	phase 3
niraparib (TESARO)	breast cancer, ovarian cancer	phase 3
nivolumab (Opdivo, Bristol-Myers Squibb) <b>READ PERSPECTIVE</b> on this drug from Vamsidhar Velcheti, MD, on page 105.	acute myelogenous leukemia, anal cancer, bladder cancer, colorectal cancer, diffuse large B-cell lymphoma, follicular lymphoma, Hodgkin's lymphoma, melanoma, nasopharyngeal cancer, non-Hodgkin's lymphoma, pancreatic cancer, renal cell carcinoma	phase 2
	gastric cancer (unresectable advanced or recurrent disease), glioblastoma, head and neck cancers, melanoma, non-small cell lung cancer	phase 3
non-Hodgkin's lymphoma vaccine (XEME Biopharma)	non-Hodgkin's follicular lymphoma	phase 2
nonpegylated liposomal doxorubicin (Myocet, Sopherion Therapeutics)	breast cancer (metastatic disease)	phase 3
NS-018 (NS Pharma)	myelofibrosis	phase 2
NTO-1151 (Triapine, Nanotherapeutics/NCI)	cervical cancer, vaginal cancer	phase 2
NX-1207 (Nymox Pharmaceutical Corporation)	prostate cancer (early-stage disease)	phase 2
NY-ESO-1/LAGE-1-specific T cells (Adaptimmune)	melanoma, myeloma (advanced disease), ovarian cancer	phase 2
obinutuzumab (Gazyva; Genentech, Biogen Idec, Roche)	chronic lymphocytic leukemia, diffuse large B-cell lymphoma, non-Hodgkin's lymphoma	phase 3
ODM-201 (Bayer/Orion)	prostate cancer	phase 3
ODSH (Cantex Pharmaceuticals)	acute myelogenous leukemia	phase 2
ofatumumab (Arzerra, GlaxoSmithKline)	chronic lymphocytic leukemia (relapsed disease), diffuse large B-cell lymphoma (relapsed disease), follicular lymphoma (refractory and relapsed disease)	phase 3
olaparib (Lynparza, AstraZeneca)	breast cancer, endometrial cancer, fallopian tube cancer, non-small cell lung cancer, ovarian cancer, peritoneal cancer, prostate cancer	phase 2
	breast cancer, gastric cancer, ovarian cancer, pancreatic cancer	phase 3
olaratumab (IMC-3G3, Eli Lilly)	brain tumors, central nervous system tumors, gastrointestinal stromal tumors, non-small cell lung cancer, ovarian cancer, prostate cancer	phase 2
omacetaxine mepesuccinate (Teva)	acute myelogenous leukemia (elderly), myelodysplastic syndrome	phase 2
onartuzumab (MetMAb, Genentech)	breast cancer (triple-negative disease), colorectal cancer, glioblastoma (bevacizumab-naive recurrent disease), non-small cell lung cancer (non-squamous)	phase 2
	gastric cancer (metastatic HER-2-negative disease), non-small cell lung cancer (metastatic)	phase 3
ONC1-13B (AllaChem)	prostate cancer (metastatic disease)	phase 2
Oncoquest-L (XEME Biopharma)	follicular non-Hodgkin's lymphoma	phase 2
Oncovax (Vaccinogen)	colon cancer (stage II disease)	phase 3

## Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
OPN-305 (Opsona Therapeutics)	myelodysplastic syndrome	phase 2
oprozomib (Amgen/Onyx)	multiple myeloma, Waldenström's macroglobulinemia	phase 2
oregovomab (Quest Pharmaceuticals)	ovarian cancer (first-line)	phase 2
orteronel (TAK-700, Millennium)	prostate cancer	phase 3
otlertuzumab (Emergent BioSolutions)	chronic lymphocytic leukemia	phase 2
ozarelix (Spectrum)	prostate cancer	phase 2
paclitaxel poliglumex (CTI Biopharma)	glioblastoma, head and neck cancers	phase 2
	ovarian cancer (first-line maintenance)	phase 3
paclitaxel polymeric micelle for injection (Cynviloq, Sorrento Therapeutics)	bladder cancer, ovarian cancer, pancreatic cancer	phase 2
	breast cancer (metastatic disease), non-small cell lung cancer	phase 3
paclitaxel protein-bound particles for injectable suspension, albumin-bound (Abraxane, Celgene)	breast cancer (triple-negative, metastatic), pancreatic cancer (adjuvant)	phase 3
pacritinib (CTI Biopharma/Baxter International)	acute myelogenous leukemia	phase 2
	myelofibrosis	phase 3
<b>READ PERSPECTIVE</b> on this drug from Ruben A. Mesa, MD, FACP, on page 104.		
palbociclib (Ibrance, Pfizer)	breast cancer (recurrent advanced disease; high-risk early disease)	phase 3
panitumumab (Vectibix, Amgen)	colorectal cancer (chemorefractory, KRAS exon 2 wild type disease)	phase 3
panobinostat (LBH589, Novartis)	acute myelogenous leukemia (post-allogeneic stem cell transplantation), Hodgkin's lymphoma, myelodysplastic syndrome (post-allogeneic stem cell transplantation), melanoma (combination therapy), multiple myeloma (combination therapy), myelofibrosis, non-Hodgkin's lymphoma, renal cell cancer (combination therapy)	phase 2
	multiple myeloma (relapsed disease)	phase 3
patritumab (Daiichi-Sankyo)	breast cancer, non-small cell lung cancer	phase 2
pazopanib (Votrient, GlaxoSmithKline)	renal cell cancer (adjuvant therapy)	phase 3
PEG-SN38 (Belrose Pharma)	breast cancer	phase 2
PEGPH20 (Halozyme Therapeutics)	pancreatic cancer (metastatic disease)	phase 2
pelareorep (Reolysin, Oncolytics Biotech)	fallopian tube cancer, glioma (recurrent disease), head and neck cancers (advanced disease), lung cancer (squamous cell carcinoma), melanoma (metastatic disease), non-small cell lung cancer, ovarian cancer, pancreatic cancer, peritoneal cancer, sarcoma (metastatic disease)	phase 2
	head and neck cancers (platinum-refractory disease)	phase 3
pembrolizumab (Keytruda, Merck)	bladder cancer, head and neck cancers, non-small cell lung cancer	phase 3
pertuzumab (Perjeta; Genentech, Roche)	breast cancer (HER-2-positive metastatic disease), gastric cancer (HER-2-positive disease)	phase 2
	breast cancer (early HER-2-positive disease), gastric cancer (advanced HER-2-positive disease)	phase 3
pexastimogene devacirepvec (SillaJen Biotherapeutics)	colorectal cancer (treatment-refractory disease), kidney cancer, liver cancer	phase 2
PF-03084014 (Pfizer)	breast cancer (triple-negative disease)	phase 2
PF-05280014 (Pfizer)	breast cancer (metastatic)	phase 3
PF-05280586 (Pfizer)	follicular lymphoma	phase 3
PF-06834635 (Pfizer)	Merkel cell carcinoma (metastatic)	phase 2
pictilisib (GDC-0941/RG7321; Genentech, Roche)	breast cancer (ER-positive metastatic disease; metastatic HER-2-negative, hormone receptor-positive disease), non-small cell lung cancer (metastatic disease)	phase 2
pimasertib (EMD Serono)	melanoma, ovarian cancer, pancreatic cancer	phase 2
pinatuzumab vedotin (Genentech)	diffuse large B-cell lymphoma, non-Hodgkin's lymphoma	phase 2
pixantrone (Pixuvri, CTI BioPharma)	non-Hodgkin's lymphoma	phase 3
PKC412 (Novartis)	acute myelogenous leukemia	phase 3

# Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
plitidepsin (PharmaMar)	T-cell lymphoma	phase 2
	multiple myeloma	phase 3
PLX3397 (Daiichi-Sankyo)	acute myelogenous leukemia, glioblastoma, melanoma	phase 2
PM01183 (PharmaMar)	breast cancer, non-small cell lung cancer	phase 2
	ovarian cancer, small cell lung cancer	phase 3
PNT2258 (ProNAi Therapeutics)	diffuse large B-cell lymphoma, non-Hodgkin's lymphoma, solid tumors	phase 2
POL-103A (Polynoma)	melanoma (late-stage disease)	phase 3
polatuzumab vedotin (DCDS4501A/RG7596; Genentech, Roche)	diffuse large B-cell lymphoma, non-Hodgkin's lymphoma	phase 2
ponatinib (Iclusig, ARIAD)	acute lymphoblastic leukemia (Philadelphia chromosome-positive disease), acute myelogenous leukemia, biliary cancer, gastrointestinal stromal tumors, lung cancer, medullary thyroid cancer	phase 2
porfimer sodium (PDT with Photofrin, Pinnacle Biologics)	epithelioid malignant pleural mesothelioma, perihilar cholangiocarcinoma Bismuth type III/IV (unresectable advanced disease)	phase 3
pracinostat (MEI Pharma)	acute myelogenous leukemia, myelodysplastic syndrome	phase 2
pralatrexate injection (Folotyn, Spectrum)	peripheral T-cell lymphoma	phase 3
PRAME immunotherapeutic (GlaxoSmithKline)	non-small cell lung cancer (resectable)	phase 2
PRI-724 (PRISM Pharma)	acute myelogenous leukemia, chronic myelogenous leukemia	phase 2
PRM-151 (Promedior)	myelofibrosis	phase 2
PROSTVAC (Bristol-Myers Squibb)	prostate cancer	phase 3
PSMA targeted imaging compound (1404, Progenics)	prostate cancer	phase 2
PT 107 (Pique Therapeutics)	non-small cell lung cancer	phase 2
PV-10 (Provectus)	melanoma	phase 2
PVX-410 (OncoPep)	multiple myeloma (smoldering disease)	phase 2
QS-21 Stimulon (Agenus)	melanoma	phase 3
quizartinib (AC220; Daiichi-Sankyo, Ambit Biosciences)	acute myelogenous leukemia	phase 3
radium-223 dichloride (Xofigo, Bayer)	breast cancer	phase 2
	prostate cancer	phase 3
ramucirumab (Cyramza, Eli Lilly)	colorectal cancer, esophageal cancer, gastric cancer, hepatocellular carcinoma, non-small cell lung cancer, renal cell carcinoma	phase 2
	stomach cancer	phase 3
rebastinib (Deciphera Pharmaceuticals)		phase 2
refametinib (BAY 86-9766, Bayer)	breast cancer, colorectal cancer, hepatocellular carcinoma, lung cancer	phase 2
regorafenib (Stivarga, Bayer)	adenoid cystic carcinoma, angiosarcoma, biliary cancer, colorectal cancer, esophageal cancer, gastric cancer, gastrointestinal stromal tumor, soft tissue sarcoma, solid tumors	phase 2
	colorectal cancer (with resected liver metastases), hepatocellular carcinoma	phase 3
reparixin (Dompé)	breast cancer	phase 2
rexlemestrocel-L (Mesoblast)	acute lymphoblastic leukemia, acute myelogenous leukemia, non-Hodgkin's lymphoma	phase 3
RG6046 (Roche)	breast cancer	phase 2
RG7601 (Roche)	chronic lymphocytic leukemia, diffuse large B-cell lymphoma, follicular lymphoma (combination regimen)	phase 2
RG7686 (Roche)	liver cancer (metastatic)	phase 2
ricolinostat (ACY-1215, Acetylon Pharmaceuticals)	lymphoma, myeloma (relapsed/refractory disease)	phase 2
rigosertib (Onconova Therapeutics)	myelodysplastic syndrome	phase 3

## Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
rilatumumab (AMG 102, Amgen)	fallopian tube cancer, gastroesophageal adenocarcinoma (advanced disease), non-small cell lung cancer, ovarian epithelial cancer, primary peritoneal cancer	phase 2
	gastric cancer	phase 3
rindopepimut (Celldex Therapeutics)	glioblastoma (recurrent)	phase 2
	glioblastoma (front-line)	phase 3
rituximab biosimilar (APB 798, Amgen)	non-Hodgkin's lymphoma	phase 3
rituximab biosimilar (PF-05280586, Pfizer)	follicular lymphoma	phase 3
rociletinib (CO-1686, Clovis)	non-small cell lung cancer (first- or second-line, EGFR-mutated disease)	phase 2
	non-small cell lung cancer (third-line or later, EGFR-mutated disease)	phase 3
rocilinostat (Acetylon Pharmaceuticals)	multiple myeloma	phase 2
romidepsin (Istodax, Celgene)	peripheral T-cell lymphoma (first-line)	phase 3
roniciclib (BAY 1000394, Bayer)	small cell lung cancer	phase 2
RRx-001 (RadioRx)	colorectal cancer (metastatic disease)	phase 2
rucaparib (Clovis)	ovarian cancer (treatment), pancreatic cancer (BRCA-mutated disease)	phase 2
	ovarian cancer (maintenance)	phase 3
ruxolitinib (Jakafi, Incyte)	acute myelogenous leukemia, breast cancer, chronic lymphocytic leukemia, chronic myelogenous leukemia, colorectal cancer, myelofibrosis, myeloproliferative neoplasms, non-small cell lung cancer, T-cell leukemia	phase 2
	pancreatic cancer, polycythemia vera	phase 3
RXDX-101 (Ignyta)	solid tumors	phase 2
S-1 (Taiho Oncology)	hepatocellular carcinoma, pancreatic cancer	phase 2
	gastric cancer	phase 3
sapacitabine (Cyclacel Pharmaceuticals)	myelodysplastic syndrome, non-small cell lung cancer	phase 2
	acute myelogenous leukemia	phase 3
SAR125844 (Ligand/Sanofi)	malignant neoplasms	phase 2
SAR245409 (Sanofi)	ovarian cancer (combination regimen)	phase 2
SAR3419 (Sanofi)	B-cell refractory/relapsed malignancies	phase 2
SAR650984 (Sanofi)	multiple myeloma	phase 2
sarcoma vaccine (MabVax Therapeutics)	sarcoma (metastatic disease)	phase 2
Sativex (GW Pharmaceuticals/Otsuka)	cancer pain	phase 3
SC16LD6.5 (Stem Centrx)	small cell lung cancer	phase 2
SD101 (Dynavax)	B-cell lymphoma (low-grade, recurrent disease)	phase 2
selective estrogen receptor degrader (GDC-0810)	breast cancer (ER-positive, HER-2-negative disease)	phase 2
seliciclib (Cyclacel Pharmaceuticals)	nasopharyngeal cancer, small cell lung cancer	phase 2
selinexor (KPT-330, Karyopharm Therapeutics)	acute myelogenous leukemia, chronic lymphocytic leukemia, diffuse large B-cell lymphoma, glioblastoma, head and neck squamous cell carcinoma, multiple myeloma, prostate cancer (metastatic disease), solid tumors	phase 2
selumetinib (AZD6244; AstraZeneca, Array)	AIDS-related Kaposi's sarcoma, biliary tract cancer, gallbladder cancer, glioma, non-small cell lung cancer (KRAS-mutant disease), uveal melanoma	phase 2
	non-small cell lung cancer, thyroid cancer, uveal melanoma	phase 3
SG2000 (Spirogen)	acute myelogenous leukemia, chronic lymphocytic leukemia	phase 2
SGI110 (Astex)	acute myelogenous leukemia, colorectal cancer, liver cancer, myelodysplastic syndrome, ovarian cancer	phase 2
SGN-CD19A (Seattle Genetics)	diffuse large B-cell lymphoma (relapsed)	phase 2
SGX301 (Soligenix)	cutaneous T-cell lymphoma	phase 2

# Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
SHAPE (TetraLogic Pharmaceuticals)	cutaneous T-cell lymphoma	phase 2
SI-701 (Stemline Therapeutics)	glioblastoma	phase 2
siltuximab (Sylvant, Janssen)	multiple myeloma (smoldering disease)	phase 2
simtuzumab (Gilead)	colorectal cancer, myelofibrosis	phase 2
sipuleucel-T (Provenge, Dendreon)	prostate cancer (recurrent, hormone-refractory, metastatic disease) prostate cancer (recurrent early-stage disease)	phase 2 phase 3
SL-401 (Stemline Therapeutics)	acute myelogenous leukemia (advanced disease), blastic plasmacytoid dendritic cell neoplasm, myeloproliferative neoplasms	phase 2
SNDX-275 (Syndax Pharmaceuticals)	Hodgkin's lymphoma (relapsed/refractory disease)	phase 2
SNS01 (Sevion Therapeutics)	diffuse large B-cell lymphoma, mantle cell lymphoma	phase 2
sonecipzumab (Lpath)	renal cell carcinoma	phase 2
sonidegib (LDE225, Novartis)	acute leukemia (relapsed/refractory disease), basal cell carcinoma, breast cancer, medulloblastoma, multiple myeloma, myelofibrosis, ovarian cancer, pancreatic adenocarcinoma	phase 2
sorafenib (Nexavar, Bayer)	acute myelogenous leukemia, hepatocellular carcinoma, renal cell carcinoma	phase 3
sotatercept (ACE-011, Celgene)	myelodysplastic syndrome	phase 2
SPI-1620 (Spectrum)	biliary cancer, non-small cell lung cancer	phase 2
SPI-2012 (Spectrum)	neutropenia in breast cancer	phase 2
sunitinib (Sutent, Pfizer)	renal cell carcinoma (adjuvant)	phase 3
Sym004 (EMD Serono)	colorectal cancer	phase 2
TAK-385 (Millennium)	prostate cancer	phase 2
talazoparib (BMN 673, BioMarin)	breast cancer (metastatic disease)	phase 3
talimogene laherparepvec (Amgen)	melanoma	phase 3
tarextumab (OncoMed Pharmaceuticals)	pancreatic cancer	phase 2
TAS-120 (Taiho)	multiple myeloma	phase 2
taselisib (Roche)	solid tumors	phase 2
tasquinimod (Active Biotech)	prostate cancer (metastatic, hormone-refractory disease)	phase 3
Tavocept (BioNumerik Pharmaceuticals)	lung cancer	phase 3
TCN-P (Cahaba Pharmaceuticals)	solid tumors	phase 2
telatinib (Eddingpharm)	gastric cancer	phase 2
telotristat etiprate (Lexicon Pharmaceuticals)	malignant carcinoid syndrome	phase 3
tergenpumatumucel-L (NewLink Genetics)	non-small cell lung cancer (advanced or metastatic disease)	phase 2
tetradecanoylphorbol acetate (RP-323, Rich Pharmaceuticals)	acute myelogenous leukemia	phase 2
TG-1101 (TG Therapeutics)	mantle cell lymphoma (combination therapy) chronic lymphocytic leukemia (combination therapy)	phase 2 phase 3
TG4010 (Transgene)	non-small cell lung cancer (advanced disease)	phase 2
TH-302 (EMD Serono)	melanoma, multiple myeloma, non-small cell lung cancer pancreatic cancer, soft tissue sarcoma	phase 2 phase 3
tirapazamine (SRI International)	cervical cancer	phase 2

## Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
tivantinib (Daiichi-Sankyo)	malignant mesothelioma	phase 2
	hepatocellular carcinoma	phase 3
tivozanib (AVEO)	epithelial ovarian cancer, fallopian tube cancer, peritoneal cancer	phase 2
TKM-PLK1 (Tekmira Pharmaceuticals)	adrenocortical carcinoma, gastrointestinal neuroendocrine tumors, hepatocellular carcinoma	phase 2
TL-118 (Tiltan Pharma)	pancreatic cancer (metastatic disease, first-line)	phase 2
TMX-101 (Vesimune, Telomedix)	bladder cancer	phase 2
Toca 511 and Toca FC (Tocagen)	glioma	phase 2
topotecan optisome (Spectrum)	breast cancer, lung cancer	phase 2
tosedostat (CTI Biopharma)	acute myelogenous leukemia, myelodysplastic syndrome	phase 2
TPI 287 (Cortice Biosciences)	glioblastoma, neuroblastoma	phase 2
trabectedin (Yondelis, Janssen)	ovarian cancer, soft tissue sarcoma	phase 3
trametinib (Mekinist, GlaxoSmithKline)	colorectal cancer, hairy cell leukemia ( <i>BRAF V600E</i> -positive disease), non-small cell lung cancer, rare cancers	phase 2
	melanoma (adjuvant therapy, metastatic disease)	phase 3
trans sodium crocetinate (Diffusion Pharmaceuticals)	glioblastoma	phase 2
trastuzumab biosimilar (Actavis/Amgen)	breast cancer	phase 3
TRC105 (TRACON Pharmaceuticals)	glioblastoma, renal cell carcinoma, soft tissue sarcoma (advanced disease)	phase 2
trebananib (Amgen)	ovarian cancer	phase 3
tremelimumab (AstraZeneca/MedImmune)	mesothelioma	phase 3
TSR-011 (Tesaro)	lymphoma, non-small cell lung cancer	phase 2
tumor infiltrating lymphocyte (Lion Biotechnologies/NCI)	melanoma (second-line)	phase 2
TUSC2 (Genprex)	non-small cell lung cancer	phase 2
TVI-Brain-1 (TVAX Biomedical)	glioma	phase 2
TZ101 (Targazyme)	cord blood stem cell transplantation	phase 2
VAL-083 (DelMar Pharmaceuticals)	glioblastoma	phase 2
vandetanib (Caprelsa, AstraZeneca)	gastrointestinal stromal tumors, head and neck cancers, non-small cell lung cancer	phase 2
vanucizumab (Roche)	colorectal cancer	phase 2
VB-111 (VBL Therapeutics)	glioblastoma (recurrent disease), ovarian cancer, thyroid cancer	phase 2
veliparib (ABT-888, AbbVie)	brain metastasis and other cancers	phase 2
	breast cancer ( <i>BRCA</i> -deficient disease, triple-negative disease), non-small cell lung cancer	phase 3
veltuzumab (Immunomedics)	non-Hodgkin's lymphoma	phase 2
vemurafenib (Zelboraf; Genentech, Daiichi-Sankyo)	colorectal cancer, hairy cell leukemia, multiple myeloma, thyroid cancer	phase 2
	melanoma (advanced, metastatic, <i>BRAF</i> -positive disease)	phase 3
vincristine sulfate liposome injection (Marqibo, Spectrum)	acute lymphoblastic leukemia, acute myelogenous leukemia, uveal melanoma	phase 2
	acute lymphoblastic lymphoma (Philadelphia chromosome-negative), non-Hodgkin's lymphoma	phase 3
vinorelbine optisome (Spectrum)	small cell lung cancer, ovarian cancer	phase 2
vintafolide (Endocyte)	non-small cell lung cancer	phase 2
vismodegib (Erivedge, Genentech)	basal cell carcinoma	phase 2



# Oncology Drugs in the Pipeline

Generic name (Brand name, Manufacturer)	Indication(s)	Development status
volasertib (BI 6727, Boehringer Ingelheim)	acute myelogenous leukemia	phase 3
volitinib (AZD6094, AstraZeneca)	renal cell carcinoma	phase 2
vorinostat (Zolinza, Merck)	acute lymphoblastic leukemia (combination therapy), acute myelogenous leukemia (combination therapy), HIV-related diffuse large B-cell lymphoma, mantle cell lymphoma, multiple myeloma (combination therapy), myelodysplastic syndrome (combination therapy), non-Hodgkin's lymphoma (combination therapy), ocular melanoma, uveal melanoma (recurrent disease)  acute myelogenous leukemia (combination therapy for younger patients with treatment-naïve disease), cutaneous T-cell lymphoma (relapsed/refractory disease), multiple myeloma (combination therapy for newly diagnosed disease)	phase 2  phase 3
vosaroxin (Qinprezo, Sunesis)	myelodysplastic syndrome  acute myelogenous leukemia	phase 2  phase 3
VT-122 (Vicus Therapeutics)	liver cancer (advanced disease), prostate cancer (pre-chemotherapy)	phase 2
VTX-2337 (VentiRx Pharmaceuticals)	head and neck cancers	phase 2
WT1 immunotherapeutic (GlaxoSmithKline)	breast cancer	phase 2
Xilonix (XBiotech)	colorectal cancer	phase 3
zoptarelin doxorubicin (Aeterna Zentaris)	endometrial cancer (second-line), prostate cancer (castration-/taxane-resistant disease)	phase 2

Information in this chart was compiled from the Pharmaceutical Research and Manufacturers of America, NIH ([www.clinicaltrials.gov](http://www.clinicaltrials.gov)), corporate websites and the databases of HEMONC TODAY. The publisher or editors do not assume responsibility for any errors or omissions.

