EDUCATION UPDATE

Allegheny Health Network Cancer Institute

FUNDAMENTALS of ANTICANCER THERAPY COURSE

PRACTICE WORKBOOK

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ACT YouTube Videos

Anticancer Therapy ACT Release | AHN Cancer Institute	https://youtu.be/Sy72uT2cXiE
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Extravasation | AHN Cancer Institute	https://youtu.be/lyaqyHrHjHY
Anticancer Therapy ACT Hypersensitivity | AHN Cancer Institute	https://youtu.be/CULFdZ_p8xg
Spill Kit/ PAPR Demonstration | AHN Cancer Institute	https://youtu.be/mDoTJX8HtsE
ACT Spills | AHN Cancer Institute	https://youtu.be/rmiDTj5SrME

ABBREVIATION REFERENCE

ABC—adenosine triphosphate–binding cassette
AC—anthracycline plus cyclophosphamide
ACCC—Association of Community Cancer Centers
ACE—angiotensin-converting enzyme
ACoS CoC—American College of Surgeons Commission on Cancer
ACS—American Cancer Society
ACVBP—doxorubicin, cyclophosphamide, vindesine, bleomycin, prednisone
ADL—activities of daily living
AE—adverse event
AHRQ—Agency for Healthcare Research and Quality
AI—aromatase inhibitor
AIDS—acquired immunodeficiency syndrome
AJCC—American Joint Committee on Cancer
AKI—acute kidney injury
ALK—anaplastic lymphoma kinase
ALL—acute lymphoblastic leukemia
ALP—alkaline phosphatase
ALT—alanine aminotransferase
AML—acute myeloid leukemia
ANA—American Nurses Association
ANC—absolute neutrophil count
ANLL—acute nonlymphocytic leukemia
Anti-HBc—hepatitis B core antibody
APL—acute promyelocytic leukemia
APOE—apolipoprotein E
Ara-C—cytarabine
ARDS—acute respiratory distress syndrome
ASCO—American Society of Clinical Oncology
ASHP—American Society of Health-System Pharmacists
ASM—aggressive systemic mastocytosis
AST—aspartate aminotransferase
ATRA—all-trans-retinoic acid **AUC**—area under the plasma concentration versus time curve
BCG—bacillus Calmette-Guérin
BCRP—breast cancer resistance protein
BDNF—brain-derived neurotrophic factor **BID**—twice daily
BMD—bone mineral density
BMI—body mass index
BNP—B-type (brain) natriuretic peptide
bpm—beats per minute
BRCA—breast cancer gene
BSA—body surface area
BSC—biosafety cabinet
BTK—Bruton tyrosine kinase
BUN—blood urea nitrogen
CAB—combined androgen blockade
CACI—compounding aseptic containment isolator
CAR—chimeric antigen receptor
CBC—complete blood count
CBT—cognitive behavioral therapy
CBT-I—cognitive behavioral therapy for insomnia
CD—cluster of differentiation
CDK—cyclin-dependent kinase
CHF—congestive heart failure
CHOP—cyclophosphamide, doxorubicin, vincristine, prednisone
CI—confidence interval
CIN—chemotherapy-induced neutropenia
CINV—chemotherapy-induced nausea and vomiting
CIPN—chemotherapy-induced peripheral neuropathy
CLL—chronic lymphocytic leukemia
CML—chronic myeloid leukemia
CNS—central nervous system **COPD**—chronic obstructive pulmonary disease
C-PEC—containment primary engineering control
CPK—creatine phosphokinase
CR—complete response
CrCl—creatinine clearance
CRF—cancer-related fatigue
CRS—cytokine release syndrome
CSTD—closed-system drug-transfer device
CT—computed tomography
CTCAE—Common Terminology Criteria for Adverse Events
CTEP—Cancer Therapy Evaluation Program
CTLA-4—cytotoxic T-lymphocyte antigen 4
CTZ—chemoreceptor trigger zone
CVD—cardiovascular disease
CYP—cytochrome P450
D5W—5% dextrose in water
DBP—diastolic blood pressure
DEHP—di(2-ethylhexyl) phthalate
DHEA—dehydroepiandrosterone
DLBCL—diffuse large B-cell lymphoma
DLCO—diffusing capacity of the lung for carbon monoxide
DNA—deoxyribonucleic acid
DTR—deep tendon reflexes
EBMT—European Society for Blood and Marrow Transplantation
ECG—electrocardiogram
Echo—echocardiography
ECOG—Eastern Cooperative Oncology Group
EEG—electroencephalogram
EGFR—epidermal growth factor receptor
EGFRI—epidermal growth factor receptor inhibitor
EML4—echinoderm microtubule-associated protein-like 4
EPO—erythropoietin
ESA—erythropoiesis-stimulating agent
EstCrCl—estimated creatinine clearance
FAACT—Functional Assessment of Anorexia/Cachexia Therapy
FDA—U.S. Food and Drug Administration
FDG—fluorodeoxyglucose
^{1}**F-FDG**—fluorine-18 fluorodeoxyglucose
FiO$_2$—fraction of inspired oxygen
5-FU—5-fluorouracil
5-HT$_3$—5-hydroxytryptamine-3
FLT3—FMS-like tyrosine kinase 3 **FLT3-ITD**—FLT3–internal tandemduplication
FSH—follicle-stimulating hormone
G$_0$—gap 0
G$_1$—gap 1
G$_2$—gap 2
G-CSF—granulocyte–colony-stimulating factor
GD2—ganglioside
GFR—glomerular filtration rate
GGT—gamma glutamyl transferase **GI**—gastrointestinal
GIST—gastrointestinal stromal tumor
GM-CSF—granulocyte macrophage – colony-stimulating factor
GVHD—graft-versus-host disease
Gy—gray
H—histamine
HAMAs—human anti-mouse antibodies
HBsAg—hepatitis B surface antigen
HBV—hepatitis B virus
HCl—hydrochloride
HCV—hepatitis C virus
HCW—healthcare worker
HD—hazardous drug
HDAC—histone deacetylase
HEPA—high-efficiency particulate air
HER—human epidermal growth factor receptor
Hgb—hemoglobin
HGFR—hepatocyte growth factor receptor
HIF-1—hypoxia-inducible factor-1
HIPEC—heated intraperitoneal chemotherapy
HIV—human immunodeficiency virus
HL—Hodgkin lymphoma
HNC—head and neck cancer
HNSCC—head and neck squamous cell carcinoma
HPV—human papillomavirus
HR—hormone receptor
HSC—hematopoietic stem cell
HSCT—hematopoietic stem cell transplantation
HTN—hypertension
IAP/APA—International Association of Pancreatology/American Pancreatic Association
IC—informed consent
IDH2—isocitrate dehydrogenase
IFN—interferon
IFRT—involved-field radiation therapy
Ig—immunoglobulin
IgE—immunoglobulin E

IGF-1R—insulin-like growth factor 1 receptor
IL—interleukin
ILD—interstitial lung disease
IM—intramuscular
IND—investigational new drug
INR—international normalized ratio
INSR—insulin receptor
irAE—immune-related adverse event **IRB**—institutional review board
ISMP—Institute for Safe Medication Practices
ISONG—International Society of Nurses in Genetics
ISOO—International Society of Oral Oncology
IT—intrathecal
IV—intravenous
IVP—intravenous push
IVPB— intravenous piggyback
JAK2—Janus kinase-2
LDH—lactate dehydrogenase
LFT—liver function test
LH—luteinizing hormone
LHRH—luteinizing hormone–releasing hormone
LLN—lower limit of normal
LV—leucovorin
LVEF—left ventricular ejection fraction
M—mitosis
mAb—monoclonal antibody
MAP—mitogen-activated protein
MASCC—Multinational Association of Supportive Care in Cancer
MCV—mean corpuscular volume
MDR1—multidrug resistance protein 1
MDS—myelodysplastic syndrome
MHC—major histocompatibility complex
MI—myocardial infarction
MIU—million international units
MOPP—mechlorethamine, vincristine, procarbazine, prednisone
MRI—magnetic resonance imaging
mRNA—messenger RNA
MRSA—methicillin-resistant *Staphylococcus aureus*
ms—millisecond
MTD—maximum tolerated dose
mTOR—mammalian target of rapamycin
MUGA—multigated acquisition
NaCl—sodium chloride
NCCN—National Comprehensive Cancer Network
NCI—National Cancer Institute
NDA—new drug application
NET—neuroendocrine tumor
NHL—non-Hodgkin lymphoma
NIDDK—National Institute of Diabetes and Digestive and Kidney Diseases
NIOSH—National Institute for Occupational Safety and Health
NK_1—neurokinin-1
NK—natural killer
NKT—natural killer T
NLM—National Library of Medicine
NPH—neutral protamine Hagedorn
NS—normal saline
NSAID—nonsteroidal anti-inflammatory drug
NSCLC—non-small cell lung cancer
n/v—nausea and vomiting
NYHA—New York Heart Association
O_2—oxygen
OAC—oral agent for cancer
OBI—on-body injector
ONS—Oncology Nursing Society
OSHA—Occupational Safety and Health Administration
PAP—prostatic acid phosphatase
PARP—poly(ADP-ribose) polymerase
PCR—polymerase chain reaction
PD-1—programmed cell death protein 1
PDE5—phosphodiesterase type 5
PDGF—platelet-derived growth factor
PDGFR—platelet-derived growth factor receptor
PD-L1—programmed cell death-ligand 1
PD-L2—programmed cell death-ligand 2
PE—pulmonary embolism
PEB—cisplatin, etoposide, bleomycin
PEG-G-CSF—pegylated granulocyte–colony-stimulating factor
PEP—Putting Evidence Into Practice
PERCIST—Positron Emission Tomography Response Criteria in Solid Tumors
PET—positron-emission tomography
PET-CT—positron-emission tomography–computed tomography
PFT—pulmonary function test
PFU—plaque-forming units
P-gp—P-glycoprotein
Ph—Philadelphia chromosome
PI3K—phosphoinositide 3-kinase
PJP—*Pneumocystis jiroveci* pneumonia
PML—progressive multifocal leukoencephalopathy
PMN/poly—polymorphonuclear neutrophil **pNET**—pancreatic neuroendocrine tumor **PO**—by mouth
PPE—personal protective equipment **PPI**—proton pump inhibitor
PR—partial response; progesterone receptor
PRES—posterior reversible encephalopathy syndrome
PRN—as needed
PRO—patient-reported outcomes
PROMIS SexFS—Patient-Reported Outcomes Measurement Information System Sexual Function and Satisfaction Measure
PT—prothrombin time
PVC—polyvinyl chloride
Q5M—every 5 minutes
Q10M—every 10 minutes
Q15M—every 15 minutes
QID—four times daily
QOL—quality of life
QTc—QT interval corrected
QTc—QT interval corrected
QTcF—corrected QT interval using Fridericia's calculation
RANK—receptor activator of nuclear factor kappa-B
RANKL—receptor activator of nuclear factor kappa-B ligand
RBC—red blood cell
RCC—renal cell carcinoma
RECIST—Response Evaluation Criteria in Solid Tumors
rHu—recombinant human
RIT—radioimmunotherapy
RNA—ribonucleic acid
RPLS—reversible posterior leukoencephalopathy syndrome
RR—relative risk
RSO—radiation safety officer
RT—radiation therapy
S—synthesis
SBP—systolic blood pressure
SC—subcutaneous
SCF—stem cell factor
SCLC—small cell lung cancer
SCP—survivorship care plan
SCr—serum creatinine
SDS—safety data sheet
segs—segmented neutrophils
SERM—selective estrogen receptor modulator
SIADH—syndrome of inappropriate antidiuretic hormone secretion
SIR—standardized incidence ratio
6-MP—6-mercaptopurine
SLAMF7—signaling lymphocytic activation molecule family member 7
SLL—small lymphocytic lymphoma
SMN—second malignant neoplasm
SOS—sinusoidal obstruction syndrome
SPF—sun protection factor
SpO_2—blood oxygen saturation level
SSRI—selective serotonin reuptakeinhibitor
TBI—total body irradiation
T-DM1—ado-trastuzumab emtansine
TdP—torsades de pointes
TEC—toxic erythema of chemotherapy
T4—thyroxine
TH1, TH2—helper T cells
TID—three times daily
TKI—tyrosine kinase inhibitor
TLS—tumor lysis syndrome
TPO—thrombopoietin
Tregs—regulatory T cells
TSH—thyroid-stimulating hormone
UA—urinalysis
ULN—upper limit of normal
USP—U.S. Pharmacopeial Convention
UV—ultraviolet
VAD—venous access device
VC—vomiting center
VEGF—vascular endothelial growth factor
VEGFR—vascular endothelial growth factor receptor
VOD—veno-occlusive disease
VSP—vascular signaling pathway
VTE—venous thromboembolism
WBC—white blood cell
WHO—World Health Organization

EPIC Beacon Oncology Terminology

Abbreviation	Meaning
IP	**In-patient**
OP	**Out-patient**
Treatment Plan	**(IP/OP)** **The chemotherapy anti-cancer therapy (ACT) regimen is now the treatment plan** • Treatment plans are only available in Beacon (IP and OP). Only staff who have completed Beacon classes receive access to order and release treatment plans. AHN has validated that only oncology providers would have this access to Beacon.
Therapy Plan	**(OP Only)** This would include non-oncology plans used in the OP areas (examples include immunosuppressant's for rheumatology etc)
Supportive Plan	**(OP Only)** This would include medications such as ESAs, iron infusions etc)

Non-oncology ACT agents are NOT beacon treatment plans in the IP or OP setting

i. In the OP setting they are built as **therapy plans** and the non-oncology specialties are to be ordering and managing those patients, not oncology!
ii. In the IP setting **order sets** are built into EPIC. Again the non-oncology physicians are to handle these not Oncology (unless a consult). Even then they are not in Beacon when not for oncology, they are order sets.
iii. Examples include:
    a. Methotrexate tablets (indication rheumatoid arthritis)
    b. Cyclophosphamide tablets and parenteral (indication lupus nephritis)
    c. Hydroxyurea tablets (indication polycythemia vera, sickle cell anemia, essential thrombocytosis)
    d. Rituxan is built as an order set IP (indication vasculitis, ITP, other diseases)
    e. Intrahepatic mitomycin and doxorubicin (Dr. Thai and Thoc)
    f. Cisplatin and mitomycin (Gyne oncology HIPEC procedure)
    g. Methotrexate order set for ectopic pregnancy

ACT Foundations for Ordering

This guide outlines the different methods of ordering chemotherapy for oncology and non-oncology patients.

