



Chest Tubes

Objectives

- Identify the indications for a chest tube
- Discuss the most serious potential problem of a chest tube and its related treatment
- Explain the importance of drainage monitoring
- Discuss what should be observed for in the drainage
- State the procedure to re-establish chest tube patency

Objectives (cont.)

- Discuss the four primary functions of a chest tube
- Discuss the proper maintenance of chest tubes Explain the significance of constant bubbling in the seal chamber
- Defend the rationale for not routinely “milking” the chest tube
- Explain the importance of maintaining a dependent loop

Four Primary Functions

- Act as a drain
- Replace negative pressure
- Provide a water seal
- Prevent return into patient

Chambers of the drainage

- Collection chamber
- Water seal chamber
- Suction control chamber

Indications

- Any event which significantly disrupts chest wall integrity

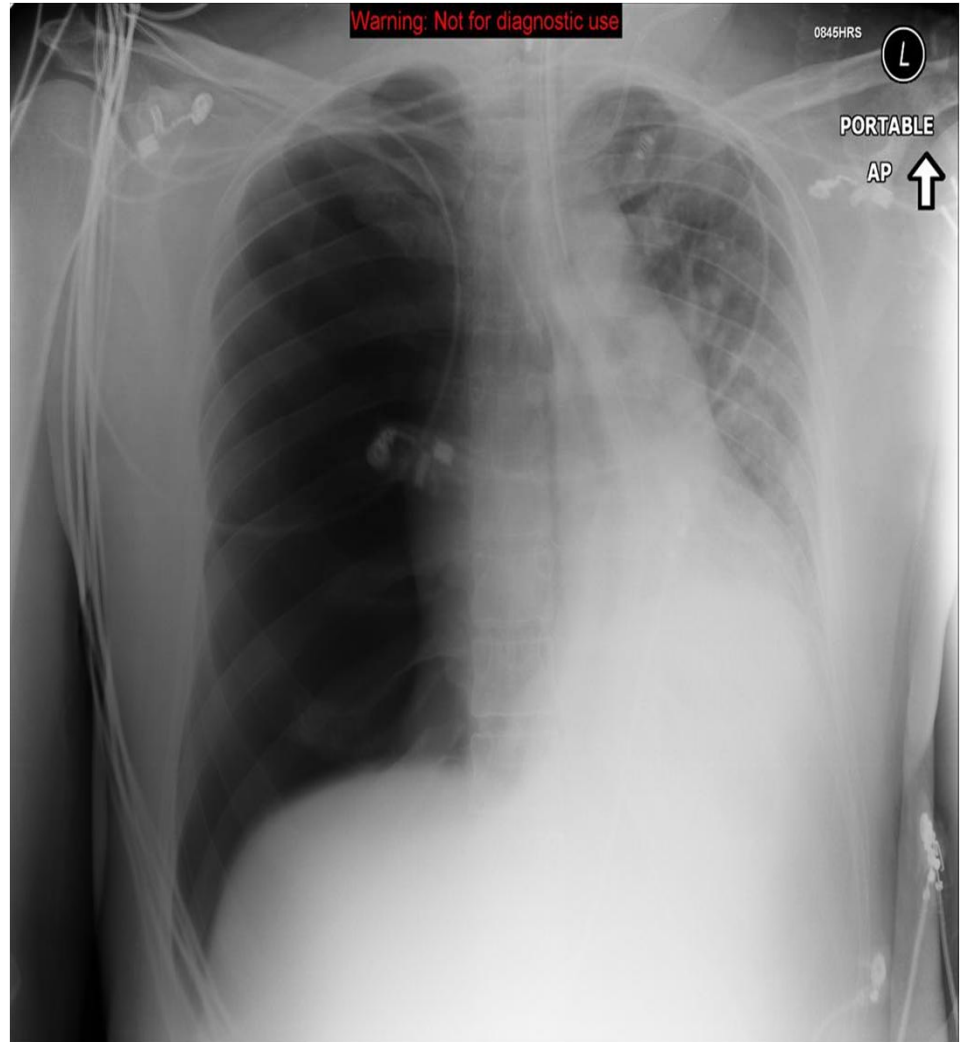


Maintenance of Chest Tubes

- Semi-Fowler's position is ideal, if permitted
- Turn the patient every two hours, if permitted
- Frequently lift tubing to drain contents into collection chamber
- NEVER raise drainage system above level of patient's chest
- Fluctuations in the water seal chamber are normal
Avoid creating loops in the system
- Encourage patient to breathe deeply and to cough
- Watch for signs of subcutaneous emphysema

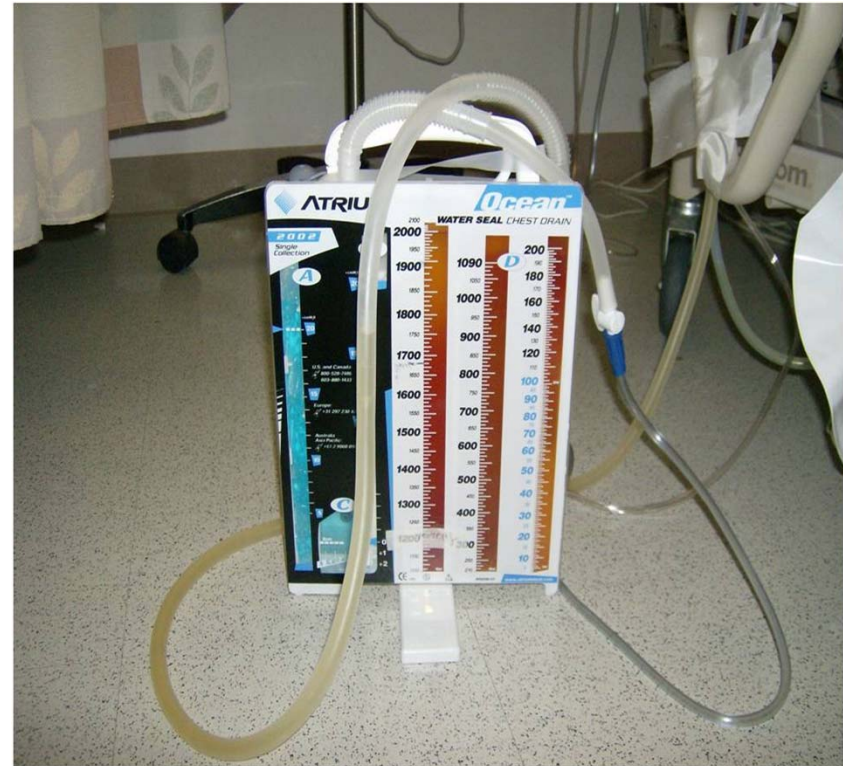
Problems with Chest Tubes

- Tension pneumothorax
- Chest tube removal



Drainage monitoring

- Watch for:
 - Color
 - Consistency
 - Amount
- ***ANY SUDDEN CHANGE IN THE AMOUNT OF DRAINAGE, WHETHER AN INCREASE OR DECREASE, IS CAUSE FOR CONCERN.***



Procedures for Re-establishing Tube Patency

- If possible reposition the patient
- Check for clots in system
- Squeeze and release tubing to dislodge clot
- “Milking the tube” is a last resort
 - Excessive pressures
 - Rupture of alveoli
 - Pleural leak



Fibrinolytics

Objectives

- Discuss the purpose of fibrinolytic therapy
- List the five types of fibrinolytic agents with their respective doses
- List the potential side effects of fibrinolytics
- Explain the purpose of the five adjunctive pharmacologic agents during fibrinolytic therapy
- Describe the proper methods for administering the five fibrinolytic agents
- Identify the proper dosage and potential side effects of the seven pharmacologic agents during fibrinolytic therapy

Objectives (cont.)

- Describe the pathophysiology involved in an acute myocardial infarction
- Recall that fibrinolytic agents may be used for other thrombotic emergencies
- State the sequential management to handle bleeding problems
- Explain the importance of handling a fibrinolytic patient gently
- Explain the rationale for dividing the contraindications to fibrinolytics into potential and absolute
- Defend the reasons for adjunctive pharmacologic therapy

Pathophysiology of an AMI

- Damage to the interior of a blood vessel
- Platelets adhere to the damaged area
- Serotonin, ADP, and thromboxanes are released
- Clot increases in size
- Occlusion of the artery produces an AMI

Transport Considerations

- Reperfusion arrhythmias usually occur within 1 ½ hours from onset of treatment
- Watch for development of bundle branch blocks

Fibrinolytic Agents

- **Alteplase**
 - Dosage- 100 mg IV over 3 hours
 - 6 -10 mg is bolused over 1-2 minutes
 - Remaining 40 mg infused at 20 mg/hr



Types of Fibrinolytic Agents (cont.)

