Patho-Analogies: A Path to Clinical Judgment & Prioritization Using Visual & Kinesthetic Analogies

Presenters:

Dr. Leigh Snead, DNP, RN, CHSE, CNE

Mrs. Janet Fletcher, MSN, RN

Disclosures & Permissions

- There are no conflicts of interest to disclose.

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Objective 1: Discuss the Use of low-tech, low-cost, simulated analogies to teach pathophysiology concepts

- Origin of this strategy
- Sources for materials
- Pairing of analogies, patho. concept, and props

Patho Determines Priority

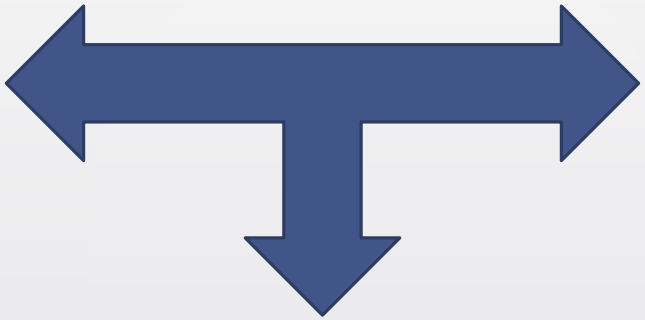
- Pathophysiology: Dysfunction at the cellular or tissue level → Clinical Presentation → Signs & Symptoms

- Patho (can't see) + S/Sx. (can see, hear, feel, smell) = Clinical Picture

Why is Pathophysiology so difficult for students to grasp?

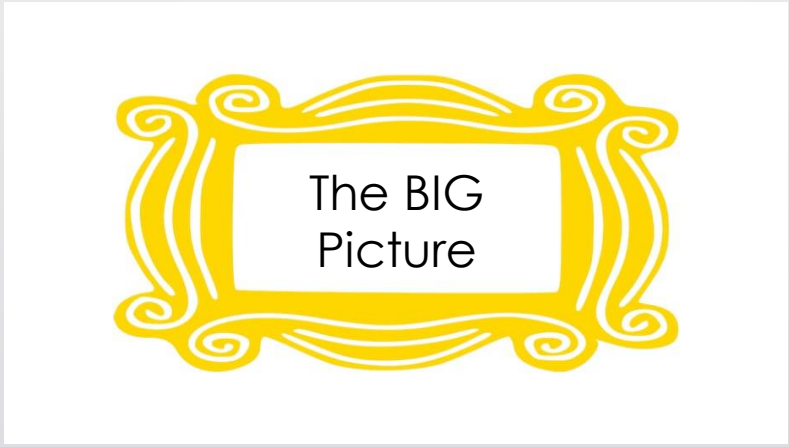
Pathophysiology

- Abstract
- Dysfunction @ cellular/tissue level

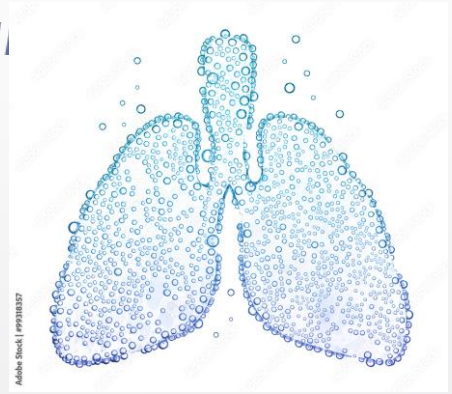


Signs & Symptoms

- Concrete
- Visual, audible, tangible



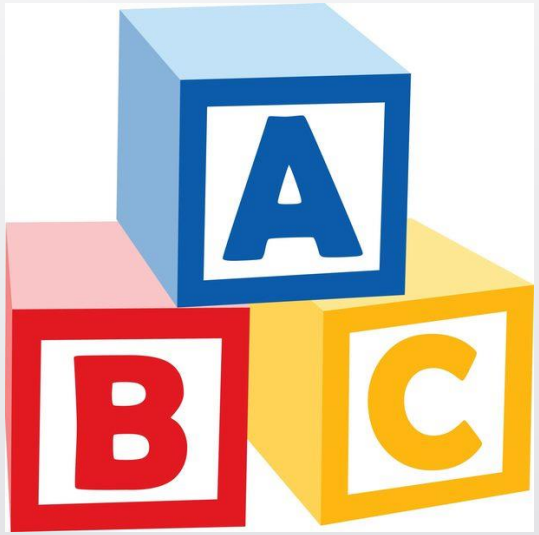
Oxygenation (Problem)



- **Global Concept**: Impaired Gas Exchange
- **End Goal:** Improve Oxygenation
- **Hallmark Sign:** Drop in Pulse ox
- **Initial Intervention:** Initiate Supplemental O2 → **BUT**……Why doesn't this "fix" them & bring pulse ox back to normal?
- **Answer:** can be found in the PATHO

Oxygenation (Problems)

- AIRWAY
- BREATHING
- CIRCULATION



Oxygenation: AIRWAY Problems
Airways as Doorways to Gas Exchange

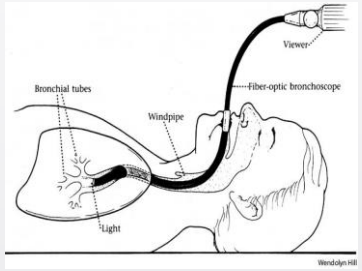
- **AIRWAY** = mouth/nose to alveoli & everywhere in between
- **Global Concept**: Impaired Gas Exchange
- **End Goal:** RESTORE AIRWAY → Improve Oxygenation
- **Hallmark Sign:** Characteristic Breath Sounds, Dyspnea, **cyanosis**
- **Initial Intervention:** Initiate Supplemental O2 → **THEN WHAT?**
- **Answer:** can be found in the PATHO

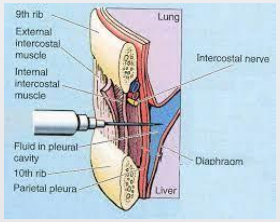
AIRWAYS as DOORWAYS to Gas Exchange

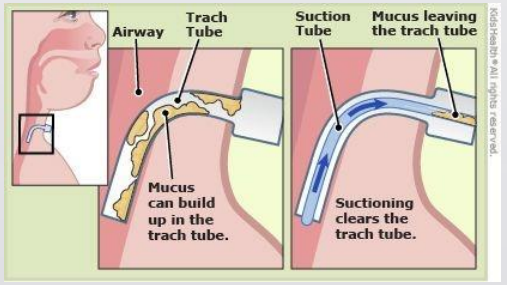
- <u>Impaired Doorways</u>:
- Blocked: Foreign Body
- Collapsed: No entrance
- Closing: Narrowed
- Obstructed: Junky Closet
- Submerged: Fluid-filled