Foundations:	When this is used:
Orders with Inpatient (Bed) Icons	▪ Medications that are administered in clinic or in the hospital ▪ Labs that are performed in-house i.e. in the MSSU or Inpatient
Orders with Outpatient (House) Icons	▪ Medication Prescriptions that should be taken to a retail pharmacy ▪ Labs that are performed elsewhere i.e. Sunquest, Quest, LabCorp
Treatment Plans	▪ Treatment Plans are used for oncology patients. ▪ Treatment Plans are P&T approved ACT regimens used in the Outpatient or Inpatient areas. ▪ Only staff who have completed Beacon training receive access to order and release Treatment Plans. AHN has validated that only oncology providers should be placing these orders. ▪ MSSU uses OP treatment plans with inpatient orders. ▪ Orders cross encounters for multiple visits.
Supportive Care Plans	▪ Supportive Care Plans are used for oncology patients. ▪ Supportive Care Plans are P&T approved ACT regimens used in the Outpatient Oncology or WPH MSSU areas. ▪ Orders cross encounters for multiple visits.
Therapy Plans	▪ Therapy Plans are used for oncology and non-oncology patients. ▪ Therapy Plans are **non-oncology** regimens used in the Outpatient or MSSU areas. ▪ Examples include immunosuppressants for rheumatology, etc. ▪ Orders cross encounters for multiple visits. ▪ Orders must be removed that are not intended to be used.
SmartSets	▪ A preconfigured group of orders that are commonly ordered together for a specific problem or diagnosis, used in the Outpatient area.
Non-Oncology ACT Inpatient OrderSets	▪ This includes **non-oncology** regimens used in the Inpatient area. ▪ Examples Include: Methotrexate for Ectopic Pregnancy, Bleomycin for Pleural Sclerotherapy, and Bleomycin for Cardiac Sclerotherapy. ▪ These are NOT Beacon Treatment Plans. ▪ The Outpatient counterpart to this functionality is a Therapy Plan. ▪ If applying an OrderSet before the Admission, utilize the 'Orders for Hospital' Activity so that the appropriate Phase of Care is used to 'hold' these orders until the patient is admitted.
OrderSets	▪ A preconfigured group of orders that are commonly ordered together for a specific problem or diagnosis, used in the Inpatient area or MSSU. ▪ Typically used in the MSSU for one-time infusions or orders. ▪ Examples Include: Patient gets admitted to inpatient unit-these orders would include: Admission Orders, Code Status, Vital Signs, Physician Notification, Isolation, Activity, Diet, Nursing Assessments, Nursing Interventions, Respiratory Interventions, Consults, Apheresis and Precautions, Labs, IV, Medications, DVT Prophylaxis, etc. ▪ If applying an OrderSet before the Admission or for MSSU, utilize the 'Orders for Hospital' Activity so that the appropriate Phase of Care is used to 'hold' these orders until the patient is admitted. ▪ Only place these orders for one day then sign and hold and reenter the orders again for the next day if using in the MSSU.

ACT WORKBOOK SECTION
Take Home Assignment Day 1

Cell Cycle Specific
Plant Alkaloids
Antimetabolites
Miscellaneous
Myelosuppression

1. The Vinca Alkaloids have which dose-limiting toxicity:
   _____

   State three examples of how you assess for the dose-limiting toxicity:

2. Etoposide (VP-16) has this known side effect with rapid infusion:
   _____

3. When administering taxanes, what is the total bilirubin requirement?
   _____

4. Capecitabine (Xeloda) should not be taken with which medication?
   _____

   What is the known dose-limiting toxicity for this drug?
   _____

5. Which two agents are used for MDS 5q?
   a. _____
   b. _____

6. Procarbazine requires which type of diet?
   _____

   Provide 2 examples of restrictions on this diet:
   _____
   _____

7. This metabolite drug requires vigorous hydration, dexamethasone, anti-emetics, and folic acid:
   _____

8. These medications are indicated for acute promyelocytic leukemia (APL).
   _____

   Provide three KEY side effects to monitor:
   a. _____
   b. _____
   c. _____

9. List three examples of Hematopoietic Growth Factors (HGFs) which affect the white blood cell lineage.

a. _____

b. _____

c. _____

What is the major side effect of these white blood cell growth factors?

_____

10. List three examples of HGFs which affect the red blood cell lineage.

a. _____

b. _____

c. _____

What are the major side effects of these red blood cell growth factors?

_____

11. List two examples of HGFs which affect the platelet blood cell lineage.

a. _____

b. _____

What is the major side effect of these platelet blood cell growth factors?

_____

Short Answer

Please read each statement carefully and provide the answer with your rationale.

12. Cell cycle specific agents

a. Describe how cell cycle specific agents work (mechanism of actions) in the cell cycle.

b. Provide one example from each cell cycle specific classification and include an example of dose-limiting toxicity or side effects.

Plant Alkaloids _____

Antimetabolites _____

Miscellaneous _____

13. This new colo-rectal patient is scheduled for the first cycle of FOLFIRI: (Irinotecan, Fluorouracil, and Leucovorin).

a. How does Leucovorin differ with this protocol as opposed to Methotrexate treatments?

b. What does the patient need to know about Irinotecan treatment and side effects?

14. This patient arrived for consolidated chemotherapy for AML with high dose Cytarabine (Ara-C) days 1-3-5 every 12 hours.

a. What assessment(s) do you need to perform routinely and prior to each dose of Cytarabine? (Ara-C))?

b. What concerns do you have for this patient's eyes? How would this be prevented or treated?

15. This patient was admitted with CNS lymphoma and is scheduled to receive high dose Methotrexate (MTX) for 24 hours with Leucovorin rescue.

a. What does this patient need to know about this treatment with Methotrexate (MTX)?

b. Why is Leucovorin rescue necessary and for how long?

c. What other concerns do you have for this patient in respect to this treatment?

Matching

The following section consists of matching drug classifications.

For each drug listed in Column A select the correct drug classification from Column B. **Each letter may be used more than once or not at all.**

Column A	**Column B**
_____ 16. Trisenox (Arsenic)	
_____ 17. Irinotecan (Camptosar) CPT-11	A. Antimetabolites
_____ 18. Fluorouracil (Flouracil) 5FU	B. Miscellaneous
_____ 19. Docetaxel (Taxotere)	C. Plant Alkaloids
_____ 20. Romiplostim (Nplate)	D. Growth Factors
_____ 21. Tbo-filgrastim (Granix)	
_____ 22. Vincristine (Oncovin)	
_____ 23. Gemcitabine (Gemzar)	
_____ 24. Filgrastim (Neupogen)	
_____ 25. Vinorelbine (Navelbine)	
_____ 26. Methotrexate (MTX)	
_____ 27. Etoposide (Toposar, VePesid)	
_____ 28. Hydroxyurea (Hydrea)	
_____ 29. Ixabepilone (Ixempra)	
_____ 30. Filgrastim-sndz (Zarxio)	
_____ 31. Darbepoetin (Aranesp)	

ACT WORKBOOK SECTION
Take Home Assignment Day 2

Targeted Therapies – Tyrosine Kinase Inhibitors (TKI's), Multi-Kinase Inhibitors (MKI's), EGFR, VEGF, Proteosome inhibitors, Protein kinases, Hedgehogs, PARPs, mTOR
Immunotherapies - Cytokines, Monoclonal Antibodies, Bispecific Antibodies, Immunomodulators, CAR-T, Immunotherapy
Hormonal Therapy

1. Interferons and interleukins are examples of which targeted therapy classifications?

   _____

   What are the major side effects of the above agents and classifications of agents?

   _____

2. Provide two examples of immunomodulators:

   _____

   _____

   Provide two side effects _____
   What program must patients be enrolled in to receive these drugs _____

3. Provide one example from breast and one from prostate hormone targeted therapy and include an example of dose-limiting toxicity or side effect.

   Breast _____
   Prostate _____

4. Which agent greatly impacts wound healing and should not be administered within 30 days of a surgical procedure?

   _____

5. Bortezomib (Velcade) has this dose-limiting toxicity especially when administered IV as opposed to SQ.

   _____

6. Imatinib (Gleevec) and Erlotinib (Tarceva) are examples of which targeted therapy classifications?

   _____

7. Sorafenib (Nexavar), Sunitinib (Sutent), and Dasanitib (Sprycel) are examples of which targeted therapy drug classifications?

   _____

8. Ibritumomab (Zevalin) and Tositumomab (Bexxar) are examples of which targeted therapy classification?

   _____

9. Blinatumomab (Blincyto) and Tarlatamab (Imdelltra) are examples of which targeted therapy classification?

   _____

10. List two examples of monoclonal antibodies and which CD antigen- receptor they target.
    a. _____
    b._____

11. The biggest side effect concern related to monoclonal antibodies is _____
    How can this be potentially mitigated? _____

12. The biggest concern with the TKIs and MKIs is that they are administered:

    _____

    These drugs are inhibitors and inducers of _____ that involves the liver enzyme _____.

13. The unique side effect associated with bispecific antibodies is:

    _____

14. What is the treatment for cytokine release syndrome (CRS)?

    _____

15. What is the treatment for immune effector cell associated-neurotoxicity syndrome (ICANS)?

    _____

16. Blood pressure must be monitored with which targeted therapy agents (provide three specific examples)?
    a. _____
    b. _____
    c. _____

17. Tamoxifen and Raloxifene are examples of this type of hormone:
    _____

18. Cytraden, Arimidex, Aromasin, and Femara are examples of this type of hormone:
    _____

For each drug listed in Column A, select the correct drug classification from Column B. **Each letter may be used more than once or not at all.**

Column A	**Column B**
_____ 35. Rituximab (Rituxan)	A. Cytokine
_____ 36. Bevacizumab (Avastin)	B. Tyrosine Kinase Inhibitor
_____ 37. Ibritumomab Tiuxetan (Zevalin)	C. Monoclonal Antibody
_____ 38. Sorofenib Tosylate (Nexavar)	D. VEGF
_____ 39. Cetuximab (Erbitux)	E. EGFR
_____ 40. Lenalidomide (Revlamid)	F. Multi Kinase Inhibitor
_____ 41. Aldueleukin (IL-2)	G. Immunomodulator
_____ 42. Tisagenlecleucel (Kymriah)	H. Radioimmunotherapy
_____ 43. Niraparnib (Zejula)	I. PARP Inhibitor
_____ 44. Daratumumab (Darzalex)	J. CAR-T
_____ 45. Ibrutinib (Imbruvica)	K. Checkpoint Inhibitor
_____ 46. Nivolomab (Opdivo)	L. Bispecific Antibody
_____ 47. Trastuzumab (Herceptin) HER 2	
_____ 48. Mosunetuzumab (Lunsumio)	
_____ 49. Nilotinib (Tasigna)	
_____ 50. Ruxolitinib (Jakafi®)	
_____ 51. Teclistamab (Tecvayli)	

ACT WORKBOOK SECTION

Take Home Assignment Day 3

Cell Cycle Non-Specific Agents – AAN
Anti-tumor Antibiotics
Alkylating Agents
Nitrosoureas

1. High-dose Cyclophosphamide (Cytoxan) and all Ifosfamide (Ifex) must also receive what agent?

_____

To protect which organ?

_____

2. This drug has renal and oto-toxicity, depletes magnesium, and severe N&V (acute and delayed):

_____

The creatinine must be ___ to administer safely?

3. Delayed thrombocytopenia and anaphylaxis after 4- 6th dose is noted side effect of this drug:

_____

In what sequence should the above drug be administered when ordered with a taxane?

_____

4. This drug has known neurotoxicities and is exacerbated by cold:

_____

5. Which diagnostic test must be performed prior to the administration of all anthracyclines?

_____

State two drug examples:

_____

_____

6. This drug requires PFT's prior to and follow-up of administration:

_____

7. This drug must be taken on an empty stomach, cannot be crushed, causes severe myelosuppression, and crosses the blood brain barrier (BBB):

_____

Matching

The following sections consist

of matching drug classifications. For each drug listed in column A, select the correct drug classification from Column B. **Each letter may be used more than once or not at all.**

COLUMN A	COLUMN B
_____ 8. Idarubicin (Idamycin)	A. Alkylating Agents
_____ 9. Fulvestrant (Faslodex)	B. Anti-tumor
_____ 10. _ Temozolamide Temodar)	C. Hormones
_____ 11. Cyclophosphamide (Cytoxan)	D. Nitrosoureas
_____ 12. Carmustine (BCNU)	E. Growth Factors
_____ 13. Anastrozole (Arimidex)	
_____ 14. Darbepoetin (Aranesp)	
_____ 15. Carboplatin (Paraplatin)	
_____ 16. Bleomycin (Blenoxane)	
_____ 17. Tbo-filgrastim (Granix)	
_____ 18. Oxaliplatin (Eloxitan)	
_____ 19. Melphalan (Alkeran)	
_____ 20. Filgrastim-sndz (Zarxio)	
_____ 21. Doxorubicin (Adriamycin)	
_____ 22. Cisplatin (Platinol)	

For each example of nausea and vomiting listed in Column A, select the correct anti-emetic classification from

In Column B. **On the blank list one example for that classification.**

COLUMN A	COLUMN B
_____ 23. Anticipatory	A. NK-1 _____
_____ 24. Acute	B. Benzodiazepine _____
_____ 25. Delayed	C. 5-HT3 serotonin inhibitor _____

For each drug in Column A, select the dose-limiting organ toxicity from Column B. **Each letter may be used than once or not at all.**

COLOUMN A	**COLUMN B**
_____ 26. Cisplatin (Cisplatin)	A. Capillary leak syndrome
_____ 27. Bleomycin (Blenoxane)	B. Cardiac toxicity
_____ 28. Vincristine (Oncovin)	C. Hemorrhagic cystitis/urologic
_____ 29. Doxorubicin Liposomal (Doxil)	D. Neurologic/neuropathies
_____ 30. Cytarabine (Ara-C)	E. Ocular
_____ 31. Idarubicin (Idamycin)	F. Ototoxicity
_____ 32. Ifosfamide (Ifex)	G. Hand-foot syndrome (PPE)
_____ 33. Interleukin 2 (IL-2)	H. Pulmonary
_____ 34. Paclitaxel/Docetaxol (Taxanes)	I. Renal/nephrotoxicity
_____ 35. Carfilzomib (Kyprolis)	J. CNS toxicity
_____ 36. Oxaliplatin	K. Cerebellar toxicity
_____ 37. Erlotinib (Tarceva)	L. Endocrine
_____ 38. Pembrolizumab (Keytruda)	M. Integumentary
_____ 39. Axicabtagene ciloleucel	N. Cytokine release syndrome (CRS)
_____ 40. Arsenic	O. Differentiation Syndrome
_____ 41Teclistamab (Tecvayli)	P. Immune effector cell-associated neurotoxicity syndrome (ICANS)

For each drug in Column A, select from the terms and the correct compress for an extravasation from Column B. **Each letter may be used more than once or not at all.**

COLUMN A	**COLUMN B**
_____42. Doxorubicin (Adriamycin)	A. Vesicant
_____43. Fluorouracil (5-FU)	B. Non-irritant
_____44. Daratumumab (Darcelex)	C. Irritant
_____45. Mitomycin C (Mutamycin)	D. Cold compress
_____46. Vincristine (Oncovin)	E. Warm compress
_____47. Etoposide (VP-16)	
_____48. Oxaliplatin	
_____49. Paclitaxel (Taxol)	
_____50. Bendamustine (Treanda)	
_____51. Bortezomib (Velcade)	
_____52. Carboplatin (Paraplatin)	
_____53. Nivolomab (Opdivo)	

54. When preparing to administer chemotherapy to a patient who is reporting to the clinic for Day 1 of cycle 2 of Doxorubicin (Adriamycin) and Cyclophosphamide (Cytoxan) (AC). The patient had no complications with the first cycle 2 weeks ago. Recent labs (within 72 hours) reveal:

WBC = 3.5	Hgb/Hct = 12.5/38.7
Segs/Neutrophils = 32	Plts = 75,000
Bands = 3	Creat = 1.0
K+ = 4.0	T Bili = 0.9

After reviewing the labs, what is determined about the laboratory findings?

The oncologist orders Cycle #2 to begin today despite the above lab findings but does not provide a rationale.

a. The patient is concerned about proceeding with chemotherapy and asks you why the oncologist decided to proceed with treatment. Please explain why would the oncologist administer therapy rather than decrease the dose?

b. The patient would also like to know if there is anything else the need to observe until they receive the next cycle.