HEMONC TODAY asked key opinion leaders to offer perspective about oncology drugs in the pipeline they believe have the greatest potential to improve patient care.

## PERSPECTIVE: PACRITINIB



Ruben A. Mesa

Pacritinib (CTI Biopharma/Baxter International), previously known as SB1518, is an oral JAK2 and FLT3 inhibitor. Phase 1 and phase 2 testing in the United States and Australia demonstrated the agent was efficacious in improving the splenomegaly and symptoms of patients with myelofibrosis (Komrokji RS, et al. *Blood*. 2015; Published online ahead of print March 11), with manageable gastrointestinal toxicities but minimal hematological toxicities, a limiter of FDA-approved ruxolitinib (Jakafi, Incyte).

These latter results led to the PERSIST-1 trial (NCT01773187), a randomized phase 3 trial of pacritinib vs. best alternative therapy in JAK inhibitor-naïve patients. The trial had the unique aspect of not excluding patients based on thrombocytopenia. Top-line results of PERSIST-1, announced March 9, showed the study met its primary endpoint of superior improvement in splenomegaly at 24 weeks in the pacritinib arm, along with improvement in myelofibrosis-associated symptoms, and improvements in anemia in many erythrocyte transfusion-dependent patients. In parallel, a second phase 3 trial — PERSIST-2 (NCT02055781) is enrolling for patients with myelofibrosis who have baseline thrombocytopenia (<100 x 10<sup>9</sup>/L) who may have had prior JAK inhibitor exposure.

Several areas of further investigation of pacritinib are ongoing given its favorable safety profile and activity. These include pre-allogeneic transplant in myelofibrosis (NCT02410551) and acute myeloid leukemia with *FLT3* mutations (NCT02323607). Exploratory trials of pacritinib in patients with myelodysplastic syndrome and in patients with solid tumors are planned, including those with non-small cell lung cancer who have *EGFR*-mutant disease and failed one prior tyrosine kinase inhibitor (NCT02342353), as well as for those with refractory colorectal cancer (NCT02277093).

Pacritinib seems to represent an incrementally important addition to therapeutic options for patients with myelofibrosis with cytopenias, and this combination of efficacy without hematological toxicity might prove beneficial in other hematologic and solid tumor indications.

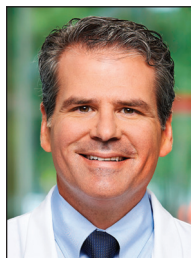
— Ruben A. Mesa, MD, FACP

HEMONC TODAY Editorial Board member

Mayo Clinic

Disclosure: Mesa reports a consultant role with Novartis, as well as research support from CTI BioPharma, Genentech, Gilead, Incyte and Promedior.

## PERSPECTIVE: DEFACTINIB



James Stevenson

Focal adhesion kinase (FAK) is a non-receptor tyrosine kinase that mediates signaling through integrins associated with extracellular matrix attachment as well as other growth factors. Enhanced FAK signaling has been shown to promote cell survival through resistance to apoptotic stimuli, cell migration and epithelial-mesenchymal transition, making FAK an attractive therapeutic target in oncology.

FAK is important in the maintenance of cancer stem cell populations; in a mesothelioma xenograft model, FAK inhibition was shown to eliminate stem cells that were enriched following treatment with pemetrexed (Alimta, Eli Lilly) and cisplatin (Shapiro IM, et al. *Sci Transl Med*. 2014;doi:10.1126/scitranslmed.3008639). FAK also has been linked to mesothelioma in other ways; the tumor suppressor merlin, the gene product of the neurofibromatosis 2 gene (*NF2*), is frequently inactivated in mesothelioma and has been shown to be a negative regulator of FAK activity (Poulidakos PI, et al. *Oncogene*. 2006;25:5960-5968).

Defactinib (VS-6063, Verastem) is a potent and selective orally available FAK inhibitor that is active against human mesothelioma cell lines and xenograft models, and displays greater activity against merlin-negative tumors (Shapiro IM, et al. *Mol Cancer Ther*. 2013;doi:10.1158/1535-7163.TARG-13-C262). A phase 1 trial in patients with solid tumors demonstrated good tolerability at doses above the minimal efficacious concentration.

Defactinib is now being studied in the COMMAND trial (NCT01870609), an international phase 2 study of oral defactinib vs. placebo as maintenance therapy following front-line pemetrexed/platinum chemotherapy for patients with malignant pleural mesothelioma who have shown disease stability/response. Patients are stratified by high vs. low merlin expression status, which will allow the assessment of merlin as a predictive biomarker. Other trials of defactinib in mesothelioma include a phase 2 neoadjuvant trial of single-agent therapy prior to extrapleural pneumonectomy or pleurectomy (NCT02004028), and a phase 2 trial of defactinib in combination with the PI3K/mTOR inhibitor VS-5584 in patients with relapsed pleural mesothelioma who have received at least one line of prior chemotherapy (NCT02372227).

