Hematology-Oncology
2015 Wards Manual
UCLA – Olive View Medical Center

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"The art of medicine is to cure sometimes, to relieve often, to comfort always." - Ambroise Paré

Structure of hematology/oncology wards

Introduction

- Welcome to OVMC's hematology/oncology wards! We anticipate that you will have an excellent learning experience.
- This manual is a basic reference and should not replace discussion w/ fellows, attendings.
- The team: 2 residents w/ separate patient lists, supervised by 1 fellow + 1 attending.
- Days off: Either Sat. or Sun., you will cover the other resident's patients on their day off.
- Internal Medicine Noon Conference attendance is mandatory.
- Attend oncology teaching conferences as permitted: See Appendix 4 for schedule.

Admissions

- You will be admitting Monday-Friday, 8am to 3pm. Occasionally you may admit hematologic emergencies on the weekend as transfers from medicine.
- Admissions are scheduled (chemotherapy) + unscheduled (chemotherapy complications, oncologic emergencies). Residents will focus on general medicine issues for these patients.
- For scheduled admissions, the fellow will have chemotherapy orders including fluids, anti-emetics. Make 2 copies before placing in the chart (1 for the fellow, 1 for you).
- Write the other admission orders, see section on supportive care (i.e., pain control, anti-emesis, constipation, VTE prevention).

Presentations (general format)

- New patients:
    - ID: Type of disease, stage of disease, date of diagnosis
    - Chief complaint (complication, induction, consolidation, maintenance)
    - Initial presentation of malignancy (e.g., mass, B-symptoms, bruising, etc.)
    - Diagnosis (imaging, biopsy, IHC, molecular studies)
    - Treatment, response, complications, relapses in chronologic order
    - ROS upon admission
    - Physical exam, recent labs, radiology
    - Assessment and Plan, goals of therapy
- Daily updates:
    - Identification/Summary statement
    - Cycle x, Day y of ___ chemotherapy
    - SOAP format
    - Outpatient follow-up
- Signout:
    - Chain of command: NF intern→ H/O fellow→H/O attending
    - Include contingencies as discussed w/ attending:
        - Fevers: diagnostics (e.g., cultures), changes in antibiotics
        - Bleeding: need for scans (e.g., CTs), threshold for blood products
        - Chemotherapy reactions: when to stop infusion, antidotes

Radiation therapy

- Some patients have radiation therapy off-site while hospitalized for chemotherapy
- Fellow sets up transportation one day prior to admission
- For initial consultations, fellow arranges with STC RN for XRT doc to get all the info
- Patients do not need to be NPO
- If on continuous infusion chemo, OK to hold chemo until they return
- Patients will not have pain meds during sessions. Especially for 1st session, consider giving usual/extra opioid dose prior to departure.

ICU transfers

- Continue to follow patient daily as co-managing service, but do not write orders
- Heme/onc team resumes primary team role once patient is transferred out of ICU

Medical Alert Center system (MAC):

- Coordinates transfer of patients to county-operated hospitals
- Reasons for MAC: neurosurgery (e.g., Ommaya reservoir placement, spinal cord compression), cardiothoracic surgery, orthopedic surgery (pathologic fractures)
- Call MAC operator at (866) 940-4401, fax: 323.890.7643
- Discuss case w/ consulting physician
- If accepted, prepare and print transfer summary for chart
- When transport ready, write orders: (1) copy chart, (2) county transfer

Discharges:

- Write d/c instructions and d/c summary.
- The fellow will write a summary note, and set up outpatient f/u + labs. Include appointment time/date in discharge instructions.
- Obtain general Rx forms from 5A equipment room (behind clerk), triplicates from fellow/attending. For terminally ill, can write schedule II narcotics in California on regular Rx form w/o any other medication if you write "11159.2 exemption."
- Anti-emetic regimen, anti-constipation regimen, GCSF, PICC line supplies
- Weekly PICC line dressing appts to be scheduled by fellow

Code status

- Licensed physicians may complete paper POLST forms w/ patients (or surrogate decision makers). Must complete POLST template in CWS for documentation.
- Even if POLST exists, still need order for DNR/DNI for each admission. Residents are able to write a DNR/DNI lasting 24 hours. A DNR/DNI order by an attending is valid for the entire hospitalization. Code status should be documented in CWS under DNR discussion note.
- Give patient/family POLST form if newly completed during hospitalization

Palliative care

- Contact: Veronica Villatoro, RN
- Phone 818.364.3483, Pager: 818.313.1036, Room 5D129
- Monday-Friday 8:30am-5:00pm
- Referrals: refractory sx (e.g., pain, anxiety/depression, nausea, dyspnea), goals of care, transition to hospice, frequent ED visits/admissions for same dx, prolonged ICU stay w/ poor prognosis or no evidence of improvement

Coumadin clinic:

- Fax intranet form to 4747, call 4418 to ensure receipt of form and appointment time
- Any changes to anticoagulation regimen need to be communicated with Coumadin Clinic

Useful phone numbers for finding fellow/attendings

- Clinic C: 3133
- Fellows' workroom: 3149
- STC (outpt chemo): 3540
- STC fellow: 3875

ECOG Grade	Description
0	Fully active
1	Restricted in physically strenuous activity, ambulatory, able to carry out light work
2	Ambulatory, does all self-care but not work activities, out of bed/chair > 50% of waking hr
3	Does only limited self-care, confined to bed/chair > 50% of waking hr
4	Completely disabled, cannot carry on any self-care, totally confined to bed/chair
5	Deceased

Supportive Care

Pain management

- Nociceptive (somatic, visceral) vs. neuropathic (nervous system dysfunction)
- Stepwise approach:
  - Non-opioid (NSAID, tylenol) + adjuvant
  - Opioid + non-opioid
  - Opioid + non-opioid + adjuvant
- Avoid NSAIDS if thrombocytopenia anticipated (esp leukemia, lymphoma, small cell)
- Avoid Norco/Vicodin as inpatient, as Tylenol may mask fevers
- Opioid side effects:
  - Sedation, N/V, constipation, urinary retention, myoclonus, respiratory depression, cognitive impairment, pruritus, loss of libido.
  - **Always** start bowel regimen if receiving standing opioid regimen (see next page)
  - Opioid naïve pt more likely to experience sedation w/ opioids during first 3-4 days
- Opioid dose titration:
  - ↑ 25-50% increase for mild-moderate pain
  - ↑ 50-100% increase for moderate-severe pain.
  - Consider PCA if unknown pain medication requirements, then transition to long-acting scheduled regimen + short-acting PRN
- Breakthrough pain: Acute pain in otherwise controlled pain.
  - Chronic cancer pain generally requires long acting opioid around the clock w/ short acting agent for breakthrough pain
  - Cover w/ short-acting opioids using ~10% of total 24h standing opioid dose available q1-2h.
  - e.g., MS-Contin 60mg PO q12h + morphine 12mg PO q2h PRN BTP
- Converting between opioids:
  - Desired 24 hr dose of drug B = (Current 24 hr dose of Drug A) x (Reference value drug B / Reference value drug A) x (cross tolerance factor, generally 50-75%).
  - Opioid rotation may be helpful if requirements continue to increase w/o efficacy
  - For calculating equivalence, rectal=oral route, SQ=IV route
  - Avoid IM as causes pain, onset slower than SQ/IV
- Low-potency opioid agonists: Codeine, hydrocodone, tramadol
  - Mild-mod pain (e.g., mild bone pain, early visceral pain)
- High-potency opioid agonists: Morphine, oxycodone, hydromorphone, fentanyl, methadone
  - Wide variability in patient response
- Adjuvant:
  - TCAs: Neuropathic pain, inhibit serotonin/norepi at nerve endings in spinal cord and in brain (e.g., amitriptyline 25mg daily, up to 100mg/day)
  - AEDs: Brachial/lumbosacral plexopathies (e.g. gabapentin 100-1200 mg TID)
  - Misc: SNRI, benzodiazepine, bisphosphonates, steroids, muscle relaxants, lidocaine, capsaicin, nerve blocks

Opioid conversion chart

Opioid agonist	Parental dose	Oral dose	Factor (IV→PO)
Morphine	10 mg (6-7x; 20x)	30 mg (4x)	3
Hydromorphone (Dilaudid)	1.5 mg	7.5 mg	5
Oxycodone	-	15-20 mg	-
Hydrocodone	-	30 mg (Norco 5/325 x 6tabs)	-
Codeine	-	200 mg	-

Opioid conversion charts, cont'd

Morphine PO	Dose conversion ratio (Morphine PO: Methadone PO)
30-90 mg	4:1
91-300 mg	8:1
>300 mg	12:1
If total daily dose equivalent of PO morphine >800mg, higher ratio necessary, consult palliative care	

Adapted from NCCN Guidelines Version 2.2013 Adult Cancer Pain

Morphine		Transdermal Fentanyl
Oral	IV/SubQ	
30 mg/d	10 mg/d	12 mcg/h
60 mg/d	20 mg/d	25 mcg/h
120 mg/d	40 mg/d	50 mcg/h
180 mg/d	60 mg/d	75 mcg/h
240 mg/d	80 mg/d	100 mcg/h

Opioid starting dose, half-life, duration of analgesia

Drug	Initial dose for opioid-naïve adult	Half-life (hours)	Duration of analgesia (hours)	Notes
Morphine	2-5 mg IV q 2-4h	2-3	3-4	Hepatically converted to M3G/ M6G which are excreted by kidney, beware in renal failure
	10-30 mg PO q4h	2-3	3-6	
Morphine, extended (MS-Contin)	15 mg PO BID		8-12	
Hydromorphone (Dilaudid)	0.3-1 mg IV q2-4h	2-3	3-4	
	2-4 mg PO q3-4h	2-3	3-6	
Codeine	30-60 mg PO q4-6h	2-4	4-6	Hepatically converted to morphine beware of hypermetabolizers
Oxycodone	5-15 mg PO q4-6h	2-3	3-6	
Oxycodone, extended (Oxycontin)	10 mg PO BID		8-12	
Hydrocodone	5-10 mg PO q3-4h	3-4	4-8	Limited by formulation w/ acetaminophen
Methadone	2.5-10 mg PO q8-12h, not for opioid-naïve	12-150	3-4 initially use; 6-8 chronic use	Variable + long T1/2 (12-150h), watch for accumulation. Potency 2/2 d-isomer (NMDA antagonist, ↓ tolerance + ↑ analgesia). ↑QTC, interacts w/ CYP3A4. Consider palliative consult before initaition.
Fentanyl transdermal	See notes for OVMC policy, not for opioid-naïve	17 after removal	48-72 per patch, up to 12 after removal	Useful if stable pain, unable to take PO. Patch changed q72h. Dose based on avg daily opioid req. over 7d. If switching to fentanyl, overlap w/ previous opioid by 12h for fentanyl to reach therapeutic levels. Pass test on OVMC intranet to prescribe.
Tramadol (Ultram)	50-100 mg PO q4-6h	~6-9	~4-6 initial use ~3-11 chronic use	Mixed mech. (weak mu agonist, SNRI, SSRI). Avoid if renal insufficiency, risk for seizures or depression