55. A newly diagnosed 19-year-old male is admitted as a new testicular diagnosis for the first cycle of Bleomycin, Cisplatin, Etoposide (BEP).

a. What concerns do you need to address prior to treatment with Bleomycin?

b. What teaching do you need to do with this patient in regard to Cisplatin? Which organs are <u>most</u> significantly at risk?

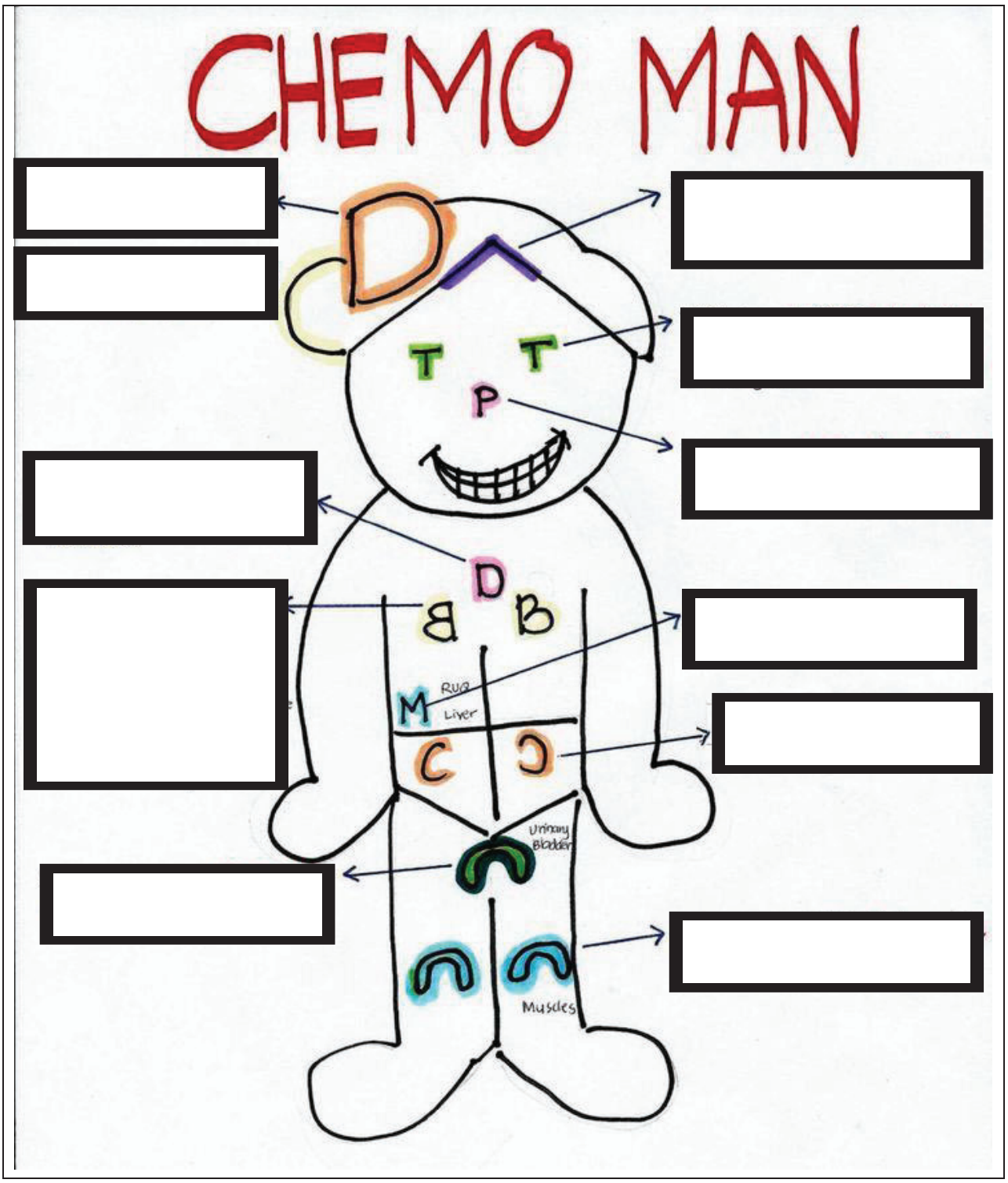
56. A newly diagnosed patient with ovarian presents for treatment consisting of Paclitaxel (Taxol) and Carboplatin (Paraplatin).

a. What information needs to be provided to this patient about Paclitaxel (Taxol)?

b. What information do you need to prepare the patient for with Carboplatin (Paraplatin) and why?

c. How would you manage an infusion related reaction?

Instructions: Fill in the blanks with toxicities identified by site and drug name identified by the initial



FORMULAS FOR CALCULATIONS

ORDER OF OPERATIONS

When performing calculations, follow this order:

1. Parentheses/Brackets: Perform any calculations inside parentheses or brackets first.
2. Exponents: Calculate any exponents (not applicable in these formulas).
3. Multiplication and Division: Perform multiplication and division from left to right.
4. Addition and Subtraction: Perform addition and subtraction from left to right.

CONVERSION FACTORS

Inches to Centimeters (number of inches) x 2.54 = cm

Pounds to Kilograms (number of pounds) / 2.2 = kg

DEVINE IDEAL BODY WEIGHT

Males: IBW (kg) = 50 + [2.3 x (height (inches) – 60)]

Females: IBW (kg) = 45.5 + [2.3 x (height (inches) - 60)]

Absolute Neutrophil Count (ANC)

ANC = (Polys (neutrophils) + Bands) x total WBC mm^3 / 100

OR

ANC = (Polys (neutrophils) + Bands) x total WBC K/uL x 10

Mostellar Body Surface Area (BSA)

BSA (m2) = $\sqrt{\ }$ (height (cm) x weight (kg) / 3600) ($\sqrt{\ }$ means square root)

Carboplatin Dosing

Two steps:

1. **Cockcroft-Gault Equation = Creatinine Clearance (CrCl)**

Males: CrCl (mL/min) = [(140 - age) x weight (kg)] / [72 x serum creatinine (mg/dL)]

Females: CrCl (mL/min) = 0.85 x [(140 - age) x weight (kg)] / [72 x serum creatinine (mg/dL)]

2. **Calvert Equation**

Dose (mg) = AUC (Area under the curve) x [CrCl + 25]

Practice Problems/ Calculations

IBW – kg

1. Calculate the IBW for a male with height of 6'2"
   IBW = _____

2. Calculate the IBW for a female with height of 5'5"
   IBW = _____

BSA - m2

3. A patient weighs 63.6 kg and is 168.4 cm.
   BSA = _____

4. A patient weighs 56.8 kg and is 163.6 cm.
   BSA = _____

5. A patient weighs 80 kg and is 173.2 cm.
   BSA = _____

6. **Calculate the BSA:**
   Height 161.2 cm Weight 50 kg BSA _____

THEN **Validate dosages:**

Drug	**Calculate the Actual Dose**	**The ordered dose and range** **Is the ordered dose:** **a. Too high** **b. Within correct range** **c. Too low**
Adriamycin 50 mg/m2		**Ordered dose is 95 mg**
Cyclophosphamide 650 mg/m2		**Ordered dose is 1650 mg**
Vincristine 1.4 mg/m2		**Ordered dose is 2 mg**

7. **Calculate the BSA:**

   Height 167.2cm Weight 88.6 kg BSA_____

-THEN-

Validate the dosages:

Drug	Calculate the Actual Dose	Is the ordered dose: a. Too high b. Within correct range c. Too low
Pemetrexed 500 mg/m2		**Ordered dose is 700 mg**
Cisplatin 75 mg/m2		**Ordered dose is 180 mg**

8. 169.6 cm 78.1 kg BSA= _____

   AML: (Calculate the ordered dose for each)

   Ara-C 25 mg/m2 IVP _____

   Ara-C 200 mg/m2 over 24 hours for 5 days CIVI _____

   Idarubicin 12 mg/m2 IVP days 1-2-3 _____

9. 161.3 cm 84kg BSA = _____

   Low Grade Follicular Lymphoma: (Calculate the ordered dose for each)

   Bendamustine 90mg/m^2 IV _____

   Rituximab 375mg/m^2 IV _____

Carboplatin Dosing (CrCl/GFR and AUC)

10. A 65-year-old male is admitted to receive Carboplatin. Calculate the **CrCl or GFR** from the information provided below:

    AUC = 4

    Serum creatinine = 1.2

    Weight = 82.7kg

    CrCl - GFR = _____

    Use the Calvert Formula to calculate the dose of Carboplatin

    Dose (mg) = _____

11. A 52-year-old male is admitted to receive Carboplatin. Calculate the **CrCl or GFR** from the information provided below:
    AUC = 5
    Serum creatinine = 0.6
    Weight = 72.1kg
    CrCl - GFR = _____
    Use the Calvert Formula to calculate the dose of Carboplatin
    Dose (mg) = _____

12. A 56-year-old female admitted for Carboplatin. Calculate the **CrCl or GFR** from the information provided below:
    AUC = 6
    Serum creatinine = 0.8
    Weight = 75 kg
    CrCl - GFR = _____
    Use the Calvert Formula to calculate the dose of Carboplatin
    Dose (mg) = _____

13. A 68-year-old female admitted for Carboplatin. Calculate the **CrCl or GFR** from the information provided below:
    AUC = 4
    Serum creatinine = 1.0
    Weight = 95 kg
    Cr/Cl - GFR = _____
    Use the Calvert Formula to calculate the dose of Carboplatin
    Dose (mg) = _____

ANC

14. WBC = 3.5 K/UL
    Neutrophil = 5%
    Band = 2%

    _____

15. WBC = 6.4 K/UL
    Neutrophil = 5%

    _____

16. WBC = 1.2 K/UL
    Neutrophil = 6%
    Band = 2%

    _____

17. Listed below are CBC's and differential counts for 4 patients. Which patient is at the greatest risk for infection?

    a. WBC = 2300/ul
       Diff:
       Neutrophils = 40%
       Bands =12
       Lymph = 40
       Monos = 5
       Eos = 2
       Baso = 0
       Atypical lymphs = 1

ANC =

    b. WBC = 3400/ul
       Diff:
       Neutrophils = 15%
       Bands
       Lymph = 70
       Monos = 8
       Eos = 2
       Baso = 0
       Metamyelocytes = 2
       Myelocytes = 1

ANC =

    c. WBC = 4700/ul
       Diff:
       Neutrophils = 15%
       Bands
       Lymph = 76
       Monos
       Eos = 2
       Baso = 0
       Atypical lymphs = 1

ANC =

    d. WBC = 5200/uL
       Diff:
       Neutrophils = 15%
       Bands = 9
       Lymph = 30
       Eos = 0
       Baso = 0
       Monos = 5

ANC =

18. Listed below are CBC's and differential counts of four patients who are scheduled to receive chemotherapy. Which patient qualifies for chemotherapy if the patient is not on dose-dense therapy or a hematological malignancy?

a. WBC = 5600/uL
Diff:
Neutrophils = 50%
Bands = 2
Lymphs = 36
Monos = 8
Eos = 2
Baso = 1
Atypical lymphs = 1
Platelets = 85,000/uL

ANC =

b. WBC = 4100/uL
Diff:
Neutrophils = 50%
Bands =
Lymphs = 36
Monos = 5
Eos = 2
Baso = 2
Atypical lymphs =
Platelets = 250,000/uL

ANC =

c. WBC = 3200/uL
Diff:
Neutrophils = 39%
Bands = 8
Lymphs = 46
Monos = 4
Eos = 2
Baso = 0
Atypical lymphs = 1
Platelets = 95,000/uL

ANC =

d. WBC = 2900/uL
Diff:
Neutrophils = 46%
Bands = 8
Lymphs = 38
Monos = 5
Eos = 0
Baso = 0
Atypical lymphs = 1
Platelets = 65,000/uL

ANC =

EXTRA - Practice Problems/ Calculations

IBW – kg

1. Calculate the IBW for a male with height of 5'5"
   IBW =_____

2. Calculate the IBW for a female with height of 5'9"
   IBW = _____

BSA - m2

3. A patient weighs 129.5 kg and is 177.8 cm.
   BSA = _____

4. A patient weighs 50 kg and is 175.3 cm.
   BSA = _____

5. A patient weighs 91kg and is 157.5 cm.
   BSA = _____

6. **Calculate the BSA:**

   Height 182.3 cm Weight 68.1 kg BSA _____

   THEN

   Validate dosages:

Drug	Calculate the Actual Dose	Is the ordered dose: a. Too high b. Within correct range c. Too low
Pemetrexed 500 mg/m2		**Ordered dose is 800 mg**
Cisplatin 75 mg/m2		**Ordered dose is 120 mg**
Pembrolizumab 2mg/kg		**Ordered dose is 130 mg**

7. 175.26 cm 88.6 kg BSA= _____

AML: (Calculate the ordered dose for each)

Ara-C 25 mg/m2 IVP _____

Ara-C 200 mg/m2 over 24 hours for 5 days CIVI _____

Idarubicin 12 mg/m2 IVP days 1-2-3 _____

8. 161.3 cm 68 kg BSA = _____

Low Grade Follicular Lymphoma: (Calculate the ordered dose for each)

Bendamustine 90mg/m^2 IV _____

Rituximab 375mg/m^2 IV _____

Carboplatin Dosing (CrCl/GFR and AUC)

9. A 67-year-old male is admitted to receive Carboplatin. Calculate the **CrCl or GFR** from the information provided below:

AUC = 6

Serum creatinine = 1.8

Weight = 93 kg

CrCl - GFR = _____

Use the Calvert Formula to calculate the dose of Carboplatin

Dose (mg) = _____

10. A 52-year-old male is admitted to receive Carboplatin. Calculate the **CrCl or GFR** from the information provided below:

AUC = 2

Serum creatinine = 0.6

Weight = 72.1kg

CrCl - GFR = _____

Use the Calvert Formula to calculate the dose of Carboplatin

Dose (mg) = _____

11. A 36-year-old female admitted for Carboplatin. Calculate the **CrCl or GFR** from the information provided below:

AUC = 4

Serum creatinine = 0.8

Weight = 75 kg

CrCl - GFR = _____

Use the Calvert Formula to calculate the dose of Carboplatin

Dose (mg) = _____

12. A 68-year-old female admitted for Carboplatin. Calculate the **CrCl or GFR** from the information provided below:

AUC = 2

Serum creatinine = 2.0

Weight = 65 kg

Cr/Cl - GFR = _____

Use the Calvert Formula to calculate the dose of Carboplatin

Dose (mg) = _____

Cancer Therapeutic Regimens

DOWNLOAD - APP – https://www.cancertherapyadvisor.com/
http://www.chemocare.com
https://www.cancercare.org
https://www.oncolink.org

Regimen	Names		Regimen	Names		Regimen	Names
CHOP	Cyclophosphamide Doxorubicin Vincristine Prednisone		FOLFIRI	Irinotecan Leucovorin Fluorouracil		**PBSCT Regimens**	
EPOCH	Etoposide Doxorubicin Vincristine Cyclophosphamide Prednisone Filgrastim		FOLFOX4	Oxaliplatin Leucovorin Followed by Fluorouracil Leucovorin		BEAM (transplant)	BCNU Etoposide Cytosine Arabinoside Melphalan
AC	Doxorubicin Cyclophosphamide		BEP	Bleomycin Etoposide Cisplatin		FLU-BU-TBI	Fludarabinee Busulfan Total Body Irradiation
RICE	Rituxan Ifosfamide Carboplatin Etoposide		Hyper-CVAD	Cyclophosphamide Mesna Vincristine Doxorubicin Dexamethasone Filgrastim		FLU-BU	Fludarabine Busulfan
AC-T	Doxorubicin Cyclophosphamide Taxol		7 & 3	Cytarabine Idarubicin/Anthracycline		CY/VP (mobilization)	Cyclophosphamide Etoposide
TC	Docetaxel Cyclophosphamide		HiDAC	High Dose Cytarabine		BU-CY	Busulfan Cyclophosphamide
TCH	Docetaxel Cyclophosphamide Trastuzumab		FC	Fludarabine Cyclophosphamide			
MAID	Mesna Doxorubicin Ifosphamide Dacarbazine		PCR	Pentostatin Cyclophosphamide Rituxan		MVAC	Methotrexate Vinblastine Adriamycin Cisplatin
ABVD	Doxorubicin Bleomycin Vinblastine Dacarbazine		BEACOPP	Bleomycin Etoposide Doorubicin Vincristine Procarbazine Prednisone		VCD Or CyBorD	Velcade (Bortezomib) Cyclophosphaimde Dexamethasone
MOPP	Methlorethamine Vincristine Procarbazine Prednisone		CVP-R	Cyclophosphamide Vincristine Prednisone Rituxan		IFL	Irootecan Flourouracil Leucovorin
ESHAP	Etoposide Methylprednisone Cytarabine Cisplatin		FLAG-IDA	Fludarabine Cytarabine Idarubicin		Hd-MTX	High dose Methotrexate

https://www.oralchemoedsheets.com/

SAMPLE TREATMENT PLAN

☐ PACLitaxeL (TAXOL) 156 mg in NS 250 mL chemo infusion

✔ 156 mg (rounded from 154.4 mg = 80 mg/m2 × 1.93 m2 Treatment plan BSA), intravenous, Administer over 60 Minutes, Once, Starting 30 minutes after treatment start time, For 1 dose
Give paclitaxel after pre-medications. Use non-PVC bag and tubing with filter.
ACT COMPETENT. HAZARDOUS AGENT PRECAUTIONS. CAUTION: VESICANT. Use non-DEHP infusion bag and administration set. Use 0.2 micron filter. Look Alike/Sound Alike Medication.