Goals Based on Improving/Resolving Patho

- **GOALS OF TREATMENT:**
  - **Restore Airway** by addressing the specific AIRWAY Problem (patho)
  - **UNBLOCK** the Door:
    - Heimlich Maneuver (choking)
    - Bronchoscopy
  - **Re-inflate** Collapsed Doors
    - Chest tube
    - Needle aspiration
  - **Open** the Closing Doors:
    - Bronchodilators (widen airways)
    - Stop Inflammatory Response (put out the fire)
      - Epinephrine, H1 and H2 Blockers, Steroids
  - **Remove secretions** from doorway
    - Suction (secretions)
  - **Remove fluid** from doorway:
    - Diuretics (dry up fluid)







Oxygenation: BREATHING Problems
No, Low, or OverDRIVE

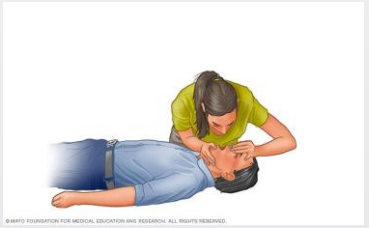
- **Respiratory DRIVE = EFFORT**
- **Global Concept**: Ineffective Breathing Pattern
- **End Goal:** Restore Normal Drive → Improve Gas Exchange
- **Hallmark Sign:** Respiratory rate (no, low, high RR); Responsiveness
- **Initial Intervention:** Initiate Supplemental O2 → **THEN WHAT?**
- **Answer:** can be found in the PATHO

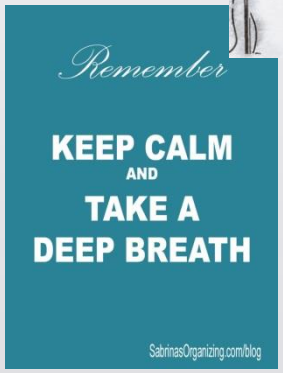
Breathing Patterns as Impaired Respiratory Drive

- NO or LOW Drive
  - Insufficient respiratory Rate
  - Turning BLUE (cyanosis)
  - Retaining too much CO2
    - Acidosis
- OVERDRIVE
  - Breathing too fast → exhaustion → Respiratory Failure
  - Blowing off too much CO2
    - Alkalosis

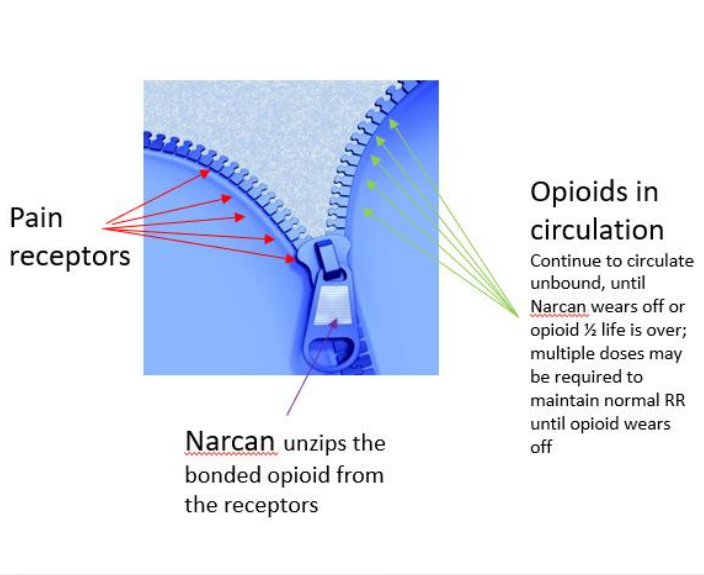
Goals Based on Improving/Resolving Patho

- **<u>GOALS OF TREATMENT:</u>**
  - **Restore Normal Drive** by addressing the specific BREATHING Problem (patho)
  - **No or Low DRIVE:**
  - **Reverse Respiratory Depression (Overdose):**
    - Administer Reversal Agent (i.e., Narcan, Flumazenil)
  - **Drive FOR the patient:**
    - Bag Mask Ventilation
    - Mechanical Ventilation
  - **Calm the Driver down (Anxiety/Panic Attack):**
    - Rebreathe CO2 (paper bag)
    - Sedative agents





Opioid Overdose Reversal/Narcan



- Opioids bind to pain receptors like a closed zipper
- Narcan opens the zipper
- Opioid's (any) half-life > Narcan's half-life
- Multiple doses of Narcan may be required, especially in illicit drug use situations where dose consumed is unknown

How Narcan works

<u>Pain receptors</u>
Opioid medication

Opioids bound to pain receptors
→ Respiratory Depression (No Drive problem)

Narcan starting dose:
Controlled Narcotic Administration = 0.2mg
Unknown Narcotic dosage start with 0.4 mg

<u>Pain receptors</u>
Opioid medication

Narcan unzips the opioids from the pain receptors, but the opioids are still present as their half life is much longer than Narcan, so there is always the risk of the opioids zipping back onto the receptors

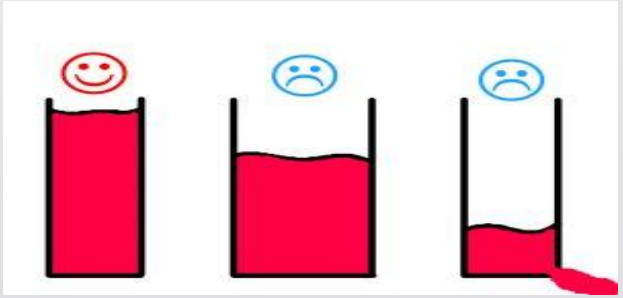
<u>Resp. Rate & effort</u>
Main indicators of Narcan effectiveness

Depending on which narcotic was received and whether it was a normal or overdose can cause the patient to need multiple doses of Narcan for Respiratory Depression reversal and restoration of spontaneous respiration. Bagging or Mechanical ventilation & a Narcan IV drip may be necessary for extreme cases.

