Cancer Treatment

Chemotherapy

Chemotherapy literally means using chemicals to treat disease, but it usually refers to medications that fight cancer. Cytotoxic (also known as antineoplastic) chemotherapy halts cell division and kills rapidly growing cells. Unfortunately, it affects not only cancer cells but also fast-growing healthy cells, which can lead to side effects such as nausea, hair loss and susceptibility to infections.

In contrast to traditional chemotherapy, which has been used since the 1940s, a newer type of treatment known as targeted therapy works more specifically against cancer cells with certain gene mutations or other characteristics, while immunotherapy helps the immune system fight cancer. Chemotherapy is often tried first before targeted therapy or immunotherapy, but these types of treatment may also be used together.

How does chemotherapy work?

Chemotherapy works by interfering with cancer cell multiplication. Normal cells undergo a regular cycle of growth, division and resting phases, but cancer cells grow out of control. Some chemotherapy drugs only affect only actively dividing cells, while others are most effective during the resting phase.

Many chemotherapy drugs interfere with DNA, the cell's genetic blueprint. Medications known as alkylating agents cause cross-links in DNA strands that prevent copying and repair of genetic material. These include drugs derived from mustard gas (for example, cyclophosphamide and mechlorethamine) and platinum (for example, cisplatin and carboplatin).

Drugs known as antimetabolites (for example, capecitabine and methotrexate) inhibit enzymes needed to produce DNA or RNA or act as defective DNA building blocks. Others interfere with microtubules, tiny structures that play a role in cell division. Several cancer medications (for example, vincristine and paclitaxel) are alkaloids derived from plants. Some antibiotics have antitumor activity (for example, doxorubicin and bleomycin). Certain steroids (for example, dexamethasone and prednisone) both have anticancer activity and are used to help manage side effects.

How is chemotherapy used?

Usually, the chemotherapy medications that have been shown to offer the best balance of effectiveness and tolerability are tried first, known as first-line therapy. If this doesn't work or if the cancer becomes resistant or relapses, second-line drugs may be tried. Sometimes older and sicker

patients start with less intense chemotherapy to minimize side effects.

Chemotherapy may be given as the first treatment to shrink cancer before surgery or radiation therapy. This is known as neoadjuvant chemotherapy. It may also be used after surgery to kill any remaining cancer cells and reduce the risk of recurrence. This is known as adjuvant chemotherapy. Chemotherapy that delays disease progression or shrinks tumors can help relieve symptoms even if it is not expected to lead to a cure or prolong survival. This is known as palliative therapy.

Often, a combination of chemotherapy drugs works better than a single medication used alone, and this can reduce the development of drug resistance. Sometimes additional medications are administered before, during or after chemotherapy to help prevent or manage side effects.

Chemotherapy may be given in a variety of ways, including pills, injections and intravenous (IV) infusions. Infusions are usually administered at a medical facility while pills can be taken at home. People who receive ongoing infusions may get a catheter inserted into a vein (such as a PICC line) or a port inserted under the skin to allow treatment to be administered without puncturing a vein each time. In some cases, chemotherapy drugs may be injected directly into a tumor or administered to a specific part of the body—for example, into the abdominal cavity or the fluid surrounding the brain and spinal cord. Some medications are topical, or applied to the skin.

Chemotherapy is typically given in cycles—for example, one week of treatment followed by three weeks off. The timing of cycles is based on cancer cell growth rates and other factors. This allows breaks from side effects and give normal cells a chance to recover. Chemotherapy is often given for a set period (for example, six months or a year), but sometimes it is continued as long as it is still working.

Chemotherapy Side Effects

Because chemotherapy harms rapidly dividing healthy cells along with cancer cells, it can cause side effects throughout the body. These include cells in the mouth lining, hair follicles and bone marrow, leading to side effects such as mouth sores, hair loss and low blood cell counts. Loss of germ-fighting white blood cells can leave you more susceptible to infections, and loss of platelets can lead to easy bleeding.

Other common chemotherapy side effects include fatigue, nausea and vomiting, loss of appetite, diarrhea, headaches, cognitive problems (chemo brain or brain fog), muscle or joint pain, heart damage and peripheral neuropathy (nerve damage in the hands and feet). Because some drugs can impair fertility, younger people may wish to discuss ways to preserve their reproductive options.