- **Anistreplase**
 - Dosage- 30 units over 2-5 minutes



Types of Fibrinolytic Agents (cont.)

- **Streptokinase**
 - Dosage- 140,000 units followed by maintenance infusion
 - Loading dose is 20,000 units
 - Maintenance infusion is 2,000 IU/min over 1 hour



Types of Fibrinolytic Agents (cont.)

- **Urokinase**
 - Dosage- 6,000 IU/min over 2 hours
 - Typical dose is 500,000 IU total



Types of Fibrinolytic agents (cont.)

- **Reteplase**
 - Dosage- Double bolus of 10 U + 10 U given over 2 minutes
 - Second bolus is administered over 30 minutes if no adverse reactions have occurred



Potential Absolute Contraindications

- Active internal bleeding
- History of CVA, intracranial neoplasm, AVM, aneurysm
- Recent intracranial or intraspinal injury
- Past or present bleeding disorder
- Uncontrolled hypertension (systolic >180 mm/Hg, diastolic >110 mm/Hg)
- Pregnancy

Potential Relative Contraindications

- Diabetic hemorrhagic retinopathy or other hemorrhagic ophthalmic conditions
- Prolonged CPR (longer than 10 minutes)
- Major surgery at non-compressible site (eg. CABG) within 10 days
- Documented cerebrovascular disease
- Gastrointestinal or genitourinary bleeding within last 7 days
- Significant liver dysfunction
- PHYSICALLY advanced age (>75 years with multiple disease states beyond AMI).
- Patients currently receiving oral anticoagulants
- Previous thrombolytic therapy
- Trauma to the head in the last two weeks
- Any trauma in the last two weeks
- Surgery in the last two weeks

Side effects

- Anaphylaxis
- Hemorrhage



Bleeding Management

- Avoid IM Injections
- Avoid unnecessary handling of patient
- Pad side rails of cot
- Reduce venipunctures to a minimum
- Apply direct pressure to active bleeding sites for 15 minutes
- Keep involved extremity straight
- Watch for internal hemorrhage
- Avoid nasotracheal intubation and NG tubes

Sequential Bleeding Management

- Apply manual pressure to bleeding site
- Administer crystalloid volume replacement
- Interrupt anticoagulant therapy
- Interrupt thrombolytic therapy

Adjunctive Pharmacologic Agents

- Nitroglycerin
- Lidocaine
- Heparin
- Aspirin
- Beta Blockers
- Morphine Sulfate
- Oxygen

Nitroglycerin

- Effects
 - Smooth muscles relaxant which decreases the demand of oxygen while at the same time increasing the supply of the same.
- Dosage
 - IV form typically initiated at 10-20 mcg/min, titrate to effect
- Contraindications
 - Hypersensitivity to agent
 - Hypotension
- Side Effects
 - Headache
 - Orthostatic hypotension
 - Tachycardia
 - Flushing
 - Palpitation
 - Nausea and vomiting

Lidocaine

- **Effects**

- Class IB antiarrhythmic
- Decreases excitability and conduction
- Increases the fibrillation
- Works only on the ischemic portions of the myocardium

- **Dosage**

- 1-1.5 mg/kg IV bolus
- Maximum bolus is 3 mg/kg
- 4:1 infusion at a rate of 2-4 mg/min

- **Contraindications**

- Hypersensitivity to the agent
- Heart blocks
- Sick sinus syndrome

- **Side Effects**

- Seizures
- Confusion
- Tremor
- Hypotension
- Bradycardia
- Worsened arrhythmias

Heparin

- **Effects**

- Inhibits the formation of new clots by deactivating thrombin

- **Dosage**

- Patient specific
- Typical dosing is 5,000 to 7,500 units IV bolus
- Infusion rate of 1,000 units/hr

- **Contraindications**

- Coagulation disorders
- Ulcers
- Recent surgery
- Active bleeding
- Hypersensitivity to the agent

- **Side Effects**

- Hemorrhage
- Increased clotting times

Aspirin

- **Effects**

- Blocks prostaglandin which decreases production of thromboxanes

- **Dosage**

- 324 mg orally

- **Contraindications**

- Known hypersensitivity to the drug
- Bleeding disorders
- Use caution with patients with known hypersensitivity to NSAIDs

- **Side effects**

- Tinnitus
- Dizziness
- GI disorders

Beta Blockers

- **Effects**

- Decreases the workload on the heart
- Reduces automaticity of the heart

- **Dosage (metoprolol)**

- 5 mg IV every 5 minutes
- Total of three doses
- 25-50 mg PO every 6 hours

- **Contraindications**

- Known hypersensitivity to the drug
- Heart rate < 45 beats per minute
- 2nd or 3rd degree heart block
- PR interval >.24 seconds
- Systolic BP < 100 mmHg
- Moderate to severe cardiac failure

- **Side effects**

- Fatigue
- Dizziness
- Bradycardia
- Hypotension

Morphine Sulfate

- **Effects**

- Vasodilator
- CNS depressant
- Potent vasodilator

- **Dosage**

- 1-3 mg every 5 minutes

- **Contraindications**

- Known hypersensitivity
- Hypotension

- **Side effects**

- Respiratory depression
- Hypotension
- Lightheadedness

Oxygen

- **Effects**
 - Elevates the arterial pressure of oxygen increasing the perfusion to the cells
- **Dosage**
 - AHA recommends beginning at 4 L/min via nasal cannula and increasing level until pulse oximetry is >95%
- **Contraindications**
 - There are no contraindications to the administration of oxygen in the setting of an acute myocardial infarction
- **Side effects**
 - None



Fluid and Blood Therapy

Objectives

- List the indications for crystalloid therapy
- List the indications for colloid therapy
- Recognize examples of the following
 - Hypertonic
 - Isotonic
 - Hypotonic
- Recognize examples of colloids
- List the indications for parenteral therapy
- Define TPN

Objectives (cont.)

- List the four indications for blood therapy
- Identify commonly used blood products
- Identify the four components that blood must be checked for prior to administration
- State the proper procedure to administer blood
- List the three major types of reactions associated with blood product administration

Objectives (cont.)

- Describe the proper patient management for the three major types of blood infusion reactions
- Defend the need to watch for signs of fluid overload with colloidal administration
- Explain the rationale for using a sterile technique when changing solution bags of TPN
- Defend the reason why blood is initially infused slowly

Indications for Crystalloid Therapy

- Rehydration
- Replenish sodium and chloride
- Provide energy



Solutions

- **Isotonic**

- Ringer's
- Lactated Ringer's
- 2.5% Dextrose/Lactated Ringer's
- 0.9% Normal Saline

- **Hypertonic**

- 10% Dextrose
- 20% Dextrose
- 50% Dextrose
- 3% Saline
- 5% Saline
- 5% Dextrose/.45% Saline
- 5% Dextrose/.9% Normal Saline
- 5% Dextrose/Lactated Ringer's

- **Hypotonic**

- 2.5% Dextrose
- 5% Dextrose
- 0.45% Saline

Crystalloid Precautions

- Hypertonic solutions should be administered slowly
- Monitor flow rate to prevent overload

Indications for Colloid Administration

- Rapid replacement of intravascular fluid
- Hypotension
- Correct albumin and protein levels