<u>Half Life information:</u>
Morphine: 2-4 hours
Fentanyl: 4 hours
Demerol: 3-8 hours
Ketamine: 2.5- 4 hours
Dilaudid: 8-15 hours
Narcan: 30-60 minutes
Davis Drug Guide 2023

Oxygenation: CIRCULATION Problems
CARDIAC FUEL TANKS

- **Fuel Level:** Hypovolemia or Hypervolemia
- **Fuel Quality:** Oxygen-carrying capacity r/t RBC dysfunction
- **Global Concept**: Fluid Volume Deficit/Excess; Decreased Cardiac Output
- **End Goal:** Restore Normal Fluid/Blood Volume → Improve Gas Exchange
- **Hallmark Sign:** Tachycardia & Hypotension
- **Initial Intervention:** Initiate Supplemental O2 → **THEN WHAT?**
- **Answer:** can be found in the PATHO

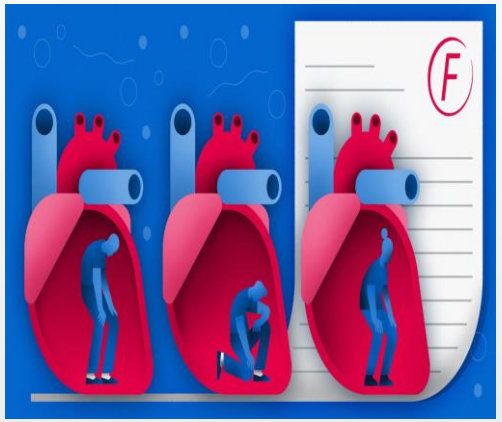


Fluid Volume Deficit/Overload as Cardiac Fuel Level & Quality

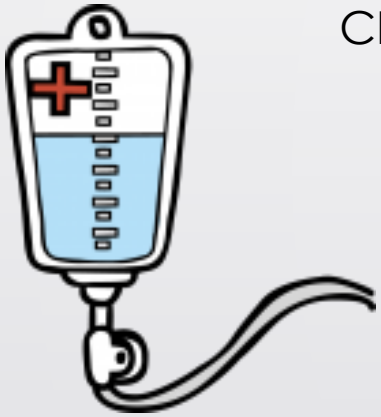
- **Low Fuel Volume (Hypovolemia):**
  - Simple (Losses)
    - Dehydration = fluid loss
    - Hemorrhage = Blood loss
  - Complex (INFLAMMATION):
    - Leaky Tank r/t Systemic Vasodilation & ↑Capillary Permeability
      - Sepsis (infection)
      - Anaphylaxis (allergen)
      - Large Surface Area Burns (Injury)

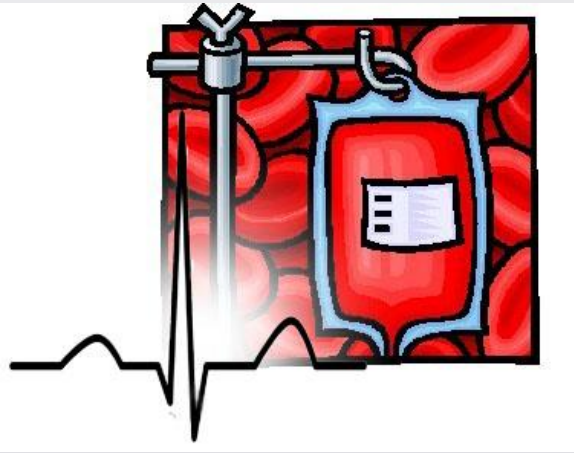
- **Low Fuel Quality (RBC Dysfunction = ↓ O2 carrying capacity):**
  - RBC shape/size/#
    - Hemorrhage
    - Anemias

Goals Based on Improving/Resolving Patho



- **GOALS OF TREATMENT:**
  - **Restore Normal Fluid/Blood Volume/Quality** by addressing the specific CIRCULATION Problem (patho)
    - **Low Fluid VOLUME:**
      - **SIMPLE:** Replace WHAT was lost
        - Fluid resuscitation (Fluid Bolus = ↑BP ↓HR, Allows O2 Saturation of RBCs =↑POX)
        - Blood Transfusion (↑volume→ ↑BP ↓HR = fixes volume & O2 carrying capacity issues)
      - **COMPLEX:** Restore Homeostasis
        - INFLAMMATION:
          - Epinephrine = Vasoconstriction
          - H1 & H2 Blockers = Stops Vasodilation from Histamine Release
          - Steroids = Suppress Immune Response
  - **Restore Normal Fuel Quality**
    - Blood Transfusion (Provides more RBCs to Carry O2)





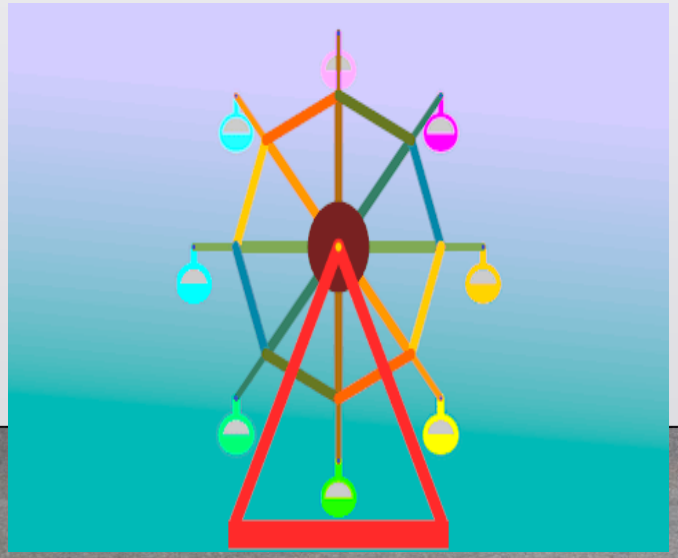
How Does Hypovolemia Affect Oxygenation?

