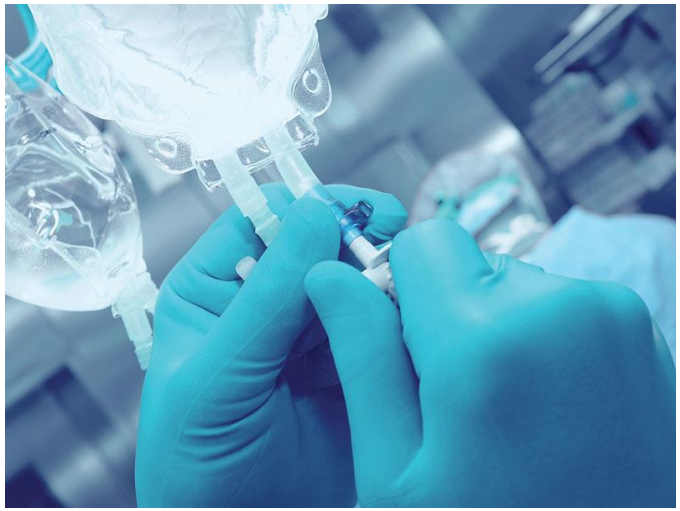
Chemotherapy Agents



August 2023

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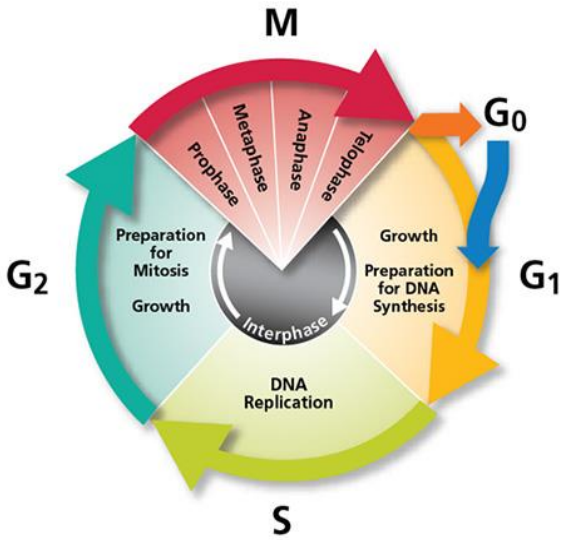
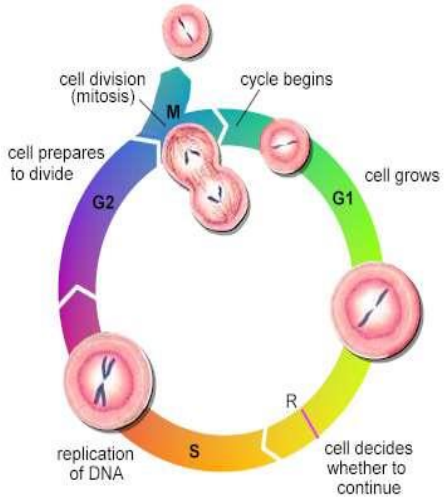
Abbreviation Table

ALL	Acute lymphocytic leukemia
AML	Acute myeloid leukemia
ANLL	Acute non lymphocytic leukemia
APL	Acute promyelocytic leukemia
APL differentiation syndrome	Acute promyelocytic leukemia differentiation syndrome
AUC	Area under the curve
BCG	Bacillus Calmette-Guerin (BCG) Treatment
CBC	Complete blood count
CLL	Chronic lymphocytic leukemia
CML	Chronic myeloid leukemia
CNS tumors	Central nervous system tumors
ECG	Electrocardiogram
GI	Gastrointestinal
HL	Hodgkin's lymphoma
IM	Intramuscular
IV	Intravenous
LFT	Liver function testing
MDS	Myelodysplastic syndrome
MM	Multiple myeloma
MOA	Mechanism of action
NHL	Non-Hodgkin’s lymphoma
NSAID	Non-steroidal anti-inflammatory drug
NSCLC	Non-small cell lung cancer
PFT	Pulmonary function testing
PO	Oral
REMS	Risk evaluation mitigation strategy
SCLC	Small cell lung cancer
SCT	Stem cell transplant
SIADH	Syndrome of inappropriate antidiuretic hormone secretion
SQ	Subcutaneous
TLS	Tumor lysis syndrome

The Cell Cycle

The Cell Cycle					
Phase	Gap 0 (G0), resting or dormant phase	Gap 1 (G1), postmitotic phase	Synthesis (S)	Gap 2 (G2), premitotic phase	Mitosis (M) phase
Process	Temporarily out of cell cycle; not actively reproducing	First phase of reproduction; growth occurs by synthesizing proteins and RNA needed for cell division.	DNA is replicated.	Second phase of protein and RNA synthesis; preparation for mitotic spindle formation occurs; cell is prepared for division.	Cell division occurs; mitosis causes the formation of two cells with exact copies of parent cells' DNA.
Note. Based on information from Olsen et al., 2019.					





Alkylating Agents;

Mechanism of Action (MOA): Alkylating agents are cell-cycle nonspecific drugs that exert effects in all phases of the cell cycle. These agents break the DNA helix strand, which interferes with the DNA replication process and results in cell death. These medications are given intermittently, allowing the patient time to recover from toxicities prior to administering the medication again.

All alkylating agents are highly emetogenic.