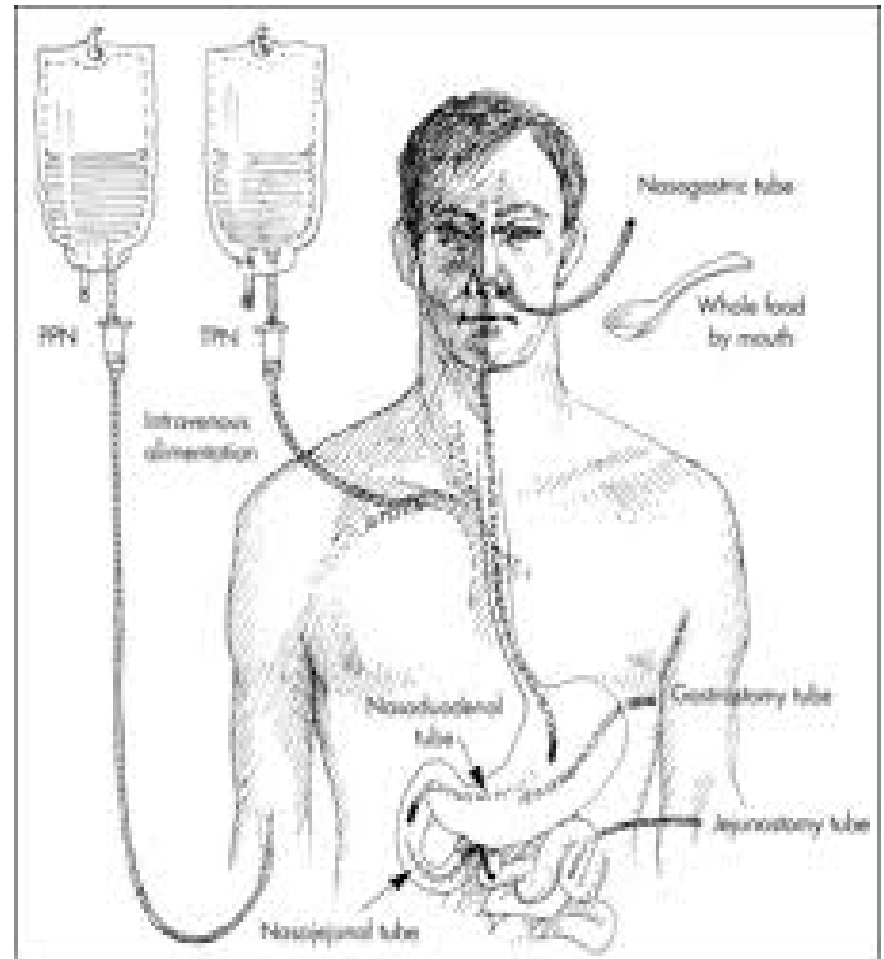
Colloid Examples

- 5% Albumin
- 25% Albumin
- Plasma protein fraction

Due to extreme osmotic gradient be alert for signs of fluid overload

Indications for Parenteral Therapy (TPN)

- Provide calories
- Spare the body's protein
- Maintenance of nutritional status



Parenteral therapy

- **Examples**
 - Amino acids
 - Fat emulsions
 - TPN



Parenteral Therapy Precautions

- Fat emulsions are incompatible with electrolytes
- Adverse reactions to emulsion therapy:
 - Nausea and vomiting
 - Headache
 - Dyspnea
 - Allergic reactions
- Avoid using an in-line filter for fat administration
- Use an IV pump to administer TPN
- Use a sterile technique changing IV bags
- Watch for signs of glucose intolerance when administering TPN

Blood Therapy

- Indications
 - Decreased hemoglobin
 - Decreased hematocrit
 - Large volume/blood loss
 - To increase oxygen carrying capacity

Types of Blood Products

- Packed red blood cells
- Platelets
- Fresh frozen plasma
- Whole blood

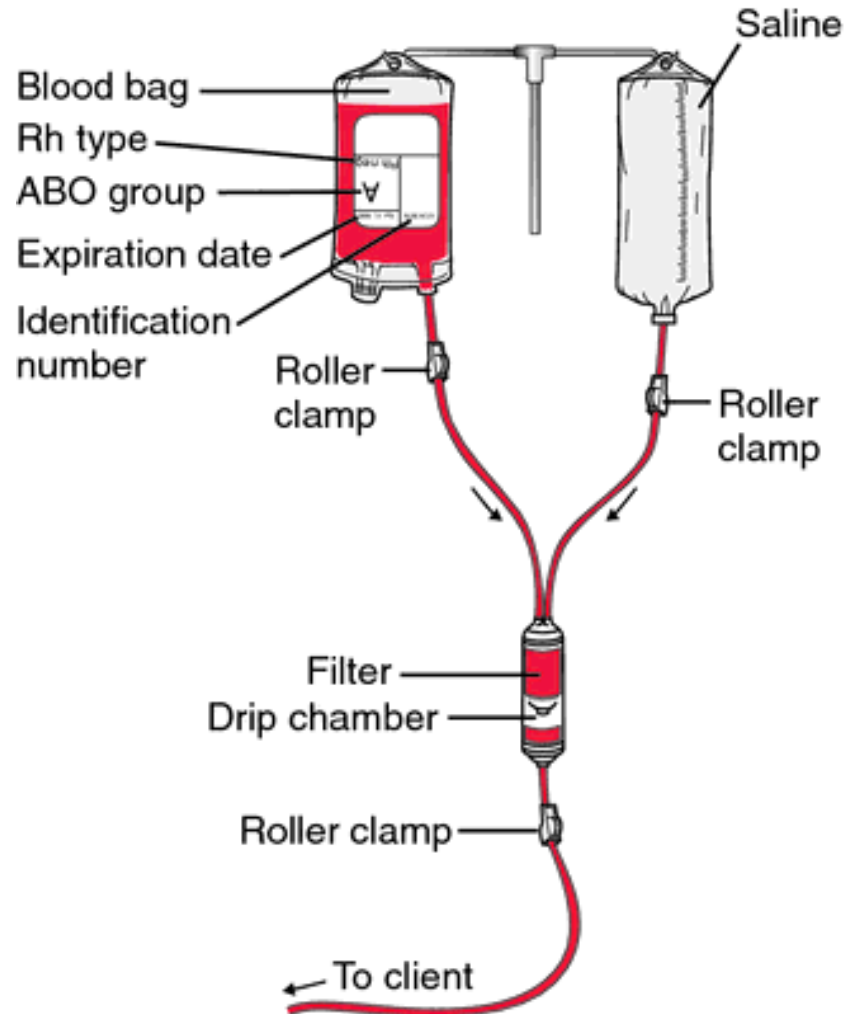


Check blood for:

- The right patient
- The right blood product
- The right blood type
- Expiration date

Considerations

- 18 gauge needle or larger
- Flush tubing with normal saline
- Use a blood administration set
- Never “piggyback” blood with anything else
- Start infusion slowly





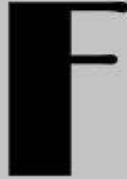


Blood Infusion

- No more than 1 drop every 5 seconds initially.
- 5-10 ml of blood required to initiate a reaction.
- Increase rate in 15 minutes if no reaction.
- Complete infusion in 1 to 1 ½ hours.
- Blood can remain at room temperature for four hours.
- Never reuse the same administration set if further units are required.
- Stop infusion immediately if a reaction occurs.
- Save the blood.
- Avoid pressure infusing blood.

Transfusion reactions

- Circulatory overload
- Febrile reaction
- Allergic reaction

Blood Transfusion Reaction

| | | | |
|---|------------------|---|--|
|  | Allergic | MILD Facial Flushing Hives/ Rash SEVERE Increased Anxiety Wheezing Decreased BP |  |
|  | Febrile | Headache Tachycardia Tachypnea Fever/Chills Anxiety |  |
|  | Hemolytic | Decreased BP Increased RR Hemoglobinuria Chest Pain | Apprehension Low Back Pain Fever Tachycardia Chills |

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Circulatory Overload

- **Signs and Symptoms**

- Dyspnea, coughing, and cyanosis
- Headache, sudden anxiety
- Increase in systolic blood pressure
- JVD
- Pulmonary edema followed by peripheral edema

- **Treatment**

- Stop the infusion
- IV Normal Saline at TKO
- Oxygen
- Consider:
 - Diuretics*
 - Analgesics*
 - Aminophylline*

Febrile Reaction

- Most common reaction with blood transfusions
- Caused by immune reaction
- Usually occurs within 30 minutes

Febrile Reaction (cont)

- **Signs and Symptoms**

- Elevated temperature
- Chills
- Stable vital signs

- **Treatment**

- Stop the infusion
- Change the tubing
- Maintain venous access
- Aspirin or Tylenol for fever
- Document
 - *Episode*
 - *Time*
 - *Amount of blood administered*
 - *Treatment performed*

Allergic Reaction

- More common in patients with history of receiving multiple transfusions.
- More common in patients with a history of allergies.
- Reactions may be grouped into two classifications: mild and severe.