- Conceptual Analogy: Ferris Wheel of Oxygenation
- Size of Ferris Wheel = Fluid Volume (Blood Pressure)
- Speed of Ferris Wheel = Heart Rate
- Seats (O2 carrying capacity) = Red Blood Cells (each good RBC can hold 4 O2 people)
- Supplemental O2 (O2 Availability) = line of Oxygen People waiting to ride
- Dysfunctional RBCs = sickled (wrong shape), iron deficient (too small), absent (blood loss) and these hold 0-4 Oxygen people

Hypovolemia → Fluid Bolus→ Bld Transfusion

Hypovolemia
Low BP
High HR
Few Good RBCs
Low POX
Supplemental O2 doesn't help much (HR too fast for all good RBCs to get fully saturated)

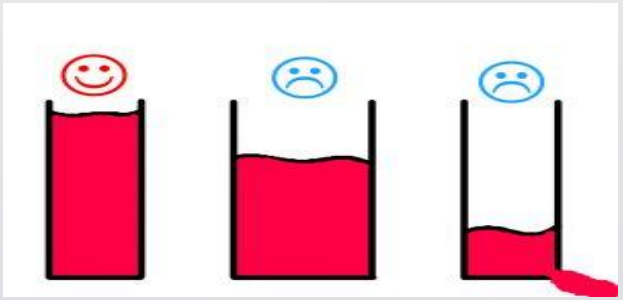
Fluid Bolus (volume expander)→ increases circulating volume → increases BP →Decreases HR → makes good RBCs more available for O2 saturation (4 O2 per seat) → slight increase in pox; fluid bolus does not give more seats (Buys time)



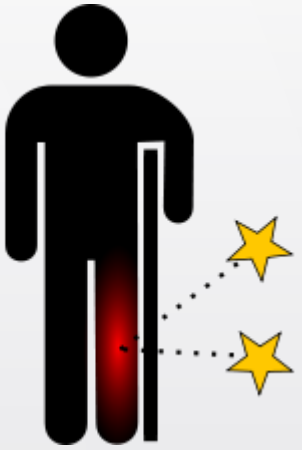
Blood Transfusion increases blood volume → increases BP, decreases HR, & Provides more RBCs (seats) to restore adequate oxygen saturation

Oxygenation: CIRCULATION Problems
CARDIAC FUEL TANKS (Perfusion)

- **Fuel Line Blockage:** Hypovolemia or Hypervolemia
- **Global Concept**: Altered Tissue Perfusion
- **End Goal:** Restore Normal Blood Flow→ Improve Gas Exchange
- **Hallmark Sign:** Pain (Ischemia)in affected tissue
- **Initial Intervention:** Initiate Supplemental O2 → **THEN WHAT?**
- **Answer:** can be found in the PATHO



Fluid Volume Deficit/Overload as Cardiac Fuel Line Blockage

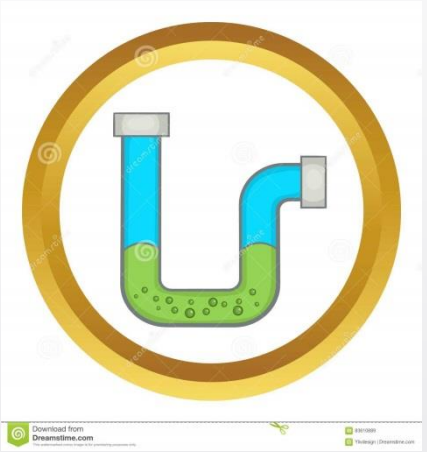


- **Fuel Line Blockage (Ischemia):**
  - Tissue Starving of Oxygen r/t disrupted blood flow
    - Ischemic Pain = arterial occlusion NOT venous
      - Different from DVT; How?
- Mini—A&P Review:
  - Arteries: smaller of the 2 vessels, muscular, deeper, high pressure, carry blood AWAY from ♥
  - Veins: larger, distend easier, work off valve system, more superficial. Carries blood BACK to the ♥
  - Makes sense that occlusions would occur in smaller vessels first, right? ☺

Goals Based on Improving/Resolving Patho

- **GOALS OF TREATMENT:**
  - **Restore Normal Blood Flow (Perfusion)**
    - **Vasodilate:**
      - Morphine Sulfate
      - Nitroglycerin
      - **Supplemental O2**
    - **Hydrate:** in cases where dehydration may have been the cause, when HF is not a concern
    - **Anticoagulants:** in diseases where appropriate; TPA in specific cases only

Blocked Fuel Lines: Ischemia

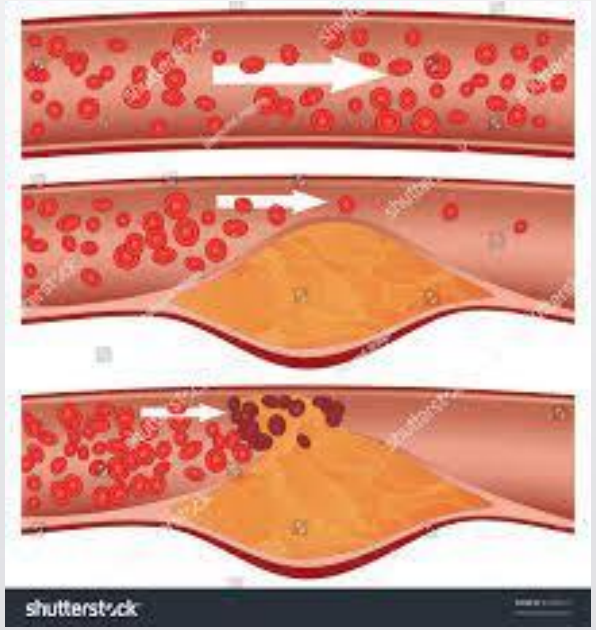


- Arterial Occlusion
- Conceptual Analogy: CLOGGED DRAIN
- How do we FIX it?:
- Initial Intervention: VASODILATE (Widen the Drain to = restore some perfusion around clog)
  - If dehydration (polycythemia/clumping), then restore hydration (flush the drain)
  - If arterial plaque, CALL MONA (Morphine, O2, NITROGLYCERIN, Aspirin) to restore some perfusion until Cardiac Cath for stent placement or bypass
  - If CLOT, Call "Clot busters", initiate anti-coagulation, and possible Surgical Intervention

Visual Analogy

Left: Notice the arrows (blood flow that is blocked by the occlusion (sickled cells, clot, fatty plaque, foreign material, etc.)