Administer Dose:	80 mg/m2 × 1.93 m2 (BSA based on [Treatment plan weight: 79.7 kg as of 12/13/2022] [Treatment plan height: 167.6 cm as of 12/13/2022]) = 156 mg (rounded to the nearest 12 mg) = 156 mg × 5 mL/30 mg = 26 mL × 30 mg/5 mL = 156 mg

☐ Pharmacist Communication

Carbo dose based off of adjusted wt 69.4kg, Scr 0.62 (age 65 and Scr <0.8, use 0.8 to calculate dose), CrCl 77 ml/min, carbo (AUC 1.5) = 153 mg

☐ CARBOplatin (PARAPLATIN) 153 mg in NS 250 mL chemo infusion

✔ 153 mg (rounded from 152.7 mg, Target AUC = 1.5), intravenous, Administer over 30 Minutes, Once, Starting 120 minutes after treatment start time, For 1 dose
Give carboplatin after paclitaxel.
ACT COMPETENT. HAZARDOUS AGENT PRECAUTIONS. Look Alike/Sound Alike Medication

Current formula dose:	**152.7 mg** = (76.8 mL/min + 25) x 1.5 mg/mL/min 76.8 mL/min = 0.85 (female) x (140 - 65 yrs) x 69.4 kg / (72 x 0.8 mg/dL) AUC = 1.5; SCr = 0.8 mg/dL (user-entered); Weight = 69.4 kg (based on order-specific from 2/15/2023 8:56 AM)

Performance status

Karnofsky Scale		Zubrod Scale (ECOG)	
Normal, no evidence of disease Able to perform normal activity with only minor symptoms	100 90	Normal activity	0
Normal activity with effort, some symptoms Able to care for self but unable to do normal activities	80 70	Symptomatic and ambulatory Cares for self	1
Requires occasional assistance, cares for most needs Requires considerable assistance	60 50	Ambulatory >50% of time Occasional assistance	2
Disabled, requires special assistance Severely disabled	40 30	Ambulatory ≤50% of the time Nursing care needed	3
Very sick, requires active supportive treatment Moribund	20 10	Bedridden	4

https://ncihub.org/resources/115

TOXICITY GRADING

	Grade 1 Mild	Grade 2 Moderate	Grade 3 Severe	Grade 4 Life Threatening
Constitutional				
Fever	38.0-39.0 degrees C (100.4-102.2 degrees F)	>39.0-40.0 degrees C (102.3-104.0 degrees F)	>40.0 degrees C (>104.0 degrees F) for <= 24 hours	>40.0 degrees C (>104.0 degrees F) for > 24 hours
Febrile Neutropenia			ANC <1000/mm3 with a single temperature of >38.3 degrees C (101 degrees F) or a sustained temperature of >38.0 degress C (100.4 degrees F) for more than one hours	Life threatening consequences; urgent interventions indicated
Fatigue	Relieved by rest	Not relieved by rest; limiting instrumental ADL	not relieved by rest; limiting self-care ADL	
Weight Gain/Loss	5-10% from baseline; intervention not indicated	10-20% from baseline	>20% from baseline	
Blood and Lymphatic				
Anemia	Hgb <10.0 g/dl; <6.2 mmol/L; <100g/L	Hgb <10.0 – 8.0 g/dL; <6.2 – 4.9 mmol/L; <100 – 80 g/L	Hgb <8.0 g/dl; <4.9 mmol/L; < 80g/L; transfusion indicated	Life-threatening consequences; urgent intervention indicated
Integumentary				
Rash/ Acne/ Acneiform	Papules and/or pustules covering <10% BSA, which may or maynot be associated with symptoms of pruritus or tenderness	Papules and/or pustules covering 10-30% BSA, which may or may not be associated with symptoms of pruritus or tenderness; associated with psychosocial impact; limiting instrumental ADL; papules and or pustules covering >30% BSA with or without mild symptoms	Papules and/or pustules covering >30% BSA with moderate or severe symptoms; limiting self-care ADL; associated with local superinfection with oral antibiotics indicted	Life threatening consequences; papules and/or pustules covering any % BSA, which may or may not be associated with symptoms of pruritus or tenderness and associated with extensive superinfection with IV antibiotic indicated
Palmer-plantar erythrdosis Hand/Foot Syndrome	Minimal skin changes or dermatitis (e.g. erythema. Edema, hyperkeratosis without pain	Skin changes (e.g. peeling, blisters, bleeding, fissures, edema, hyperkeratosis) with pain limiting instrumental ADL	Severe skin changes (e.g. peeling, blisters, bleeding, fissures,edema, hyperkeratosis) with main; limiting self-care ADL	_____
Nail Changes	Present; asymptomatic separation of the nail bed from the nail plate or loss	Symptomatic separation of the nail bed from the nail plate or nail loss; limiting instrumental ADL		
Pruritus	Mild or localized; topical intervention indicated	Widespread and intermittent; skin changes from scratching (e.g. edema, papulation, excoriations, lichenification, oozing/crusts); oral intervention indicated; limiting instrumental ADL	Widespread and constant; limiting self-care ADL or sleep; systemic corticosteroids or immunosuppressive therapy indicated	----------
Neurosensory				
Sleep/Insomnia	Mild difficulty falling asleep. Staying asleep or waking up early	Moderate difficulty falling asleep, staying asleep, or waking up early	Severe difficulty in falling asleep, staying asleep, or waking up early	
Neuropathy-Sensory-Motor	Asymptomatic; clinical or diagnostic observations only	Moderate symptoms; limiting instrumental ADL	Severe symptoms; limiting self-care ADL	Life-threatening consequences; urgent interventions indicated
Musculoskeletal				
Arthralgia (joint)	Mild pain	Moderate pain; limiting instrumental ADL	Severe pain; limiting self-care ADL	----------
Myalgia (muscle)	Mild pain	Moderate pain; limiting instrumental ADL	Severe pain; limiting self-care ADL	----------
Respiratory				
Cough	Mild symptoms; non-prescription intervention indicated	Moderate symptoms; medical intervention indicated; limiting instrumental ADL	Severe symptoms; limiting self-care ADL	----------
Dyspnea	Shortness of breath with moderate exertion	Shortness of breath with minimal exertion; limiting instrumental ADL	Shortness of breath at rest; limiting self-care ADL	Life-threatening consequences; urgent intervention indicated
Hiccups	Mild symptoms; intervention not indicated	Moderate symptoms; medical intervention indicated; limiting instrumental ADL	Severe symptoms; interfering with sleep; limiting self-care ADL	----------

Cardiac/PV				
Hypertension	Systolic BP 120-139 mm Hg or diastolic BP 80-89 mm Hg	Systolic BP 140-159 mm HG or diastolic BP 90-99 mm Hg if previously WNL; change in baseline medical intervention indicated; recurrent or persistent (>=24 hours); symptomatic increase by >20mm Hg (diastolic) or to >140/90 mm Hg; monotherapy indicated initiated	Systolic BP >160 mm Hg or diastolic BP >100 mm Hg; medical intervention indicated; more than one drug or more intensive therapy the previously used indicated	Life-threatening consequences (ie malignant HTN; transient or permanent neurologic deficit; HTN crises); urgent intervention indicated crises)
Hypotension	Asymptomatic, intervention not indicated	Non-urgent medical intervention indicated	medical intervention indicated; hospitalization indicated	life threatening consequences; urgent intervention)
Edema	1+ noted on exam; localized to dependent areas; no disability or functional impairment	Moderate localized edema; limiting instrumental ADL; intervention indicated	Severe localized edema; intervention indicated; limiting self-care ADLs;	life threatening consequences
Gastrointestinal				
Anorexia	Loss of appetite without alteration in eating habits	Oral intake altered without significant weight loss or malnutrition; oral nutritional supplements indicated	Associated with significant weight loss or malnutrition (ie. Inadequate oral caloric and/or fluid intake); tube feedings, or TPN indicated	Life-threatening consequences; urgent interventions indicated
Constipation	Occasional or intermittent symptoms; occasion use of stool softeners, laxatives, dietary modification, or enema	Persistent symptoms with regular use of laxative or enemas indicated; limiting instrumental ADL	Obstipation with manual evacuation indicated; limiting self-care ADL	Life-threatening consequences; urgent intervention indicated
Dehydration	Increased oral fluids indicated; dry mucous membranes; diminished skin tugor	IV fluid indicated	Hospitalization indicated	Life-threatening consequences; urgent interventions indicated
Diarrhea	Increase of <4 stool per day over baseline; mild increase in ostomy output compared to baseline	Increase of 4-6 stools per day over baseline; moderate increase in ostomy output compared to baseline; limiting instrumental ADL	Increase of ≥7 stools per day over baseline; hospitalization indicated; severe increase in ostomy output compared to baseline; limiting self-care ADL	Life-threatening consequences; urgent interventions indicated
Esophagitis	Asymptomatic; clinical or diagnostic observations only; intervention not indicated	Symptomatic; altered eating/swallowing; oral supplements indicated	Severely altered eating/swallowing; tube feeding, TPN, or hospitalization indicated	Life-threatening consequences; urgent operative intervention indicated
Nausea	Loss of appetite without alteration in eating habits	Oral intake decrease without significant weight loss, dehydration malnutrition	Inadequate oral caloric or fluid intake; tube feedings, TPN, or hospitalization indicated	Life-threatening consequences; urgent interventions indicated
Vomiting	intervention not indicated	Outpatient IV hydration; medical intervention indicated	Tube feeding, TPN, or hospitalization indicated	Life-threatening consequences
Mucositis	Asymptomatic or mild symptoms; interventions not indicated	Moderate pain or ulcer that does not interfere with oral intake; modified diet indicated	Severe pain; interfering with oral intake	Life-threatening consequences; urgent interventions indicated
Reproductive				
Sexual/Libido	Decreased in sexual interest not adversely affecting relationship	Decrease in sexual interest adversely affecting relationship		
Eyes				
add drop down 0=no 1= yes a referral:	• Photophobia • blurred visions • dry eyes • periorbital edema • watery eyes • decreased vision			

Neurovascular Case Study

A patient with non-hodgkin lymphoma is currently being treated with R-CHOP. Past medical history is remarkable for hepatitis-B that occurred after receiving a blood transfusion 20 years ago. The patient is due for cycle #3 of R- CHOP today.

The nurse observes the patient experiencing difficulty walking today. The patient admits feeling like their feet are not touching the floor at times. The patient also notices this more going up steps and has fallen twice in the past week.

The patient was afraid to say anything because they live alone and knows this treatment will cure the cancer.

1. What are the drugs in this regimen? Acronym: R-CHOP

2. What is the patients ECOG and Karnofsky score based on the above assessment?

3. What grade is the neuropathy?

4. Which ACT in this regimen is most likely causing the side effects/toxicities?

5. Would you anticipate any changes to the treatment today?

6. What would you teach the patient today?

7. What are the other neurovascular causative agents and how are the side effects/toxicities managed?

Neurotoxicity Causative Agents

- Vincristine/Vinblastine/ Vinorelbine (ANS, CN, PNS) = sensorimotor
- Paclitaxel (Taxol)/Docetaxel (Taxotere) = sensorimotor/peripheral neuropathy
- Oxaliplatin – peripheral neuropathy/cold
- Cisplatin (PNS, CN) – ototoxicity/peripheral neuropathy
- Ifosfamide (CNS) – hallucinations
- High dose Cytarabine – cerebellar
- Nitrosoureas (cross blood-brain barrier)
- Bulsulfan – seizures
- Thalidomide – ANS and CNS
- Bortezomib (Velcade) – peripheral neuropathy

Motor – Sensory- Autonomic

Neurological Toxicity Management

Pharmacologic
- Dose modification of the neurotoxic agent is the 'gold standard'
- Opioid and NSAID analgesics are ineffective
- Strongest evidence for duloxetine (Cymbalta)
- Consider use of TCAs, gabapentin, pregabalin, topical gel containing baclofen, tricyclic antidepressants, amitriptyline, and ketamine, serotonin and norepinephrine reuptake inhibitors (SNRIs), anti-epileptics

Non-pharmacologic
- Psychological, physical, and/or occupational therapy
- Relaxation
- Massage
- Acupuncture
- Audiogram

Ocular Case Studies

Case Study #1

A patient with chronic myelogenous leukemia received Imatinib (Gleevac) for three years. Recently changed to Nilotinib (Tasigna). During the 7-week visit the patient complains of watery eyes and pain with eye movements.

1. What toxicity is this patient experiencing?

2. Would you anticipate any changes or tests with the treatment today?

3. What would you teach the patient today?

Case Study 2

A patient receiving Erlotinib (Tarceva) complains of dry eyes. Upon assessment you notice red cornea, and inflammation of the eyelid and the cornea, irritation, and small ulcerations.