Mild Allergic Reaction

- **Signs and Symptoms**

- Aching joints
- Urticaria

- Mild fever

- **Management**

- Stop the infusion and change tubing
- Diphenhydramine
- Maintain IV access
- Aspirin or acetaminophen

Severe Allergic reaction

- **Signs and Symptoms**

- Occurs after a small amount has been administered
- Absence of fever
- Wheezing and/or coughing
- Treat as for anaphylaxis
- Tracheal edema
- Respiratory distress
- GI complaints
- Anaphylaxis

- **Management**

- Stop the infusion and change tubing
- IV fluids to support BP
- Treat as for anaphylaxis



Foley Catheters

Objectives

- Identify the two components in assessing a Foley catheter
- Identify the three primary indications for the placement of a Foley catheter
- Define the normal urinary output
- State the treatment for accidental removal of a Foley catheter
- State the treatment for a clotted catheter
- Defend the rationale for not raising the collection bag above the level of the patient
- Explain the reasoning for performing hourly, or sooner, recording of fluid input/output

- Indications
 - Urinary incontinence
 - Monitoring accurate fluid output
 - Inability to void
- Normal urinary output
 - 1 ml/kg/hr

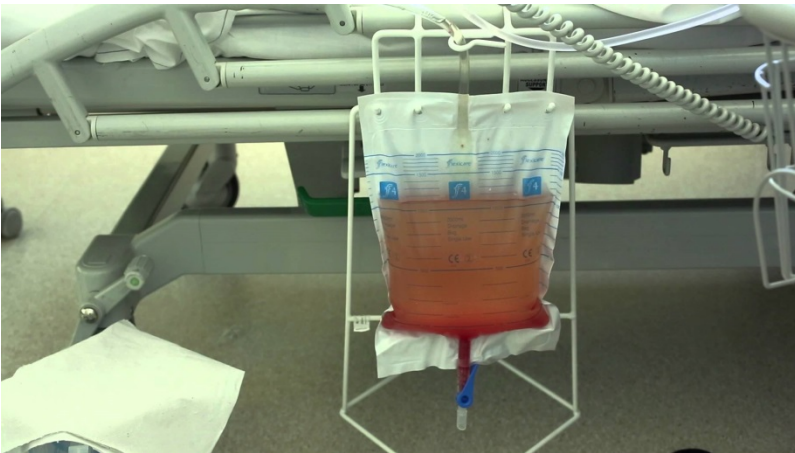
Assessment of Foley Catheters

➤ Assess drainage

- Color*
- Amount*
- Consistency*

➤ Assess entrance site

- Redness*
- Swelling*
- Warmth*
- Discharge*
- Pain*



Foley catheter complications

- Accidental removal
- Clotting
- Raising the collection bag above the level of the patient
- Sudden reduction in urine flow
- Moving the patient
- At least an hourly record of urine output needs to be kept

Accidental Removal

- Provide supportive treatment
- Apply loose dressing if severe bleeding present
- Document



Clotting of Catheter

- Maintain aseptic technique
- Flush with 50 cc of sterile saline
- If resistance is encountered, STOP!
- Document procedure and time performed



IV Pumps

Objectives

- Discuss IV pumps used at the bedside in a hospital that a provider may see in a interfacility hospital transfer.
- Be familiar with IV infusion pumps in the event a patient who you are transferring has an IV drip infusing through a IV pump.
- Discuss how to titrate a medication in the event it is needed to do so.

IV Infusion Pumps

- Variety of pumps on the market for different routes
- There are a variety of IV infusion pumps on the market today that are used for many different routes of delivery.
- Many IV pumps will already be set and infusing at the time a patient is being transferred.

Purpose of IV Infusion Pumps

- Deliver a set volume of fluid or a medication dose.
- With smart pumps the risk for medication errors is reduced.
- When programmed correctly, the correct medication can be delivered safely.

Smart Pumps

- Designed with medication doses preprogrammed
- Trained operator puts in the applicable data such as the patient weight, volume of fluid to be infused, or what medication is being given.
- Pump then initiates medication infusion automatically once started.

Baxter SIGMA SPECTRUM Infusion Pump

- Several medication and doses preprogrammed.
- Weighs 4 pounds.
- Single step titration option.
- Will help reduce medication errors.
- Audio and visual alarms:
 - air in the line
 - downstream occlusion
 - upstream occlusion



Plum 360 Infusion System by Hospira MedNet

- Can deliver set medication doses or set volumes of IV fluid.
- Used for general administration of medications and fluid.
- Weighs about 10 lbs.



Carefusion Alaris PC IV Pump

- Delivers a set volume and rate of medication and IV fluids.
- Reduces risk for medication errors by having preprogrammed medication doses.
- Can support 4 different medication infusions at the same time on 1 unit.



IV Pumps

- These IV pumps are just a few of the many IV pumps you may encounter.
- All smart IV pumps have the same function, but different steps to achieve the desired goal.
- Consult with the sending RN if you have any questions about the IV pump such as, what to do if the pump alarms, or how to titrate a medication.
- Always ask questions if in doubt!

References

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Nasogastric/Orogastric Tubes

Objectives

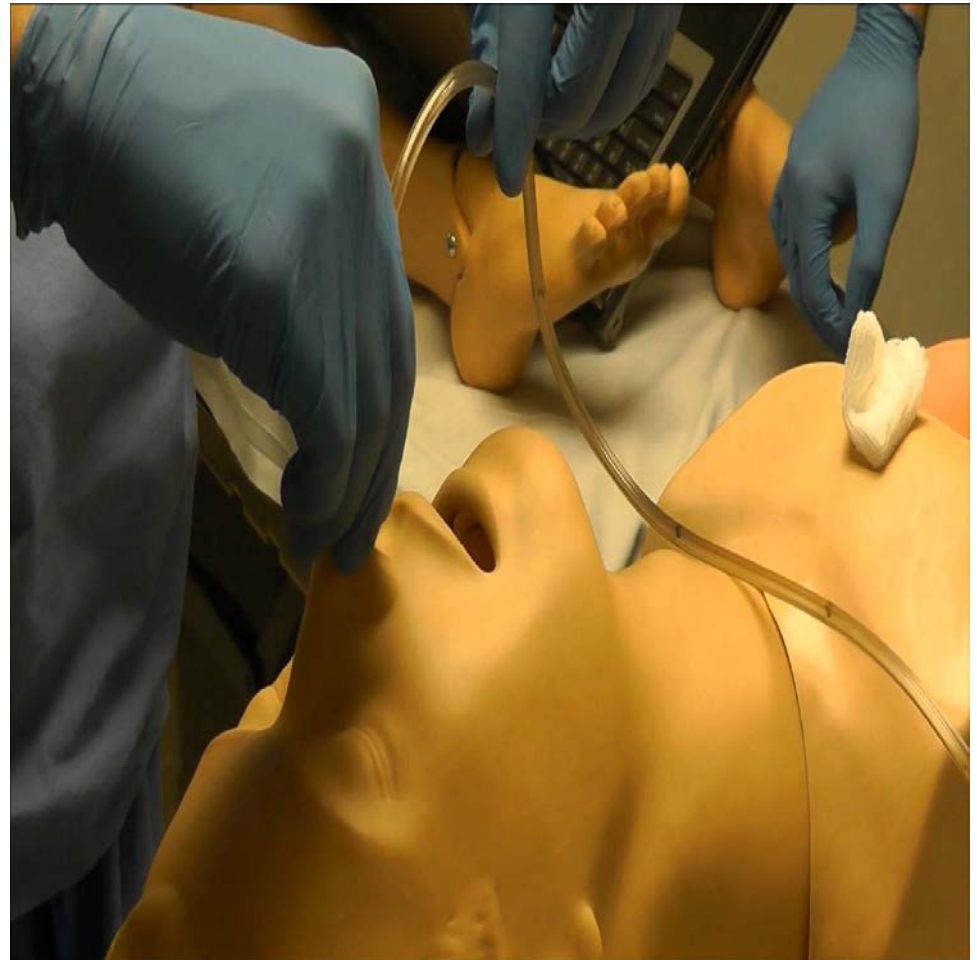
- Recall the five indications for the placement of the NG/OG tube.
- Explain some of the problems associated with NG/OG tubes.
- Discuss what the drainage from a a NG/OG tube should be assessed for.
- Defend the need to avoid lying the patient supine when a NG/OG tube is in place.