Classes of Alkylating Agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Alkyl sulfonates busulfan (Myleran po, Busulfex IV)	CML, hematopoietic stem cell transplant preparation	Profound tachycardia, hypertension, chest pain, hyperpigmentation, alopecia, confusion, seizures, mucositis, nausea, vomiting, insomnia, hyperglycemia, blurred vision, increased risk of hepatic sinusoidal obstruction syndrome	Myelosuppression, pulmonary fibrosis	Irritant: Cold	Administer seizure prophylaxis. IV form should be administered through a central line and has been associated with inflammation and pain during infusion. Increased risk of hepatic sinusoidal obstruction syndrome. Risk for secondary malignancy. Patients need to be educated on this.
Aziridines altretamine (Hexalen)	Ovarian cancer	Nausea, vomiting, skin rash, hypersensitivity reaction, diarrhea	Neurotoxicity, peripheral neuropathy, myelosuppression	None	Do not open capsules. Instruct patients to take after meals and at bedtime. Monoamine oxidase inhibitor antidepressants should be avoided because severe orthostatic hypotension may occur. Monitor for progressive neurologic toxicity.
thiotepa (Thioplex)	Bladder cancer, breast cancer, ovarian cancer, HL, NHL	Fatigue, weakness, fever, hypersensitivity reaction, nausea, vomiting, pain at infusion site, rash, alopecia, mucositis, hemorrhagic cystitis	Myelosuppression	None	Use with caution in patients with severe renal or hepatic dysfunction.
Nitrogen mustards bendamustine (Treanda)	CLL, Indolent NHL	Myelosuppression	Myelosuppression	Vesicant or irritant: Cold	Bendamustine may inflame and irritate peripheral veins and can cause skin and tissue damage (irritant and vesicant properties). Monitor closely for infusion reactions (especially in second or subsequent cycles).

Classes of Alkylating Agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
cyclophosphamide (Cytoxan)	Breast cancer, ovarian cancer, multiple myeloma, leukemias, lymphomas, neuroblastoma, retinoblastoma	Vomiting, nausea, alopecia, may cause a temporary maxillary burning if administered too quickly High-dose: Acute cardiomyopathy, SIADH	Hemorrhagic cystitis, myelosuppression	Irritant: None	Aggressive hydration and frequent bladder emptying can help reduce frequency and severity of bladder toxicity and hemorrhagic cystitis. Mesna may be considered in conjunction with hydration for prevention of hemorrhagic cystitis. Previous or concurrent radiation may increase toxicities. Risk for viral infections. Risk for secondary malignancy. Patients need to be educated.
ifosfamide (Ifex)	Lymphoma, testicular cancer, sarcomas	Nausea, alopecia, vomiting, neurotoxicity (somnolence, confusion, hallucinations, depressive psychoses, and encephalopathy), urotoxicity cardiotoxicity, pulmonary toxicity	Hemorrhagic cystitis, myelosuppression	Irritant: None	Administer over at least 30 minutes. Patient should receive extensive hydration of at least 2 liters IV or oral fluid per day. Hemorrhagic cystitis can be severe and can be reduced by the prophylactic use of mesna.
melphalan (Alkeran)	Multiple myeloma, ovarian cancer	Nausea, vomiting, mucositis, hypersensitivity reactions	Myelosuppression	Vesicant: None	Instruct patients to take on an empty stomach. Application of ice chips to oral cavity is recommended during high dose melphalan administration to prevent oral mucositis. Melphalan has been described as an irritant and a vesicant. Administer over 15–20 minutes into a fast-running IV solution into an injection port on the IV tubing; do not administer by direct injection into a peripheral vein.

Classes of Alkylating Agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
mechlorethamine (Mustargen)	HL, NHL, CLL, CML, polycythemia vera, mycosis fungus	Severe nausea, vomiting, alopecia, myelosuppression, hyperuricemia, pain or phlebitis at IV site, chills, fever		Vesicant Antidote: Sodium thiosulfate	Drug is a vesicant and irritant. Administer through the side arm of a free flowing IV. Flush with 125–150 ml NS following infusion to minimize phlebitis.
Nitrosoureas: Cross blood-brain barrier Carmustine (BCNU)	HL, NHL, CNS tumors, multiple myeloma	Nausea, vomiting, renal toxicity	Myelosuppression, pulmonary toxicity	Irritant: None	Nadir occurs 4–6 weeks after therapy starts. Rapid infusion may cause burning along the vein and flushing of the skin (infuse over at least 2 hours). Long-term therapy can result in irreversible pulmonary fibrosis. Cumulative dose of 1,400 mg/m2 should not be exceeded because of pulmonary toxicity.
Lomustine (CNU)	CNS and brain tumors, HL	Pulmonary toxicity, secondary malignancies, hepatotoxicity, nephrotoxicity, nausea, vomiting, alopecia, fatigue, visual disturbances	Myelosuppression	None	Oral agent. Because of delayed myelosuppression, do not repeat the dose more than once every 6 weeks. Only 1 dose should be dispensed per treatment cycle. Patients should take on an empty stomach. Monitor PFTs, LFTs, and renal function
Streptozocin (Zanostar)	Metastatic pancreatic carcinoma	Myelosuppression, nausea, vomiting, hypoglycemia, proteinuria, hepatotoxicity, confusion, lethargy, depression	Renal toxicity	Vesicant and irritant: None	Nephrotoxicity may be dose limiting.
Platinums carboplatin (Paraplatin)	Bladder cancer, head and neck cancer, germ cell tumors, lung cancer ovarian cancer, NHL, testicular cancer	Nausea, vomiting, hypersensitivity reaction, mild alopecia, skin rash.	Thrombocytopenia	Irritant: None	Check creatinine level prior to each dose (for AUC dosing). Have emergency medications available for hyper-sensitivity reaction, which may occur during any dose of therapy or be delayed.