1. What toxicities is this patient experiencing?

2. Would you anticipate any changes or tests with the treatment today?

3. What would you teach the patient today?

4. What are the other ocular toxic agents?

5. What are other potential management strategies for ocular side effects/toxicities?

Ocular Causative Agents

Allopurinol = retinal hemorrhages, papilledema, diplopia

Cephalosporins = color vision defects and visual hallucinations

Narcotics = visual hallucinations, dry eyes, myopia

Bulsulfan = cataracts and blurred vision

5-FU = conjunctivitis

Carmustine (BCNU) = optic neuritis

Capecitibine (Xeloda) = ocular irritation

Cytarabine (Ara-C) = photophobia, corneal toxicity in high doses, conjunctivitis

Vincristine = cranial nerve palsies

Platinums = optic neuritis, papilledema, cerebral blindness, altered color perception and color blindness

Ocular Causative Agents

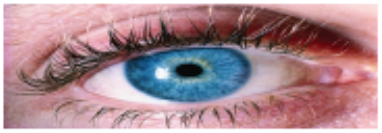
Medication	Molecular Target	Ocular ADR
Afatinib (Gilotrif) Erlotinib (Tarceva) Gefitinib (Iressa)	EGFR NCSLCA, Pancreatic, colorectal	Conjunctivitis, blepharitis, dry eyes, trichomegaly, keratitis, uveitis, corneal thinning and erosion
Crizotinib (Xalkori)	ALK NSCLCA	Photopsia, photophobia, blurred vision, vitreous floaters, diplopia
Dabrafenib (Tafinlar) Vemurafenib (Zelboraf)	BRAF inhibitor Met melanoma, thyroid cancer	Photophobia, uveitis, central macular edema
Dasatanib (Sprycel) Imatinib (Gleevac) Nilotinib (Tasigna)	BCR-ABL inhibitor, c-Kit, PDGFR CML, ALL GIST	Periorbital and eyelid edema, epiphoria, macular edema, conjunctival hemorrhage, optic disc edema, optic neuritis
Trametinib (Mekinist)	MEK Met melanoma, colorectal, NSCLCA	Blurred visions, halo vision, diplopia, central serous retinopathy, retinal vein occlusion, eyelid edema, subconjunctival hemorrhage, dry eye
Sunitinib (Sutent)	PDGFR, VEGF, c-Kit Renal cell	Periorbital and eyelid edema, epiphoria
Vandetanib (Caprelsa)	VEGF, EGFR Thyroid cancer	Blurred vision, corneal opacities (cataract)

Ocular Toxicities

- Blepharitis – inflammation of eyelids
- Trichomegaly – abnormal growth of eyelashes
- Ectropion – lower lid pulls away from the eye
- Dysfunctional tears
- Corneal tears
- Conjunctivitis – damage to epithelial layer of lining of sclera
- Diplopia – double vision
- Keratitis – inflammation of the cornea
- Photophobia
- Uveitis – inflammation of the iris
- Epiphora – watery eyes
- Optic neuritis
- Periorbital/eyelid edema
- Serious retinal detachment
- Retinal vein occlusion

Management

- Warm and/or cool compresses
- Eyelid scrubs
- Artificial tears
- Steroid eye drops
- Antihistamine eye drops
- Baby shampoo
- Topical antibiotic ointment and/or steroids
- Sunglasses
- Low sodium diet
- Sleep with head elevated
- Ophthalmologist



Pulmonary Case Study

A 25-year-old woman newly diagnosed with stage III Hodgkin Lymphoma arrives for the first treatment of ABVD. She was recently married and has no children.
Social History: tobacco 1/2ppd x 10 years

Assessment Reveals
Pulse ox 87%
RR 28-30
Lungs crackles bases bilaterally…….

1. What are the drugs in this regimen? Acronym: ABVD

2. Which side effects would you teach the patient for each drug listed for ABVD?

3. What testing needs to be completed prior to treatment?

4. The patient has recurrence and will now receive A +AVD. What is the "A"? in. What side effects do you teach for this drug?

5 How is Bleomycin toxicity managed?

6. What are the other pulmonary causative agents and how are the side effects/toxicities managed?

Pulmonary Causative Agents

Most Common
- **Bleomycin**
- **Busulfan**
- **Melphalan**
- **Carmustine (BCNU)**
- **Cyclophosphamide (Cytoxan)**
- **MABs**
- **Cytokines (ILs/Interferon)**
- **Checkpoint inhibitors**
- **Immunomodulators**

Less common
- Methotrexate (MTX)
- Mitomycin
- Fludarabine (Fluara)
- Arsenic trioxide (Trisenox)
- ATRA

- Age
- Tobacco
- Occupation
- Deteriorating creatinine clearance
- Prior lung disease
- Autoimmune disease
- COPD
- GVHD
- Thoracic radiation

Pulmonary Toxicity - Fibrosis

- **Bulsulfan and Carmustine (BCNU)**
  - Progressive
  - Insidious cough, SOB, low grade fever
  - Pulmonary fibrosis
- **Cyclophosphamide (Cytoxan)**
  - Edema
  - Fibrosis
  - Alveolar hemorrhage
  - Accumulation acrolein
  - Onset 15 weeks-6 years after

- **Melphalan**
  - Pulmonary fibrosis
  - Interstitial pneumonia
  - Bronchospasm
  - Dyspnea
- **Bleomycin**
  - Dyspnea and fine rales
  - Pneumonitis
  - More common > age 70

Pulmonary Causative Agents

Immunomodulators

Checkpoint inhibitors
- Pneumonitis
- Interstitial Lung Disease (ILD)
- Pulmonary fibrosis

Cytokines
- **Interleukin -2 (IL-2)**
  - Pulmonary congestion
  - Pulmonary edema
  - Respiratory failure
  - Pleural effusion
  - Wheezing
  - Hemoptysis
- **Interferon**
  - Fever
  - Cough
  - Dyspnea
  - Pulmonary infiltrates
  - Pneumonitis

Monoclonal Antibodies
- Alemtuzumab (Campath)
- Cetuximab (Erbitux)
- Daratunumab (Darcelex)
- Obinutuzumab (Gadyzva)
- Panitunumab (Vectibix)
- Rituximab (Rituxan)
- Trastuzumab (Herceptin)

- **Infusion Related**
  - Hypotension
  - Rigors
  - Fever
  - Bronchospasm
  - Dyspnea
  - Pleural effusions
  - Cough
  - Hypoxia

Cardiovascular Case Study

A patient with a history of breast cancer three years ago was treated partial mastectomy with SLNB, radiation times six weeks and ACT with Acronym: T-AC or AC-T. The patient was admitted for SOB on exertion and new onset of swollen ankles.

Assessment reveals:

- Crackles 1/3 way up lung fields
- SpO2 88% on RA
- +1-2 pedal edema
- Lasix was administered with improved oxygen levels and breathing 24 hours after admission.

Testing results:

- ECHO EF 35 % (previously 50%)

1. What are the drugs in this regimen (Acronym: T-AC or AC-T) and the most common side effects of each drug.

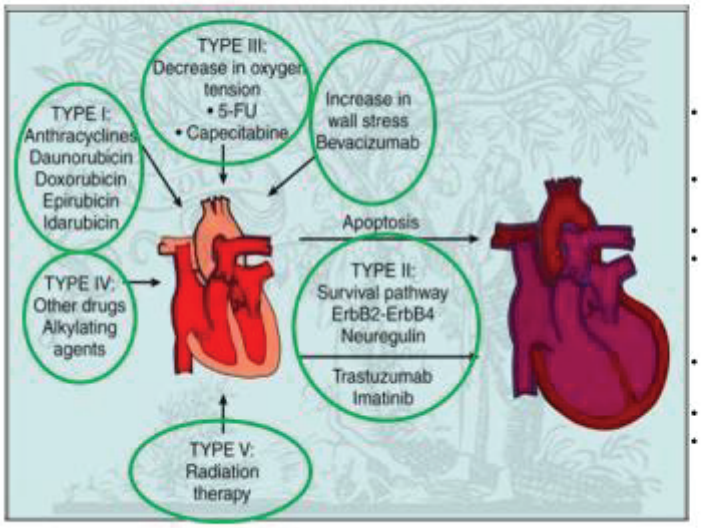
2. List any other tests that this patient may need or additional assessment.

3. List three interventions to improve the patients' symptoms.

4 What would you teach the patient today?

5. What are the other cardiovascular causative agents and how are the side effects/toxicities managed?

Cardiotoxicity Causative Agents



- **Cardiomyopathy**
  - **heart failure/left ventricle dysfunction**
- **Myocardial ischemia/infarction**
- **Hypertension**
- **Arrhythmias**
  - **QT prolongation, bradycardia, atrial fibrillation**
- **Pericarditis, pericardial effusion**
- **CHF**
- **Thromboembolism**

Abeloff et al. Cardiac Effects of Cancer Therapy. Page: 985

Cardiovascular Causative Agents

- **Anthracyclines – hypertrophy LVEF**
- **High dose Cyclophosfamide (Cytoxan) – cardiomyopathy**
- **Taxanes – hypotension/bradycardia**

Raynauds
- Bleomycin
- Plant Alkaloids
- Cisplatin
- Melphalan

Others
- Cisplatin (hypomagnesium)
- 5-FU (MI, acute ischemia)
- Arsenic (QT, KCL, Mg)
- **TKI's/MKI's (nibs) – (QT intervals)**
- MAB's (HTN/hypersensitivity)
- Cytokines (capillary leak)

Cardiovascular Assessment and Management

- Prior to beginning therapy: baseline Echo or MUGA
  - EF greater than or equal to 50%
- Baseline ECG
  - Repeat about every 3 months
- Cardiac toxicity suspected if >10 -20% decrease in LVEF
- Complications can occur at the time of treatment or any time after therapy
- Assess for signs and symptoms of toxicity before each treatment/visit
- Assess for electrolyte abnormalities on routine labs
  - KCL, magnesium, phosphorous,calcium
- Monitor renal function
  - BUN, creatinine
- Blood Pressure, edema, dyspnea on exertion, orthopnea, JVD, weight gain, fatigue, cough, dullness at the lung bases

Peripheral Vascular Case Study

A patient diagnosed with unresectable adenocarcinoma of the colon was treated with Acronym: Bev/FOLFOX6 presents with pain in the left leg. Patient also reports swelling and redness over the back of the calf with pain radiating from this location up the back of the thigh. Symptoms have been present for the past three days and have become more pronounced.

Assessment reveals:

- Tenderness of the left leg
- 1.5cm area of erythema and induration over the posterior aspect of the calf and in the popliteal fossa
- Marked tenderness to palpation over this area

1. What are the drugs in this regimen? Acronym: Bev/FOLFOX6 and the most common side effects of each drug.

2. List any tests that this patient may need or additional assessment.

3. List three interventions to improve the patients' symptoms.

4. What would you teach the patient today?

5. What are the other peripheral vascular causative agents and how are the side effects/toxicities managed?

Thromboembolism (PE, VTE)

- **Cancer induces hypercoagulable state-** 7 to 10-fold increased risk
- Risk depends on disease status, use of steroids, use of proper thromboprophylaxis, patient mobility etc.
- Unknown clear cause
- Some meds may induce platelet aggregation and also cause interaction between platelets and the endothelium

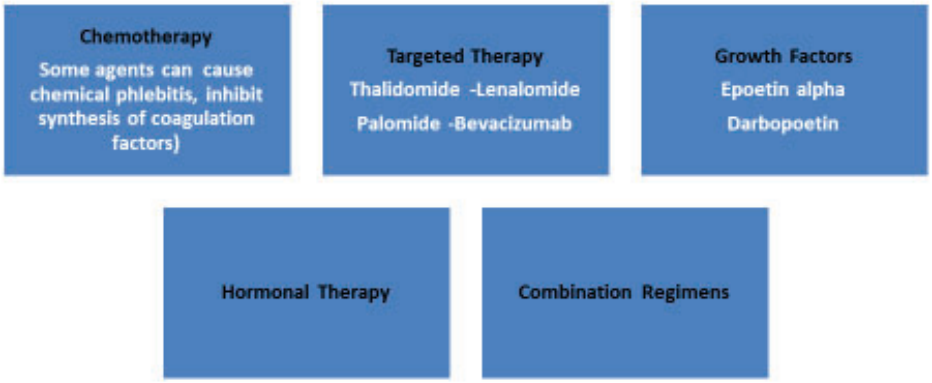


Table 5. Predictive Model for Chemotherapy-Associated VTE in the Ambulatory Setting

Patient Characteristic	Points
Site of cancer	
Very high risk (stomach, pancreas, primary brain tumor)	2
High risk (lung, lymphoma, gynecologic, bladder, testicular, renal tumors)	1
Prechemotherapy platelet count ≥ 350,000/μL	1
Hemoglobin level < 10 g/dL or use of red-cell growth factors	1
Prechemotherapy leukocyte count > 11,000/μL	1
Body mass index ≥ 35 kg/m^2	1
Calculate total score, adding points for each criterion in the model	
Interpretation:	
High risk ≥ 3 points	
Intermediate risk, 1 to 2 points	
Low risk, 0 points	

NOTE. Data adapted.[88]
Abbreviation: VTE, venous thromboembolism.

Unfractionated Heparin

- **5,000 units/SubQ Q8H (prophylaxis)**

LMWH

- **Enoxaparin**
  - **30 mg sq bid/40 mg sq daily**
  - **1mg/kg sq bid, 1.5mg/kg sq daily**
- **Tinzaparin**
  - **175 units/kg sq daily**
- **Dalteparin**
  - **5000 units sq daily, then 2500 units in subacute setting**
- **Fondaparinux**
- **Warfarin**
  - **Avoid in malignancies**

Platelet-inhibitors

- **ASA, NSAIDS etc.**

Genitourinary Case Study

A 45 year old African American male with NHL is currently being treated with Acronym: ICE. The patient calls into the phone line and complains of not making it to the bathroom in time and having trouble starting to urinate over the past week. Past medical history is remarkable for recurrent UTIs.

Assessment revealed:

- Blood streaks noted in urine
- Intermittent abdomen cramping
- Weight gain of 2.5 kg

1. What are the drugs in this regimen? Acronym: ICE and the most common side effects of each drug.

2. List any other tests that this patient may need or additional assessment that needs to occur.

3. List three interventions to improve the patients' symptoms.

4. What would you teach the patient today?

5. What are the other genitourinary causative agents and how are the side effects/toxicities managed?

Genitourinary Causative Agents – Bladder

- Ifosfamide (Ifex)
- High dose Cyclophosphamide (Cytoxan)
- HSCT
- Busulfan
- GVHD
- BK virus

Renal/Nephrotoxicity Causative Agents

- Cisplatin (Platin)
  - (extensive necrosis to proximal & distal tubules)
- Fludarabine (Fludara)
  - Acute uric acid nephropathy
  - TLS

- High Dose Methotrexate (MTX)
  - Tubular injury
  - Leucovorin rescue
- Mitomycin –C
  - HUS
  - Irreversible renal failure
- Melphalan
- Interleukin -2 (IL-2)
- TKIs/MKIs
- Immunotherapy
- Bisphosphonates
- Tumor Lysis Syndrome(TLS)
- SIADH
- Chronic comorbidities
- Acute kidney injury (AKI)

Hepatic Case Study

A patient with history of obesity, DM2, HTN, HLD, and metastatic RCC to the right kidney, adrenal gland, and right pleural node is receiving axitinib and pembrolizumab.

Labs:

AST 305

ALT 555

Alk Phos 116

TB 0.14

TSH 4.38

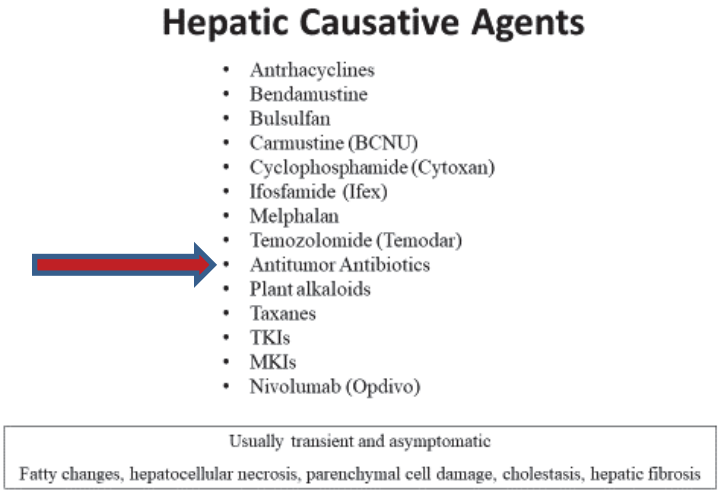
1. What concerns do you have for this patients based on these findings?