To help prepare for chemotherapy, ask your doctor or nurse about the kinds of side effects you can expect during and after treatment. But remember that people respond differently; side effects may range from mild to severe, and not everyone will experience all of them.

There are many steps you can take to lessen chemotherapy side effects. Sometimes symptoms

can be managed by adjusting your dose or treatment schedule. Chilling the scalp or hands and feet during treatment can reduce hair loss and neuropathy. Additional medications (such as anti-nausea drugs) and complementary therapies (such as acupuncture) may be used to manage side effects. Management is often easier if started early, and this may help prevent long-term effects. Let your medical team know if you experience side effects so they can help you find ways to cope with them.

Below is a list of commonly used chemotherapy medications. They are used to treat a wide variety of cancer types and are often used in combination regimens (see next table).

Generic name	Brand and other names
alitretinoin	Panretin
altretamine	Hexalen, hexamethylmelamine
amifostine	Ethyol
aminoglutethimide	Cytadren
anagrelide	Agrylin
arsenic trioxide	Trisenox
asparaginase	Elspar, Erwinase, Kidrolase, erwinia L-asparaginase
azacitidine	Vidaza, 5-azacitidine
bendamustine	Treanda, Bendeka
bexarotene	Targretin
bleomycin	Blenoxane
busulfan	Busulfex, Myleran
cabazitaxel	Jevtana
calaspargase pegol-mknl	Asparlas
capecitabine	Xeloda
carboplatin	Paraplatin
carmustine	Gliadel wafer implant, BiCNU
chlorambucil	Leukeran
cisplatin	Platinol, Platinol-AQ, CDDP
cladribine	Leustatin, 2-chlorodeoxyadenosine, 2-CDA
clofarabine	Clolar
cyclophosphamide	Cytoxan, Neosar
cytarabine	Ara-C, Cytosar-U, DepoCyt (liposomal), arabinosylcytosine
dacarbazine	DTIC, DTIC-Dome, imidazole carboxamide
dactinomycin	Cosmegen, actinomycin-D
daunorubicin	Cerubidine, DaunoXome (liposomal), daunomycin, rubidomycin hydrochloride
decitabine	Dacogen
dexamethasone	Decadron, Dexasone, Diodex, Hexadrol, Maxidex
dexrazoxane	Zinecard
docetaxel	Taxotere
doxorubicin	Adriamycin, Rubex, Doxil (liposomal), hydroxydaunomycin
epirubicin	Ellence
eribulin	Halaven

Generic name	Brand and other names
estramustine	Emcyt
etoposide	Etopophos, Toposar, VePesid, etoposide phosphate, VP-16
floxuridine	FUDR
fludarabine	Fludara
fluorouracil	Adrucil, Carac, Efudex, Fluoroplex, Tolak, 5-fluorouracil, 5-FU
fluoxymesterone	Halotestin
gemcitabine	Gemzar
hydroxyurea	Droxia, Hydrea, Mylocel
idarubicin	Idamycin, Idamycin PFS
ifosfamide	Ifex
irinotecan	Camptosar, Onivyde, camptothecin-11, CPT-11
ixabepilone	Ixempra
lanreotide	Somatuline Depot
lomustine	CeeNu, Gleostine, CCNA
mechlorethamine	Mustargen, Valchlor, mustine, nitrogen mustard, HN2
melphalan	Alkeran, L-PAM, L-sarcolysin, phenylalanine mustard
mercaptopurine	Purinethol, 6-mercaptopurine, 6-MP
methotrexate	Otrexup, Rasuvo, Rheumatrex, Trexall, amethopterin, MTX
methylprednisolone	Duralone, Medrol, Medralone, M-Prednisol, Solu-Medrol
mitomycin	Jelmyto, Mutamycin, mitomycin-C, MTC
mitotane	Lysodren
mitoxantrone	Novantrone, DHAD
nab-paclitaxel	Abraxane, albumin-bound paclitaxel
omacetaxine	Synribo
oxaliplatin	Eloxatin
paclitaxel	Onxal, Taxol
pegaspargase	Oncaspar, PEG-L-asparaginase
pemetrexed	Alimta
pentostatin	Nipent
prednisone	Deltasone, Meticorten, Orasone
pralatrexate	Folotyn
procarbazine	Matulane
rasburicase	Elitek
streptozocin	Zanosar
temozolomide	Temodar
temsirolimus	Torisel, CCI-779
teniposide	Vumon, VM-26
thalidomide	Thalomid
thioguanine	6-thioguanine, 6-TG, 2-amino-6-mercaptopurine
thiotepa	Thioplex, thiophosphoamide, TSPA
topotecan	Hycamtin
trabectedin	Yondelis
tretinoin	Vesanoid, Atralin, ATRA