Classes of Alkylating Agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
cisplatin (Platinol)	Esophageal cancer, head and neck cancer, lung cancer, ovarian cancer, testicular cancer, bladder cancer	Severe acute and delayed nausea, vomiting, ototoxicity (tinnitus and high-frequency hearing loss are most common), hyperuricemia, hypersensitivity reaction, hypomagnesia and other electrolyte abnormalities, peripheral neuropathy.	Severe nephrotoxicity, myelosuppression	Vesicant Antidote: Sodium thiosulfate	Mannitol (to maximize urine flow) and rigorous hydration (prehydration and post-hydration with NS) may reduce nephrotoxicity. Monitor serum creatinine prior to each dose. Renal function must return to normal before subsequent doses are administered; renal toxicity becomes more prolonged and severe with repeated courses. Potential exists for delayed nausea and vomiting up to 6 days after administration. Consider obtaining a baseline audiogram. Monitor electrolytes and replace as needed.
oxaliplatin (Eloxatin)	Colorectal cancers, esophageal cancer, pancreatic cancer	Acute, reversible, primary peripheral sensory neuropathy that presents within 1–48 hours, resolves within 14 days, and manifests as paresthesia, dysesthesia, or hypesthesia in hands, feet, oral cavity, and throat; can be aggravated by cold temperatures. Anaphylactic reaction, nausea, vomiting, diarrhea, pulmonary fibrosis, fatigue, fever	Peripheral neuropathy, myelosuppression	Vesicant: Heat Antidote: Dexamethasone (limited data)	For 3–4 days after therapy, patients should avoid consuming cold drinks and foods and breathing cold air (cover mouth with scarf). Dose reduce in patients with severe renal impairment

Classes of Alkylating Agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Triazenes and hydrazines dacarbazine (DTIC-DOME)	Metastatic malignant melanoma, HL	Severe nausea and vomiting for up to 12 hours, anorexia, alopecia, rash, flu-like syn- drome (fever, malaise, myalgias), hypotension, hypersensitivity reaction, photosensitivity.	Severe neutropenia and thrombocytopenia	Vesicant and irritant: None	Protect solution from light. Flu-like syndrome may occur up to 7 days after drug administration; treat symptoms.
temozolomide (Temodar)	Refractory anaplastic astrocytoma, glioblastoma multiforme	Nausea, vomiting, headache, fatigue, hepatic toxicity, constipation, rash, alopecia	Myelosuppression		Oral: Do not open capsules. Instruct patients to take on an empty stomach to decrease risk of nausea and vomiting. Do not administer temozolomide if patients have had an allergic reaction to dacarbazine. IV: Temozolomide is only compatible with 0.9% sodium chloride
Miscellaneous agents trabectedin (Yondelis)	Leiomyosarcoma liposarcoma, ovarian cancer, sarcomas	Capillary leak syndrome, nausea, vomiting, fatigue, rhabdomyolysis	Myelosuppression, (neutropenic sepsis) hepatotoxicity, cardiomyopathy	Vesicant: Cold	Drug is administered as a 24-hour continuous infusion and must be given through a central line with a 0.2 micron filter. Infusion must be completed within 30 hours of reconstitution. Trabectedin is a vesicant; extravasation can result in severe tissue injury. Premedicate with 20 mg IV dexamethasone 30 minutes prior to infusion. Dose reduce in patients with hepatic impairment. Trabectedin is metabolized through the CYP3A pathway; use caution when administering con-currently with CYP3A inducers or inhibitors

Antimetabolites

Mechanism of Action (MOA):