2. Which ACT is most likely causing the side effects/toxicities?

3. Would you anticipate any changes or tests with the treatment today?

4. What would you teach patient today?

5. What are the other hepatic causative agents and how are the side effects/toxicities managed?



Integumentary Case Study

CASE STUDY 1

A 78 year old with PMH significant for HTN and newly diagnosed melanoma metastatic to liver presents status post cycle of pembrolizumab. Patient complaining of a rash that has developed over the past two weeks.

1. What diagnosis do you suspect?

2. What treatment options could be considered?

On day 2 of steroids the patient presents again with the rash now involving 70% of body including face, trunk, arms, and legs.

3. What Grade would this be?

4. What would be the next steps?

CASE STUDY 2

A 68-year-old with metastatic breast cancer takes capecitabine 1500 mg PO BID days 1-14 every 21 days. At the two-week toxicity assessment the patient shows you her hands and reports pain in the fingertips, with erythema and peeling, beginning 3 days ago and worsening each day. Also reports difficulty preparing her meals due to the pain and discomfort. Denies any issues with the feet.

1. What grade is DB's HFS?

2. Should the capecitabine be hold or continued?

3. What supportive measures/therapies can you recommend?

4. What are the other integumentary causative agents and how are the side effects/toxicities managed?

Integumentary Toxicities

- Risk factors:
  - Age, gender, fair skin, UV exposure, smoking, combination with chemo
- Acneiform rash
- Papules
- Blisters
- Lesions
- Wounds
- Color
- Texture
- Moisture
- Integrity
- Skin turgor
- Moles
- Petechiae

https://www.google.com/search?q=integumentary+assessment&safe=active&source=lnms&tbm=isch&sa=X&ved=[illegible]

Integumentary Papulopustular (Acneiform) Rash

Grade 1	Grade 2	Grade 3	Grade 4
Papules and/or pustules covering < 10% BSA, +/- pruritus or tenderness	Papules and/or pustules covering 10-30% BSA, +/- pruritus or tenderness; associated with psychosocial impact; limiting instrumental ADL; papules and/or pustules covering > 30% BSA +/- mild symptoms	Papules and/or pustules covering >30% BSA + moderate or severe symptoms; limiting self-care ADL; antibiotics indicated	Life-threatening consequences; papules and/or pustules covering any % BSA, +/- pruritus or tenderness + extensive superinfection w/ IV antibiotics indicated

- Occurs in up to 80% of patients
- Presents in skin with high density of sebaceous glands
  - Scalp, face, upper chest, back
- May include pain, pruritus, irritation, stinging
- Risk factors:
  - Age, gender, fair skin, UV exposure, smoking, combination with chemotherapy
- Initial pustules sterile, may develop secondary bacterial infection
- May be surrogate marker for efficacy
- Resolution within 4 weeks of treatment discontinuation
- May wax and wane, and improve or resolve spontaneously without stopping treatment

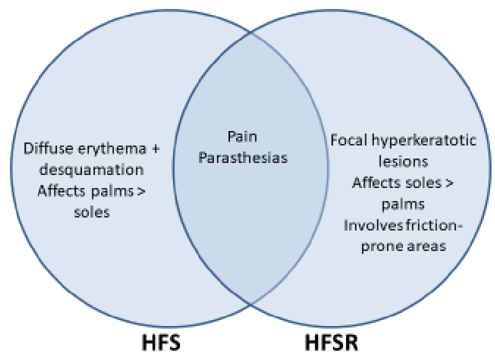
Integumentary -Maculopapular Rash

Grade	Presentation	Management
1	Macules/papules covering < 10% BSA +/- symptoms	• Continue immunotherapy • Topical emollient • Oral antihistamine for pruritus • Moderate potency topical steroids to affected area
2	Macules/papules covering 10-30% BSA +/- symptoms; limiting instrumental ADLs	• Continue immunotherapy and monitor weekly • Topical emollient • Oral antihistamine for pruritus • Moderate – high potency topical steroids to affected areas AND/OR • Prednisone 0.5-1 mg/kg/day
3-4	Macules/papules covering > 30% BSA +/- symptoms; limiting self-care ADLs	• Hold immunotherapy • High potency topical steroids to affected areas • Prednisone 0.5-1 mg/kg/day (may ↑ up to 2 mg/kg/day if no improvement) • Urgent dermatology consult; consider biopsy • Consider inpatient care

- Symptoms may include pruritus, burning, tightness
- Taper steroids over at least 4 weeks
- Avoid skin irritants and sun exposure
- For grade 2 steroid use – treat until symptoms improve to grade 1 or less and then taper over 4-6 weeks

NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®). Management of Immunotherapy-Related Toxicities. Version 1.2020. nccn.org

Integumentary HFS vs. HFSR



Miller KK, et al. *J Am Acad Dermatol.* 2014;71(4):787-94.

Integumentary – HFS/HFSR Treatment

- Most effective - dose interruption or modification
- Symptoms typically improve within 1-2 weeks
- Grades 2-3 = dose interruption
- Grade 3 = dose reduction

- Avoid direct sunlight and use sunscreen SPF ≥ 30
- Avoid hot baths/showers
- Avoid alcohol-based or fragranced skin care products
- Do not treat like acne!
- Moisturize

- Supportive measures:
  - topical corticosteroids, wound care, emollients and topical keratolytics, analgesics
- Hydrocortisone 1% + moisturizer + sunscreen + doxycycline BID x 6 weeks
- Oral Tetracyclines
  - Prevention vs treatment
    - Doxycycline
    - Minocycline – less photosensitizing
- Systemic steroids not typically used

Severe Cutaneous Adverse Reactions (SCAR)

- thought to be T-cell mediated delayed hypersensitivity reactions
- can be caused by autoimmunity and a number of allergens, including bacteria and viruses
- Types:
  - Bullous dermatitis (most common bullous pemphigoid)
  - Stevens-Johnson Syndrome (SJS)
  - Toxic epidermal necrolysis (TEN)
  - Acute generalized exanthematous pustulosis
  - Drug Reaction with Eosinophilia and System Symptoms (DRESS)/Drug induced hypersensitivity syndrome (DIHS)

Management:
- Urgent dermatology, ophthalmology, and urology consultation (skin biopsy)
- Permanently discontinue immunotherapy
- Prednisone/methylprednisolone 1-2 mg/kg/day
- Consider IVIG
- Inpatient care necessary




Chirasuthat P, Chayavichitsilp P. *Case Rep Dermatol.* 2018;10(2):199-202
Coleman EL, et al. *Clin Dermatol.* 2020;38(1):94-104.

Endocrine Case Study

A patient with resected IIIB melanoma receiving Ipilimumab (Yervoy) and Nivolumab (Opdivo) presents with complaints of fatigue "feeling like run over by a truck", abrupt onset headache, nausea, vomiting, and visual changes.

Labs:
TSH 5.5 mIU/L
Free t4 less than 0.3ng/dL
AM cortisol undetectabale
ACTH less than 5pg/mL
AST 400
ALT 550
Alk Phos 116
TB 2.3
LDH 480

1. What additional testing might you expect?

2. What is the most likely diagnosis?

3. Would you anticipate any changes or tests with the treatment today?

4. What would you teach the patient today?

5. What are the other endocrine causative agents and how are the side effects/toxicities managed?

Endocrine Causative Agents

- Adrenal, thyroid, pituitary
- Hyperthyroidism
- Hypothyroidism
- Hypophysitis
- Hyperglycemia
- Adrenal insufficiency
- Thyroiditis

- mTOR
- Interferon
- Interleukins
- Checkpoint inhibitors
- TKIs
- MKIs

Anticancer Therapy Practice Examination

1. Magnesium levels need to be monitored and supplemented for which of the following agents?

   a. Doxorubicin (Adriamycin) and Paclitaxel (Taxol)
   b. Cisplatin (Platinol) and Arsenic Trioxide (Trisenox)

2. Administering leucovorin with 5-Fluorouricil (5-FU):

   a. Increases cytotoxicity
   b. Decreases cytotoxicity

3. Administering leucovorin with Methotrexate (MTX):

   a. Increases cytotoxicity
   b. Decreases cytotoxicity

4. The neurotoxicity associated with Cytarabine (Ara-C):

   a. Occurs most commonly with low doses
   b. Manifest as peripheral neuropathy
   c. Can be prevented with the use of B-complex vitamins
   d. Manifests as cerebellar toxicity.

5. Administering steroids and histamine blockers should minimize the hypersensitivity reactions associated with the taxanes.

   a. True
   b. False

6. Which chemotherapy agent requires a dosing calculation with the Calvert Formula:

   a. Doxorubicin (Adriamycin)
   b. Vincristine (Oncovin)
   c. Carboplatin (Paraplatin)
   d. Methotrexate (MTX)

7. First-line hormonal therapy for post-menopausal woman includes:

   a. tamoxifen.
   b. LHRH.
   c. Arimidex (Anastrozole).
   d. Zoladex (Goserelin)

8. The decrease in blood pressure associated with interleukin (IL-2) cytokine biotherapy is associated with which of the following syndromes?

a. Retinoid acid
b. Metabolic
c. Capillary leak
d. Differentiation

9. Patients taking steroids are at greater risk for (Circle all that apply)

a. GI bleeding
b. Fungal infections
c. Psychosis
d. Hyperglycemia

10. Steroids are routinely administered with chemotherapy agents with LOW emetogenicity potential.

a. True
b. False

11. Trastuzumab (Herceptin) used for the management of breast cancer is: (Circle all that apply)

a. a monoclonal antibody.
b. an EGFR.
c. Cardiotoxic.
d. only used in HER2 overexpression.

12. Cell cycle specific agents increase cytotoxicity when administered as:

a. Continuous infusions
b. Boluses

13. Anti-angiogenesis agents treat cancer by which of the following mechanisms of action?
a. Induces programmed cell death (apoptosis)
b. Decreases formations of blood vessels
c. Inhibits DNA synthesis
d. Stabilize microtubules

14. Hemorrhagic cystitis is most seen with the administration of which of the following agents?
a. Busulfan (Myeleran)
b. Idarubicin (Idamycin)
c. Etoposide (VP-16)
d. Ifosfamide (Ifex)

15. Neurotoxicity associated with extreme sensitivity to cold occurs with which of the following agents?

a. Carboplatin (Paraplatin)
b. Vincristine (Oncovin)
c. Oxaliplatin (Eloxitan)
d. Melphalan (Alkeran)

16. Capecitabine (Xeloda) and Doxil are associated with which of the following side effects:

a. stomatitis
b. constipation
c. palmer-plantar erythrodysesthesia

17. Vinorelbine (Navelbine) can be administered intrathecally.

a. True
b. False

18. Patients receiving Pemetrexed (Alimta) should receive vitamin B12 and folic acid to: (select all that apply)

a. increase their sensitivity to radiation.
b. prevent neutropenia.
c. decrease the toxicity of the drug.

19. Patients receiving SERMS are at increased risk for:
a. lung cancer.
b. thrombotic events.
c. constipation.

20. Mesna is used to protect toxicity from which agent?

a. Cisplatin (Platinol)
b. Ifosfamide (Ifex)
c. Procarbazine (Matulane)
d. Azacitidine (Vidaza)

21. Which drug classification is most associated with subsequent malignancies and reproductive fertility?

a. Antimetabolites
b. Tyrosine kinases
c. Alkylating agents
d. Plant alkaloids

22. The MKIs are known to induce which dose limiting side effects:

a. pulmonary toxicity
b. renal failure
c. hypertension
d. hemorrhagic cystitis

23. Serotonin inhibitors (5HT-3) medications have which of the following side effects?

a. Hypertension
b. Headache and constipation
c. Hyperglycemia
d. Nausea and vomiting

24. Which of the following drug classifications are known to cause skin rashes?

a. VEGF and immunomodulators
b. CTLA-4 and PD1
c. TKI and EGFR
d. MABs and CAR-T

25. Which of the following are considered immunotherapies?

a. Tyrosine kinase inhibitors
b. Checkpoint inhibitors
c. Proteasome inhibitors
d. Vascular endothelial growth factors

26. Filgrastim (Neupogen) is to be administered within 24 hours of chemotherapy.

a. True
b. False

27. Which of the following medications can mitigate cytokine release syndrome (CRS)?

a. Ruxolitinib (Jackafi)
b. Ibrutinib (Imbruvica)
c. Tocilizumab (Actemra)
d. Venetoclax (Venclexta)

28. Which of the following has a black box warning for teratogenic and thrombosis effects?

a. Monoclonal antibodies
b. Immunomodulators
c. Bcl-2 inhibitors
d. Checkpoint Inhibitors

Targeted Cellular – Tyrosine Kinase Inhibitors (TKIs)	Targeted Cellular – Multi-Kinase Inhibitors (MKIs)	Targeted Cellular Therapy	Other Targeted Cellular Therapy
Acalabrutinib (Calquence®) Alectinib (Alecensa®) Aftinib (Gilotrif®) Axitinib (Inlyta®) Avapritinib (Ayvakit®) Bosutinib (Bosulif®) Binimetinib (Mektovi®) Brigtinib(Alunbrig®) Cabazantinib (Cometriq®) Capmatinib (Tabrecta®) Ceritinib (Zykadia®) Crizotinib (Xalkori®) Dacomitinib (Vizimpro®) Duvelisib (Copiktra®) Enasidenib (IDH2®) Encorafenib (Braftovi®) Erlotinib (Tarceva®) Entrectinib (Rozlytnek®) Fedratinib ((Inrebic®) Gefitinib (Iressa®) Gilterinib (Xospata®) Imatinib (Gleevac®) Ibrutinib (Imbruvica®) Idelalisib (Zydelig®) Infigratinib (Truseltiq®) Ivosidenib (Tibsovo®) Larotrectinib (Vitakvi®) Lorlatinib (Lorbrena®) Neratinib (Nerlynx®) Osimertinib (Tagrisso®) Pexidartinib (Turalio®) Pemigatinib (Pemazyre®) Ponatinib (Iclusig®) Pralsetinib (Gavreto®) Ruxolitinib (Jakafi®) Selpercatinib (Retevmo®) Selumetinib (Koselugo®) Sotorasib (Luvmakras®) Tepotinib (Tepmetko®) Trametinib (Mckinist®) Tucatinib (Tukysa®) Vandetanib (Caprelsa®)	Cobimetinib (Cotelic®) Dabrafenib (Tafnlar®) Dasatinib (Sprycel®) Erdafitinib (Balversa®) Lapatinib (Tykerb®) Lenvatinib (Lenvima®) Midostaurin (Rydapt®) Nilotinib (Tasigna®) Pazopanib (Votrient®) Regorafenib (Stivarga®) Ripretinib (Qinlock®) Sorofenib Tosylate (Nexavar®) Sunitinib Malate (Sutent®) Vemurafenib (Zelboraf®) Zanibritinib (Brukinsa ®)	**Proteasome Inhibitors** Bortezomib (Velcade®) Carfilzomib (Kyprolis®) Ixazomib (Ninlaro®) **Protein Kinase Inhibitors (CDK4/CDK6 (G1phase)** Ademaciclib (Verzenio®) Alpelisib (Piqray®) Copanlisib (Aliqopa®) Palbociclib (Ibrance®) Ribociclib (Kisqali®) Umbralisib (Ukoniq®) **PARP Inhibitors** Niraparnib (Zejula®) Olaparinib (Lynparza®) Rucaparib (Rubraca®) Talazoparib (Talzenna®) **MTor Inhibitors** Temsirolimus (Torisel®) Everolimus (Afinitor®) **Hedgehog Pathway** Glasdegib (Daurisma) Vismodegib (Erivedge®) Sonidegib (Odomzo®)	**BCL-2 Inhibitors** Venetoclax (Venclexta®) **First-in-class oral selective inhibitor of nuclear export (SINE)** Selinexor (Xpovio®) **EZH2 inhibitor** Tazemetostat (Tazverik®) **EGFR** Cetuximab (Erbitux®) Panitumumab (Vecitibix®) Trastuzumab (Herceptin®) ***BIOSIMILAR = Ogivri*** Trastuzumab and hyaluronidase-oysk (Herceptin-Hycela®) **VEGF** Bevacizumab (Avastin®) ***BIOSIMILAR – Mvasi*** Tivozanib (Fotivda®)