Generic name	Brand and other names
trifluridine/tipiricil	Lonsurf
valrubicin	Valstar
vinblastine	Alkaban-AQ, Velban, vincaleukoblastine
vincristine	Oncovin, Vincasar PFS, Leurocristine, Marqibo (liposomal)
vinorelbine	Navelbine

Generic name**:** alitretinoin
Brand and other names Panretin

Generic name**:** altretamine
Brand and other names Hexalen, hexamethylmelamine

Generic name**:** amifostine
Brand and other names Ethyol

Generic name**:** aminoglutethimide
Brand and other names Cytadren

Generic name**:** anagrelide
Brand and other names Agrylin

Generic name**:** arsenic trioxide
Brand and other names Trisenox

Generic name**:** asparaginase
Brand and other names Elspar, Erwinase, Kidrolase, erwinia L-asparaginase

Generic name**:** azacitidine
Brand and other names Vidaza, 5-azacitidine

Generic name**:** bendamustine
Brand and other names Treanda, Bendeka

Generic name**:** bexarotene
Brand and other names Targretin

Generic name**:** bleomycin
Brand and other names Blenoxane

Generic name**:** busulfan
Brand and other names Busulfex, Myleran

Generic name**:** cabazitaxel
Brand and other names Jevtana

Generic name**:** calaspargase pegol-mknl
Brand and other names Asparlas

Generic name**:** capecitabine
Brand and other names Xeloda

Generic name**:** carboplatin
Brand and other names Paraplatin

Generic name**:** carmustine
Brand and other names Gliadel wafer implant, BiCNU

Generic name**:** chlorambucil
Brand and other names Leukeran

Generic name**:** cisplatin
Brand and other names Platinol, Platinol-AQ, CDDP

Generic name**:** cladribine
Brand and other names Leustatin, 2-chlorodeoxyadenosine, 2-CDA

Generic name**:** clofarabine
Brand and other names Clolar

Generic name**:** cyclophosphamide
Brand and other names Cytoxan, Neosar

Generic name**:** cytarabine
Brand and other names Ara-C, Cytosar-U, DepoCyt (liposomal), arabinosylcytosine

Generic name**:** dacarbazine
Brand and other names DTIC, DTIC-Dome, imidazole carboxamide

Generic name**:** dactinomycin
Brand and other names Cosmegen, actinomycin-D

Generic name**:** daunorubicin
Brand and other names Cerubidine, DaunoXome (liposomal), daunomycin, rubidomycin hydrochloride

Generic name**:** decitabine
Brand and other names Dacogen

Generic name**:** dexamethasone
Brand and other names Decadron, Dexasone, Diodex, Hexadrol, Maxidex

Generic name**:** dexrazoxane
Brand and other names Zinecard

Generic name**:** docetaxel
Brand and other names Taxotere

Generic name**:** doxorubicin
Brand and other names Adriamycin, Rubex, Doxil (liposomal), hydroxydaunomycin

Generic name**:** epirubicin
Brand and other names Ellence

Generic name**:** eribulin
Brand and other names Halaven

Generic name**:** estramustine
Brand and other names Emcyt

Generic name**:** etoposide
Brand and other names Etopophos, Toposar, VePesid, etoposide phosphate, VP-16

Generic name**:** floxuridine
Brand and other names FUDR

Generic name**:** fludarabine
Brand and other names Fludara

Generic name**:** fluorouracil
Brand and other names Adrucil, Carac, Efudex, Fluoroplex, Tolak, 5-fluorouracil, 5-FU