Right:
1: normal blood flow
2: reduced blood flow due to occlusion (vasodilation of artery with Morphine helps to re-establish some flow)
3: complete obstruction of flow (vasodilation of artery with Morphine to re-establish some flow) to restore some perfusion until cath lab or surgery



Oxygenation: CIRCULATION Problems
CARDIAC FUEL TANKS (Perfusion)

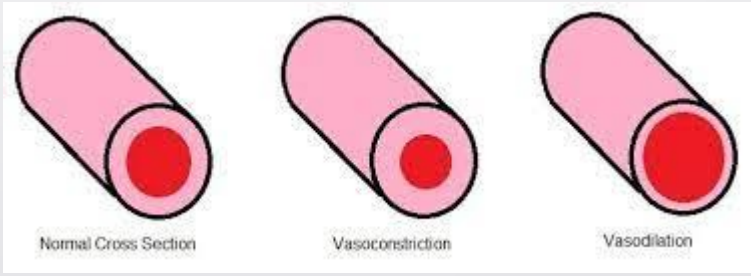
- **Fuel Line Resistance:** Vessel Inflammation (acute or chronic)
- **Global Concept**: Altered Tissue Perfusion
- **End Goal:** Restore Normal Blood Flow→ Improve Gas Exchange
- **Hallmark Sign:** Hypertension
- **Initial Intervention:** Antihypertensives → **THEN WHAT?**
- **Answer:** can be found in the PATHO

Fluid Volume Deficit/Overload as Cardiac Fuel Line Blockage

- **Fuel Line Resistance (Vessel Inflammation):**
  - ↓ Tissue Perfusion r/t disrupted blood flow (systemic vasoconstriction, ↑BP, ↓CO)
  - Mini—A&P Review:
    - Chronically high blood pressure can cause to vessels
      - Stenosis – less elastic
      - Damage to internal vessel walls
        - Turbulent blood flow r/t ↑resistance (vasoconstriction) can cause small tears in vessel
      - Plaque/clot formation
        - Formation typically occurs around injured vessel walls
        - Further ↓ perfusion re/t narrowing & hardened f the arteries
      - Damage to blood cells
        - r/t restrictive & forceful blood flow

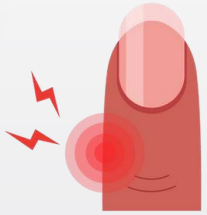
Goals Based on Improving/Resolving Patho

- **GOALS OF TREATMENT:**
  - **Restore Normal Blood Flow (Perfusion)**
    - Lower Blood Pressure to Normotensive Levels
      - Administer Antihypertensives
        - IV
        - Oral
        - Initial Treatment vs. Maintenance
        - Root Cause:
          - Diet
          - Exercise
          - Lifestyle Modification



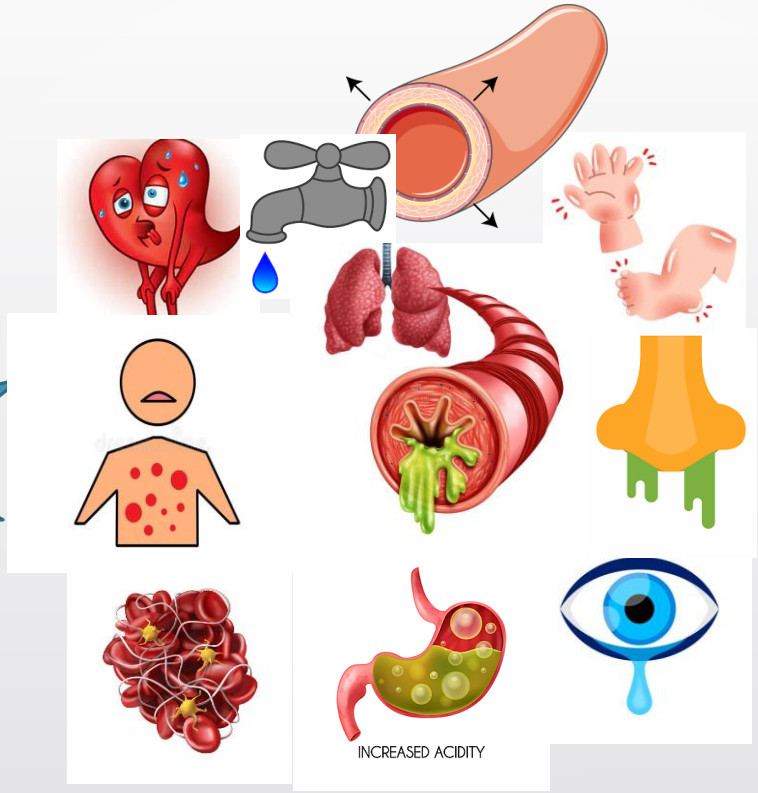
Inflammation:

Natural Immune response to Injury, Infection, or Allergen



Histamine release

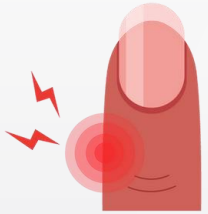
Effects of Histamine



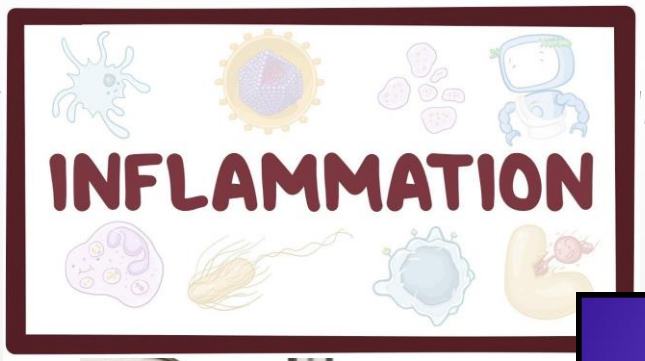
Local Inflammatory Reaction = protective & restorative compensatory mechanism
Systemic Inflammation Reaction = Life-threatening

<u>Vasodilation =</u>
↑HR
↑Blood flow to site
Warm to touch
WBC s to site (attack, remove, repair, restore)
Systemic = ↑HR ↓BP ↑temp (hypovolemic shock)

<u>↑Cap. Permeability =</u>
Swelling
Throbbing sensation
Pain (nerve compression/injury)
Systemic = ↑HR ↓BP (hypovolemic shock)



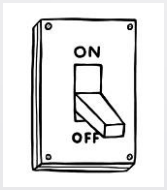
Local Inflammation from Injury. Inflammation natural response to injury, infection, or allergen



vasodilation

Massive Trauma

Systemic Inflammation



Infection

Treatment = stabilize injury (spine or hemorrhage site)