Indications for NG/OG tube

- Short term enteral feeding
- Administer medications
- Gastric lavage and/or decompression
- Removal of pills
- Hemostasis in upper GI bleeding

Problems with Ng/OG tubes

- Vomiting
- Dehydration
- Aspiration pneumonia



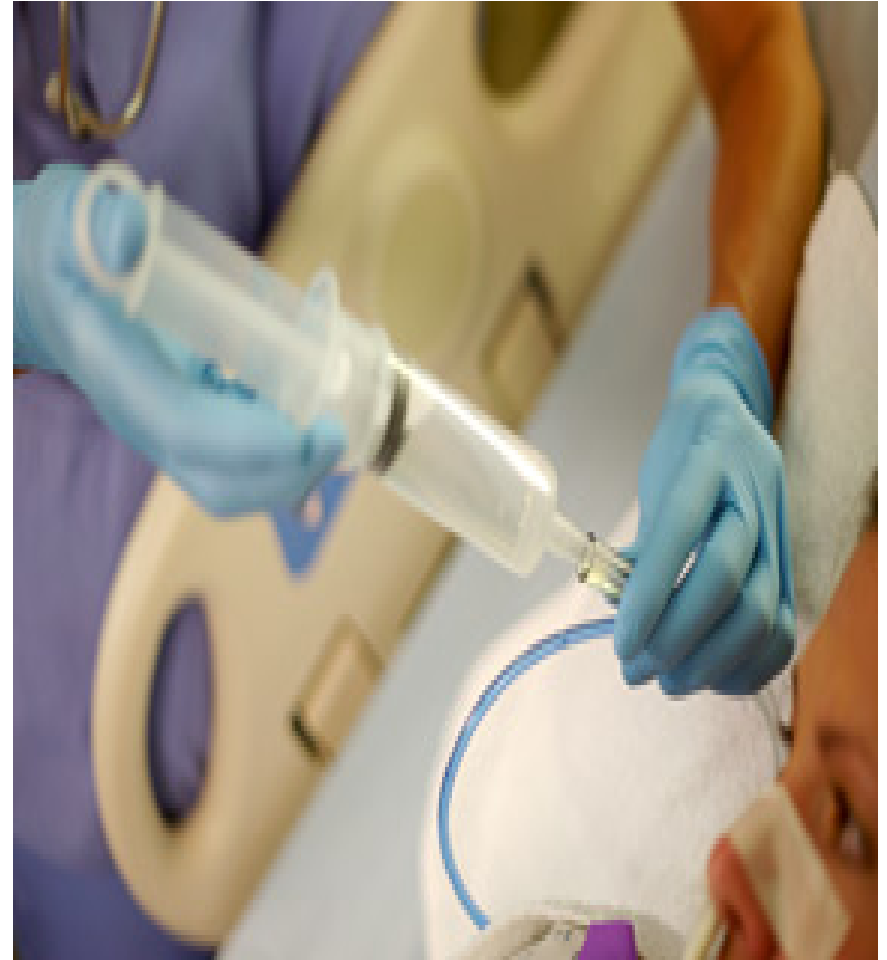
Drainage monitoring

- Check for:
 - Amount
 - Color
 - Consistency
 - Odor



NG/OG tube tips

- Avoid lying patient flat, if possible.
- Irrigate tubes before and after medication administration.
- Precise record of input and output
- Irrigate tube every four hours, or sooner.





Pharmacology

Course Objectives

- Review Terminology.
- Discuss medications drips commonly seen in the critical care interfacility transport.
- Review RSI medications.

Terminology Review

- Class
- Mechanism Of Action
- Indication
- Contraindication
- Side Effects
- Titrate
- Half life
- Onset
- Peak
- Duration
- Elimination

7 Rights to Medication Administration

- Right Patient
- Right Drug
- Right Route
- Right Dose
- Right Time
- Right Frequency
- Right Documentation

Beta Blockers



Esmolol

- **Dose:** initial dose is 150 mcg/kg/min and titrated to the desired blood pressure and heart rate.
- **Mechanism of Action:** exerts selective inhibitory effects on beta 1 receptors found in the heart, reducing blood pressure.
- **Indications:** **Aortic Dissection**, Hypertension, SVT
- **Contraindications:** cardiogenic shock, decompensated heart failure, IV administration of calcium channel blockers (i.e. Verapamil), pulmonary hypertension, 2nd or 3rd degree heart block
- **Side Effect:** hypotension, diaphoresis, weakness, dizziness, vision changes

Calcium Channel Blockers



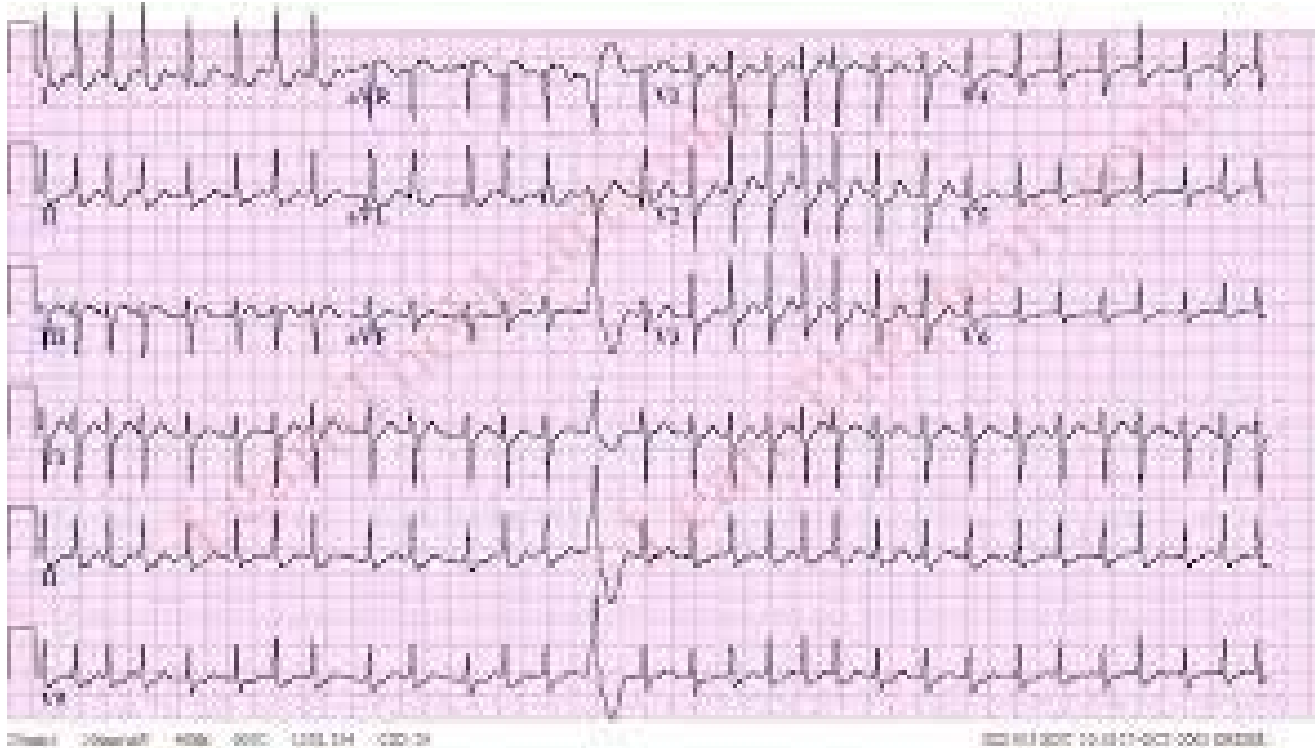
Nicardipine (Cardene)

- **Dose:** start at 2.5mg/hr and titrate up to 15 mg/hr max dose. Increase dose by 2.5 mg/hr every 15 minutes.
- **Mechanism of Action:** Calcium channel blocker that inhibits the influx of calcium ions into the myocardium and coronary vessels. This relaxes blood vessels, lowering blood pressure.
- **Indications:** Hypertension, **SAH**, CVA
- **Contraindication:** Hypotension, Aortic Stenosis
- **Side Effects:** chest discomfort, diaphoresis, nausea, edema, tremors

Diltiazem (Cardizem)

- **Dose:** 5mg/hr titrated up to 15mg/hr max dose. Increase by 5 mg/hr.
- **Mechanism of Action:** blocks calcium influx into cardiac and smooth muscle, slowing cardiac conduction to the AV node reducing thereby reducing cardiac workload
- **Indications:** A-fib or A-flutter with RVR, hypertension, PSVT, stable angina
- **Contraindication:** administration of IV beta-blockers, cardiogenic shock, WPW, V-tach, hypotension
- **Side Effects:** dizziness, weakness, headache, hypotension

Antidysrhythmic Medications



Lidocaine

- **Dose:** 1-4 mg/min
- **Mechanism of Action:** decreases automaticity, depolarization, and excitability by decreasing the influx of sodium ions during the diastolic phase.
- **Onset:** Immediate
- **Indications:** V-fib or V-Tach without a pulse, V-Tach with a pulse (stable), Multifocal PVC's
- **Contraindications:** 2nd or 3rd degree heart block
- **Side Effects:** flushing of the skin, warm skin, itching, nausea, vomiting

Amiodarone

- **Dose:** 0.5 mg/min
- **Mechanism of Action:** prolongs cardiac action potential and blocks myocardial potassium channels resulting in delayed conduction and a prolonged refractory time.
- **Indications:** V-fib or V-tach without a pulse, Stable v-tach
- **Contraindications:** hypotension, bradycardia, cardiogenic shock, 2nd or 3rd degree heart block
- **Side Effect:** dizziness, nausea, weakness or numbness to arms or legs, light sensitivity, cough