Antimetabolites are cell cycle–specific anticancer agents. Their effects are exerted during the synthesis phase of the cell cycle when incorporated into RNA and DNA. They disrupt DNA synthesis by interfering with one or more enzymes required for DNA synthesis. This prohibits DNA replication and cell proliferation, resulting in cell death. Cell cycle–specific drugs are most effective when given in divided, frequent doses. They are also given as a continuous infusion for a short cycle time. Antimetabolites are toxic to normal cells.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Folate antagonists methotrexate (Folfex)	NHL, leukemia, CNS lymphoma, lung cancer, breast cancer, head and neck cancer, osteosarcoma	Mucositis, nausea, vomiting, myelosuppression, oral or GI ulceration, pneumonitis, photosensitivity, neurotoxicity associated with high-dose therapy	Hepatotoxicity, renal toxicity	Irritant: None	High-dose methotrexate doses are adjusted for patients with renal dysfunction. High doses must be followed by timely administration of leucovorin and alkaline hydration. Follow dosing schedule carefully. Monitor serum methotrexate levels until < 0.1 mcmol/L. Monitor urine pH and maintain > 7 before and until serum methotrexate levels <0.05 mcmol/L. Depending on methotrexate clearance, some patients may require additional leucovorin rescue and serum methotrexate monitoring. Instruct patients on strict mouth care. Ensure that patients avoid taking multivitamins with folic acid.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
pemetrexed (Alimta®)	Mesothelioma nonsquamous NSCLC	Myelosuppression, fatigue, nausea, vomiting, anorexia, chest pain, and dyspnea. Vitamin supplementation reduces these side effects.	None	None	Infuse over 10 minutes. To reduce treatment-related hematologic and GI toxicities, administer folic acid 400–1,000 mcg PO daily starting 1 week prior to the first cycle and daily for 3 weeks after final cycle. Give vitamin B12 injection 1,000 mcg IM 1 week before first cycle and repeat every 9 weeks until treatment is completed. Dexamethasone 4 mg BID for 3 days starting the day before treatment decreases incidence of rash. Monitor renal and hepatic function. Concurrent use of NSAIDs may increase the risk of renal damage.
Purine analogs cladarabine (Leustatin)	Hairy cell leukemia	Fever, nausea, vomiting, hypersensitivity reaction, TLS, nephrotoxicity (high-dose therapy)	Myelosuppression, neurotoxicity	Irritant	Use with caution in patients with liver and renal dysfunction
fludarabine (Fludara)	CLL	TLS, nausea, vomiting, diarrhea, rash, neurotoxicity, interstitial pneumonitis, weakness, hemolytic anemia, cough, infection	Myelosuppression, neurotoxicity	None	Monitor PFTs. Allopurinol and IV hydration are recommended for newly diagnosed patients with CLL or patients with high tumor burden to prevent TLS. Do not use in combination with pentostatin, because it may cause severe pulmonary toxicity. Use with caution in patients with renal impairment. Oral: Tablets may be taken with or without food and must not be chewed. Do not break or crush tablets.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
6-Mercapto- purine (6-MP; Purinethol®)	ALL	Myelosuppression, hepatotoxicity, mucositis, nausea, vomiting, anorexia, hyperuricemia, hyperuricosuria, alopecia, rash, hyperpigmentation			Reduce oral dose by 75% when used concurrently with allopurinol. Instruct patient to take on an empty stomach.
nelarabine (Arranon)	T-cell ALL, T-cell lymphoblastic lymphoma	Myelosuppression, headache, nausea, vomiting, diarrhea, constipation, cough, fatigue, peripheral neuropathy, dyspnea, neurologic toxicities (somnolence, seizures, ataxia)	Neurotoxicity	None	Drug is administered as an undiluted IV infusion over 2 hours. Administer with appropriate supportive care medications to prevent hyperuricemia and TLS. Discontinue for > grade 2 neurologic events (severe somnolence, seizure, and peripheral neuropathy). Use caution in patients with renal or hepatic dysfunction.
pentostatin (Nipent)	Hairy cell leukemia	Acute pulmonary edema, hypotension, fever, chills, nausea, vomiting, rash, renal toxicity, confusion, hepatic enzyme elevation, heightened infection risk, cough.	Myelosuppression	None	Do not administer with fludarabine, carmustine, etoposide, or high-dose cyclophosphamide.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Pyrimidine analogs azacytidine (Vidaza)	MDS, AML, CML	TLS, nausea, vomiting, diarrhea, fatigue, fever, erythema at injection site, constipation IV only: Petechiae, rigors, weakness, hypokalemia	Myelosuppression, renal failure, hepatic toxicity	None	Monitor CBC and liver and renal function during therapy. Drug is contraindicated in patients with hypersensitivity to azacitidine or mannitol and those with advanced malignant hepatic tumors.
capecitabine (Xeloda)	Colon cancer, metastatic colorectal cancer, metastatic breast cancer	Mucositis, nausea, vomiting, myelosuppression, increased bilirubin, fatigue	Diarrhea, palmar-plantar erythrodysesthesia (hand-foot syndrome)	None (oral agent)	This is the oral equivalent to 5-FU. Patient education regarding importance of reporting toxicity and dose reduction is critical. Drug is contraindicated in patients with known hypersensitivity to 5-FU. Monitor PT/INR closely, as capecitabine increases effect of warfarin. Administer with food and water.
cytarabine (Cytosar)	ALL, AML, CML, CNS leukemia	Nausea, vomiting, anorexia, fever, mucositis, diarrhea, hepatic dysfunction, rash, pruritus, localized pain and thrombophlebitis at IV site. High-dose (1–3 g/m2): Cerebellar toxicity, keratitis (treat with dexamethasone ophthalmic drops), dermatologic toxicities	Myelosuppression	Irritant	Toxicities vary depending on rate of high dose cytarabine administration. Continuous infusion cytarabine is associated with pulmonary toxicity and bolus administration is associated with cerebellar toxicities. Specific nursing interventions are warranted for each.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
decitabine (Dacogen)	MDS, AML, CML	Myelosuppression, fever, fatigue, nausea, cough, diarrhea, hyperglycemia, petechiae, peripheral edema		None	Patients should be treated for a minimum of 4-6 cycles as it may take multiple cycles to see an effect. Dose adjustments may be needed depending on hematologic response. No formal recommendations, but may need to hold dose until hepatic dysfunction resolves (T Bili or SGPT < 2 x ULN – decitabine specific) Renal Dysfunction No formal recommendations, but may need to hold dose until renal dysfunction resolves.
floxuridine (FUDR)	GI adenocarcinoma with metastasis to liver	Myelosuppression, nausea, vomiting, diarrhea, stomatitis, mucositis, localized erythema, alopecia, photosensitivity, darkening of the veins, abdominal pain, gastritis, enteritis, hepatotoxicity		Irritant	Administered Intra arterial.
5-Flurorouracuil (Adrucil)	Colorectal cancer, breast cancer, gastric cancer, pancreatic cancer	Nausea, anorexia, vomiting, diarrhea, alopecia, ocular toxicities (e.g., increased lacrimation, photosensitivity), darkening of the veins, dry skin, neurotoxicity, palmar-plantar erythrodysesthesia (hand-foot syndrome)	Mucositis, Myelosuppression	Irritant	Ensure that patients take year-round photosensitivity precautions; encourage sunscreen use if patients must be exposed. Leucovorin often is given concurrently to enhance 5-FU activity. Apply ice chips to the oral cavity 10–15 minutes pre- and post-IV bolus dose of 5-FU to reduce oral mucositis in patients with GI malignancies. Ice chips are not recommended in patients receiving capecitabine or oxaliplatin because of potential discomfort with exposure to coldness.