Adapted from Overview of the treatment of chronic pain, UpToDate accessed 07.26.2013

Constipation

- Common causes:
  - Medications: opioid use, anticholinergics (TCA, antipsychotics), iron, CCB, diuretics, vinca alkaloids, Zofran
  - Obstruction: cancer causing stricture, extrinsic compression
  - Metabolic/endo: hypercalcemia, hypokalemia, hypomagnesemia
  - Other: immobility, dehydration
- Suggested treatment:
  (1) Colace 100mg BID, senna 2 tabs BID if on standing long-acting opioid
  (2) Add Miralax 17g PO daily or bisacodyl 5-15mg PO
  (3) Consider lactulose 30cc q6h until BM (can be nauseating to oncology patients)
  (4) Add bisacodyl suppository 10mg, tap water/Fleet's enema
  (4) Proximal impaction may require magnesium citrate
  (5) If hard stools in vault, may need manual disimpaction
- Naloxone PO can produce laxation but also mild withdrawal
- Methylnaltrexone subq for opiate induced constipation (non-formulary)
- Classification:
  - Bulk fiber: psyllium, methylcellulose, polycarbophil
  - Osmotic laxatives: Mag citrate, sodium phosphate, lactulose
  - Stimulant: Senna, castor oil, bisacodyl, docusate sodium
  - Enema/suppository: phosphate, tap water, soap suds, bisacodyl

Anti-emesis: (see Appendix 1)

- Vomiting is from stimulation of multistep reflex pathway, mainly serotonin (5-HT3) + dopamine receptors. Also Ach, corticosteroid, histamine, cannabinoid, opiate, neurkokinin-1.
- *Acute-onset N/V:* usually within minutes to several hours after drug administration, peaks at 5-6h, resolves within first 24h.
- *Delayed-onset N/V:* >24 hours after chemo. Common w/ cisplatin, carboplatin, cyclophosphamide, doxorubicin. For cisplatin, max intensity 48-72h after dose, can last 6-7d.
- *Other causes of emesis:* partial/complete bowel obstruction, vestibular dysfunction, brain mets, electrolyte imbalance (hypercalcemia, hyperglycemia, hyponatremia), uremia, gastroparesis (tumor or chemotherapy such as vincristine), psychophysiologic (anxiety, anticipatory)
- Consider H2 blocker or proton pump inhibitor to prevent dyspepsia (can mimic nausea).
- Initial regimen ordered by fellow based on emetogenic potential of chemo (see Appendix 5)
- Risk of emesis ↑ w/ younger age, h/o motion sickness/migraines, additive w/ chemo combos

Anti-emetic Medications:

Drug	Main Receptor	Main Indication	Starting PO Dose/Route	Side Effects
Metoclopramide (Reglan)	D2	Opioid-induced, gastric stasis	10 mg q4h PO, SC, IV (up to 2mg/kg)	EPS (akathisia, dystonia, dyskinesia) esp in young pt, diarrhea
Prochlorperazine (Compro)	D2	Opioid-induced	10 mg q6h PO, IV	Sedation, hypotension, EPS
Promethazine (Phenergan)	H1	Vestibular, motion sickness, obstruction	12.5 mg q4h PO, PR, IV	Sedation
Ondansetron (Zofran)	5-HT3	Chemotherapy, less effective for delayed emesis	8-16 mg q12h PO, IV	Headache, constipation, ↑QTc
Diphenhydramine (Benadryl)	H1, Ach	Intestinal obstruction, vestibular, ICP	25 mg q6h PO, IV, SC	Sedation, dry mouth, blurred vision
Hyoscine (Scopolamine)	Ach	Intestinal obstruction, colic, secretions	0.2-0.4 mg q4h SL, SC, TD	Dry mouth, blurred vision, urine retention, agitation
Lorazepam (Ativan)	BZD	Anxiety, anticipatory N/V	0.5-2 mg q4-6h PO, IV, SL	Sedation
Dexamethasone (Decadron)	Corticosteroid	Chemotherapy	4-12 mg PO/IV daily	Hyperglycemia, agitation, AI, myopathy
Aprepitant (Emend)	Neurokinin-1 (substance P)	Chemotherapy	150mg IV on day 1	Fatigue, weakness, hiccups, GI sx
Olanzapine (Zyprexa)	5-HT3, Ach, D, BZD	Delayed N/V from chemo, use w/ 5-HT3 antagonist + steroid	5-10 mg PO daily	Sedation, EPS, fatigue, insomnia

Adapted from Elsayem A, Driver LC, Bruera E. The MD Anderson Palliative Care Handbook. Houston, TX: MD Anderson Cancer Center; 2002.

OVMC Anti-Emesis Guidelines

- Minimal risk: No routine premeds
- Low risk premeds: Choose one of (1) Zofran 16mg PO→ 8mg BID PRN, (2) Decadron 8mg PO, (3) Reglan 10mg PO→PRN, or (4) Compazine 10mg PO→PRN. +/- Ativan 1mg or PPI/H2R blocker.
- High risk/moderate risk: see chart
- Breakthrough N/V: Add agent from different drug class (e.g., Zofran 16mg BID, Marinol 2.5-5mg BID-TID, olanzapine 5-10mg qday x3-7d, Haldol 0.5-2mg q4-6h, or scopolamine patch q72h
- Radiation-induced N/V (esp abdomen): Zofran 8-16mg PO Bid w/ XRT +/- Decadron 4mg qday, +/- Ativan +/- PPI/H2R blocker

Emetogenic Potential of IV chemo agent:	High Risk	Moderate Risk
Initial premeds:	Zofran 16mg IV (BID inpt) + Decadron 12mg IV/PO ± Ativan 1mg SL	Zofran 16mg IV + Decadron 8mg IV/PO
Delayed Emesis Prevention:	Recommended (D2-4): *Decadron 8mg PO qday + Zofran 8mg PO BID, then PRN	Optional (D2-3): Zofran 8mg PO BID, OR Decadron 8mg PO qday
If N/V uncontrolled, C2 use: (Use for Cisplatin 100mg/m^2)	Emend 150mg IV D1 + Zofran 16mg IV D1, + Decadron 12-20mg IV D1, 8mg daily PO D2, BID D3-D4 ± Ativan 1mg SL	Options include: Treat as "high risk," Include Ativan to premeds
Optional:	± Ativan 1mg SL Q4-6 ATC ± PPI or H2 Blocker	± Ativan 1mg SL Q4-6 PRN ± PPI or H2 Blocker
Continued issues w/ delayed emesis:	Olanzapine (Zyprexa) 5-10mg PO D1-2 + Zofran 16mg PO BID D1-2 (max 32mg/day) (Can extend duration of treatment beyond 2 days)	
Oral Chemo: (High/Mod Risk)	Start before chemo & cont daily w/ chemo: Zofran 16mg PO qday/BID ± Ativan 1mg SL Q4-6 PRN ± PPI or H2 Blocker	

Mucositis

- Viscous lidocaine 2% 15cc gargled (max q3h)
- Artificial saliva (e.g., Biotene spray)
- Magic mouthwash (Maalox, Benadryl, lidocaine) 5-10cc swish/swallow qAC
- For candidal superinfection: Clotrimazole troche 10mg dissolve in mouth, 5x/day x 14 days, Nystatin 500,000 units swish/swallow q6h

Venous thromboembolism prevention

- Mechanisms: venous stasis (immobility), hypercoagulability 2/2 cancer, intimal injury (catheters, surgery), chemo (esp. tamoxifen, cisplatin, cyclophosphamide, MTX, 5-FU)
- 2 studies showing ↑ risk:
  - Occurred in 1st hospitalization in 3-12% of neutropenic cancer pts
  - Occurred within 1 year in 8-19% of pt receiving outpt chemo for solid tumor
- LMWH superior to warfarin in CLOT trial (9% vs. 17% HR for **recurrent** VTE at 6 mo)
- Warfarin ineffective in cancer pts w/ active clot, use UFH/LMWH
- Pharmacologic prophylaxis: UFH vs. LMWH vs. fondaparinux, none w/ superior efficacy.
  - Heparin 5,000 units sq q8-12h
  - Lovenox 40mg sq daily (30mg daily if CrCl<30)
  - Fragmin 5,000 units sq daily
  - Fondaparinux 2.5mg sq daily (consider if HIT, but contraind. if CrCl<30, <50kg)
- Other:
  - As outpt, surgical onc pt will need VTE ppx for 4 weeks after surgery.
  - Multiple myeloma patient receiving thalidomide/lenalidomide will need ASA 81-325 daily (low risk) vs. LMWH or warfarin if high risk for VTE.
  - Consider Khorana Predictive Model for VTE ppx as outpatient (Appendix 3)

Transfusions

- Consent must be obtained from patient/family unless emergency, good for 1 year.

Blood product characteristics

	Packed RBC	Platelets	Fresh frozen plasma	Cryoprecipitate
Shelf-life	21-42 d	5 d	1 yr frozen, 24hr thawed	1 yr frozen
Volume/unit	250-350 mL	250-350 mL	200-250 mL	20-50 mL
Approximate contents	Red cells: 65-80% Plasma: 20-35%	Platelets + plasma	All factors + Protein C/S (200-250U), fibrinogen (400-500mg)	Factor VIII: 80 units Fibrinogen: 225 mg vWF: variable
Typical dose	1 unit	1 pharesis pack = 6 units of pooled donor plt	4 units or 15mL/kg	10 units or 1 units/5 kg
Typical dosage effect	↑Hgb by 1g/dL	↑ Plt by 30-60,000/μL	↑Most coag factors by 20-25% (level needed for effective hemostasis)	↑ fibrinogen by 75 mg/dL
Notes	- CBC 2 hrs after transfusion to assess response - If cardiomyopathy, can run as splits (1/2 unit over 4 hours) + Lasix IV - Watch Ca, K, Plt, coags if massive transfusion	- CBC 1 hr after transfusion to assess response - If refractory may have allo-ab, try ABO-matched platelets. If still refractory check for HLA-Ab. - Not indicated in TTP/HUS, HELLP, HIT	- Max effect declines after 2-4 hrs, transfuse 1 hr before procedure - INR of FFP ~1.3 -Acellular so does not transmit intracellular infections (e.g., CMV)	- Consider if massive transfusion

Adapted from Strecker-McGraw M. Chapter 41. Hematologic Emergencies. In: Humphries RL, Stone C, eds. CURRENT Diagnosis & Treatment Emergency Medicine. 7th ed. New York: McGraw-Hill; 2011.