Cytokines	Monoclonal Antibodies	Monoclonal Antibodies	Cellular Immunotherapy
Retinoids Tretinoin (Vesanoid®) Bexarotene (Targretin®) **Cytokines** Interferon alfa 2a (Roferon-A®) alfa 2b (Intron-A®) **Interleukins** Aldueleukin® Proleukin/IL2® Denileukin Difitox (Ontak®) **HCF Hematopoietic** Filigastrin (Neupogen®) G-CSF Pegfiligrastin (Neulasta®) Sargramostin (Leukine®) GM-CSF Tbo-filigrastin (Granix®) Epoetin (Eopgen/Procrit®) Darbopoeitin (Aranesp®) Oprelvekin (Neumega®) Romiplostim (Nplate®) Eltrombopag (Promacta®) Plerixafor (Mozobil®) Palifermin (Kepivance®) Sipuleucel-T (Provenge®)	Ado-trastuzumab (Kadcyla®) Alemtuzumab (Campath®) Amivantamab (Rybrevant®) Atezolizumab (Tecentriq®) Avelumab (Bavencio®) Belinostat mafodotin (Blenrep®) Bevacizumab (Avastin®) Brentuximab vedotin (Adcetris®) Cemiplimab-rwlc (Libtayo®) Cetuximab (Erbitux®) Copanlisib (Aliqopa®) Daratumumab (Daralex®) Daratumumab and hyaluronidase-fihj® Durvalumab (Imfinzi®) Denosumab (Prolia/Xjeva®) Dinutuximab (Unituxin®) Eculizumab (Soliris®) Elotuzumab (Empliciti®) Enfortumab vedotin-ejfi (PADCEV®) Fam-traztuzumab deruxtecan-nxki–(Enhertu®) Gemtuzumab ozogamicin (Mylotarg®) Ipilimumab (Yervoy®) Inotuzumab ozogamicin (Besponsa®) Isatuximab-irfc (Sarclisa®) Loncastuximab tesrine (Zylonta®) Margetuximab (Margenza®) Naxitamab (Danyelza®) Nectimumab (Portrazza®) Nivolumab (Opdivo®) Ofatumumab (Arzerra®) Obinutuzumab (Gazyva®) Olaratumab (Lartruvo®)	Panitumumab (Vecitibix®) Pembrolizumab (Keytruda®) Pertuzumab (Perjeta®) Pertuzumab, trastuzumab, and hyaluronidase-zzxf (Phesgo®) Polatuzumab vedotin-piiq (Polivy®) Ramucirumab (Cyramza®) Rituximab (Rituxan®) Rituximab-hyaluronidase (Rituxan Hycela®) Sacituzimab govitecan-hziy (Tradelvy®) Tafasitamab (Monjuvi®) Trastuzumab (Herceptin®) ***BIOSIMILAR – Ogivri*** Trastuzumab and hyaluronidase-oysk (Herceptin Hylecta®) - SQ **Radio-Immunotherapy** Ibritumomab Tiuxetan (Zevalin®) Tositumomab (Bexxar®) **Bispecific Antibody** Blinatumomab (Blincyto®) Emicizumab (Hemlibra®) Amivantamab-vmjw (Rybrevant®) Tebentafusp-tebn (Kimmtrak®)	**Immumodulators** Thalmid (Thalidomide®) Lenalidomide (Revlamid®) Pomalidomide (Polmalyst®) **CTLA-4 Inhibitors** Ipilimumab (Yervoy®) **PD-1 Inhibitors** Nivolumab (Opdivo®) Pembrolizumab (Keytruda®) Dostarlimab (Jemperlis®) **PD-L1 Inhibitors** Atezolizumab (Tecentriq®) Avelumab (Bavencio®) Durvalumab (Imfinzi®) **CAR-T** Tisagenlecleucel (Kymriah®) Yescarta (Axicabtagene ciloleucel®) Brexucabtagene autocucel (Tecartus®) Idecabtagene vicleucel (Abecma®) Lisocabtagene maraleucel (Breyanzi®)

TARGETED CELLULAR THERAPY

The targets are inside the cellular pathways

Side Effects: interfere with P-450 and act as inhibitors and inducers of CYP-3A4

Many drug-to-drug interactions and variances of when to take with food or on empty stomach

CELLULAR THERAPY – TYROSINE KINASE INHIBITORS (TKIs)

Tyrosine kinases are enzymes responsible for the activation of many proteins by signal transduction cascades. The proteins are activated by adding a phosphate group to the protein (phosphorylation), a step that TKIs inhibit – only one pathway involved

Generic	Trade/Brand	Target	Indication
Acalabrutinib	Calquence®	inhibits BTK	MCL
Alectinib	Alecensa®	ALK and RET	Non-small cell lung
Aftinib	Gilotrif®	EGFR exon 19 deletions or exon 21 (L858R) substitution mutations	Non-small cell lung
Avapritinib	Ayvankit®	Exon 18	GIST
Axitinib	Inlyta®	(VEGFR)-1, VEGFR-2, and VEGFR-3	Renal cell
Bosutinib	Bosulif®	inhibits Bcr-Abl kinase that promotes CML; also inhibits SRc-family kinases including Src, Lyn, and Hck	CML
Binimetinib	Mektovi®	MEK inhibitor	melanoma
Brigatinib	Alunbrig®	ALK	met anaplastic lymphoma
Cabazantinib	Cometriq®	targets RET, MET, VEGFR-1, -2, and -3, KIT, TrkB, FLT-3, AXL, and TIE-2 pathways	Renal cell
Capmatinib	Tabrecta®	Exon 14	Met NSCLCA
Ceritinib	Zykadia®	ALK inhibitor	ALK positive metastatic on-small cell lung
Crizotinib	Xalkori®	ALK inhibitor	ALK positive metastatic non-small lung
Dacomitinib	Vizimpro®	EGFR receptor	Non-small cell lung
Duvelisnib	Copiktra®	P13K	CLL or SLL; refractory follicular
Encorafenib	Braftovi®	BRAF and MAPK inhibitor	advanced melanoma
Entrectinib	Rozlytnek®	NTRK gene; ROS1; ALK	Met NSCLCA
Erlotinib	Tarceva®	EGFR receptor tyrosine kinase inhibitor	Non-small cell lung
Fedratinib	Inrebic®	JAK2; FLT3	Myelofibrosis; PCV
Gefitinib	Iressa®	EGFR; 19q	Non-small cell lung
Gilterinib	Xospata®	FLT3	Refractory/relapsed AML
Imatinib	Gleevac®	abnormal BCR-ABL tyrosine kinase produced by Philadelphia chromosome in CML/ALL	CML ALL Myeloproliferative Stromal

Generic	Trade/Brand	Target	Indication
Ibrutinib	Imbruvica®	Bruton's tyrosine kinase (BTK)	CLL
Idelalisib	Zydelig®	phosphoinositide-3 kinase (PI3K) delta	Lymphoma
Infigratinib	Truseltiq®	FGFR	Cholangiocarcinoma
Ivosidenib	Tibsovo®	IDH1	Relapsed/refractory AML
Larotrectinib	Vitakv®	TRK A-B-C	Solid tumor NTRK gene fusion
Lorlatinib	Lorbrena®	ALK inhibitor	NSCLCA
Neratinib	Nerlynx®	Her 2	early stage her2 breast
Osimertinib	Tagrisso®	EGFR	Non-small cell lung
Pemigatinib	Pemazyre®	GFR2 fusion – FGFR	Unrespectable locally advanced bile duct
Pexidartinib	Turalio®	Kinase inhibitor	Ten synovial giant cell tumor
Ponatinib	Iclusig®	targets the BCR-ABL	ALL
Pralsetinib	Gavreto®	RET	NSCLCA
Ruxolitinib	Jakafi®	JAK1 and JAK2	Myelofibrosis
Selpercatinib	Retevmo®	Gene fusion RET	NSCLCA; met thyroid
Selumetinib	Koselugo®	Her 2	Her2 Breast
Sotorasi	Lumakras®	KRAS	Lung
Tepotinib	Tepmetko®	MET – EXON	NSCLCA
Trametinib	Mckinist®	MEK1 and MEK2 k BRAF V600E	Melanoma
Tucatinib	Tukysa®	HER2	HER2 Breast
Vandetanib	Caprelsa®	VEGF, EGFR, and RET	Medullary thyroid
Zanubrutinib	Brukinsa ®	BTK	Mantle Cell

CELLULAR THERAPY – MULTIKINASE INHIBITORS (MKIs)

Tyrosine kinases are enzymes responsible for the activation of many proteins by signal transduction cascades. The proteins are activated by adding a phosphate group to the protein (phosphorylation), a step that TKIs inhibit – multiple pathways involved

Generic	Trade/Brand	Target	Indication
Cobimetinib	Cotelic®	BRAF	Melanoma
Dabrafenib	Tafnlar®	BRAF kinases with in vitro IC50 values of 0.65, 0.5, and 1.84 Nm for BRAF V600E, BRAF V600K, and BRAF V600D enzymes,	Melanoma
Dasatinib	Sprycel®	BCR-ABL, SRC family (SRC, LCK, YES, FYN), c-Kit, EPHA2 and PDGFR-beta kinases;	CML ALL Ph+
Erdafitinib	Balversa®	FGFR 1-2-3-4; FLT4; KIT; VEGFR2	Met urothelial
Fedratinib	Inrebic®	JAK2	Myeloproliferative/PCV
Lapatinib	Tykerb®	Protein inhibitor	Metastatic breast
Lenvatinib	Lenvima®	VEGFR1 (FLT1), VEGFR2 (KDR), and VEGFR3 (FLT4)	Thyroid Renal

Generic	Trade/Brand	Target	Indication
Midostaurin	Rydapt®	FLT3	AML
Nilotinib	Tasigna®	BCR-ABL Inhibits PDGFR and c-Kit kinase	CML GIST
Pazopanib	Votrient®	VEGF and PDGF	Advanced renal Soft Tissue Sarcoma Ovarian
Regorafenib	Stivarga®	VEGF and TIE 2	Metastatic colorectal Advanced GIST
Ripretinib	Qinlock®	KIT; PDGFA	Gist
Sorofenib Tosylate	Nexavar®	VEGF and PDGF	Renal Hepatocellular
Sunitinib Malate	Sutent®	VEGF and PDGF	Renal GIST
Vemurafenib	Zelboraf®	BRAF Also RAF, ARAF, wild-type BRAF, SRMS, ACK1, MAP4K5, FGR	Malignant melanoma

PROTEASOME INHIBITORS - CDK4 AND CDK6 (G1 PHASE)
block the action of proteasomes, cellular complexes that break down proteins
Diarrhea, nausea, rash, stomach pain, vomiting, headache, fever, lipodystrophy, liver toxicity, neuro toxicity

Generic	Trade/Brand	Target	Indication
Bortezomib	Velcade®	26-S proteasome	Multiple myeloma Mantle cell
Carfilzomib	Kyprolis®	Tetrapeptide epoxyketone proteasome inhibitor	Multiple Myeloma
Ixazomib	Ninlaro®	eta 5 subunit of the 20S proteasome	Multiple Myeloma

PROTEIN KINASE INHIBITORS – Cyclin Dependent Kinase (CDK)
block the action of protein kinases - can be subdivided according to the amino acid on a protein that they add the phosphate to (e.g serine, threonine or tyrosine) in order to inhibit phosphorylation of that amino acid

Generic	Trade/Brand	Target	Indication
Ademaciclib	Verzenio®	CDK4 and CDK6 inhibitor	HR+, HER2-
Alpelisib	Piqray®	inhibits PIK3 in the PI3K/AKT kinase (protein kinase B)	used with Fulvestrant in breast cancer
Copanlisib	Aliqopa®	inhibits the activation of the PI3K	relapsed follicular lymphoma
Palbociclib	Ibrance®	CDK4 and CDK6 inhibitor	ER + breast
Ribociclib	Kisqali®	inhibitor of cyclin D1/CDK4 and CDK6	used along with an aromatase inhibitor to treat women with advanced hormone receptor-positive breast cancer
Umbralisib	Ukoniq®	P13- CK1 Kinase inhibitor	Marginal zone lymphoma

Mtor INHIBITORS

inhibit the mechanistic target of rapamycin, which is a serine/threonine-specific protein kinase that belongs to the family of phosphatidylinositol-3 kinase related kinases

stomatitis, rash, anemia, fatigue, hyperglycemia/hypertriglyceridemia, decreased appetite, nausea, and diarrhea, and interstitial lung disease

Generic	Trade/Brand	Target	Indication
Temsirolimus	Torisel®	Inhibits MTor	Advanced renal cell
Everolimus	Afinitor®	TSC1 and NF2 genes	Renal cell Advanced Neuroendocrine

HEDGEHOG PATHWAY

signaling pathway that transmits information to embryonic cells required for proper cell differentiation. Different parts of the embryo have different concentrations of hedgehog signaling proteins- becomes reactivated

***Musculoskeletal events, spasms, pain, myalgia, arthralgia, N/V/D, fatigue, alopecia**

Generic	Trade/Brand	Target	Indication
Glasdegib	Daurisma®	Hedgehog pathway	With low dose cytarabine for AML >75 yrs
Sonidegib	Odomzo®	Hedgehog pathway	Metastatic basal cell
Vismodegib	Erivedge®	Hedgehog pathway	Metastatic basal cell

PARP INHIBITORS (poly adenosine diphosphate-ribose polymerase)

localizing *PARP* proteins at sites of DNA damage, which has relevance to their anti-tumor*activity*. The trapped *PARP* protein–DNA complexes are highly toxic to cells because they block DNA replication

***N/V/D, taste alterations, indigestion, headache, decreased appetite, cough, muscle pain**

Generic	Trade/Brand	Target	Indication
Niroparib	Zejula®	PARP	recurrent epithelial ovarian, fallopian, or primary peritoneal
Olaparinib	Lynparza®	BRCA	Germline BRCA mutated ovarian
Rucaparib	Rubraca®	PARP 1-2-3	ovarian
Talazoparib	Talzenna®	BRCA; Her 2	Locally advanced or met breast