Hemorrhage Treatment = See diagram (far left of page)

Neurogenic Treatment = Vasopressive support until stable

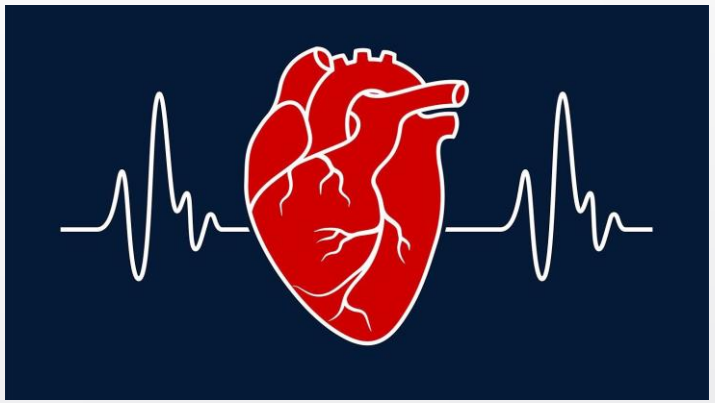
Treatment = Turn OFF Inflammatory Response

Epinephrine = vasoconstriction (seals the leaky vessels)
NS Bolus = refills the depleted tank
H1 Blockers – Stops Histamine release (cardiac & respiratory side effects) = stops vasodilation effect & decreases capillary permeability

IV Steroids = Immunosuppression = stops inflammatory response
H2 Blockers = Stops histamine release (GI side effects)

Septic:
Add IV Antibiotics or other Anti-microbials that target specific cause
Vasopressive support until stabilized

Shock Syndromes: Fluid Volume Deficit



- Hypovolemia from Actual Losses:
  - Hypovolemic: loss of fluid portion of blood (Dehydration)
  - Hemorrhagic: loss of whole blood (Trauma, surgery, etc.)
- Hypovolemia from Massive (Systemic) Vasodilation:
  - Inflammatory Response: response to Injury, Infection, or Allergen
    - Anaphylactic (Allergen): systemic allergic reaction
    - Septic (Infection): overwhelming infection
    - Trauma (Injury):
      - Hemorrhagic (Internal or External Trauma): See above
      - Neurogenic (Spinal Cord Injury): loss of sympathetic tone (labile BP/HR) which cause Massive vasodilation and subsequent hypovolemia

Shock Diagram Low Fuel

Loss of fluid or blood

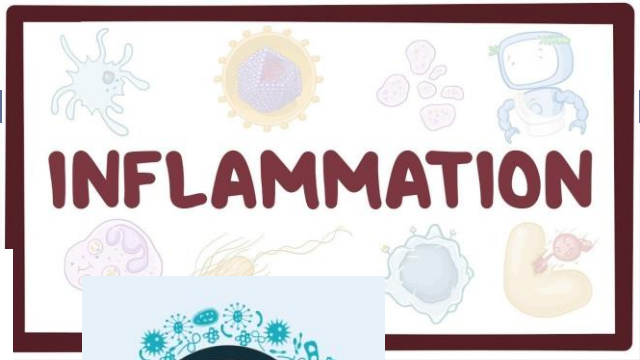
Dehydration = loss of fluid

Hemorrhage = loss of whole blood

Treatment = Replace what was Lost

NS Bolus
Maintenance IVFs

NS Bolus
PRBCs



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Treatment = stabilize injury (spine or hemorrhage site)

Hemorrhage Treatment = See diagram (far left of page)

Neurogenic Treatment = Vasopressive support until stable

Shock Syndromes: Fluid Volume Excess

- Cardiogenic Shock (Hypervolemia): Heart (pump) failure
- OverLOADED Tank

Treatment = Goals of CHF:

1. Improve Cardiac Function by vasodilating = IV Morphine
2. Remove Excess Fluid & Sodium =
   - Diuretics = remove fluid
   - ACE inhibitors = remove sodium
   - Beta Blockers = prolonged vasodilation (prevent HTN)
3. Reduce Oxygen Demands = bedrest, pain meds/sedatives, supplemental O2
4. Improve Tissue Oxygenation = Achieved once goals 1-3 have been achieved

Objective 2: Evaluate learner understanding through summative & formative assessment

- Formative
  - Observation: Simulation, Clinical, or Classroom
- Summative
  - Simulation or Clinical Outcomes
  - Exam items
- Rubric
  - Concept-based

Sample NGN Exam Item

- Chart Information
- Question
- Options
- Rationale
- Reference

Chart	Admission Day 1	Day 2
Nurse's Notes	H & P: 5 y/o history of Sickle Cell Anemia Diagnosis at age 6 months of age 0500: Report received: Brought to the ED by her mother c/o LL Leg pain x last 3 days; no appetite & has only consumed minimal fluids; has experienced these episodes before, managed @ home w/ acetaminophen & ibuprofen; hospitalized at age 4 for a VOC & age 3 for a fever	0700: Lethargic, moaning in pain, abdominal assessment reveals a firm ridge noted below the left subcostal region; tender when palpated
Assessment	0700: Currently sleeping but easily arousable. Admitted to HemOnc unit from the ED; taking small amounts of juice. Was extremely guarded when team rounded and assessed her leg. New pain med orders received.	0700: Mother mentions that leg pain is much better but that now she is c/o her stomach hurting
Vital Signs	0700: Temp: 98.8F HR: 120 RR: 30 BP: 88/68 Pox: 97 on 2L NC Pain: 6 FACES (leg)	0700: Temp: 99F HR: 158 RR: 40, shallow BP: 68/48 Pox: 88% Pain: 8 FACES (tummy)

Chart	Admission Day 1	Day 2
Labs	Lytes Na: 135 K: 4.2 Cl: 109 Ca: 9.4 BUN: 12 Cr: 0.6 Glucose: 82 CBC WBC: 10.5 RBC: 3.4 Hct: 28 Hgb: 9.2 Plt: 340 Type & Screen: pending	Lytes Na: 132 K: 3.5 Cl: 108 Ca: 9.4 BUN: 19 Cr: 09 Glucose: CBC WBC: 10.6 RBC: 2.3 Hct: 20 Hgb: 8.3 Plt: 210 Type & Screen: A+
Provider's Prescriptions	Acetaminophen Docusate Folic acid Ibuprofen Morphine	
Medication Administration Record	0600: Ketorolac IV given 0600-present: D51/2NS @ 48 ml/hr	IV Cont.: D51/2NS @ 48 ml/hr

Intro Sentence: The nurse is caring for a child experiencing a Sickle Cell Crisis….