Transfusion Goals

- *pRBC*: Hgb>7 in general, Hgb >8-9 if receiving chemo/BMT/PSCT due to decreased marrow production, Hgb >10 if CAD (no RCT to support this)
- *Platelets*: >10k in general, >20k if increased risk for bleed (febrile, infection, concurrent coagulopathy, DIC, liver/renal failure, significant splenomegaly), >50k if active bleeding/ procedure, >100k if neurologic/cardiac surgery
- *Cryoprecipitate*: Fibrinogen>100

Ordering

- *Premedication:* Tylenol 650mg PO x1, Benadryl 25-50mg PO/IV x 1
- *Type and cross:* Transfusion likely, verifies ABO-Rh status of donor+recipient, screens for unexpected Ab to common RBC Ag, mixes donor RBCs + recipient serum to exclude immediate hemolysis
- *Type and screen:* No immediate need for transfusion, tests ABO, Rh, routine Ab screen (indirect Coombs')
- *Type O, Rh-negative:* Universal donor, used in emergent transfusion
- *Leukocyte-reduced:* Removes WBCs (chief cause of alloimmunization to HLA antigens), use if long-term transfusions needed, recurrent febrile reactions. (Done for all RBCs at OVMC)
- *Irradiated:* kills donor stem cells which can cause rare GVHD. Use in BMT candidates/ recipients, immunosuppressed patients, if donor+recipient are blood relatives, patients receiving HLA matched platelets
- *CMV negative:* Use if patient CMV seronegative + candidates/recipients of bone marrow/solid organ transplants, SCID, AIDS or pregnant. Test CMV if status unknown
- *Saline washed RBC:* Removes plasma proteins, electrolytes, Ab. Use if hx of severe transfusion reactions, hyperkalemia, PNH, IgA deficiency

Complications

- *Acute hemolytic:* fever, hypotension, flank pain, renal failure <24hr after transfusion. 2/2 ABO incompatibility (preformed Abs against donor RBCs). Tx: maintain UOP w/ IVF, diuretics.
- *Delayed hemolytic:* less severe than acute hemolytic, 5-7d after transfusion. Undetected allo-Abs against minor antigens (anamnestic response). No specific tx.
- *Febrile non-hemolytic:* fevers, rigors 0-6hr after transfusion. Due to Ab against donor neutrophils + cytokines released from cells in blood product. Tx: acetaminophen, r/o infection.
- *Allergic:* urticaria, rarely anaphylaxis (bronchospasm, laryngeal edema, hypotension). Reaction to transfused proteins; anaphylaxis in IgA-deficient pts w/ anti-IgA Abs. Tx: Benadryl, epinephrine, glucocorticoids
- *Transfusion-related acute lung injury (TRALI):* non-cardiogenic pulmonary edema within 6 hours. Hypoxia, PaO2:FIO2<300. Donor Abs bind recipient neutrophils, aggregate in pulmonary vasculature, release mediators causing ↑ capillary permeability, treat as ARDS.
- *Bacterial infection:* cold-growing microbe such as *Y. enterocolitis*, otherwise wide range of GP, GN, tick-borne have been observed

Transfusion complication risks

Non-infectious	Risk (per unit)	Infectious	Risk (per unit)
Febrile	1:100	CMV	Common
Allergic	1:100	Hepatitis B	1:220,000
Delayed hemolytic	1:1,000	Hepatitis C	1:1,600,000
Acute hemolytic	<1:250,000	HIV	1:1,800,000
Fatal hemolytic	<1:100,000	Bacteria (pRBC)	1:500,000
TRALI	1:5,000	Bacteria (plt)	1:12,000

From Transfusion 5-13. Pocket Medicine 4th ediation., adapted from NEJM 1999;340:438; JAMA 2003; 289:959

If reaction (except minor allergic): fever, tachycardia, dyspnea, back pain, hemodyn. instability

(1) Stop transfusion
(2) Check ABCs, cardiac/O2 monitoring
(3) Recheck patient name, typing. Send remaining blood + fresh blood sample to blood bank for analysis. Steps 4-7 if acute hemolytic reaction suspected (as indicated):
(4) Medications: hydrocortisone 100mg IV, diphenhydramine 50mg IV, acetaminophen 650mg PO, epinephrine 0.3 mL of 1:1000 dilution subq
(5) IV fluids: D5W w/ 3 amps NaHCO3 at 250cc/hr, keep UOP > 30-50cc/hr
(6) Lab tests: CBC, coombs test, urine free Hgb, haptoglobin, coags, fibrinogen, bilirubin, LDH
(7) Leukocyte-reduced blood for future transfusions

Vitamin K:

- If healthy person has complete VK dietary absence, reserves will last x 1wk
- Absorption in terminal ileum, dependent on normal fat absorption + bile salts
- 1st line: 10mg PO x 3d if bilirubin normal (need bile salts for absorption)
- 2nd line (or if rapid reversal needed): 1-2.5mg IV (up to 10mg/60min in life-threatening bleeding in setting of vitamin K antagonism). Small risk of anaphylaxis to diluent (1 in 3000 doses), reduced if infused over 1 hr. Will see effect 6-12 hrs later, maximal at 36hr.
- 3rd line: subq, no better than placebo in large meta-analysis but should be used if patient has cholestasis

Oncologic emergencies

Neutropenic fever

- Definitions:
  - Fever: single T>38.3°C orally, T>38.0°C over 1h OR T>1.5°C from baseline
  - Neutropenia: <500 neutrophils/μL OR <1,000 neutrophils/μL and predicted decline to 500/μL over next 48h.
- Patients receiving chemo predisposed due to myelosuppression, disruption of GI mucosa. WBC nadir from chemo typically at 10-14d, recovery heralded by monocytes
- Source microbiologically identified in 20-30% of cases. Bacteremia documented in 10-25%.
- Previously mostly GN (e.g., P. aeruoginosa, generally more severe infection), now GP more common (staph epi, staph aureus, strep) possibly 2/2 broad GNR coverage in outpt/inpt setting, increased indwelling catheter use
- Dx: Blood cx x2 (include all catheter sites, also consider anaerobic/fungal), urine cx, U/A, CXR
- **Empiric coverage:** Monotherapy w/ cefepime 2g IV q8h. Meta-analysis showed increased all-cause mortality w/ cefepime use, but subsequent FDA meta-analysis showed no statistically significant difference compared to other monotherapy.
- Other single agents include imipenem/cilastatin, meropenem, piperacillin/tazobactam.
- Add vancomycin if central line, soft tissue source, severe PNA. Discontinue in 2-3d if no source identified requiring vancomycin.
- Broaden anaerobic coverage for aspiration, GI or oral source
- Add aminoglycoside if septic. E.g., amikacin 15-20mg/kg IV q24hr if normal renal fx. Has good urinary concentration, synergistic w/ beta-lactams against some *S. aureus, enteroccocus*.
- If still febrile after 5d, consider MRSA, MRSE, VRE, anaerobes (*Bacteroides, prevotella, fusobact.* not covered by cefepime), fungal coverage (esp *Aspergillus*, fluconazole-resistant *Candida*)

GCSF:

- *Prophylactic use:* assess risk of neutropenia, previous hx. Use associated w/ ↓ LOS+cost, less reduction in chemo dosage, and reduction in risk/severity/duration/mortality of febrile neutropenia. Start 1-4d after completion of chemo, tx through post-nadir recovery.
- *Therapeutic use:* less certain, 1 study showed ↓ LOS + neutropenia, but no mortality benefit.
- *Side effects:* mild-moderate bone pain (treat w/ opioids, loratadine), N/V, rare splenic rupture
- *Filgrastim (Neupogen):* 5 mcg/kg/d (rounding to 300mcg or 480mcg subq) until post-nadir ANC recovery to normal or near-normal.
- *Pegfilgrastim (Neulasta):* 1 dose of 6 mg subq/cycle of chemo. Majority of trials administered Neulasta 1d after chemo. Given as outpatient in STC only.

Additions to empiric coverage based on local symptoms:

Site	Evaluation	Additions to empiric treatment
Mouth/mucosal	Gram stain, cx of suspicious lesions. HSV/VZV DFA.	Anaerobic, HSV, fungal
Esophagus	Cx oral lesions (HSV, fungal), endoscopy	Fungal, HSV, CMV
Sinus/nasal	High res sinus CT/orbit MRI, ENT/ophtho eval, biopsy/cx	Vanco if periorbital cellulitis, amphotericin B for aspergillosis/mucormycosis if CT/MRI findings
Abdominal pain	CT abdomen, LFTs, lipase	C.diff, anaerobic
Perirectal pain	Perirectal inspection (avoid DRE), consider CT abdomen/pelvis	Anaerobic, enterococcal, local care (e.g., sitz baths, stool softener)
Diarrhea	C.dif stool antigen, stool Cx, OxP	C.diff
Urinary tract symptoms	Ucx, U/A	None additional until ID/sensitivitiy
Lung infiltrates	Blood/sputum cx, nasal wash for resp. virus, legionella urine Ag, serum galactomannan (false positives if using Zosyn), CT chest, BAL, PJP DFA	Azithromycin/FQ for atypical coverage, mold-active fungal agent, viral, TMP-SMX if PJP possible, vancomycin/linezolid for MRSA
Cellulitis/skin and soft tissue	Aspirate/biopsy	MRSA
Vascular access devices	Swab/blood culture from ports	Vanco, removal of catheter
Vesicular lesions	Aspiration/scraping for DFA VZV/HSV, cx	VZV/HSV
Disseminated papules/lesions	Aspiration/bx for bacteria/fungal/mycobacterial cultures, histopathology	Vanco, mold-active antifungal
CNS symptoms	CT +/- MRI, lumbar puncture, neuro consult	Antipseudomonal that enters CSF (cefepime, ceftazidime, meropenem) + vanco + ampicillin (if meropenem not used). Acyclovir if encephalitis