Defactinib is also being studied as a single agent in previously treated *KRAS*-mutant non-small cell lung cancer (NCT01951690), and in combination with paclitaxel in ovarian cancer (NCT01778803). Positive data from these trials would provide validation of this unique target, as well as the promise of cancer stem cell therapeutics.

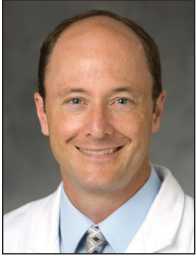
— James Stevenson, MD

Cleveland Clinic

Disclosure: Verastem provides research funding to Cleveland Clinic for a clinical trial for which Stevenson is the principal investigator.

# Oncology Drugs in the Pipeline

## PERSPECTIVE: IPILIMUMAB



Andrew J. Armstrong

Ipilimumab (Yervoy, Bristol-Myers Squibb) is one systemic therapy that may have an impact on the standard of care for men with metastatic castration resistant prostate cancer (CRPC) in the coming year.

Ipilimumab is an immune checkpoint inhibitor, specifically a CTLA-4 blocker. Immune checkpoint inhibition has led to tremendous changes in the way we treat patients with other malignancies, particularly melanoma. Other immune checkpoint inhibitors, such as PD-1 or PDL-1 inhibitors, are having a tremendous impact on the care for other solid tumors. However, no immune checkpoint inhibitor currently is available

or approved for use in men with prostate cancer.

Two phase 3 trials of ipilimumab have been completed in metastatic CRPC. The first was performed post-chemotherapy (Kwon ED. *Lancet Oncol.* 2014;doi:10.1016/S1470-2045(14)70189-5). Patients received a dose of radiation designed to release antigen and stimulate the immune system. They then were randomly assigned to ipilimumab or placebo. It narrowly missed meeting a positive primary endpoint for improving OS (HR = 0.85; P = .053).

Some patients — particularly the better-prognosis patients, such as those without liver (visceral) metastases — demonstrated a more profound improvement in survival. This suggested that men with a better long-term prognosis may have a greater survival benefit with immunotherapy, a finding that has also been observed with sipuleucel-T (Provenge, Dendreon), a commonly used immunotherapy approved in this setting.

Bristol-Myers Squibb conducted another phase 3 randomized, placebo-controlled trial performed pre-chemotherapy in men with metastatic CRPC. That trial completed more than a year ago, and I'd expect results to be reported within the next 6 to 12 months. A positive study for OS — given the challenges in meeting this endpoint with the current landscape of multiple approved and active agents — would generate a lot of optimism and hope for immunotherapy in this disease, and the concept of immune checkpoint blockade in prostate cancer would be then validated. This would help in the development of other immune checkpoint inhibitors in this disease, some of which remain in very early stages of development.

Ipilimumab has some serious side effects. Autoimmune disorders are common, and some can be life-threatening, so there is a potential for risk. However, ipilimumab is a distinct immunotherapy. It is possible it could be used in conjunction with — or before or after — other currently approved therapies and would be preferred in the pre-taxane setting in appropriately selected men without major comorbidities. If the results of the second phase 3 study demonstrate a positive impact on OS, it could fundamentally change our treatment algorithm. Based on the already nearly positive phase 3 trial in prostate cancer and the positive results observed in melanoma — and with the successes seen with immune checkpoint inhibition in general across multiple oncology indications — I believe there is a reason for optimism.

— Andrew J. Armstrong, MD, ScM, FACP

Duke Cancer Institute

Disclosure: Armstrong reports research funding to his institution from Bristol-Myers Squibb.

## PERSPECTIVE: ADO-TRASTUZUMAB EMTANSINE



Mateusz Opyrchal

Ado-trastuzumab emtansine (Kadcyla, Genentech) has been shown to be a very efficacious drug in treatment of trastuzumab (Herceptin, Genentech)-resistant HER-2-positive breast cancer. It is a drug-antibody conjugate (ADC), which is a class of drugs that combine the benefits of targeted treatment with a monoclonal antibody with a highly potent chemotherapy drug. ADC works by binding to the target antigen on cancer cells, causing the whole molecule to be internalized, leading to release of the chemotherapy moiety and cell death. This method of delivery increases the therapeutic window for the chemotherapy drugs by decreasing systemic release but increasing intratumoral concentration of the active chemotherapy agent.

Expression of the target antigen on normal cells and nonspecific antibody bindings leads to systemic release of the chemotherapy agent and induces any toxicities. Two pivotal phase 3 trials of T-DM1 — TH3RESA and EMILIA — have shown that ado-trastuzumab emtansine is very active in patients with HER-2-positive breast cancer resistant to trastuzumab therapy. Ado-trastuzumab emtansine not only has been shown to be superior to other second-line therapies, but it also has a much better toxicity profile marked by low levels of thrombocytopenia, elevated alanine and aspartate aminotransferases, fatigue, diarrhea and nausea/vomiting. It is currently being evaluated in both HER-2-positive breast cancer and HER-2-positive gastric cancers in multiple clinical trials in the neoadjuvant, adjuvant and metastatic settings, alone or in combination with various targeted, endocrine and chemotherapy agents. There are currently 34 open clinical trials with this agent listed on clinicaltrials.gov, which indicates the great interest and promise of this drug.