Classes of Antimetabolites	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
gemcitabine (Gemzar)	Pancreatic cancer, breast cancer, ovarian cancer, NSCLC	Nausea, vomiting; flu-like symptoms including fever, headache, arthralgias, and myalgias; rash, peripheral edema, dyspnea, pulmonary toxicity with increased infusion time, hepatotoxicity	Myelosuppression (especially thrombocytopenia)	Irritant	Hematologic toxicity. Use with caution in patients with renal impairment. Increased (severe and life-threatening) toxicity may occur when gemcitabine is administered within 7 days of radiation therapy.

Antitumor Antibiotics: Topoisomerase II Inhibitors

MOA: Antitumor antibiotics are cell cycle nonspecific. They are Topoisomerase II inhibitors. They work by binding with DNA, thereby inhibiting DNA and RNA synthesis.

Classes of Antitumor antibiotics	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Anthracenediones bleomycin sulfate (Blenoxane)	Testicular cancer, HL, NHL, squamous cell cancers of the head and neck, cervix, vulva, and penis	Hyperpigmentation, alopecia, photosensitivity, renal toxicity, hepatotoxicity, fever, chills, erythema, rash, mucositis	Hypersensitivity or anaphylactic reaction (rare), pulmonary toxicity	Vesicant or irritant	Bleomycin is not compatible with D5W. Patients have a high incidence of anaphylaxis (usually occurring after the first or second dose). Therefore (per institutional protocol), two test doses of 1–2 units IV, IM, or SC may be administered before the first regular dose of bleomycin. Patients who have received prior bleomycin are at risk for pulmonary toxicity when exposed to oxygen during surgery. Ensure that patients and family members understand the lifelong necessity of disclosing previous use of bleomycin when future needs for anesthesia occur to prevent a fatal episode of pulmonary failure. Because of the dose related incidence of pulmonary fibrosis, the cumulative lifetime dose should not exceed 400 units. PFTs are recommended at initiation of bleomycin and every 1–2 months thereafter. Consider stopping drug if a 30%–35% decrease from pretreatment values occurs. Acetaminophen and an antihistamine may decrease fever and chills in first 24 hours after administration.

Classes of Antitumor antibiotics	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
dactinomycin (Actininomycin-D)	Wilms tumor, testicular cancer, sarcomas	Nausea, vomiting, alopecia, mucositis, diarrhea, radiation recall, sinusoidal obstruction syndrome, renal toxicity, hepatotoxicity	Myelosuppression	Vesicant: Cold	Dactinomycin is highly toxic and corrosive to soft tissues; inhalation and contact with the eyes must be avoided.
mitomycin C (Mutamycin)	Pancreatic cancer, stomach cancer, bladder cancer	Nausea, vomiting, anorexia, fever, renal toxicity, pulmonary toxicity, fatigue	Myelosuppression	Vesicant: Cold	Drug is purple/blue in color. Mitomycin is a vesicant; extravasation can result in severe tissue injury. Nadir occurs within 8 weeks after treatment begins (average of 4 weeks). Acute shortness of breath and bronchospasm can occur very suddenly when this drug is given with a vinca alkaloid. Hemolytic uremic syndrome has been seen with a single dose > 60 mg. Mitomycin is contraindicated in patients with coagulation disorders.

Classes of Antitumor antibiotics	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
mitoxantrone (Novantrone)	Prostate cancer, ANLL	Nausea, vomiting, mucositis, alopecia, fever, weakness, hyperuricemia, amenorrhea, blue green–colored urine, bluish skin or sclera	Myelosuppression, cardiotoxicity	Vesicant and irritant: Cold	Drug is blue in color. Mitoxantrone is fatal if given intrathecally. Risk of cardiotoxicity with mitoxantrone is less than that with doxorubicin, but prior anthracycline use, chest irradiation, or cardiac disease increases risk. Prior to beginning therapy, evaluate patients for cardiac signs and symptoms, including obtaining multigated acquisition scan, baseline left ventricular ejection fraction, and ECG. Mitoxantrone should not be used in patients with hepatic impairment.
Anthracyclines daunorubicin (Cerubidine)	Induction therapy for AML, ALL	Nausea, vomiting, alopecia, mucositis,	Myelosuppression, cardiotoxicity	Vesicant: Cold Antidote: Dexrazoxane	Total lifetime daunorubicin dose in adults is 550 mg/ m2 in those without cardiovascular risk factors and 400 mg/m2 in adults receiving chest irradiation.
daunorubicin, liposomal (DaunoXomel)	AML	Nausea, vomiting, alopecia, mucositis	Myelosuppression, cardiotoxicity,	Irritant	Drug with liposome is protected from systemic degradation. Cardiotoxicity is less. Extravasation injuries are less
doxorubucin (Adriamycin)	Breast cancer ALL, AML, HL, NHL, Wilms tumor, neuroblastoma, sarcoma, ovarian cancer, bladder cancer, thyroid cancer, stomach cancer	Nausea, vomiting, alopecia, mucositis, radiation recall, hyperuricemia, photosensitivity, red-colored urine	Myelosuppression, cardiotoxicity, hepatotoxicity	Vesicant: Cold Antidote: Dexrazoxane	Drug is red in color. Dose reduce in patients with elevated serum total bilirubin. Test patients' cardiac ejection fraction before starting therapy. Do not exceed a lifetime cumulative dose of 550 mg/m2 (450 mg/m2 if the patient has had prior chest irradiation or concomitant cyclophosphamide treatment). Consider initiating dexrazoxane for cardiac protection in patients who have received a cumulative dose of 300 mg/m2 and are continuing. doxorubicin treatment.