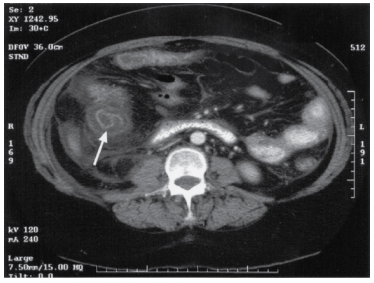
Adapted from NCCN Guidelines Version 1.2013 Prevention and Treatment of ß

Commonly used antimicrobials in neutropenic fever:

Agent		Dose	Coverage, comments
Antibacterial Pseudomonal activity	Imipenem/cilastatin	500 mg IV q6h	Most GP, GN, anaerobic. Preferred in ESBL, serious Enterobacter infections, intra-abdominal source. Meropenem > imipenem for CNS infection.
	Meropenem	1 gram IV q8h (2 g IV q8h for meningitis)	
	Piperacillin/tazobactam	4.5 grams IV q6h	Most GP, GN, anaerobic. Use for intra-abdominal source, not meningitis.
	Cefepime	2 grams IV q8h	Most GP, GN. Not active against some anaerobes and Enterococcus spp (add Flagyl).
Antibacterial Gram-positive activity	Vancomycin	15 mg/kg IV q12h For C.diff: 125 mg PO q6h	GP except VRE + some rare GP.
	Linezolid	600 mg PO/IV q12h	GP + VRE. ↓plt, rare serotonin syndrome rare, peripheral/optic neuropathy w/ long-term use.
	Daptomycin	6 mg/kg/d IV	GP, in vitro activity vs. VRE but not FDA-approved for this indication. Weekly CPK for rhabodo. Not for PNA, inactivated by pulmonary surfactant.
	Dalfopristin/ quinupristin	7.5 mg/kg IV q8h	GP + most VRE, not E. faecalis. Limited by myalgias/ arthralgias (47%), requires central line
	Ceftaroline	600 mg IV (over 1h) q12h	GP+GN+MRSA, not enterococcus. Can cause seroconversion from neg to pos direct Coombs'.
Antibacterial Other	Ciprofloxacin	500-750 mg PO q12h. If low risk: 500 mg PO q8h + Augmentin 500 mg q8h	GN + atypicals, not anaerobes. Less active than respiratory FQ against GP.
	Levofloxacin	500-750 mg PO or IV daily	GN + atypicals, not anaerobes.
	Aminoglycosides	Dosing individualized, monitor levels	GN + ESBL. Nephrotoxicity, ototoxicity.
Antifungals	Fluconazole	400 mg IV/PO daily	Candida, Histo, Cocci, Crypto. Inactive against C. galbrata, C. krusei, Aspergillus, zygomycetes.
	Itraconazole	400 mg PO daily (measure trough after 7d)	Candida, Aspergillus, Histo, Cocci, Crypto. Negative inotropic, contraindicated in cardiomyopathy
	Voriconazole	Invasive aspergillosis: 6mg/kg q12h x 2doses, then 4 mg/kg q12 h OR 200mg PO BID.	Candida, Aspergillus, Histo, Cocci, Crypto. Not zygomycetes. Primary tx of invasive aspergillosis.
	Posaconazole	Prophylaxis 200mg PO TID Salvage therapy: 200mg PO QID, then 400mg PO BID once stable.	Candida, Aspergillus, Histo, Cocci, Crypto, Zygometes. Prophylaxis in neutropenic patients w/ MDS, AML, HSCT w/ GVHD. PPI lowers levels.
	Liposomal amphotericin	3mg/kg/d IV	Candida, Aspergillus (except terreus), Zygomycetes, Histo, Cocci, Crypto.
	Caspofungin	70mg IV x1 dose, then 50mg IV daily	Primary tx for candidemia, salvage for Aspergillus.
	Micafungin	100mg IV/d	Primary tx for candidemia, salvage for Aspergillus. Superior c/w fluconazole for HSCT prophylaxis.
Antiviral	Acyclovir	Variable dosing depending on indications (HSV, VZV, CMV; prophylaxis vs. treatment)	HSV, VZV. Hydration to avoid crystal nephropathy w/ high doses. Dosing based on ideal body weight.
	Valacyclovir		HSV, VZV.
	Ganciclovir		CMV, HSV, VZV, HHV-6. May cause myelosuppression.
	Valganciclovir		CMV. May cause myelosuppression.
	Foscarnet		HSV, VZV, CMV, HH-6. Drug of choice for HSV/VZV resistant to acyclovir, and CMV resistant to ganciclovir. Nephrotoxic, monitor electrolytes.

Adapted from NCCN Guidelines Version 1.2013 Prevention and Treatment of Cancer-Related Infections

Typhlitis/Neutropenic enterocolitis



Source: Kantarjian HM, Wolff RA, Koller CA: *The MD Anderson Manual of Medical Oncology, 2nd Edition:* www.accessmedicine.com

- Bowel inflammation, intramural edema, wall thickening, discrete/confluent ulcers, hemorrhage, necrosis involving proximal large bowel (cecum, ascending + transverse colon)
- Cecum most affected (decreased vasculature, increased distensibility).
- Breakdown of gut mucosal integrity from cytotoxic chemo, impaired host defense
- Most common in neutropenic patients w/ hematologic malignancies, often 10-14d s/p chemo.
- Clostridium, GNR most commonly isolated, but also GPC, candida.
- Present w/ fever, RLQ pain, diarrhea (can be bloody).
- Mucositis (somatitis, pharyngitis) may be present, indicates diffuse gut involvement.
- Ddx: Appendicitis, pseudomembranous colitis, ischemic colitis, colonic obstruction
- Dx: Plain film often inconclusive unless perforation, order CT if suspected
- Tx:
    - Bowel rest, IVF, broad-spectrum abx including anaerobic coverage, correct cytopenias/coagulopathy.
    - If febrile >72hr, consider antifungal (voriconazole/amphotericin B will cover aspergillus and fluconazole-resistent candida).
    - Surgery if peritonitis, free perforation, GI bleed.

Increased intracranial pressure

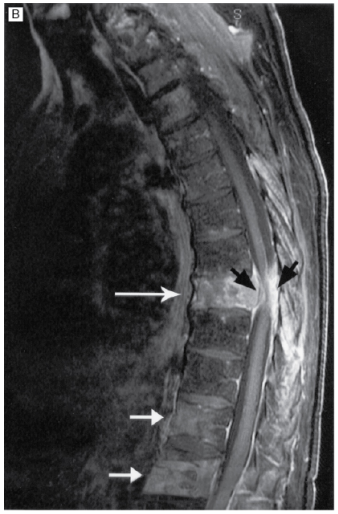
- Causes: hemorrhage, brain mets (vasogenic edema, mass effect), hydrocephalus from obstruction, radiation therapy
- Most common sx is headache: present on waking, recur throughout day, increased w/ Valsava, associated w/ N/V, AMS, visual changes, seizures, neurologic deficits..
- With brain mets, seizures are presenting symptom in 15-20% of patients. However, also may not have focal findings.
- Brain mets:
    - most common are lung, breast, melanoma
    - also colorectal, kidney, prostate, testicular, ovarian, sarcomas
    - pelvic tumors have ↑ propensity for mets to posterior fossa.
- Tx: may include initial steroids, neurosurgical intervention or palliative XRT if multiple mets

Leptomeningeal disease (LMD)

- Invasion of brain, spinal parenchyma, nerve roots, blood vessels of nervous system
- Occurs in 0.8-8% of all cancer pt
- Spreads hematogenously, via direct extension, or through bone marrow mets
- Most common malignancies: breast, lung, melanoma, NHL, leukemia
- Variable sx depending on location (H/A, AMS, CN palsy, incontinence, back pain, sensory changes, seizures, stroke-like presentation)
- MRI better than CT, but not diagnostic. May see leptomeningeal enhancement, hydrocephalus, cortical nodules.
- CSF analysis = gold standard, may need multiple LP as 50% of pt have positive cytology on 1st evaluation. Other findings are high OP, low glucose, high protein, mononuclear pleocytosis
- Tx: chemo through LP instillation (subarachnoid space missed 10-15% of time) vs. implanted subq reservoir + ventricular catheter (Ommaya reservoir). Use methotrexate, thiotepa, cytarabine (leukemia/lymphoma only). Radiation tx for localized LMD or areas of nerve root involvement not likely to reach adequate concentration
- Once leptomeningeal disease detected: median survival 3-6mo, 15-25% surviving >1yr

Spinal cord compression

- Affects 2.5% of oncology pt
- Not immediately life-threatening unless involves C1-C3, but emergent imaging needed
- Breast, lung, prostate = 50% of cases
- Others = multiple myeloma, RCC, melanoma, sarcoma, lymphoma, GI
- 75% epidural mets, 25% bony collapse
- Neuro sx: Pain most common, then motor. Autonomic sx are late (urinary/stool retention). May also effect sensory, spinocerebellar (ataxia).
- Imaging:
    - XR has false neg in 30%+ of cases as 30-50% of bone must be destroyed before lesions seen.
    - MRI w/ contrast best, consider entire spine.
    - CT myelography "gold standard" but invasive, time-consuming, painful
- Tx: Dexamethasome 20mg IV IMMEDIATELY, then 10-20mg IV/PO q4-6hr. Radiotherapy and/or surgery (anterior decompression w/ spinal stabilization)
- Will need to discuss w/ neurosurgery through MAC
- General surgical indications: recurrent/progressive disease at area w/ previous max radiotherapy, spinal mechanical instability, unknown tissue dx of malignancy, compression of spinal cord by bony structure/fragment. If ambulatory upon presentation, ¾ regain strength w/ tx. 10% presenting paralyzed able to walk again
- Median survival ~3mo (but dependent on underlying malignancy)



Source: Kantarjian HM, Wolff RA, Koller CA: *The MD Anderson Manual of Medical Oncology, 2nd Edition:* www.accessmedicine.com

67-yo man w/ melanoma + back pain. Post-contrast T1-weighted MR image of thoracic cord compression at T8 level produced by an epidural tumor from vertebral body metastasis (large arrow). Smaller arrows point to other sites of bony metastasis. The epidural tumor is visualized better w/ contrast (black arrows).