Generic name**:** fluoxymesterone
Brand and other names Halotestin

Generic name**:** gemcitabine
Brand and other names Gemzar

Generic name**:** hydroxyurea
Brand and other names Droxia, Hydrea, Mylocel

Generic name**:** idarubicin
Brand and other names Idamycin, Idamycin PFS

Generic name**:** ifosfamide
Brand and other names Ifex

Generic name**:** irinotecan
Brand and other names Camptosar, Onivyde, camptothecin-11, CPT-11

Generic name**:** ixabepilone
Brand and other names Ixempra

Generic name**:** lanreotide
Brand and other names Somatuline Depot

Generic name**:** lomustine
Brand and other names CeeNu, Gleostine, CCNA

Generic name**:** mechlorethamine
Brand and other names Mustargen, Valchlor, mustine, nitrogen mustard, HN2

Generic name**:** melphalan
Brand and other names Alkeran, L-PAM, L-sarcolysin, phenylalanine mustard

Generic name**:** mercaptopurine
Brand and other names Purinethol, 6-mercaptopurine, 6-MP

Generic name**:** methotrexate
Brand and other names Otrexup, Rasuvo, Rheumatrex, Trexall, amethopterin, MTX

Generic name**:** methylprednisolone
Brand and other names Duralone, Medrol, Medralone, M-Prednisol, Solu-Medrol

Generic name**:** mitomycin
Brand and other names Jelmyto, Mutamycin, mitomycin-C, MTC

Generic name**:** mitotane
Brand and other names Lysodren

Generic name**:** mitoxantrone
Brand and other names Novantrone, DHAD

Generic name**:** nab-paclitaxel
Brand and other names Abraxane, albumin-bound paclitaxel

Generic name**:** omacetaxine
Brand and other names Synribo

Generic name**:** oxaliplatin
Brand and other names Eloxatin

Generic name**:** paclitaxel
Brand and other names Onxal, Taxol

Generic name**:** pegaspargase
Brand and other names Oncaspar, PEG-L-asparaginase

Generic name**:** pemetrexed
Brand and other names Alimta

Generic name**:** pentostatin
Brand and other names Nipent

Generic name**:** prednisone
Brand and other names Deltasone, Meticorten, Orasone

Generic name**:** pralatrexate
Brand and other names Folotyn

Generic name**:** procarbazine
Brand and other names Matulane

Generic name**:** rasburicase
Brand and other names Elitek

Generic name**:** streptozocin
Brand and other names Zanosar

Generic name**:** temozolomide
Brand and other names Temodar

Generic name**:** temsirolimus
Brand and other names Torisel, CCI-779

Generic name**:** teniposide
Brand and other names Vumon, VM-26

Generic name**:** thalidomide
Brand and other names Thalomid

Generic name**:** thioguanine
Brand and other names 6-thioguanine, 6-TG, 2-amino-6-mercaptopurine

Generic name**:** thiotepa
Brand and other names Thioplex, thiophosphoamide, TSPA

Generic name**:** topotecan
Brand and other names Hycamtin

Generic name**:** trabectedin
Brand and other names Yondelis

Generic name**:** tretinoin
Brand and other names Vesanoid, Atralin, ATRA

Generic name**:** trifluridine/tipiricil
Brand and other names Lonsurf

Generic name**:** valrubicin
Brand and other names Valstar

Generic name**:** vinblastine
Brand and other names Alkaban-AQ, Velban, vincaleukoblastine

Generic name**:** vincristine
Brand and other names Oncovin, Vincasar PFS, Leurocristine, Marqibo (liposomal)

Generic name**:** vinorelbine
Brand and other names Navelbine

Below is a list of acronyms for some combination chemotherapy regimens. It is not a complete list of all possible combinations.