— Mateusz Opyrchal, MD, PhD

Roswell Park Cancer Institute

Disclosure: Opyrchal reports no relevant financial disclosures.

## PERSPECTIVE: DARATUMUMAB



Sarah Holstein

The multiple myeloma community has with great interest watched the development of daratumumab (Janssen). Daratumumab is a human monoclonal antibody directed against CD38, an antigen highly expressed on myeloma cells. Preclinical studies have demonstrated complement-dependent cytotoxicity, antibody-dependent cell-mediated cytotoxicity, antibody-dependent cellular phagocytosis and inhibition of CD38 ADP-ribosyl cyclase activity. The initial phase 1/phase 2 dose-escalation study has shown single-agent activity in very heavily pre-treated patients, with an overall response rate of approximately 40%.

Notably, activity has been observed in patients who are dual refractory to immunomodulatory agents and proteasome inhibitors, a subgroup of patients who historically have had a dismal prognosis. The side-effect profile has thus far been shown to be quite manageable, with the primary toxicity being related to infusion reactions. Currently, daratumumab is being investigated in a variety of other drug combinations, including in both the upfront and relapsed/refractory settings. Preliminary reports have indicated very high response rates when used in combination with standard agents. For example, the combination of daratumumab with lenalidomide (Revlimid, Celgene) and dexamethasone in relapsed/refractory patients yielded a 100% overall response, with a 31% complete response rate in the dose-escalation phase. Thus, not only does this drug provide hope for patients refractory to standard therapies, but if it is used with standard therapies in the upfront setting, this could result in significantly deeper responses that in turn could translate to improved long-term survival.

— Sarah Holstein, MD, PhD

Roswell Park Cancer Institute

Disclosure: Holstein reports no relevant financial disclosures.

## PERSPECTIVE: NIVOLUMAB



Vamsidhar Velcheti

Over the past few years, we have seen the clinical development of an exciting new class of drugs called immune checkpoint inhibitors. One of the most actively studied immune checkpoint pathways is the programmed death-1 (PD-1) axis. PD-1 is a negative regulator of T cells, and tumors express PD-L1, the ligand for PD-1 that binds to PD-1 on T cells to inactivate the anti-tumor immune response by the T cells. Nivolumab (Opdivo, Bristol-Myers Squibb) is a fully human IgG4 anti-PD-1 monoclonal antibody.

In a recently published update from a multicenter dose escalation phase 1 study with nivolumab, encouraging OS rates were observed in patients with non-small cell lung cancer who had been heavily pretreated (Gettinger SN, et al. *J Clin Oncol.* 2015;published online ahead of print April 20). The analysis included 129 patients who received nivolumab at three different doses: 1 mg/kg, 3 mg/kg and 10 mg/kg. The overall response rate was 17.1% (95% CI, 11-24.7) and median OS was 9.9 months. Researchers reported survival of 42% at 1 year, 24% at 2 years and 18% at 3 years. With the caveats of this being a phase 1 study, these findings represent a significant advance in treatment of patients with previously treated NSCLC.

These findings were further supported by a subsequent single-arm multicenter phase 2 trial, CheckMate 063 (Rizvi NA, et al. *Lancet Oncol.* 2015;doi:10.1016/S1470-2045(15)70054-9). In this trial, nivolumab was administered 3 mg/kg every 2 weeks to previously treated squamous NSCLC (≥2 prior lines of therapy) until progression or unacceptable toxic effects. Seventeen (14.5%) of 117 patients had an objective response, median OS was 8.2 months and 1-year survival was 41%.

A randomized phase 3 trial that compared docetaxel to nivolumab in previously treated advanced squamous NSCLC (CheckMate 017) was stopped early due to efficacy, but the clinical data have not yet been published or presented at a meeting. However, in a somewhat unprecedented manner, FDA had expeditiously approved nivolumab (3 months ahead of schedule) for patients with metastatic squamous NSCLC that progressed after platinum-based chemotherapy.

Another phase 3 randomized trial (CheckMate 057) of docetaxel vs. nivolumab in non-squamous NSCLC was stopped early due to efficacy, and data are under FDA review for consideration of expansion of nivolumab's indication to non-squamous NSCLC histology.

Data from these trials and other similar drugs that target the PD-1 axis have induced a new wave of excitement and hope for patients with lung cancer. Even though the lure of long-term survival with the PD-1 inhibitors is appealing, the response rates in unselected patients are only modestly better than those of cytotoxic chemotherapy. Further studies will need to focus on evaluating potential predictive biomarkers for these drugs.

— Vamsidhar Velcheti, MD

Cleveland Clinic

Disclosure: Velcheti reports no relevant financial disclosures.