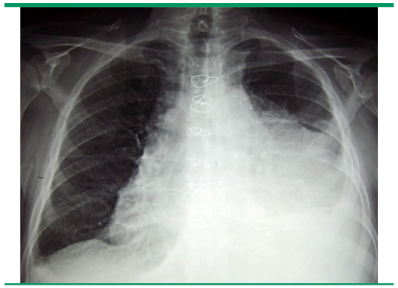
Common chemotherapy neurotoxicities:

Chemotherapy	Seizure	Neuropathy, Sensory Δ	Encephalopathy	Cerebellar Symptoms	CVA	Dementia, Nerve Palsy	Visual Δ	Myelopathy	Other
BCNU	+		+		+	+	+		
Busulfan	+								
Cisplatin	+	+	+		+				Ototoxicity
Ara-C		+	+	+		+		+	
Dacarbazine	+								
Docetaxel		+							
Doxorubicin							+		
Etoposide	+								
Fludarabine			+						
5-Fluorouracil			+	+					
Gemcitabine		+							
Ifosfamide	+	+	+	+					
Interferon	+		+			+			
Interleukin-2			+						
L-Asparaginase	+		+		+				
Methotrexate	+		+	+	+	+		+	
Paclitaxel	+								Gait abnormality
Procarbazine		+	+	+					
Tamoxifen			+				+		
Taxol		+							
Tenoposide		+							
Thalidomide		+							
Thiotepa								+	
Vincristine	+	+		+		+	+		Vertigo, autonomic neuropathy
Vinorelbine		+							

Adapted from Yeung SJ, Manzullo EF. Chapter 46. Oncologic Emergencies. In: Kantarjian HM, Wolff RA, Koller CA, eds. *The MD Anderson Manual of Medical Oncology*. 2nd ed. New York: McGraw-Hil
http://www.accessmedicine.com/content.aspx?aID=8315103. Accessed July 31, 2013.â

Cardiac tamponade:

- Tumors involving heart are mostly metastatic (lung, breast, GI tract, leukemia, lymphoma, melanoma, sarcoma)
- Consider in patients receiving chemo associated w/ cardiomyopathy: cyclophosphamide, ifosfamide at high doses, all-trans retinoic acid (ATRA), doxorubicin, radiation
- SOB, cough, hoarseness, epigastric pain, chest pain worse w/ lying down/leaning forward
- JVD, hypotension, ↓ pulse pressure, ↓ heart sounds, pulsus paradoxus
- Dx: EKG, CXR, TTE
- Tx: O2, IV fluids, vasopressors, pericardiocentesis (daily drainage catheter until <50cc/day). Pre-load dependent, avoid diuretics.
- Prevention of reaccumulation: Pericardial window, radiation, chemo, sclerosis of pericardium
- MI associated w/ 5-FU, interferons, capecitabine, radiation (esp. ostial coronaries arteries)



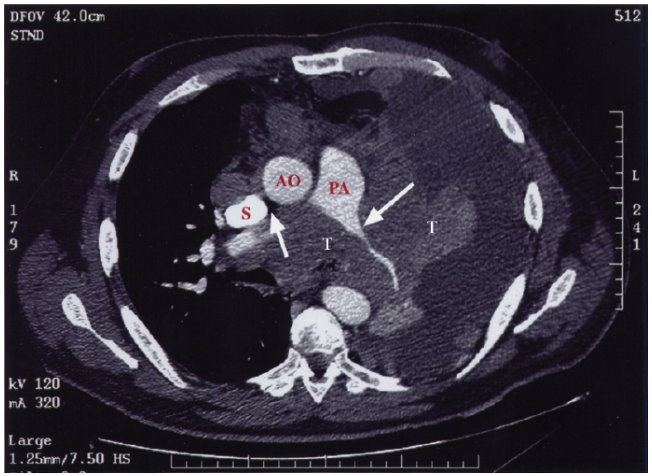
Cardiomegaly due to a massive pericardial effusion. At least 200 mL of pericardial fluid must accumulate before the cardiac silhouette enlarges.

Courtesy of Massimo Imazio, MD, FESC.

Source: http://www.uptodate.com/contents/images/CARD/57640/CXR_perieff.jpg?title=Chest+x-ray+of+a+pericardial+effusion. Accessed 3/22/2015.

SVC syndrome

- Low blood flow from SVC to RA
- Lung cancer most common cause (small cell, Pancoast tumors), followed by lymphoma, breast, GI, sarcoma, melanoma, prostate, mediastinal tumor
- Extrinsic compression by tumor, intrinsic compression by tumor/clot, fibrosis
- UE/face/neck swelling, SOB, dysphagia, H/A, dizziness, confusion. Chest wall collateral vessels on exam.
- Dx: CT w/ contrast, biopsy of tumor if unknown type
- Tx: elevation of head, diuretics, lytics for thrombosis, chemo (e.g., small cell lung cancer), radiation, intravascular stenting, angioplasty, corticosteroids for elevated ICP.



Source: Kantarjian HM, Wolff RA, Koller CA: *The MD Anderson Manual of Medical Oncology, 2nd Edition:* www.accessmedicine.com

Large arrow indicates compression of the left pulmonary artery; small arrow indicates obliteration of the right pulmonary artery. T, tumor; AO, aorta; PA, main pulmonary artery; S, superior vena cava.

Toxic lung injury

- ATRA: Retinoic acid syndrome (RAS) causing ARDS in 26% of patients 2-47d after tx
- Cytarabine: diffuse lung injury, capillary leakage, pulmonary edema after 6d of therapy
- Pulmonary edema: mitomycin C, gemcitabine, cyclosporine, interferon, TNF, IL-2, GMCSF
- ILD: bleomycin (hypersensitivity pneumonitis, dose related, usually >450 units), carmustine, lomustine, busulfan (3 wk - 3 yr, high mortality), cyclophosphamide (early onset = pneumonitis responsive to steroids, late onset = progressive fibrosis not responsive to steroids), methotrexate (days to years), doxorubicin (pulmonary fibrosis "recall" effect after radiation therapy), actinomycin D (see note on doxorubicin), tyrosine kinase inhibitors
- Pulmonary veno-occlusive disease: bleomycin, mitomycin C, busulfan

Hemorrhagic cystitis

- Inflammation, bleeding of bladder
- Causes:
    - Radiation (3mo-yrs after)
    - Viral infection (BK in BMT patients)
    - Chemo (cyclophosphamide, ifosfomide)
- Hydration, diuresis, Mesna to bind cyclophosphamide/ifosfomide metabolites (acrolein, chloroacetaldehyde) during administration, consider Urology evaluation
- Other tx: gentle bladder irrigation to remove clots, decompress bladder. Also prostaglandins, 1% alum, formalin, surgery, hypogastric artery embolization

Hyperviscosity

- ↑ concentration of paraproteins→ ↑ viscosity, RBC sludging, low O2 delivery to tissues
- Occurs in 15% of pt w/ Waldenstrom macroglobulinemia (IgM)
- Can also occur in other myelomas (IgG, IgA), polycythemia vera, essential thrombocythemia, dysproteinemia, occasionally leukemia
- Present w/ bleeding 2/2 abnormal platelet function, thrombosis, visual complaints, H/A, dizziness, AMS, mucosal bleeding, retinal hemorrhage, CHF (increased plasma volume), weakness, fatigue
- Avoid transfusions, as may worsen hyperviscosity
- Dx: CXR, serum viscosity (normal 1.4-1.8, sx when >5), fundoscopic exam
- Tx: IV fluids, plasma exchange with saline, chemotherapy.

Leukostasis

- Hyperleukocytosis: WBC > 100k/μL. Can be seen w/ blasts > 50-80k/μL or rapid increase
- Seen in AML and CML w/ blast crisis. Less commonly ALL/CLL (lymphocytes smaller).
- H/A, dizziness, vertigo, SOB, AMS, hemoptysis, retinopathy (vascular engorgement, exudates, hemorrhage), CNS bleed
- WBC poorly deformable, lodged in microvasculature of kidneys, lungs (ARDS vs. V/Q mismatch), brain
- If untreated, 1-week mortality 20-40%
- Tx: leukopharesis via HD line, chemotherapy, hydration

Tumor lysis

- Result of excessive tumor breakdown, generally w/ chemotherapy (but also radiation, hormonal agents, corticosteroid)
- Causes ↓calcium, ↑phosphate, ↑potassium, ↑uric acid, renal failure (generally reversible)
- Risk factors: high tumor burden, CKD, tumor type (Burkitt's lymphoma, lymphoblastic lymphoma, DLBCL, undifferentiated lymphoma, leukemia)
- Prophylaxis includes IV fluids, allopurinol 300-600mg daily (dose renally)
- If uric acid >8mg/dL:
    - BMP, Ca, phosphate, uric acid, LDH q8h
    - IV fluids 200-300 cc/hr if no contraindications, maintain UOP >100cc/hr (consider Lasix, also decreases K)
    - Allopurinol 100mg/m^2 q8h (max 800mg/day, dose renally)
    - Rasburicase: 0.15-0.2 mg/kG IV (needs H/O attending approval)
        - Recombinant urate oxidase, converts uric acid to allantoin rapidly.
        - Contraindicated if G6PD, methemoglobinemia, pregnancy.
        - Can cause hemolytic anemia, reabsorption of phosphate leading to calcium phosphate deposition
    - Hemodialysis if persistent hyperuricemia
- Hyperkalemia: kayexalate, hydration, insulin + D50, Lasix
- Hyperphosphatemia: diet restriction, non-calcium-based phosphate binders

Hypercalcemia

- Occurs in 10-20% of patients w/ advanced cancer (lung squamous cell, breast cancer, multiple myeloma, lymphoma)
- Causes: PTHrP, ↑ Vitamin D 1,25 (lymphoma), bony mets (most common)
- Symptoms: AMS, polyuria, polydipsia, N/V, anorexia, constipation, seizures
- Adjust for albumin or use ionized calcium
- Treatment: Ca > 14mg/dL requires treatment, consider if 12-14 and symptomatic
    - IV fluids important esp in setting of polyuria/vomiting, 200-300cc/hr if no contraindications w/ goal UOP 100-150cc/hr, aim for euvolemia
    - Bisphosphonates: Zoledronic acid 4mg IV over 15min more effective in malignancy compared to pamidronate 60-90mg IV over 2h. Onset is 12-48h, used for long-term lowering of calcium by inhibiting bone resorption.
    - Corticosteroids may be considered if ↑ Vitamin D from lymphoma. Decreases calcitriol production by activated cells in lung/lymph nodes
    - Dialysis if unable to tolerate hydration
    - Calcitonin: 4 units/kg subq q6-12h, up to 8 units/kg. Onset 2-4h, used for rapid lowering of calcium by increasing renal excretion of Ca + decreasing bone resorption. Tachyphylaxis after 2 days, limiting utility. Best for periop use. May cause nausea, abdominal cramps, hypersensitivity.