Classes of Antitumor antibiotics	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
doxorubicin, liposomal (Doxil®)	Ovarian cancer, AIDS-related Kaposi sarcoma, multiple myeloma	Nausea, vomiting, alopecia, mucositis, arrhythmia, amenorrhea, radiation recall, palmar-plantar erythrodysesthesia, hypersensitivity reaction, red-colored urine	Myelosuppression, cardiotoxicity, infusion-related reactions	Vesicant: Cold	Drug is red in color. The same warnings as with conventional doxorubicin apply regarding cardiovascular complications. Do not substitute for doxorubicin. Do not use an in-line filter.
epirubicin (Ellence®)	Breast cancer	Nausea, vomiting, mucositis, diarrhea, alopecia, amenorrhea, infection, hyperuricemia, radiation recall, flushing, red-colored urine.	Myelosuppression, cardiotoxicity	Vesicant: Cold Antidote: Dexrazoxane	Drug is red in color. Consider dose reduction in patients with hepatic and severe renal impairment. Cumulative dosing should not exceed 900 mg/m2. Test patients' cardiac ejection fraction before starting epirubicin therapy.
idarubicin (Idamycin)	AML	Hyperuricemia, nausea, vomiting, alopecia, vein itching, radiation recall, rash, mucositis, diarrhea, severe enterocolitis with perforation, red- colored urine	Myelosuppression, cardiotoxicity,	Vesicant: Cold Antidote: Dexrazoxane	Less cardiotoxic than doxorubicin or daunorubicin. Urine will be red. Local reactions (hives at injection site) may occur. Consider dose reduction in patients with renal or hepatic impairment.
valrubicin (Valstar®)	Carcinoma in situ of bladder, BCG refractory disease,	Dysuria, bladder spasm and irritation, urinary incontinence, leukopenia, hyperglycemia; drug may turn the urine red.	None	Vesicant	Administer via intravesical route only. Do not use in pediatric patients. Valrubicin is a vesicant; extravasation can result in severe tissue injury if perforation of bladder occurs. Use non-PVC, non-DEHP containing tubing.

Miscellaneous agents: Group of antineoplastic agents with a unique MOA. They do not fit well into any category or major class of chemotherapeutic agents. They all have a unique side effect profile.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
arsenic trioxide (Trisenox)	APL	Fatigue, prolonged QT interval, APL differentiation syndrome, leukocytosis, headache, nausea, vomiting, diarrhea, abdominal pain, fever, dermatitis, cough, dyspnea, peripheral neuropathy			Box warning: APL differentiation syndrome; QTc prolongation; encephalopathy Use with caution with other agents that prolong QT/QTc interval. Obtain baseline ECG prior to therapy. QTc intervals should be measured periodically during therapy (e.g., weekly). Use with caution in patients with renal impairment. Monitor electrolytes during therapy. Renal or hepatic impairment may increase toxicity risk
asparaginase erwinia chrysanthemi (Erwinaze®)	ALL	Hypersensitivity reaction (including anaphylaxis), pancreatitis, glucose intolerance, thrombosis, abdominal pain, diarrhea			Keep medications to treat anaphylaxis at bedside. Limit the volume of reconstituted asparaginase at a single injection site to 2 ml; if reconstituted dose to be administered is > 2 ml, use multiple injection sites.
pegaspargase (Oncaspar®)	ALL	Pancreatitis, thrombosis, glucose intolerance, coagulopathy, hepatotoxicity, allergic reactions (including anaphylaxis)			When given IM, maximum volume per injection site is 2 ml. When given IV, give over 1–2 hours.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
hydroxyurea (Hydrea®, Mylocel®)	CML, squamous cell cancer of the head and neck	Vasculitic toxicities, macrocytosis, nausea, vomiting, diarrhea, renal failure, mucositis, fever, hyperuricemia, rash, alopecia, second malignancies	Myelosuppression		MOA: Acts in S phase as antimetabolite
procarbazine (Matulane®)	Stage III and IV HL	Nausea, vomiting, hepatic dysfunction	Myelosuppression		Oral pill Patients should avoid foods high in tyramine, such as aged cheeses, air-dried or cured meats, fava or broad bean pods, tap/draft beer, wine, vermouth, marmite concentrate, sauerkraut, and soy sauce and other soy-bean condiments because procarbazine inhibits monoamine oxidase. Patients should avoid alcohol for possible disulfiram like reaction
eribulin (Halaven®)	Metastatic breast cancer, unresectable metastatic liposarcoma	Fatigue, alopecia, nausea, constipation, anemia, QTc prolongation	Neutropenia, peripheral neuropathy		Monitor electrolytes, ECG, and renal and liver function tests. Initiate at lower doses with hepatic or renal insufficiency. eribulin is not compatible with D5W.
romidepsin (Istodax®)	Cutaneous and peripheral T-cell lymphoma	QTc prolongation, fatigue, fever, pruritus, nausea, vomiting, anorexia, constipation, diarrhea, TLS	Myelosuppression, life-threatening infections		Obtain baseline and periodic ECG. Monitor electrolytes and correct imbalances.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
tretinoin (Vesinoid)	Acute Promyelocytic Leukemia (APL) induction, consolidation, maintenance (intermediate and high-risk patients)	Fever, headache, dry skin, dry mucous membranes, hemorrhage, infection, nausea, vomiting, dyspnea			Patients at risk for differentiation syndrome. Treat with steroids immediately, (35% mortality without treatment) Educate patients to report all side effects, especially APL differentiation syndrome, promptly. Monitor CBC with differential, liver function, coagulation profile, cholesterol and triglyceride levels. Avoid medications and supplements that contain vitamin A or vitamin A derivatives. Avoid in 1st trimester in pregnancy. Monitoring pregnancy status (1 week prior to treatment and monthly during treatment) Recommended to use 2 reliable forms of contraception during and for 1 month after tretinoin discontinuation, unless abstinence is the chosen method. Avoid breastfeeding starting 1 week prior to and during treatment.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
lenalidomide (Revlimid)	Multiple myeloma, MDS, Lymphomas	Neutropenia, thrombocytopenia, rash, thrombolytic events, fever, fatigue, diarrhea, headache			Oral pills. Box warning: Pregnancy and thrombolytic events REMS (Risk evaluation mitigation strategy) Patient and prescriber must complete monthly survey before drug can be dispensed. Instruct patient to take with or without food. Increased risk of secondary malignancy Notify provider if skin rash develops (e.g., Stevens-Johnson syndrome) Monitor for s/s of thromboembolic events. Do not donate blood during treatment or for 1 month after stopping treatment. Education about risk for birth defects with males & females Need to use double barrier methods of contraception.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
pomalidomide (Pomalyst)	Relapsed/refractory multiple myeloma, Kaposi sarcoma	Neutropenia, thrombocytopenia, rash, thrombolytic events, fever, fatigue, diarrhea, headache			Oral pills. Box warning: Pregnancy and thrombolytic events REMS (Risk evaluation mitigation strategy) Patient and prescriber must complete monthly survey before drug can be dispensed. Instruct patient to take with or without food. Notify provider if skin rash develops (e.g., Stevens-Johnson syndrome) Monitor for s/s of thromboembolic events. Do not donate blood during treatment or for 1 month after stopping treatment. Precautions: do not handle medication or bodily fluids without gloves Education about risk for birth defects with males & females Need to use double barrier methods of contraception. Monitor CBC, LFTs, and serum creatinine.