Regimen	Component drugs
ABVD	Adriamycin (doxorubicin), bleomycin, vinblastine, dacarbazine
ABVE	Adriamycin (doxorubicin), bleomycin, vinblastine, etoposide
ACE	Adriamycin (doxorubicin), cyclophosphamide, etoposide
ADE	Ara-C (cytarabine), daunorubicin, etoposide
ADOC	cisplatin, doxorubicin (Adriamycin), Oncovin (vincristine), cyclophosphamide
BEACOPP	bleomycin, etoposide, Adriamycin (doxorubicin), cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone
CAF	cyclophosphamide, Adriamycin (doxorubicin), fluorouracil
CEPP	cyclophosphamide, etoposide, procarbazine, prednisone
CFAR	cyclophosphamide, fludarabine, alemtuzumab, rituximab
CHOP	cyclophosphamide, hydroxydaunomycin (doxorubicin), Oncovin (vincristine), prednisone
CLAG-M	cladribine, Ara-C (cytarabine), mitoxantrone
COPDAC	cyclophosphamide, Oncovin (vincristine), prednisone, dacarbazine
COPP	cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone

Regimen	Component drugs
CVD	cisplatin, vinblastine, dacarbazine
CVP	cyclophosphamide, vincristine, prednisone
DHAP	dexamethasone, high-dose Ara-C (cytarabine), Platinol (cisplatin)
EOX	epirubicin, oxaliplatin, Xeloda (capecitabine)
EPOCH	etoposide, prednisone, Oncovin (vincristine), cyclophosphamide, hydroxydaunomycin (doxorubicin)
ESHAP	etoposide, Solu-Medrol (methylprednisolone), Ara-C (cytarabine), Platinol (cisplatin)
FAMTX	fluorouracil, Adriamycin (doxorubicin), MTX (methotrexate)
FLAG-IDA	fludarabine, Ara-C (cytarabine), G-CSF (filgrastim), idarubicin
FOLFIRI	folinic acid, fluorouracil, irinotecan
FOLFIRINOX	folinic acid, fluorouracil, irinotecan, oxaliplatin
FOLFOX	folinic acid, fluorouracil, oxaliplatin
GEMOX	gemcitabine, oxaliplatin
Hyper-CVAD	cyclophosphamide, vincristine, Adriamycin (doxorubicin), dexamethasone
ICE	ifosfamide, carboplatin, etoposide
JEB	JM8 (carboplatin), etoposide, bleomycin
MAID	mesna, Adriamycin (doxorubicin), ifosfamide, dacarbazine
MINE	mesna, ifosfamide, Novantrone (mitoxantrone), etoposide (Etopophos, Toposar, VePesid, etoposide phosphate, VP-16)
MMM	mitoxantrone, mitomycin, methotrexate
MOPP	mechlorethamine, Oncovin (vincristine), prednisone, procarbazine
MVAC	methotrexate, vinblastine, Adriamycin (doxorubicin), cisplatin
OPPA	Oncovin (vincristine), procarbazine, prednisone, Adriamycin (doxorubicin)
PAC	Platinol (cisplatin), Adriamycin (doxorubicin), cyclophosphamide
PCV	procarbazine, CCNU (lomustine), vincristine
PEB	Platinol (cisplatin), etoposide, bleomycin
TAC	Taxotere (docetaxel), Adriamycin (doxorubicin), cyclophosphamide
TIP	Taxol (paclitaxel), ifosfamide, Platinol (cisplatin)
VAD	vincristine, Adriamycin (doxorubicin), dexamethasone
VAMP	vincristine, Adriamycin (doxorubicin), methotrexate, prednisone

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Regimen**:** ABVD
Component drugs Adriamycin (doxorubicin), bleomycin, vinblastine, dacarbazine

Regimen**:** ABVE
Component drugs Adriamycin (doxorubicin), bleomycin, vinblastine, etoposide

Regimen**:** ACE
Component drugs Adriamycin (doxorubicin), cyclophosphamide, etoposide

Regimen**:** ADE
Component drugs Ara-C (cytarabine), daunorubicin, etoposide

Regimen**:** ADOC
Component drugs cisplatin, doxorubicin (Adriamycin), Oncovin (vincristine), cyclophosphamide

Regimen**:** BEACOPP
Component drugs bleomycin, etoposide, Adriamycin (doxorubicin), cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone

Regimen**:** CAF
Component drugs cyclophosphamide, Adriamycin (doxorubicin), fluorouracil