Chemotherapy–induced extravasations (See Appendix 2)

- Can cause skin irritation/ulceration, tissue necrosis, nerve damage
- Can be avoided by using central venous catheters
- Most severe reactions:
    - Alkylating agents (mechlorethamine, cisplatin, mitmoycin C)
    - DNA intercalating agents (doxorubicin, daunarubicin)
    - Plant alkaloids (vincristine, vinblastine, vinorelbine)
- Mitomycin, anthracyclines: Topical DMSO (dimethylsulfoxide) in 50% solution, 1.5cc applied to site q6h x 7-14d
- Plant alkaloids, etoposide: 150 units of hyaluronidase in 1 to 3cc saline injected into needle and subq around extravasated site
- If still symptomatic w/ anthracyclines, will need plastic surgery consultation for excision/skin grafting. Doxorubicin especially remains in skin for extended time.
- Apply cool or warm packs (see Appendix 2)

Curability of Cancers with Chemotherapy

Table 85-2 from Sausville EA, Longo DL. Chapter 85. Principles of Cancer Treatment. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, eds. *Harrison's Principles of Internal Medicine*. 18th ed. New York: McGraw-Hill; 2012. http://www.accessmedicine.com/content.aspx?aID=9114487. Accessed July 31, 2013.

A. Advanced Cancers With Possible Cure
Acute lymphoid and acute myeloid leukemia (pediatric/adult)
Hodgkin's disease (pediatric/adult)
Lymphomas—certain types (pediatric/adult)
Germ cell neoplasms
  Embryonal carcinoma
  Teratocarcinoma
  Seminoma or dysgerminoma
  Choriocarcinoma
Gestational trophoblastic neoplasia
Pediatric neoplasms
  Wilms' tumor
  Embryonal rhabdomyosarcoma
  Ewing's sarcoma
  Peripheral neuroepithelioma
  Neuroblastoma
Small cell lung carcinoma
Ovarian carcinoma
B. Advanced Cancers Possibly Cured by Chemotherapy and Radiation
Squamous carcinoma (head and neck)
Squamous carcinoma (anus)
Breast carcinoma
Carcinoma of the uterine cervix
Non-small cell lung carcinoma (stage III)
Small cell lung carcinoma
C. Cancers Possibly Cured With Chemotherapy as Adjuvant to Surgery
Breast carcinoma
Colorectal carcinomaa
Osteogenic sarcoma
Soft tissue sarcoma
D. Cancers Possibly Cured with "High-Dose" Chemotherapy With Stem Cell Support
Relapsed leukemias, lymphoid and myeloid
Relapsed lymphomas, Hodgkin's and non-Hodgkin's
Chronic myeloid leukemia
Relapsed germ cell tumors
E. Advanced Cancers Responsive With Useful Palliation, But Not Cure, by Chemotherapy
Bladder carcinoma
Chronic myeloid leukemia
Hairy cell leukemia
Chronic lymphocytic leukemia
Lymphoma—certain types
Multiple myeloma
Gastric carcinoma
Cervix carcinoma
Endometrial carcinoma
Soft tissue sarcoma
Head and neck cancer
Adrenocortical carcinoma
Islet-cell neoplasms
Breast carcinoma
Colorectal carcinoma
Renal carcinoma
F. Tumor Poorly Responsive in Advanced Stages to Chemotherapy
Pancreatic carcinoma
Biliary-tract neoplasms
Thyroid carcinoma
Carcinoma of the vulva
Hepatocellular carcinoma
Salivary gland cancer

Common chemotherapy regimen acronyms

Name	Components	Example of uses
ABVD	Adriamycin (doxorubicin), bleomycin, vinblastine, dacarbazine	Hodgkin's lymphoma
AC	Adriamycin (doxorubicin), cyclophosphamide	Breast
BEACOPP	Bleomycin, etoposide, Adriamycin (doxorubicin), cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone	Hodgkin's lymphoma
BEP	Bleomycin, etoposide, platinum agent (cisplatin (Platinol))	Testicular
BFM	Berlin-Frankfurt-Münster (see protocol)	ALL
CAF	Cyclophosphamide, Adriamycin (doxorubicin), fluorouracil (5-FU)	Breast
ChlVPP/EVA	Chlorambucil, vincristine (Oncovin), procarbazine, prednisone, etoposide, vinblastine, Adriamycin (doxorubicin)	Hodgkin's lymphoma
CIA	Clofarabine, idarubicin, cytarabine	AML
COP or CVP	Cyclophosphamide, Oncovin (vincristine), prednisone	NHL
CMF	Cyclophosphamide, methotrexate, fluorouracil (5-FU)	Breast cancer
COPP	Cyclophosphamide, Oncovin (vincristine), procarbazine, prednisone	NHL
CAPeOX	capecitabine and oxaliplatin (same as XELOX)	Colorectal cancer
CVAD / HyperCVAD	Cyclophosphamide, Vincristine, Adriamycin (doxorubicin), dexamethasone	NHL, lymphoblastic lymphoma, some forms of leukemia
DCF	Docetaxol, cisplatin, fluorouracil	Head and neck
EC	Epirubicin, cyclophosphamide	Breast
ECF	Epirubicin, cisplatin, fluorouracil (5-FU)	Gastric, esophageal
EP	Etoposide, platinum agent (cisplatin (Platinol))	Testicular, germ cell, small cell lung
EPOCH	Etoposide, prednisone, Oncovin, cyclophosphamide, and daunorubicin	Lymphoma
ESHAP	Etoposide, solumedrol, high-dose ARA-C, cisplatin	NHL
FCR	Fludarabine, cyclophosphamide, rituximab	CLL/SLL
FEC	Fluorouracil (5-FU), epirubicin, cyclophosphamide	Breast
FOLFOX	Fluorouracil (5-FU), leucovorin (folinic acid), oxaliplatin	Colorectal
FOLFIRI	Fluorouracil (5-FU), leucovorin (folinic acid), irinotecan	Colorectal
HiDAC	High dose cytarabine	AML
ICE	ifosfamide, carboplatin, etoposide (VP-16)	Aggressive lymphomas, progressive neuroblastoma
MVAC	methotrexate, vinblastine, adriamycin, cisplatin	Bladder
PCV	Procarbazine, CCNU (lomustine), vincristine	Brain tumors
POMP	6-mercaptopurine (Purinethol), vincristine (Oncovin), methotrexate, and prednisone	ALL
R-CHOP	Rituximab, Cyclophosphamide, daunorubicin (doxorubicin), vincristine (Oncovin), prednisone	NHL
R-FCM	Rituximab, fludarabine, cyclophosphamide, mitoxantrone	B cell non-Hodgkin lymphoma
RICE	ICE + rituximab	Aggressive lymphomas, progressive neuroblastoma
Stanford V	Doxorubicin, mechlorethamine, bleomycin, vinblastine, vincristine, etoposide, prednisone	Hodgkin lymphoma
TC	Taxotere, cyclophosphamide	Breast
TCH	Taxotere, carboplatin/cyclophosphamide, herceptin	Breast
TCHP	Taxotere, carboplatin, Herceptin, pertuzumab	Breast
TPF	Taxotere, platinol, fluorouracil	Head and neck
Thal/Dex	Thalidomide, dexamethasone	Multiple myeloma
TIP	Paclitaxel, ifosfamide, platinum agent cisplatin (Platinol)	Testicular, germ cell
VAC	Vincristine, Actinomycin, Cyclophosphamide	Rhabdomyosarcoma
VAD	Vincristine, Adriamycin (doxorubicin), dexamethasone	Multiple myeloma
VIP	Vinblastine, ifosfamide, platinum agent cisplatin (Platinol)	Testicular, germ cell
XELOX	Xeloda, oxaliplatin (same as CApeOx)	Colorectal