Nitrates



Sodium Nitroprusside (Nipride)

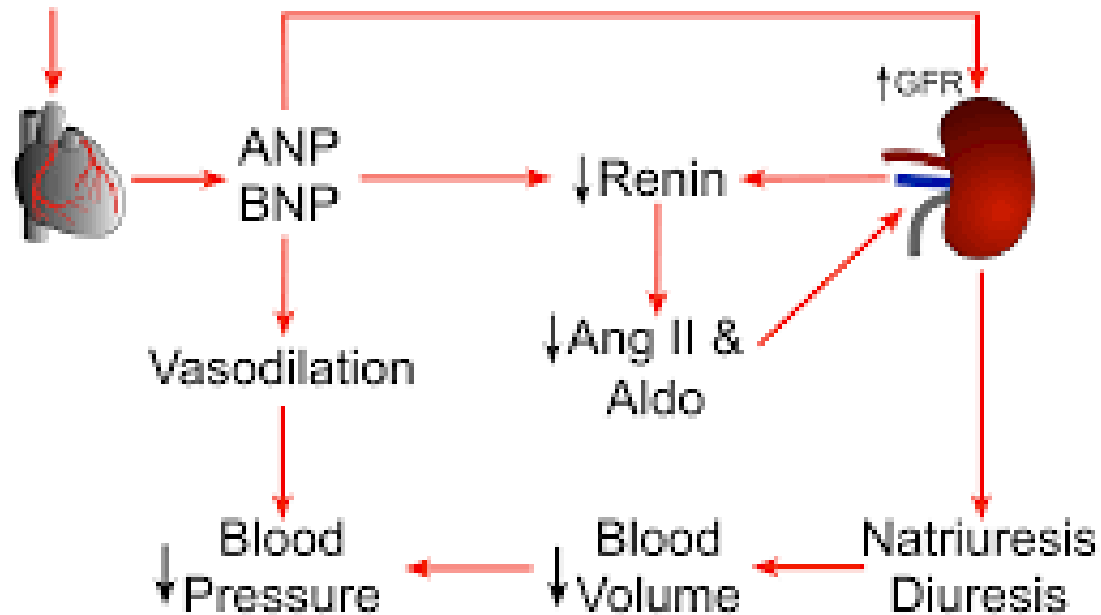
- **Dose:** 0.3-10 mcg mcg/kg/min; 10 mcg/kg/min is **MAX** dose
- **Mechanism of Action:** relaxes smooth muscles of blood vessels and consequently dilates peripheral arteries and veins.
- **Route:** IV
- **Indications:** Hypertension, acute CHF, pulmonary hypertension
- **Contraindications:** hypotension
- **Side Effects:** hypotension, tachycardia, bradycardia, dizziness, tremors.
- **Precautions:** Prolonged administration can lead to cyanide toxicity or thiocyanate. Symptoms include: nausea, confusion, and tinnitus (ringing in the ears).

Nitroglycerin

- **Dose:** 5-300 mcg/min; start at 5mcg/min and titrate every 3-5 minutes to desired blood pressure or a reduction in chest pain associated with angina or an AMI.
- **Mechanism of Action:** causes arterial and venous vasodilation, and helps to decrease preload, reduce pulmonary congestion, and decrease cardiac workload and oxygen consumption.
- **Route:** IV
- **Indications:** Chest pain, hypertension
- **Contraindications:** hypotension, inferior wall MI, shock, cardiac tamponade, severe anemia
- **Side Effects:** flushing, headache, weakness, hypotension, nausea, vomiting

Natriuretic Peptides

Cardiac distension
Sympathetic stimulation
Angiotensin II



Nesiritide (Natrecor)

- **Dose:** 0.01 mcg/kg/min
- **Mechanism of Action:** increases available cGMP in turn relaxing vascular smooth muscle.
- **Indications:** acute CHF
- **Contraindications:** **hypotension**, cardiogenic shock, systolic BP less than 100 mmHg.
- **Side Effects:** hypotension, weakness, nausea, dizziness
- **Precautions:** stop or discontinue if pt has a systolic BP less than 100 mmHg.

Sympathomimetic Agents / Vasopressors



Dopamine (Inotropin)

- **Dose:** 2-20 mcg/kg/min; titrate to effect.
- **Mechanism of Action:** Dopamine is a neurotransmitter that stimulates alpha and beta receptors thereby increasing heart rate and blood pressure.
- **Indications:** hemodynamically significant hypotension
- **Contraindications:** pheochromocytoma, hypertension, tachyarrhythmias
- **Side Effects:** ventricular ectopy, hypertension, nausea, vomiting, oliguria

Dobutamine (Dobutrex)

- **Dose:** 2-20 mcg/kg/min
- **Mechanism of Action:** synthetic catecholamine that produces an inotropic effect on the heart.
- **Indications:** decreased cardiac output, heart failure
- **Contraindications:** hypersensitivity to corn or corn products, subaortic stenosis
- **Side Effects:** chest pain, hypertension, tachyarrhythmia, headache

Epinephrine

- **Dose:** 2-10 mcg/kg/min; 10 mcg/kg/min is MAX dose
- **Mechanism of Action:** catecholamine produced by the adrenal glands that exerts its effect on the alpha and beta receptors of the hearts and blood vessels, increasing blood pressure and heart rate, and relaxing bronchial smooth muscle.
- **Indications:** hypotension, septic shock
- **Contraindications:** hypertension, ischemic heart disease, tachycardia
- **Side Effects:** palpitations, tremors, headache, dizziness

Norepinephrine (Levophed)

- **Dose:** 2-20 mcg/kg; titrate to effect
- **Mechanism of Action:** similar to epinephrine, norepinephrine is a catecholamine that stimulates alpha and beta receptors increasing heart rate and blood pressure, but not relaxing bronchial smooth muscle.
- **Indications:** septic shock, hypotension
- **Contraindications:** hypotension due to hypovolemia, hypovolemic shock, hypertension
- **Side Effects:** hypertension, nausea, vomiting, tremors, extravasation at IV site

Phenylephrine (Neo-Synephrine)

- **Dose:** 10-100 mcg/min; titrate to MAX dose of 100 mcg/min
- **Mechanism of Action:** synthetic sympathomimetic agent that exerts its effect on the alpha receptors of the heart with minimal effect on the beta receptors. It exerts moderately extended vasoconstriction, and increases heart rate.
- **Indications:** hypotension, neurogenic shock
- **Contraindications:** v-tach, narrow angle glaucoma, hypertension
- **Side Effects:** reflex bradycardia, chest pain, decreased cardiac output, cardiac dysrhythmia's

Vasopressin (Pitressin)

- **Dose:** 0.01-0.04 units/min with a MAX dose of 0.2 units/min; titrate to effect
- **Mechanism of Action:** vasopressin directly stimulates V1 receptors in the vascular smooth muscle, resulting in vasoconstriction of capillaries and small arterioles.
- **Indications:** hypotension, shock
- **Contraindications:** hypertension
- **Side Effects:** brady or tachy arrhythmias, right heart failure, pulmonary edema, limb ischemia

Anticoagulants



Heparin

- **Dose:** 12units/kg/hr; MAX dose is 1000 units/hr
- **Mechanism of Action:** prevents conversion of prothrombin to thrombin, and fibrin to fibrinogen. This inhibits the mechanisms that lead to the formation of blood clots.
- **Indications:** DIC, PE, A-fib, ACS, DVT
- **Contraindications:** pregnant or nursing women, thrombocytopenia, uncontrolled active bleeding except when due to DIC, neonates and infants
- **Side Effects:** bleeding, heparin induced thrombocytopenia

Glycoprotein IIb/IIIa Inhibitors



Eptifibatide (Integrillin)

- **Dose:** 180mcg/kg bolus dose followed by a 2 mcg/kg/min
- **Mechanism of Action:** prevents the aggregation of platelets by reversibly binding to the platelet receptor GP IIb/IIIa. This prevents the binding of fibrinogen, von Williebrand factor, and other binding agents.
- **Indications:** ACS
- **Contraindications:** abnormal bleeding, hypertension, renal dialysis, hemorrhagic stroke, major surgery within the previous 6 weeks
- **Side Effects:** hypotension, hemorrhage, thrombocytopenia, cerebral hemorrhage

Tirofiban (Aggrastat)

- **Dose:** Initial bolus of 25 mcg/kg, then a maintenance infusion of 0.15mcg/kg/min
- **Mechanism of Action:** inhibits aggregation of platelets by reversibly antagonizing fibrinogen binding to the GP IIb/IIIa receptor.
- **Indications:** ACS, NSTEMI, Ischemic CVA
- **Contraindications:** bleeding, thrombocytopenia
- **Side Effects:** coronary artery dissection, bleeding, bradyarrhythmia

Sedatives



Things To Consider

- Many sedatives can cause a substantial drop in blood pressure. Closely monitor the patient's vital signs as you titrate the sedation of the medication based on the clinical presentation.