Classes of Miscellaneous agents	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
thalidomide (Thalidomid)	Multiple myeloma	Thrombolytic events, fatigue, headache, constipation			REMS (Risk evaluation mitigation strategy) Patient and prescriber must complete monthly survey before drug can be dispensed. Box warning: Pregnancy and thrombolytic events Instruct patient to take medication at bedtime one hour after eating. Notify provider if skin rash develops (e.g., Stevens-Johnson syndrome) Monitor for s/s of thromboembolic events. Do not donate blood during treatment or for 1 month after stopping treatment. Precautions: do not handle medication or bodily fluids without gloves Education about risk for birth defects with males & females Need to use double barrier methods of contraception. Monitor CBC, LFTs, and Serum creatinine.

Plant Alkaloids: Derived from Plants

MOA: Plant alkaloids are cell cycle specific. They work in the S, late G2, and mitosis phases of division. These agents interfere with microtubular function which prevents cell division. They help to disrupt microtubular synthesis and the intracellular structuring so cancer cells cannot replicate.

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Antimicrotubular agents: **Taxanes** **MOA: Stabilize microtubules, inhibiting cell division; effective in G_2 and M phases**					
cabazitaxel (Jevtana)	Hormone refractory metastatic prostate cancer	Hypersensitivity reaction, myelosuppression, fatigue, diarrhea, nausea, vomiting, peripheral neuropathy		Vesicant or irritant: Cold	Premedicate to prevent hypersensitivity reaction, including anaphylaxis, at least 30 minutes before treatment with IV diphenhydramine dexamethasone and ranitidine. Administer over 1-hour infusion through a 0.2 micron in-line filter. Use non-PVC bags and tubing. Do not use in patients with severe hepatic impairment.

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
docetaxel (Taxotere)	Breast cancer, NSCLC, Hormone refractory prostate cancer, gastric adenocarcinoma, squamous cell carcinoma of the head and neck	Myelosuppression, febrile neutropenia, hypersensitivity reaction, fluid retention, alopecia, skin and nail changes, nausea, vomiting, neurotoxicity		Vesicant: Cold	Premedicate to reduce the severity of hypersensitivity reaction and fluid retention with Dexamethasone 8 mg PO BID for 3 days, beginning 1 day prior to docetaxel treatment and continuing for the day of treatment and 1 day after. Docetaxel extravasation may cause local pain, edema, erythema, and hyperpigmentation at infusion site. Use glass or non-PVC containers and tubing. Administer over 1-hour infusion. Fluid retention: educate patient on the use of compression socks and elevating legs as needed.
paclitaxel (Taxol)	Breast cancer, ovarian cancer, NSCLC, AIDS-related Kaposi sarcoma, metastatic bladder cancer	myelosuppression, peripheral neuropathy, alopecia, facial flushing, myalgia, mucositis, diarrhea, nausea	Hypersensitivity reactions including SOB, hypotension, angioedema, (urticaria)	Vesicant or irritant: Cold	8-50% of patients experience hypersensitivity reaction during cycle 1 or 2. Patients should be premedicated to minimize reaction risk with Dexamethasone, diphenhydramine, and ranitidine prior to infusion. Filter paclitaxel with a 0.2 micron in-line filter. Use non-PVC, non-DEHP bags and tubing to administer paclitaxel. To prevent severe myelosuppression, give paclitaxel before platinum-containing drugs.
paclitaxel protein bound (Abraxane, Nab-paclitaxel)	Metastatic breast cancer, NSCLC, metastatic adenocarcinoma of the pancreas	Sepsis, pneumonitis, hypersensitivity reaction, alopecia, anemia, myalgia, arthralgia, nausea, vomiting, diarrhea	Myelosuppression, sensory or peripheral neuropathy	Vesicant or irritant: None	Withhold dose for grade 3–4 peripheral neuropathy; resume only with grade 1 or complete resolution.