Common chemotherapy toxicities: Direct DNA-interacting agents

Drug	Toxicity	Interactions, Issues
Alkylators		
Cyclophosphamide	Marrow (relative platelet sparing), cystitis, alopecia, pulm., infertility, teratogenesis	Liver metabolism required to activate to phosphoramide mustard + acrolein. MESNA protects against "high-dose" bladder damage.
Mechlorethamine	Marrow, vesicant, nausea	Topical use in cutaneous lymphoma
Chlorambucil	Marrow, alopecia, pulm., infertility, teratogenesis	
Melphalan	Marrow (delayed nadir), GI (high dose)	↓ renal function delays clearance
Bendamustine	N/V, hyperbilirubinemia, cough, N/V	CLL, NHL
Carmustine (BCNU)	Marrow (delayed nadir), GI, liver (high dose), renal	
Lomustine (CCNU)	Marrow (delayed nadir)	
Ifosfamide	Myelosuppressive, bladder, neurologic, metabolic acidosis, neuropathy	Isomeric analogue of cyclophosphamide. More lipid soluble, ↑ activity vs testicular neoplasms and sarcomas. Must use MESNA.
Procarbazine	Marrow, nausea, neurologic, alopecia, pulmonary, infertility, teratogenesis	Liver + tissue metabolism required. Disulfiram-like effect w/ ethanol. Acts as MAOI. HBP after tyrosinase-rich foods.
Dacarbazine (DTIC)	Marrow, nausea, flu-like syndrome	Metabolic activation
Temozolomide	N/V, headache, fatigue, constipation, infrequent myelosuppression	
Altretamine (formerly hexamethylmelamine)	Nausea, neurologic (mood swing), neuropathy	Liver activation. Barbiturates enhance/cimetidine diminishes.
Cisplatin	Nausea, neuropathy, auditory, marrow (plt >WBCs), renal (Mag, K wasting)	Maintain high urine flow; osmotic diuresis, monitor intake/output K+, Mg2+. Emetogenic—prophylaxis needed. Full dose if CrCl > 60 mL/min + tolerate fluid push.
Carboplatin	Marrow (plt > WBCs), nausea, renal (high dose)	↓ dose according to CrCl: to AUC of 5–7 mg/mL per min [AUC = dose/(CrCl + 25)]
Oxaliplatin	Nausea, anemia	Acute reversible neurotoxicity, chronic sensory neurotoxicity cumulative w/ dose. Reversible laryngopharyngeal spasm (avoid cold).
Antitumor Antibiotics and Topoisomerase Inhibitors		
Bleomycin	Pulm., skin effects, Raynaud's, hypersensitivity, allergic reactions	Deactivated by bleomycin hydrolase (decreased in lung/skin). O2 ↑ pulm. toxicity. Cisplatin-induced decrease in CrCl may increase skin/lung toxicity, reduce dose if CrCl < 60 mL/min. Radiation recall.
Actinomycin D	Marrow, nausea, mucositis, vesicant, alopecia	
Etoposide (VP16-213)	Marrow (WBCs > platelet), alopecia, hypotension, hypersensitivity (rapid IV), nausea, mucositis (high dose)	Hepatic metabolism—renal 30%, reduce doses w/ renal failure. Schedule-dependent (5 day better than 1 day). Late leukemogenic. Accentuates antimetabolite action.
Topotecan	Marrow, mucositis, nausea, mild alopecia	↓ dose w/ renal failure, no liver toxicity.
Irinotecan (CPT II)	Diarrhea: "early onset" w/ cramping, flushing, vomiting; "late onset" after several doses, marrow, alopecia, N/V, pulmonary	Prodrug requires enzymatic clearance to active drug "SN 38." Early diarrhea likely 2/2 biliary excretion. Late diarrhea: use "high-dose" loperamide (2 mg q2–4 h).
Doxorubicin and daunorubicin	Marrow, mucositis, alopecia, cardiovascular (acute/chronic)	Vesicant. Heparin aggregate; coadministration ↑clearance. Acetaminophen, BCNU ↑ liver toxicity. Radiation recall.
Idarubicin	Marrow, cardiac (less than doxorubicin)	
Epirubicin	Marrow, cardiac	
Mitoxantrone	Marrow, cardiac (less than doxorubicin)	Vesicant (mild)

Adapted from Table 85-1 of Sausville EA, Longo DL. Chapter 85. Principles of Cancer Treatment. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, eds. Harrison's Principles of Internal Medicine. 1 http://www.accessmedicine.com/content.aspx?aID=9114487. Accessed July 31, 2013.

Common chemotherapy toxicities: Indirect DNA-interacting agents

Drug	Toxicity	Interactions, Issues
Antimetabolites		
Deoxycoformycin	Nausea, immunosuppression, neurologic, renal	Excretes in urine, reduce dose for renal failure, inhibits adenosine deaminase
6-Mercaptopurine	Marrow, liver, nausea	Variable bioavailability. Metabolized by xanthine oxidase, decrease dose w/ allopurinol. ↑ toxicity w/ thiopurine methyltransferase deficiency.
6-Thioguanine	Marrow, liver, nausea	Variable bioavailability. Increased toxicity w/ thiopurine methyltransferase deficiency.
Azathioprine	Marrow, nausea, liver	Metabolizes to 6MP, therefore reduce dose w/ allopurinol. ↑ toxicity w/ thiopurine methyltransferase deficiency.
2-Chlorodeoxyadenosine	Marrow, renal, fever	Notable use in hairy cell leukemia
Hydroxyurea	Marrow, nausea, mucositis, skin changes. Rare renal, liver, lung, CNS.	Decrease dose w/ renal failure. Augments antimetabolite effect.
Methotrexate	Marrow, liver/lung, renal tubular, mucositis	Rescue w/ leucovorin. Excreted in urine, start alkalinization upon admission. ↓ dose in renal failure. NSAIDs ↑ renal toxicity. Hold omeprazole/ Bactrim when on MTX.
5-Fluorouracil (5FU)	Marrow, mucositis, neurologic, skin changes, vasospasm	Toxicity enhanced by leucovorin. Dihydropyrimidine dehydrogenase deficiency ↑ toxicity. Metabolizes in tissues.
Capecitabine	Diarrhea, hand-foot syndrome	Prodrug of 5FU
Cytosine arabinoside	Marrow, mucositis, neurologic (high dose), conjunctivitis (high dose), noncardiogenic pulmonary edema	Enhances activity of alkylating agents, metabolizes in tissues by deamination. Start pred forte eye drops to prevent chemical conjunctivitis.
Azacitidine	Marrow, nausea, liver, neurologic, myalgia	Use limited to leukemia. Altered methylation of DNA alters gene expression.
Gemcitabine	Marrow, nausea, hepatic, fever ("flu syndrome")	
Fludarabine phosphate	Marrow, neurologic, lung	Dose reduction w/ renal failure. Metabolized to F-ara converted to F-ara ATP in cells by deoxycytidine kinase.
Asparaginase	Decreased clotting factors, glucose intolerance, hypersensitivity, CNS, pancreatitis, hepatic toxicity	Blocks methotrexate action
Pemetrexed	Anemia, neutropenia, thrombocytopenia	Supplement folate/B12. Caution in renal failure.
Antimitotic Agents		
Vincristine	Vesicant, marrow, neurologic, GI (ileus/constipation; bladder hypotoxicity), SIADH, cardiovascular	Hepatic clearance. Dose reduction for bilirubin >1.5 mg/dL. Prophylactic bowel regimen.
Vinblastine	Vesicant, marrow, neurologic (less common but similar to other vincas), HTN, Raynaud's	Hepatic clearance. Dose reduction as w/ vincristine.
Vinorelbine	Vesicant, marrow, allergic/bronchospasm (immediate), dyspnea/cough (subacute), neurologic (less prominent but similar to other vincas)	Hepatic clearance
Paclitaxel	Hypersensitivity, marrow, mucositis, alopecia, sensory neuropathy, CV conduction disturbance, nausea (infrequent)	Premedicate w/ steroids, H1 and H2 blockers. Hepatic clearance. Dose reduction as w/ vincas.
Docetaxel	Hypersensitivity, fluid retention syndrome, marrow, dermatologic, sensory neuropathy, nausea (infrequent), stomatitis (some)	Premedicate w/ steroids, H1 and H2 blockers
Eribulin	Alopecia, peripheral neuropathy, cytopenias, constipation, arthralgia/myalgias	Metastatic breast cancer
Nab-paclitaxel (protein bound)	Neuropathy, anemia, neutropenia, thrombocytopenia	Caution in hepatic insufficiency
Ixabepilone	Myelosuppression, neuropathy	

Adapted from Table 85-1 of Sausville EA, Longo DL. Chapter 85. Principles of Cancer Treatment. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, eds. Harrison's Principles of Internal Medicine. 18th ed. New York: McGraw-Hill; 2012. http://www.accessmedicine.com/content.aspx?aID=9114487. Accessed July 31, 2013.

Common chemotherapy toxicities: Molecularly-targeted agents

Drug	Toxicity	Interactions, Issues
Retinoids		
Tretinoin	Teratogenic, cutaneous	APL differentiation syndrome: pulm. dysfunction/ infiltrate, pleural/pericardial effusion, fever
Bexarotene	↑cholesterol+Tg, cutaneous, teratogenic, central hypothyroidism	
Targeted Toxins		
Denileukin	N/V, fever, chills, asthenia, hepatic, acute hypersensitivity (hypotension, vasodilation, rash, chest tightness), vascular leak (hypotension, edema, hypoalbuminemia, thrombotic events)	
Tyrosine Kinase Inhibitors		
Imatinib	Nausea, periorbital edema	Myelosuppression not frequent in solid tumor indications
Gefitinib	Rash, diarrhea	In U.S., only w/ prior documented benefit
Erlotinib	Rash, diarrhea	1 h before, 2 h after meals
Dasatinib	Liver changes, rash, neutropenia, thrombocytopenia, pericardial/pleural effusions	
Sorafenib	Diarrhea, hand-foot syndrome, other rash	Tx RCC, multiple targets including RAF/VEGF
Sunitinib	Fatigue, diarrhea, neutropenia	Tx RCC
Proteosome Inhibitors		
Bortezomib	Neuropathy, thrombocytopenia	
Histone Deacetylase Inhibitors		
Vorinostat	Fatigue, diarrhea, thrombocytopenia, embolism	
Romidepsin	N/V, cytopenias, cardiac conduction	
Anti-EGFR		
Cetuximab (Erbitux)	Weakness, fever, H/A, acneiform rash, nausea, hypersensitivity reaction	Tx colon ca, NSCLC, head/neck SCC
Panitumumab	Skin toxicity, vomiting, diarrhea,	Tx colon ca
Trastuzumab (Herceptin)	Infusion reaction, cardiomyopathy, pulm. toxicity	Anti-HER2, tx breast ca
Pertuzumab	Cardiomyopathy, alopecia, diarrhea, cytopenia	Anti-HER2, tx breast ca
mTOR Inhibitors		
Temsirolimus	Stomatitis, thrombocytopenia, nausea, anorexia, fatigue, metabolic (glucose, lipid)	
Everolimus	Stomatitis, fatigue	
Monoclonal antibodies		
Bevacizumab (Avastin)	Proteinuria, HTN, GI perforation, arterial embolism	Colon Ca, NSCLC, renal, breast
Rituximab (Rituxan)	Severe mucocutaneous reactions, infusion reaaction, PML, cytopenias	Hepatitis B reactivation
Other		
Ipilumumab	Severe immune-mediated reactions (enterocolitis, hepatitis, dermatitis, neuropathy, endocrinopathy)	Monoclonal ab against CTLA-4
Nivolumab	Severe immune-mediated reactions (enterocolitis, hepatitis, dermatitis, neuropathy, endocrinopathy)	Monoclonal ab against PD-1
Pembrolizumab	Severe immune-mediated reactions (enterocolitis, hepatitis, dermatitis, neuropathy, endocrinopathy)	Monoclonal ab against PD-1
Arsenic trioxide	QTc prolongation, peripheral neuropathy, MSK pain, hyperglycemia, APL differentiation syndrome	

Adapted from Table 85-1 of Sausville EA, Longo DL. Chapter 85. Principles of Cancer Treatment. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, eds. Harrison's Principles of Internal Medicine. 18th ed. New York: McGraw-Hill; 2012. http://www.accessmedicine.com/content.aspx?aID=9114487. Accessed July 31, 2013.