Regimen**:** CEPP
Component drugs cyclophosphamide, etoposide, procarbazine, prednisone

Regimen**:** CFAR
Component drugs cyclophosphamide, fludarabine, alemtuzumab, rituximab

Regimen**:** CHOP
Component drugs cyclophosphamide, hydroxydaunomycin (doxorubicin), Oncovin (vincristine), prednisone

Regimen**:** CLAG-M
Component drugs cladribine, Ara-C (cytarabine), mitoxantrone

Regimen**:** COPDAC
Component drugs cyclophosphamide, Oncovin (vincristine), prednisone, dacarbazine

Regimen**:** COPP
Component drugs cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone

Regimen**:** CVD
Component drugs cisplatin, vinblastine, dacarbazine

Regimen**:** CVP
Component drugs cyclophosphamide, vincristine, prednisone

Regimen**:** DHAP
Component drugs dexamethasone, high-dose Ara-C (cytarabine), Platinol (cisplatin)

Regimen**:** EOX
Component drugs epirubicin, oxaliplatin, Xeloda (capecitabine)

Regimen**:** EPOCH
Component drugs etoposide, prednisone, Oncovin (vincristine), cyclophosphamide, hydroxydaunomycin (doxorubicin)

Regimen**:** ESHAP
Component drugs etoposide, Solu-Medrol (methylprednisolone), Ara-C (cytarabine), Platinol (cisplatin)

Regimen**:** FAMTX
Component drugs fluorouracil, Adriamycin (doxorubicin), MTX (methotrexate)

Regimen**:** FLAG-IDA
Component drugs fludarabine, Ara-C (cytarabine), G-CSF (filgrastim), idarubicin

Regimen**:** FOLFIRI
Component drugs folinic acid, fluorouracil, irinotecan

Regimen**:** FOLFIRINOX
Component drugs folinic acid, fluorouracil, irinotecan, oxaliplatin

Regimen**:** FOLFOX
Component drugs folinic acid, fluorouracil, oxaliplatin

Regimen**:** GEMOX
Component drugs gemcitabine, oxaliplatin

Regimen**:** Hyper-CVAD
Component drugs cyclophosphamide, vincristine, Adriamycin (doxorubicin), dexamethasone

Regimen**:** ICE
Component drugs ifosfamide, carboplatin, etoposide

Regimen**:** JEB
Component drugs JM8 (carboplatin), etoposide, bleomycin

Regimen**:** MAID
Component drugs mesna, Adriamycin (doxorubicin), ifosfamide, dacarbazine

Regimen**:** MINE
Component drugs mesna, ifosfamide, Novantrone (mitoxantrone), etoposide (Etopophos, Toposar, VePesid, etoposide phosphate, VP-16)

Regimen**:** MMM
Component drugs mitoxantrone, mitomycin, methotrexate

Regimen**:** MOPP
Component drugs mechlorethamine, Oncovin (vincristine), prednisone, procarbazine

Regimen: MVAC	
Component drugs	methotrexate, vinblastine, Adriamycin (doxorubicin), cisplatin
Regimen: OPPA	
Component drugs	Oncovin (vincristine), procarbazine, prednisone, Adriamycin (doxorubicin)
Regimen: PAC	
Component drugs	Platinol (cisplatin), Adriamycin (doxorubicin), cyclophosphamide
Regimen: PCV	
Component drugs	procarbazine, CCNU (lomustine), vincristine
Regimen: PEB	
Component drugs	Platinol (cisplatin), etoposide, bleomycin
Regimen: TAC	
Component drugs	Taxotere (docetaxel), Adriamycin (doxorubicin), cyclophosphamide
Regimen: TIP	
Component drugs	Taxol (paclitaxel), ifosfamide, Platinol (cisplatin)
Regimen: VAD	
Component drugs	vincristine, Adriamycin (doxorubicin), dexamethasone
Regimen: VAMP	
Component drugs	vincristine, Adriamycin (doxorubicin), methotrexate, prednisone

The following resources offer more information about chemotherapy:

American Cancer Society

American Society of Clinical Oncology

Chemocare

National Cancer Institute

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