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Topoisomerase I inhibitors (Camptothecins) **MOA: Act in S phase; inhibit topoisomerase I; cause double-strand DNA changes**					
topotecan (Hycamtin)	Metastatic ovarian cancer, cervical cancer, SCLC	Diarrhea, alopecia, nausea, vomiting, fatigue, interstitial lung disease	Myelosuppression	Irritant: Cold	Risk for development of secondary malignancies.
irinotecan (Camptosar)	Metastatic colorectal cancer, pancreatic cancer, esophageal cancer	Hypersensitivity reaction, alopecia, fever, nausea, vomiting, diarrhea	Diarrhea, myelosuppression, hypersensitivity reactions	Irritant: none	This drug can cause early and late diarrhea, which can be dose limiting. Early diarrhea can occur within 24 hours of administration and generally is cholinergic. Consider prophylactic or therapeutic administration of 0.25–1 mg of IV or SC atropine. Patients should receive antiemetic premedication: 10 mg dexamethasone and a 5-HT_3 blocker at least 30 minutes prior to administration. Late diarrhea occurring after 24 hours of administration should be treated with loperamide (Imodium) Patients may also be treated with Lomotil and/or octreotide for late diarrhea

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
irinotecan liposomal (Onivyde)	In combination with 5-fluorouracil and leucovorin for the treatment of metastatic adenocarcinoma of the pancreas after disease progression following gemcitabine therapy	Interstitial lung disease, diarrhea, fatigue, nausea, vomiting stomatitis, pyrexia			Less chance for Hypersensitivity reactions. Premedicate with a corticosteroid and an anti- emetic 30 minutes prior to administration.
Topoisomerase II inhibitors Epipodophyllotoxins **MAO: Induce irreversible blockade of cells in premitotic phases of cell cycle (late G_2 and S phases); interfere with topoisomerase II enzyme reaction**					

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
Etoposide (VePesid, VP-16)	Testicular cancer, SCLC, lymphoma, stem cell transplant	Hypersensitivity reaction, nausea, vomiting, alopecia, anorexia, hypotension	Myelosuppression	Vesicant or irritant: None	Can cause hypotension with rapid infusion. Infuse over 30-60 minutes. If a patient has an allergic reaction to etoposide, premedicate with diphenhydramine. Consider dose reduction in patients with renal impairment. Can cause radiation recall. Can cause secondary malignancies and MDS
Vinca Alkaloids **MOA: Act in late G_2 phase, blocking DNA production, and in M phase, preventing cell division**					
vinblastine (Velban)	HL, NHL mycosis fungoides, testicular cancer, Kaposi sarcoma, breast cancer bladder cancer,	neurotoxicity, peripheral neuropathy, jaw pain, alopecia	Myelosuppression, constipation	Vesicant: Heat Antidote: Hyaluronidase	Shorter nadir: 4-10 days Drug is fatal if given via routes other than IV. Drug must be administered via a mini bag through the side port of a free flowing IV. Vinblastine is a vesicant; extravasation can result in severe tissue injury.

Classes of Plant Alkaloids	Indications	Side Effects	Dose Limiting Toxicities	Vesicant/Irritant/ Treatment/ Antidote	Nursing Considerations
vincristine (Oncovin)	ALL, HL, NHL, neuroblastoma Wilms tumor, rhabdomyosarcoma, CNS tumors	Alopecia, peripheral neuropathy, constipation, paralytic ileus, renal toxicity, hepatotoxicity, hypersensitivity reaction	Neurotoxicity, constipation	Vesicant: Heat Antidote: Hyaluronidase	Drug is fatal if given via routes other than IV. Vincristine is a vesicant; extravasation can result in severe tissue injury. Administer via a minibag through the side port of a free flowing IV. Neurotoxicity is cumulative; conduct a neurologic evaluation before each dose. Withhold dose if severe paresthesia, motor weakness, or other abnormality develops. Stool softeners and/or a stimulant laxative may help to prevent severe constipation.
vincristine liposomal (Marqibol)	Philadelphia negative ALL in second or greater relapse whose disease has progressed after 2 or more antileukemic regimens.	Fatigue, nausea, pyrexia, myelosuppression, neurologic toxicity, TLS, liver toxicity, constipation, embryofetal toxicity		Vesicant: Heat Antidote: Hyaluronidase	Vincristine liposomal is a vesicant; extravasation can result in severe tissue injury. Drug is fatal if given via routes other than IV
vinorelbine (Navelbine)	NSCLC, breast	Nausea, vomiting, alopecia	Myelosuppression, hepatic toxicity, severe constipation and bowel obstruction, neurologic toxicity (peripheral neuropathy), pulmonary toxicity	Vesicant: Heat Antidote: Hyaluronidase	Vinorelbine is fatal if given via routes other than vesicant intravenously. Vinorelbine is an irritant with vesicant potential. Extravasation can result in severe tissue injury. Administer via a minibag through the side port of a free flowing IV. Flush with 75–125 ml solution after completion of vinorelbine administration to prevent phlebitis.

Disclaimer: This appendix is reviewed and annually updated. Not all side effects and indications are included in this table. Please refer to UpToDate for the most recent list of medications

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