Grading Toxicity

Grade	Description
1 (Mild)	Asymptomatic or mild symptoms. Clinical or diagnostic observation only. No intervention indicated.
2 (Moderate)	Minimal, local, or noninvasive intervention indicated. Limiting age-appropriate IADLs (preparing meals, shopping for groceries/clothes, using telephone, managing money.
3 (Severe)	Hospitalization or prolongation of hospitalization indicated. Disabling, limiting ADLs (bathing, dressing/undressing, feeding self, using toilet, taking medications)
4 (Life-threatening)	Urgent intervention indicated
5 (Death)	Death

Full Common Terminology Criteria for Adverse Events by specific toxicity available at http://evs.nci.nih.gov/ftp1/CTCAE/CTCAE_4.03_2010-06-14_QuickReference_5x7.pdf

Appendix 1: Pathophysiology of nausea and vomiting

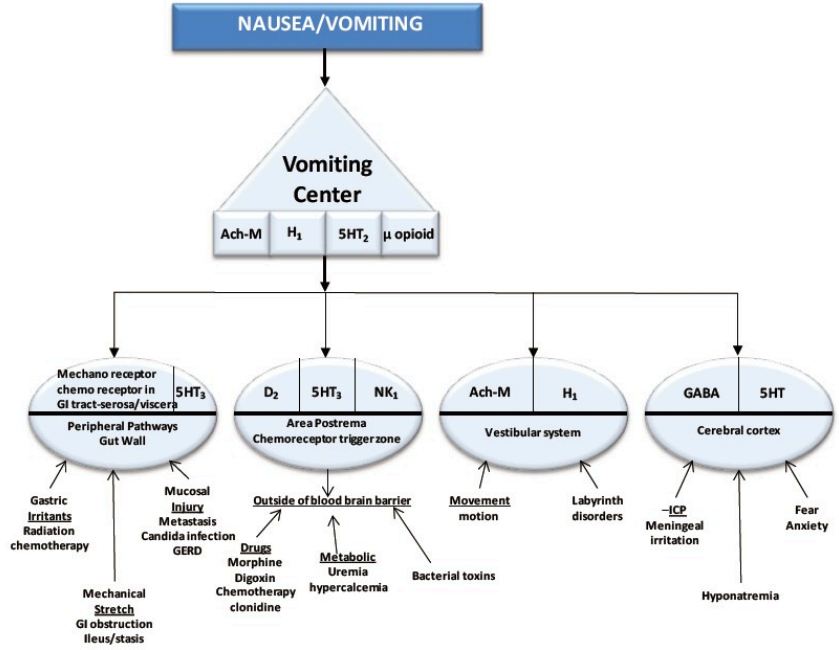


Figure 1. HS Smith, LR Cox, BR Smith. Dopamine Receptor antagonists. Annals of Palliative Medicine. Vol 1, No 2 (July 2012)

Appendix 2: Chemotherapeutic extravasations and their antidotes

Chemotherapy	Irritant vs. Vesicant	Sodium Thiosulfate	DMSO	Hyaluronidase	Cold Packs	Warm
Carboplatin	I	+			+	
Carmustine	I/V	+		+		Dry warm
Cisplatin		I/V	+			+
Cyclophosphamide	I	+			+	
Dacarbazine	I/V	+				
Dactinomycin	I/V				+	
Daunorubicin	I/V		+		+	
Docetaxel	I				+	Warm soaks
Doxorubicin	I/V		+		+	
Epirubicin	I/V		+		+	
Etoposide	I/V			+		+
Idarubicin	I/V		+		+	
Ifosfamide	I				+	
Mechlorethamine	I/V	+				
Mitomycin C	V		+		+	
Oxaliplatin	I/V	+				
Paclitaxel	I/V			+		
Plicamycin	I/V					
Streptozocin	I/V					
Teniposide	I/V			+		+
Topotecan					+	
Vinblastine	I/V			+		+
Vincristine	I/V			+		+
Vindesine	I/V			+		+
Vinorelbine	I/V			+		+

From: Yeung S, Manzullo EF. Chapter 46. Oncologic Emergencies. In: Kantarjian HM, Wolff RA, Koller CA. eds. The MD Anderson Manual of Medical Oncology, 2e. New York, NY: McGraw-Hill; 2011. http://accessmedicine.mhmedical.com/content.aspx?bookid=379&Sectionid=39902077. Accessed March 23, 2015.

Appendix 3

Khorana Predictive Model For Chemotherapy-Associated VTE[1]

Patient Characteristic	Risk Score
• Site of primary cancer	
➤ Very high risk (stomach, pancreas)	2
➤ High risk (lung, lymphoma, gynecologic, bladder, testicular)	1
• Prechemotherapy platelet count 350X10^9/L or higher	1
• Hemoglobin level less than 10 g/dL or use of red cell growth factors	1
• Prechemotherapy leukocyte count higher than 11X10^9/L	1
• BMI 35 kg/m^2 or higher	1

Total Score	Risk Category	Risk of Symptomatic VTE[2]
0	Low	0.8-3%
1, 2	Intermediate	1.8-8.4%
3 or higher	High	7.1-41%

Per NCCN: *"Consider patient conversation about risks and benefits of VTE prophylaxis in the Khorana score ≥3 patient population."*

Appendix 4: Oncology Conferences

- Bone Marrow Rounds - Friday at 1:00 PM
- Tumor Board - Weekly on Thursday at 1:00 PM
- Gyn Onc Tumor Board - Weekly on Monday 11:30 AM
- Lymphoma Conference - Monthly on Tuesday
- Breast Multiconference - Monthly on Thursday
- Heme/onc Journal Club - Monthly on Thursday
- Thoracics Conference- Every other week on Thursday
- Hepatobiliary Conference - Monthly on Tuesday at 3 PM
- Heme/onc Core Curriculum Conference - Monthly on Thursday

Appendix 5: Emetogenic potential of chemo

High risk (>90% frequency of emesis)	Moderate risk (30-90% frequency of emesis)	Low emetic risk (10-30% frequency of emesis)	Minimal emetic risk (<10% frequency of emesis)
Doxorubicin or epirubicin + cyclophosphamide	Aldesleukin >12-15 million IU/m2	Amifostine ≤300mg	Alemtuzumab
Carmustine > 250mg/m2	Amifostine >300 mg/m2	Adlesleukin ≤12 million IU/m2	Asparaginase
Cisplatin	Arsenic trioxide	Brentuximab vedotin	Bevacizumab
Cyclophosphamide >1500 mg/m2	Azacitidine	Cabazitaxel	Bleomycin
Dacarbazine	Bendamustine	Capecitabine (oral)	Bortezomib
Doxorubicin >60mg/m2	Busulfan	Carfilzomab	Cetuximab
Epirubicin >90mg/m2	Carboplatin	Cytarabine 100-200mg/m2	Chlorambucil (oral)
Hexamethylmelamine (oral)	Carmustine ≤250 mg/m2	Docetaxel	Cladribine
Ifosfamide ≥2 g/m2 per dose	Clofarabine	Doxorubicin (liposomal)	Cytarabine <100mg/m2
Mechlorethamine	Cyclophosphamide ≤ 1500 mg/m2	Eribulin	Decitabine
Procarbazine (oral)	Cytarabine >200 mg/m2	Etoposide	Denileukin diftitox
Streptozocin	Dactinomycin	Everolimus (oral)	Dexrazoxane
	Daunorubicin	5-FU	Erlotinib (oral)
	Doxorubicin ≤60 mg/m2	Fludarabine (oral)	Fludarabine
	Epirubicin ≤90 mg/m2	Floxuridine	Gefitinib (oral)
	Idarubicin	Gemcitiabine	Hydroxyurea (oral)
	Ifosfamide <2g/m2	IFN-α 5-10 million IU/m2	IFN-α <5 million IU/m2
	Imatinib (oral)	Ixabepilone	Ipilmumab
	Interferon alfa ≥ 10 million IU/m2	Lapatinib (oral)	L-phenylalanine mustard (oral)
	Irinotecan	Lenalidomide (oral)	Methotrexate <50mg/m2
	Melphalan	Methotrexate 50-250mg/m2	Nelarabine
	Methotrextate ≥ 250mg/m2	Mitomycin	Ofatumumab
	Oxaliplatin	Mitoxantrone	Panitumumab
	Temozolomide	Paclitaxel	Pegaspargase
	Vinorelbine (oral)	Paclitaxel-ablumin	Peginterferon
		Pemetrexed	Pertuzumab
		Pentostatin	Rituximab
		Pralatrexate	6-thioguanine (oral)
		Romidepsin	Sorafenib (oral)
		Thalidomide (oral)	Temsirolimus
		Thiotepa	Trastuzumab
		Topotecan	Valrubicin
		Sunitinib (oral)	Vinblastine
			Vincristine
			Vincristine (liposomal)
			Vinorelbine

Adapted from Grunberg SM, Warr D, Gralla RJ, et al. Evaluation of new antiemetic agents and definition of antineoplastic agent emetogenicity--state of the art. Support Care Cancer. 2011 Mar;19 Suppl

Resources:

- **Accessmedicine.com** (use UCLA proxy):
  -- Williams Hematology
  -- MD Anderson Oncology
  -- Harrison's Internal Medicine

- **NCCN.org** (free account): Comprehensive management guidelines, see also free app

- **Chemotherapy regimens:**
  -- Chemoregimen.com
  -- Hemonc.org

- **Patient information (English + Spanish):**
  -- Cancer.net

- **American Society of Hematology Image Bank:**
  imagebank.hematology.org/

- **University of Utah Hematopathology slides**:
  library.med.utah.edu/WebPath/HEMEHTML/HEMEIDX.html

- **NEJM procedure videos**
  -- Lumbar puncture: www.nejm.org/doi/full/10.1056/NEJMvcm054952
  -- Paracentesis: www.nejm.org/doi/full/10.1056/NEJMvcm062234
  -- Thoracentesis: www.nejm.org/doi/full/10.1056/NEJMvcm053812
  -- Bone marrow biopsy: www.nejm.org/doi/full/10.1056/NEJMvcm0804634

- **California POLST forms in multiple languages**:
  CApolst.org/

- **Informed consent summary:**
  www.ama-assn.org//ama/pub/physician-resources/legal-topics/patient-physician-relationship-topics/informed-consent.page

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