Things To Consider

- Many patients who are intubated require continuous sedation and even intermittent pain management.
- Patients who are intubated and under-sedated can self extubate themselves.
- Monitor vital signs very closely.
- Some signs and symptoms of under-sedation include:
 - Restlessness
 - Agitation
 - Biting the ETT
 - Tachycardia
 - Elevated blood pressure
 - Movement of the eyelids, tongue, fingers, hands, or arms.

Things To Consider

- Administer a fluid bolus if the patient becomes hypotensive and is receiving sedation.
- A decreased blood pressure could be a result of an antihypertensive medication along with a sedative.
- Sedative medications **do not** treat pain. Treat pain per protocol.
- Consult the sending physician or OLMD for guidance.

Diprivan (Propofol)

- **Dose:** 5-50 mcg/kg/min
- **Class:** Sedative - Hypnotic
- **Mechanism of Action:** Propofol crosses the blood-brain barrier, slowing cerebral metabolism, and leading to sedation. Exact mechanism is unknown.
- **Onset:** 1-2 minutes
- **Duration:** 5-10 minutes
- **Indications:** sedation for a mechanically ventilated patient
- **Contraindications:** allergy to eggs or egg products, hypersensitivity to Propofol.
- **Side Effects:** hypotension, respiratory depression, apnea
- **Special Consideration:** Give Propofol through a dedicated IV with no other medications infusing. Can cause profound hypotension. Use with caution.

Midazolam (Versed)

- **Dose:**
 - *Adult:* 2-5 mg bolus dose every 3-5 min; 0.02 to 0.1 mg/kg/hr continuous dose
 - *Pediatric:* 0.05-0.1 mg/kg
- **Class:** Benzodiazepine
- **Mechanism of Action:** CNS depressant that binds with GABA receptors in the CNS which exhibit sedative, amnesic, and hypnotic effects.
- **Onset:** 2-5 minutes after administration
- **Duration:** 30-45 minutes
- **Indications:** sedation for mechanically intubated patients
- **Contraindications:** hypotension
- **Side Effects:** hypotension, respiratory depression

Ketamine (Ketalar)

- **Dose:** 0.5-1 mg/kg IV every 10 minutes as necessary
- **Class:** Anesthetic Adjunct
- **Mechanism of Action:** blocks NMDA receptors leading to sedation and amnesia
- **Onset:** 30 seconds to 1 minute
- **Duration:** 5-10 minutes
- **Indications:** sedation for mechanically intubated patients, induce sedation for RSI procedure
- **Contraindications:** hypertension (SBP >180), closed head injury
- **Side Effects:** hypertension, tachycardia, respiratory depression
- **Special Considerations:**
 - Give medication slowly over 1-2 minutes to prevent laryngospasm.
 - Can lead to increased intracranial pressure in patients with a closed head injury to intracranial hemorrhage.

Lorazepam (Ativan)

- **Dose:**
 - *Adult:* 1-2 mg bolus dose; 0.05-0.1 mg/kg/hr continuous infusion.
 - *Pediatric:* 0.05-0.1 mg/kg
- **Class:** Benzodiazepine
- **Mechanism of Action:** binds with the GABA-benzodiazepine receptor complex exerting tranquilizing action on the CNS.
- **Onset:** 2-5 minutes after administration
- **Duration:** 15-20 minutes
- **Indications:** status epilepticus, anxiety, sedation of mechanically ventilated patients.
- **Contraindications:** narrow-angle glaucoma, respiratory depression (unless the patient is intubated)
- **Side Effects:** hypotension, respiratory depression
- **Special Considerations:** If giving an IV bolus dose, dilute the medication with 10ml of NS prior to administration.

Etomidate (Amidate)

- **Dose:** 0.3 mg/kg
- **Class:** Anesthetic
- **Mechanism of Action:** short acting hypnotic. Produces GABA like effects, and reduces subcortical inhibition.
- **Onset:** 30 seconds – 1 minute
- **Duration:** 3-5 minutes
- **Indications:** Induction of sedation for RSI
- **Contraindications:** **sepsis**, adrenal insufficiency
- **Side Effects:** nausea, vomiting, pain at injection site

Opiates



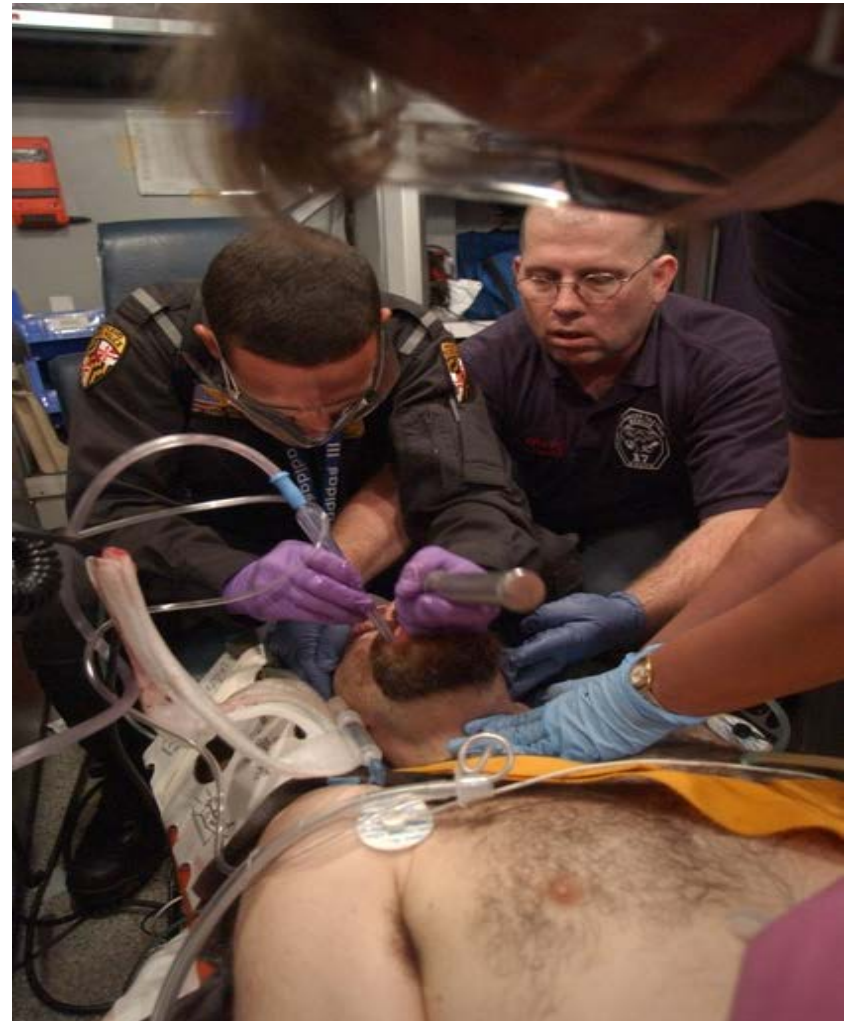
Fentanyl (Sublimaze)

- **Dose:** 0.5-1mcg/kg slow IV
- **Mechanism of Action:** narcotic agonist-analgesic of opiate receptors. Inhibits ascending pain pathways, thus altering response to pain.
- **Onset:** 2-3 minutes
- **Duration:** 30-60 minutes
- **Indications:** pain management
- **Contraindications:** hypersensitivity to Fentanyl
- **Side Effects:** dyspnea, nausea, vomiting
- **Special Considerations:**
 - Give slow IVP to prevent rigid chest syndrome.
 - Can cause respiratory depression and apnea.

Rapid Sequence Intubation Medication Overview

Rapid Sequence Intubation

- Assume the patient's stomach is full..
- Preoxygenate.



RSI Medications

- Induction Agents (Sedatives):
 - Etomidate
 - See above medication overview
 - Ketamine
 - See above medication overview
- Paralytics:
 - Succinylcholine
 - Rocuronium

Succinylcholine (Anectine)

- **Dose:** 1.5-2 mg/kg
- **Class:** Depolarizing Neuromuscular Blocking Agent (NMBA)
- **Mechanism of Action:** The onset, activity, and duration depend on rapid hydrolysis by pseudocholinesterase (PCHE), an enzyme of the liver and plasma that is not present at the neuromuscular junction. Succinylcholine depolarization manifests as fasciculations, but this is followed rapidly by complete motor paralysis.
- **Onset:** 45 seconds
- **Duration:** 5-10 minutes
- **Indication:** Induce paralysis for RSI
- **Special Considerations:**
 - Only use for induction only.
 - Multiple contraindications for this medication. See next slide.