BCL-2 INHIBITORS

A selective inhibitor of the anti-apoptotic protein B-cell lymphoma 2 (Bcl-2), with potential pro-apoptotic and antineoplastic activities. Upon administration, Bcl-2 inhibitor BCL201 binds to and inhibits the activity of Bcl-2. This restores apoptotic processes in tumor cells

Generic	Trade/Brand	Target	Indication
Venetoclax	Venclexta®	BCL2 inhibitor	CLL or SLL

FIRST IN CLASS ORAL SELECTIVE INHIBITOR OF NUCLEAR EXPORT (SINE)
Binds to exportin 1 thus blocking the transport of several proteins involved in cancer-cell growth from the cell nucleus to the cytoplasm, which ultimately arrests the cell cycle and leads to apoptosis

Generic	Trade/Brand	Target	Indication
Selinexor	Xpovio®	Exportin 1 –inhibits mRNA	multiple cancers with Dex relapsed/refractory MM

EZH2 INHIBITOR
prevents the methylation of histone H3 lysine 27 (H3K27) - decreases in histone methylation alters gene expression patterns associated with cancer pathways and results in decreased tumor cell proliferation in *EZH2* mutated cancer cells

Generic	Trade/Brand	Target	Indication
Tazemetostat	Tazverik®	selective EZH2 inhibitor	adults and adolescents aged 16 years and older with metastatic or locally advanced epithelioid sarcoma not eligible for complete resection

EPIDERMAL GROWTH FACTOR RECEPTORS (EGFR)
they prevent ligand binding; inhibit receptor activation; and induce dimerization, internalization and downregulation of the EGFR

Generic	Trade/Brand	Target	Indication
Cetuximab	Erbitux®	EGFR	Colorectal Head and neck
Panitumumab	Vectibix®	EGFR	Colorectal
Trastuzumab BIOSIMILAR = Ogivri	Herceptin®	HER 2	HER 2 positive breast Gastric
Trastuzumab and hyaluronidase-oysk	Herceptin Hycela® (SQ)	HER 2	HER 2 positive breast Gastric

VASCULAR ENDOTHELIAL GROWTH FACTOR (VEGF)
stimulate cellular responses by binding to tyrosine kinase receptors (the VEGFRs) on the cell surface, causing them to dimerize and become activated through transphosphorylation
these drugs search out and bind themselves to VEGF molecules, which prohibits them from activating receptors on endothelial cells inside blood vessels

Generic	Trade/Brand	Target	Indication
Bevacizumab BIOSIMILAR –Mvasi	Avastin®	VEGF	mCRC Ovarian Cervical
Tivozanib	Fotivda®	VEGF	RCC

IMMUNOTHERAPY

The target is the immune system. They can be supportive therapy, cytokine therapy, monoclonal antibodies, radio-immunotherapy, immuomodulators, CTLA-4, PD-1, PD-L1, CAR-T

Side Effects – fevers, chills, flu-like symptoms, nausea, vomiting, diarrhea, capillary leak syndrome
***Retinoic acid syndrome and leukocytosis – characterized by fever, dyspnea, acute respiratory distress, weight gain, radiographic pulmonary infiltrates, pleural and pericardial effusions, edema, and hepatic, renal, and multi-organ failure.
***Cytokine Release Syndrome (CRS) - caused by large, rapid release of cytokines into the blood from the immune cells affected by immunotherapy. Characterized by fever, nausea, headache, rash, tachycardia, hypotension, SOB, and multiple organ dysfunction

Generic	Trade/Brand	Target	Indication
CYTOKINES **Cytokines bind to the specific receptors on the membrane of target cells, triggering signal transduction pathways that ultimately alter gene expression in the target cells. ... may bind to receptors on the membrane of the same cell that secreted it, exerting autocrine action**			
Generic	**Trade/Brand**	**Target**	**Indication**
Interferon	alfa 2a (Roferon-A) ® alfa 2b (Intron-A) ®	Immune system	Multiple cancers CML
Interleukins	Aldueleukin® (Proleukin/IL2)	Immune system	Melanoma Renal Cell
Denileukin Difitox	(Ontak)	IL-2 CD-25	CTCL
RETINOIDS **induce differentiation and to inhibit proliferation in a series of human transformed hematopoietic and epithelial cell lines**			
Generic	**Trade/Brand**	**Target**	**Indication**
Tretinoin	Vesanoid®	induces maturation of acute promyelocytic leukemia (APL) cells in culture. I	APL
Bexarotene	Targretin®	selectively activate retinoid X receptors (RXRs)	CTCL
SUPPORTIVE THERPY - COLONY STIMULATING FACTORS			
Generic	**Trade/Brand**	**Target**	**Indication**
Filigastrin	Neupogen® G-CSF	granulocytes	White cells growth factor
Pegfiligrastin	Neulasta®	granulocytes	White cells growth factor
Sargramostin	Leukine® GM-CSF	granulocytes macrophages	White and macrophages growth factor
Tbo-filigrastin	Granix®	granulocytes	White cells growth factor
Epoetin	Epopgen/Procrit®	erythrocytes	Red cells growth factor
Darbopoeitin	Aranesp®	erythrocytes	Red cells growth factor
Oprelvekin	Neumega® IL-11	thrombocytes	Platelet growth factor
Romiplostim	Nplate®	thrombocytes	Thrombocytes growth factor
Eltrombopag	Promacta®	thrombocytes	Thrombocyte growth factor

Generic	Trade/Brand	Target	Indication
Plerixafor®	Mozobil®	granulocytes	Pluripotent stem cell growth factor
Palifermin®	Kepivance®	keratinocyte	Mouth and intestinal tract

MONOCLONAL ANTIBODIES
The target is clusters of differentiation (CD) on the outside of the cells (antigens)- antibodies are made to attach to the antigens to create the antigen-antibody complex to destroy the cells
Side effects – infusion related reactions

Generic	Trade/Brand	Target	Indication
Ado-trastuzumab	Kadcyla®	HER 2	Metastatic breast cancer
Alemtuzumab	Campath®	CD 52	B-Cell CLL PSCT
Amivantamab	Rybrevant®	EGFR and MET	Lung
Atezolizumab	Tecentriq®	PDL-1	Locally advanced or metastatic urothelial
Avelumab	Bavencio®	PD-L1	merkle cell cancer
Belantamab mafodotin	Blenrep®	MAB with chemo conjugate	Relapsed MM
Bevacizumab	Avastin®	VEGF	Colorectal Lung Ovarian
Brentuximab vedotin	Adcetris®	CD 30	Hodgkin Large cell lymphoma
Cemiplimab-rwlc	Libtayo®	PD1	Squamous cell
Cetuximab	Erbitux®	EGFR	Colorectal Head and neck
Copanlisib	Aliqopa®	inhibitor of phosphatidylinositol-3-kinase (PI3K) with inhibitory activity predominantly against PI3K-α and PI3K-δ	B-Cell Lymphoma
Daratumumab	Darzalex®	CD 38	Multiple Myeloma
Daratumumab and hyaluronidase-fihj	Darcelex SQ®	CD 38	Multiple myeloma
Durvalumab	Imfinzi®	PD-L1 – CD274	locally advanced or met urothelial bladder
Denosumab	Prolia/Xjeva®	RANKL and inhibits its binding to RANK receptor, preventing osteoclast formation; results in decreased bone resorption and increases bone mass in osteoporosis; in solid tumors with bony metastases, RANKL inhibition decreases tumor-induced bone destruction and SREs	Osteoporosis
Dinutuximab	Unituxin®	GD2	Neuroblastoma
Eculizumab	Soliris®	Complement protein C5	Paroxysmal nocturnal hemoglobinuria (PNH)
Elotuzumab	Empliciti®	signaling Lymphocyte Activation Molecule Family 7 (SLAMF7). SLAMF7	Multiple Myeloma

Generic	Trade/Brand	Target	Indication
Enfortumab vedotin-ejfv	PADCEV®	Nectin 4	Bladder
Fam-traztuzumab deruxtecan-nxki	Enhertu®	Her 2	Met breast
Gemtuzumab ozogamicin	Mylotarg®	CD 33	AML
Ipilimumab	Yervoy®	human cytotoxic T-lymphocyte antigen 4 (CTLA-4)	Metastatic melanoma
Inotuzumab ozogamicin	Besponsa®	CD 22	B-cell lymphoma
Isatuximab-irfc	Sarclisa®	------	Multiple myeloma
Loncastuximab tesirine	Zylonta®	CD19	B-cell
Margetuximab	Margenza®	Her-2 and IgG	Breast
Naxitamab	Danyelza®	IgG1 and G2	Neuroblastoma
Nectimumab	Portrazza®	EGFR	met NSCLCA
Nivolumab	Opdivo ®	cell death-1 protein (PD-1); blocks the interaction between PD-1 and its ligands, PD-L1 and PD-L2 -BRAF V600 wildtype or mutation-positive	Non-small cell lung Melanoma SCLCA RCC cHL SCCHN
Ofatumumab	Arzerra®	CD 20	CLL
Obinutuzumab	Gazyva®	CD 20	CLL
Olaratumab	Lartruvo®	PDGF	soft tissue sarcoma
Panitumumab	Vectibix®	EGFR	Colorectal
Pembrolizumab	Keytruda®	programmed cell death-1 protein (PD-1); blocks the interaction between PD-1 and its ligands, PD-L1 and PD-L2 - BRAF V600 mutation after BRAF inhibitor	Non-small cell lung Melanoma
Pertuzumab	Perjeta®	HER 2	Metastatic breast cancer
Pertuzumab, trastuzumab, hyaluronidase-zzxf	Phesgo®	HER 2	Breast
Polatuzumab vedotin-piiq	Poliyo	CD79B	With R-Benda relapsed/refractory DBCL
Ramucirumab	Cyramza®	Vascular endothelial growth factor receptor 2 (VEGFR2) antagonist that specifically binds VEGF receptor 2 and blocks binding of VEGFR ligands, VEGF-A, VEGF-C, VEGF-D	Non-small cell lung Gastric
Rituximab	Rituxan®	CD 20	CLL Non-Hodgkin lymphoma
Rituximab-hyaluronidase	Rituxan Hycela®	CD 20	DLBCL and FL
Sactizimab govitecan-hziy	Tredelvy®	----	Triple neg breast

Generic	Trade/Brand	Target	Indication
Tafasitamab	Monjuvi®	CD19	DLBCL
Trastuzumab BIOSIMILAR = Ogivri	Herceptin®	HER 2	HER 2 positive breast Gastric
Trastuzumab and hyaluronidase-oysk	Herceptin Hycela® (SQ)	HER 2	HER 2 positive breast Gastric
RADIOIMMUNOTHERPAY **antibody labeled with a radionuclide to deliver cytotoxic radiation to a target cell -specificity for a tumor-associated antigen is used to deliver a lethal dose of radiation to the tumor cells**			
Generic	**Trade/Brand**	**Target**	**Indication**
Tositumomab	Bexxar®	CD 20	Non Hodgkin lymphoma
Ibritumomab tiuzetan	Zevalin®	CD 20	Non-Hodgkin lymphoma
BISPECIFIC ANTIBODY (BITE IMMUNOTHERAPY) **Bispecific antibodies (BsAbs) are antibodies with two binding sites, directed against two different antigens or two different epitopes on the same antigen.** **An important mechanism of action of bispecific antibodies is to activate immune cells. Bispecific antibodies have two antigen-binding arms, one of which binds to the target antigen and the other to a labeled antigen on the effector cell (T cells and NK cells are commonly used), which activates the effector cell and allows it to target and kill tumor cells.** **CD3 is currently a popular immune cell surface target for bispecific antibody development, with a greater ability to activate and recruit T cells.**			
Blinatumomab	Blincyto®	CD 3 & CD19	Ph- ALL B-Cell
Emicizumab	Hemlibra	FIXa/FX	Bleeding due to hemophilia
Amivantamab-vmjw	Rybrevant	EGFR/cMet	NSCLCA
Tebentafusp-tebn	Kimmtrak	GP100/CD3	unresectable or metastatic uveal melanoma
Mosunetuzumab	Lunsumio	CD20/CD3	relapsed or refractory (R/R) follicular lymphoma (FL)
Teclistamab	Tecvayli	BCMA/CD3	relapsed and refractory multiple myeloma
IMMUNOMODULATORS **suppress or weaken immune system to reduce inflammation and the symptoms it causes** ***VTE, PE, vascular, HTN**			
Generic	**Trade/Brand**	**Target**	**Indication**
Thalidomide	Thalmid®	reblon (CRBN) as a thalidomide-binding protein VEGF	Multiple myeloma
Lenalidomide	Revlamid®	stimulating proliferation of anti-CD3 stimulated T cells VEGF	MDS Multiple Myeloma MCL

Generic	Trade/Brand	Target	Indication
Pomalidomide	Polmalyst®	enhances T-cell and natural killer cell-mediated immunity and suppresses production of TNF-alpha and interleukin-6; down-modulates cell surface adhesion molecules involved in leukocyte migration	Multiple myeloma
CTLA- 4 INHIBITORS **A protein found on T cells (a type of immune cell) that helps keep the body's immune responses in check. When CTLA-4 is bound to another protein called B7, it helps keep T cells from killing other cells, including cancer cells**			
Generic	**Trade/Brand**	**Target**	**Indication**
Ipilimumab	Yervoy®	human cytotoxic T-lymphocyte antigen 4 (CTLA-4)	Metastatic melanoma
PD-1 INHIBITORS **The binding of PD-L1 to PD-1 keeps T cells from killing tumor cells in the body by blocking the binding of PD-L1 to PD-1 with an immune checkpoint inhibitor (anti-PD-L1 or anti-PD-1) allows the T cells to kill tumor cells**			
Generic	**Trade/Brand**	**Target**	**Indication**
Dostarlimab	Jemperli®	PD-1	Endometrial
Nivolumab	Opdivo ®	cell death-1 protein (PD-1); blocks the interaction between PD-1 and its ligands, PD-L1 and PD-L2 -BRAF V600 wildtype or mutation-positive	Non-small cell lung Melanoma SCLCA RCC cHL SCCHN
Pembrolizumab	Keytruda®	programmed cell death-1 protein (PD-1); blocks the interaction between PD-1 and its ligands, PD-L1 and PD-L2 - BRAF V600 mutation after BRAF inhibitor	Non-small cell lung Melanoma
PD-L1 INHIBITORS **The binding of PD-L1 to PD-1 keeps T cells from killing tumor cells in the body (left panel). Blocking the binding of PD-L1 to PD-1 with an immune checkpoint inhibitor (anti-PD-L1 or anti-PD-1) allows the T cells to kill tumor cells**			
Generic	**Trade/Brand**	**Target**	**Indication**
Atezolizumab	Tecentriq®	PDL-1	Locally advanced or metastatic urothelial
Avelumab	Bavencio®	PD-L1	merkle cell cancer
Durvalumab	Imfinzi®	PD-L1 – CD274	locally advanced or met urothelial bladder

CAR-T : CHIMERIC ANTIGEN RECEPTOR T-cell Therapy
CD19-directed genetically modified autologous T cell immunotherapy – uses tumor specific antigen recognition to attack target cells
CRS is a major side effect

Generic	Trade/Brand	Target	Indication
Brexucabtagene autoleucel	Tecartus®	CD19	T-cell lymphoma
Idecabtagene vicleucel	Abecma®	CD19	T-cell MM
Lisocabtagene maraleucel	Breyanzi®	CD19	Large B-cell
Tisagenlecleucel	Kymriah®	CD-19	ALL up to 25 year's of age
Yescarta	Axicabtagene ciloleucel®	CD-19	

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