Question: The nurse anticipates the provider to order as evidenced by the child's _____ (Drop Down Box 2) and _____ (Drop Down Box 2) _____ (Drop Down Box 1)

- **Drop Down Box 1**
- Packed Red Blood Cell Transfusion
- Prep for the O.R.
- Additional Morphine dose
- STAT Antibiotics

- **Drop Down Box 2**
- Heart Rate & BP
- Temperature
- Abdominal Assessment
- Pain Level

Rationale

- **Rationale:** When **Generating Solutions**, the nurse should recognize that the child's condition has drastically changed since the day before AEB change in location and intensity of pain, drop in Hematology Labs (H&H, RBC, Plt.), Tachycardia and Hypotension (hypovolemia); Abdominal Assessment (splenomegaly), and lethargy. These findings indicate that the child is most likely experiencing Splenic Sequestration, a complication of Sickle Cell Crisis. Therefore, the nurse will anticipate the need for a PRBC transfusion to correct the life-threatening hypovolemia.
- **Case Study Reference:** Ricci, S. R., Kyle, T. and Carman, S. (2021). Maternity and Pediatric Nursing (4th Ed.). Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins. CoursePoint+ ISBN: 978-1-975156-79-4 (Brittany Long vSim)

Rubric: Simulation or Clinical

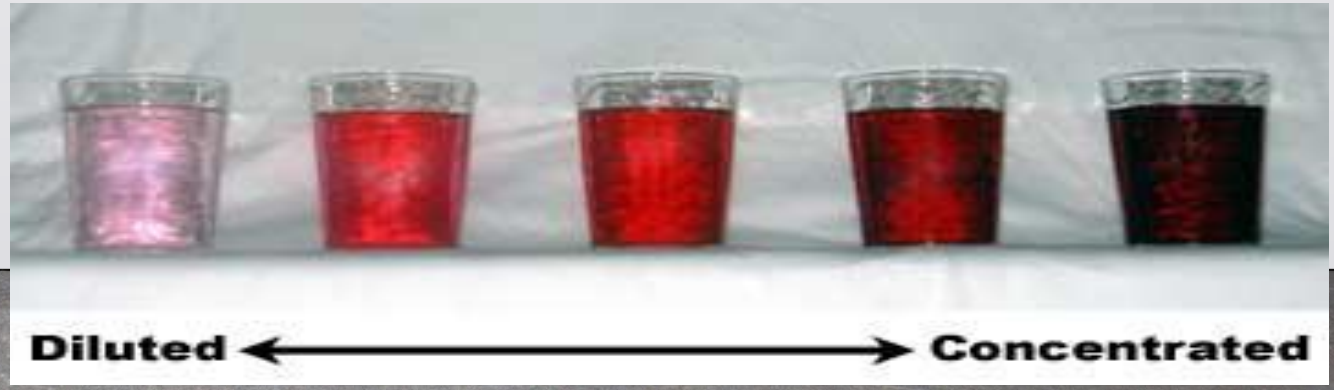
Ferris Wheels of Oxygenation Rubric	**Outcome Met**	**Outcome Partially Met: Needs Improvement**	**Outcome Not Met: Remediation Needed**
#1 Concept: Oxygenation related to Circulation Issue	Learner recognized #1 Client Problem/Concept of: **Oxygenation** related to Airway, Breathing, or **Circulation**	Learner recognized #1 Client Problem/Concept of: **Oxygenation** but was unable to determine Root Cause as Airway, Breathing, or Circulation	Learner did not recognize #1 Client Problem/Concept
Priority Intervention to address Root Cause: **Fluid Bolus** **Blood Transfusion**	Learner recognized Priority Intervention needed: Fluid Bolus, then Blood Transfusion to correct Fluid Volume Deficit & O2-carrying capacity	Learner recognized Priority Intervention needed: But not in correct order	Learner did not recognize Priority Intervention needed or stopped after applying supplemental O2.

Other Patho-Analogies

Hemo-Concentration
in Dehydration

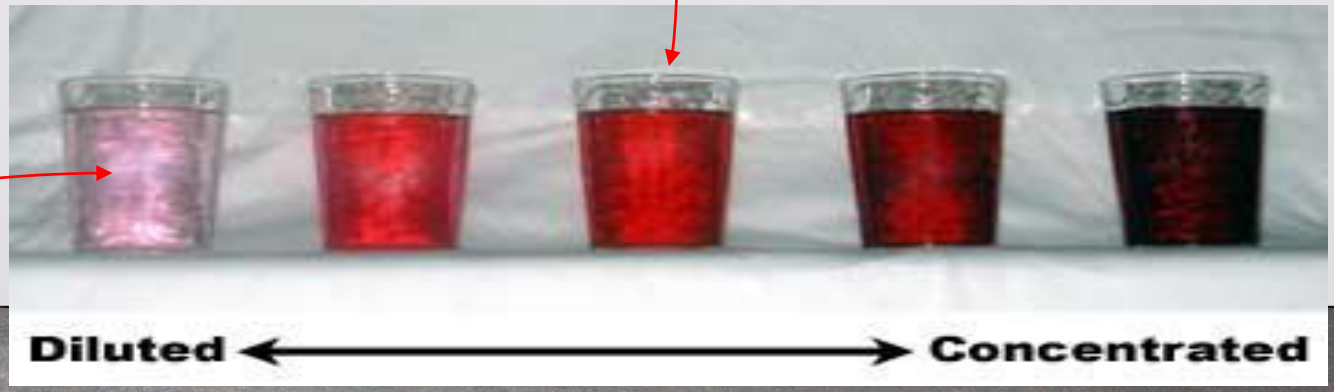
- **Dehydration** = loss of fluid (essentially plasma; liquid portion of blood)
  - Concept analogy: Sugar water boiled on stove to make simple syrup (boils away water) so left with **THICK**, concentrated sugary solution

- Hematocrit = HIGH (more cells than plasma ratio)
- Treatment: replace what was lost
  - IV Fluids