Succinylcholine Contraindications

- Known or suspected hyperkalemia (watch your P waves)
- Severe crush or traumatic injuries > 2 days old
- Spinal cord injuries > 2 days old
- Burn injuries > 24 hours old
- Renal Failure
- Pseudocholinesterase deficiencies
- Hx of malignant hyperthermia
- Neuromuscular disorders such as Muscular Dystrophy
- Penetrating Eye Injuries

Rocuronium (Zemuron)

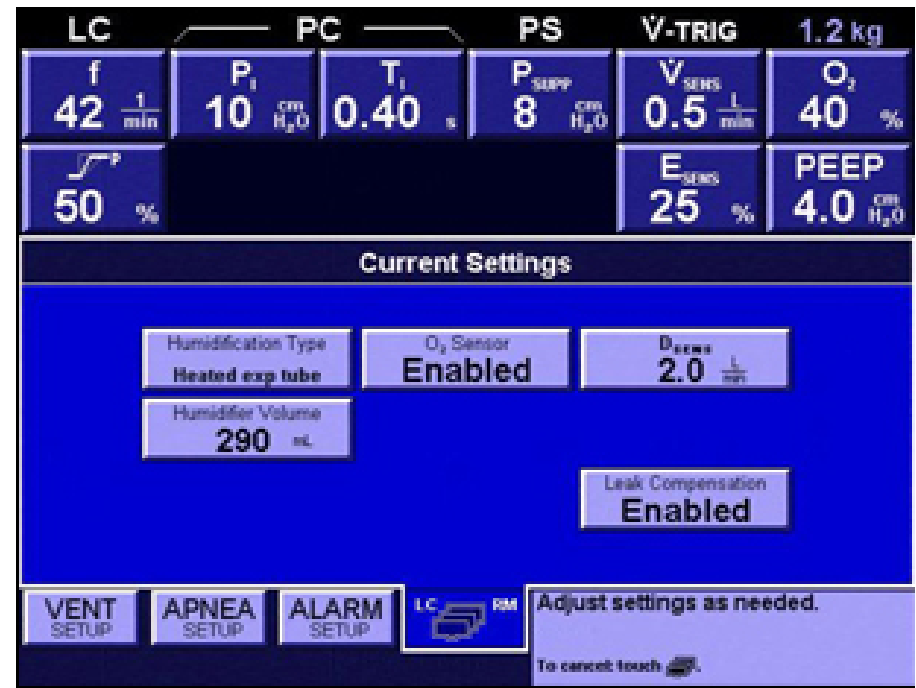
- **Dose:** 1mg/kg
- **Class:** Non-depolarizing Neuromuscular Blockers
- **Mechanism of Action:** Competes with, and blocks the action of ACH at the motor end plate postjunctional cholinergic nicotinic receptors.
- **Onset:** 60 seconds
- **Duration:** 40-60 min
- **Indications:** Induction of paralysis, and for continued paralysis
- **Contraindication:** known anaphylaxis
- **Special Considerations:** May be used as the primary drug of choice for RSI when Succinylcholine is contraindicated.



Ventilators

Ventilator Terminology

- Tidal Volume (V_t)
- Respiratory Rate (f)
- Minute Ventilation (V_E)
- Exhaled Tidal Volume (V_{te})
- I:E Ratio
- I-Time
- Fraction of Inspired Oxygen (F_iO_2)



Ventilator Terminology

- Positive End-Expiratory Pressure (PEEP)
- Trigger (Sensitivity)
- Pressure Support (PS)
- Compliance
- Resistance
- Peak Inspiratory Pressure (PIP)
- Plateau Pressure (Pplat)
- Mean airway pressure
- Dead space



Causes of High Pplat

- A Pplat >30 cmH₂O is usually caused by:
 - Increased Vt
 - Decreased pulmonary compliance
 - Pulmonary Edema
 - Pleural Effusion
 - Peritoneal Gas Insufflation
 - Tension Pneumothorax
 - Trendelenburg
 - Ascites
 - Abdominal Packing

Modes of Ventilation

- **Volume-Targeted (Initiated Ventilation)**
 - Volume determined by 4-8 ml/kg.
 - Can lead to barotrauma and high Pplat if too high.



Modes of Ventilation

- **Pressure-Targeted (Initiated) Ventilation**
 - “Balloon” setting
 - Good for sick lungs
 - lung protective
 - preferred for neonates and pediatrics



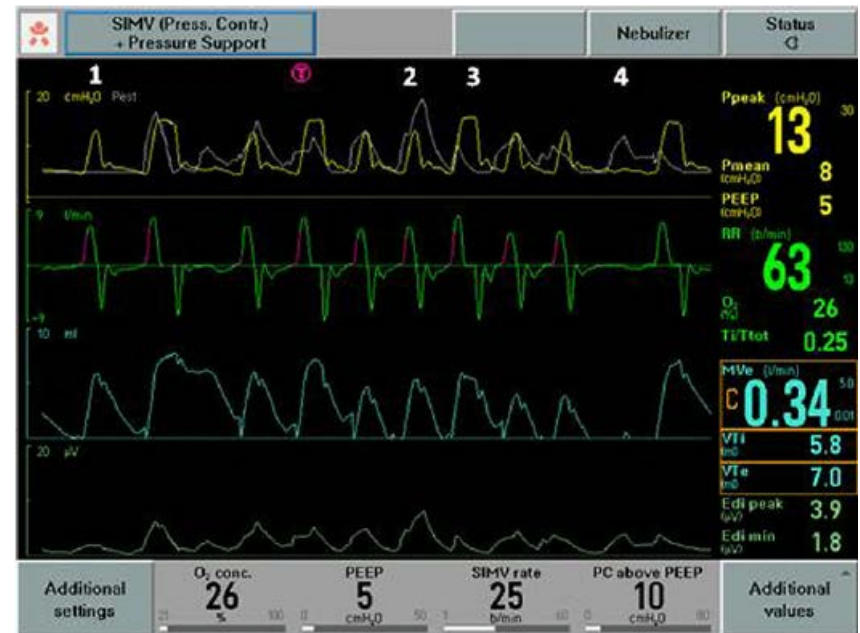
Modes of Ventilation

- **Assist Control (AC)**
 - guaranteed breaths based on V_t and f
 - pressure and volume
 - patient can trigger and vent assist with what's needed
 - ***maintain adequate sedation!***

Modes of Ventilation

- **Synchronized Intermittent Mandatory Ventilation (SIMV)**

- Patient triggered
- can augment breaths and assist in weaning
- set pressure support at least 5-10
- the more pressure support, the easier the patient can breath
- decreases workload for patient



Modes of Ventilation

- **Pressure Regulated Volume Control (PRVC)**
 - constant pressure + decreased inspirations=improved oxygenation
 - vent monitors each breath for V_t
 - measures V_{te} and compares to desired V_t

Modes of Ventilation

- **Continuous Positive Airway Pressure (CPAP)**
- CPAP overpowers the residual pressure that prevents the lungs from fully emptying on exhalation. This decreases the pt's workload and increases oxygenation.
- CPAP essentially equals PEEP in the sense that both maintain alveolar recruitment and prevent atelectasis.
- Intubation can be avoided in some pt's by the application of CPAP, which in turn reduces hospital stays and the risk for VAP.

Modes of Ventilation

- **Bi-Level Positive Airway Pressure (BiPAP)**
- BiPAP can be described as a continuous positive airway pressure system with a time-cycled or flow-cycled change of the applied CPAP level by using PEEP.
- It delivers a preset inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) by applying PEEP.
- This mode is better overall and is used more consistently in treating pt's.
- A good starting point for a BiPAP setting is an IPAP of 10 and EPAP of 5, and adjust to maintain an appropriate oxygenation status.
- Monitor you PIP's as the PIP should correlate with your IPAP and EPAP's respectively, and be no higher than your IPAP.

Making Vent Changes

- **To Improve Oxygenation (SpO₂):**
 - Increase the FiO₂
 - Increase the PEEP

- **If the EtCO₂ is high:**
 - Increase the respiratory rate
 - Increase the V_t in volume mode
 - Increase the pressure in pressure mode

- **If the EtCO₂ is low:**
 - Decrease the respiratory rate
 - Decrease the V_t in volume mode
 - Decrease the pressure in pressure mode

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