↓ Hematocrit Post-Hemorrhage

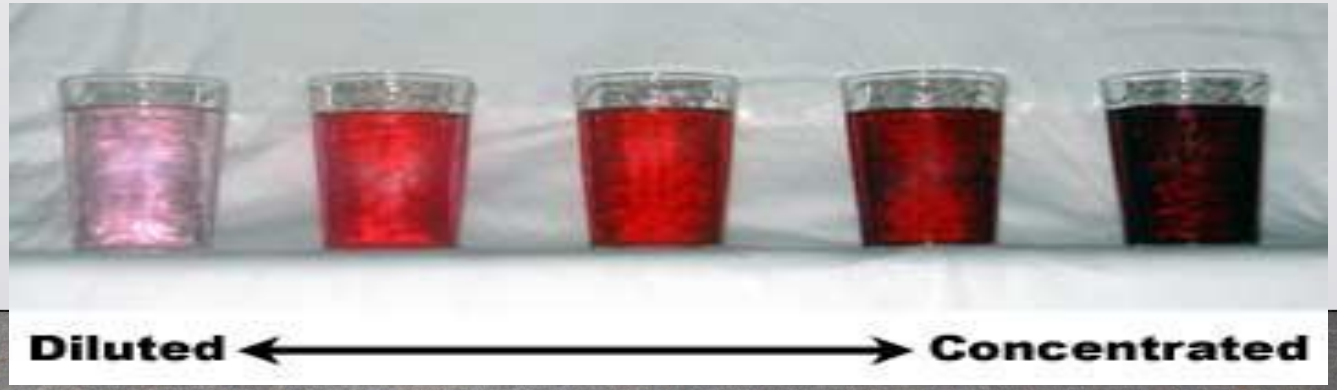
- Hemorrhage = loss of whole blood
- Concept analogy: Spill equal parts of blood cells & plasma from same pot = less of both portions
- Hematocrit: LOW (equal loss of cells & plasma)
- Treatment: Replace what was lost
- Blood Transfusion
  - Whole Blood
  - Packed Red Cells
  - IVFs for Hydration
    - Caution: Can cause Over-hydration



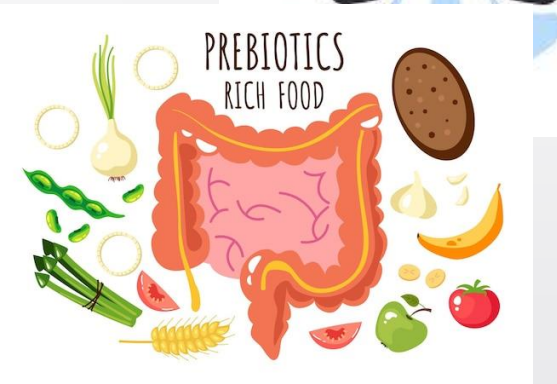
Hemo-Dilution

Water Intoxication or Fluid Overload

- **Hemodilution:** more fluid/plasma portion of the blood than blood cells (ratio)
- **Concept analogy:** Add more water to the pot than sugar (solid)
- **Hematocrit:** LOW (no actual loss of cells, just too much fluid/plasma)
- **Treatment:** Remove whatever is in excess
  - Fluid Restriction
  - Diuretic Therapy
  - Monitor Electrolytes
  - IVFs + ↑Sodium



Diverticulitis

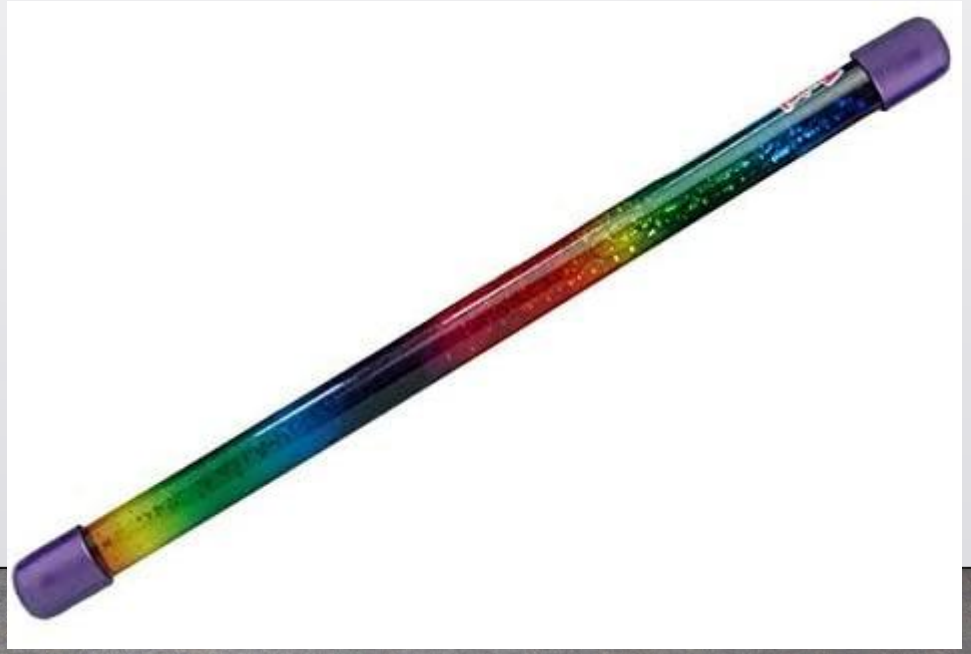


- Fiber is like weight lifting for your gut
  - Builds stronger intestinal walls
  - Decreases incidence of many GI disorders/diseases

- Herniation(s) of the gut wall → small pouches
  - Caused by low ingestion of fiber in diet
  - Small food particles get caught in pouches → inflammation/infection (pus formation) which can lead to rupture of pouches & peritonitis

Diffusion

- Prop: Glitter Wand
- Concept: Diffusion of solute from higher concentration to lower concentration



GI Disorders

- Prop: Water Snake Toy
- Concepts to demonstrate:
  - Intestinal Volvulus
  - Prolapsed Ostomy
    - Can choose color to represent poor or adequate perfusion
  - Intussusception

Arteries, Veins, & Capillaries

- Prop: Colored, coffee stirrers, reg. drinking straws, & milkshake straws
  - Concept:
    - A&P: size of vessels; constricted vs. dilated
- Prop: Finger Traps (toy or medical-use)
  - Concept:
    - Vasodilation
    - Vasoconstriction
    - Capillary Permeability

Objective 3: Identify Concepts within your own teaching that you will use in combination with this strategy.

- Brainstorm session
- Collaborate with others

Questions?