VOLUME MANAGEMENT

BECKY NESS, PA-C, MPSA, DFAAPA, FNKF

INSTRUCTOR OF MEDICINE, MAYO COLLEGE OF MEDICINE

AMERICAN ACADEMY OF NEPHROLOGY PA

DISCLOSURES

- *NON-DECLARATION STATEMENT: I HAVE NO RELEVANT RELATIONSHIPS WITH INELIGIBLE COMPANIES TO DISCLOSE WITHIN THE PAST 24 MONTHS. (NOTE: INELIGIBLE COMPANIES ARE DEFINED AS THOSE WHOSE PRIMARY BUSINESS IS PRODUCING, MARKETING, SELLING, RE-SELLING, OR DISTRIBUTING HEALTHCARE PRODUCTS USED BY OR ON PATIENTS.)*

PRE-TEST QUESTIONS

1. What is the correct balance for body fluids?
    a. Intracellular 26%, Interstitial 67%, intravascular 1%, and cerebrospinal fluid 7%
    b. Intracellular 67%, Interstitial 26%, intravascular 7%, and cerebrospinal fluid 1%
    c. Intracellular 50%, Interstitial 40%, intravascular 5%, and cerebrospinal fluid 5%
    d. None of the above

PRE-TEST QUESTIONS

1. Both hypovolemia and hypervolemia can be caused by renal dysfunction

    a. True

    b. False

PRE-TEST QUESTIONS

1. Which symptoms can be seen with both hypovolemia and hypervolemia?

    a. Fatigue

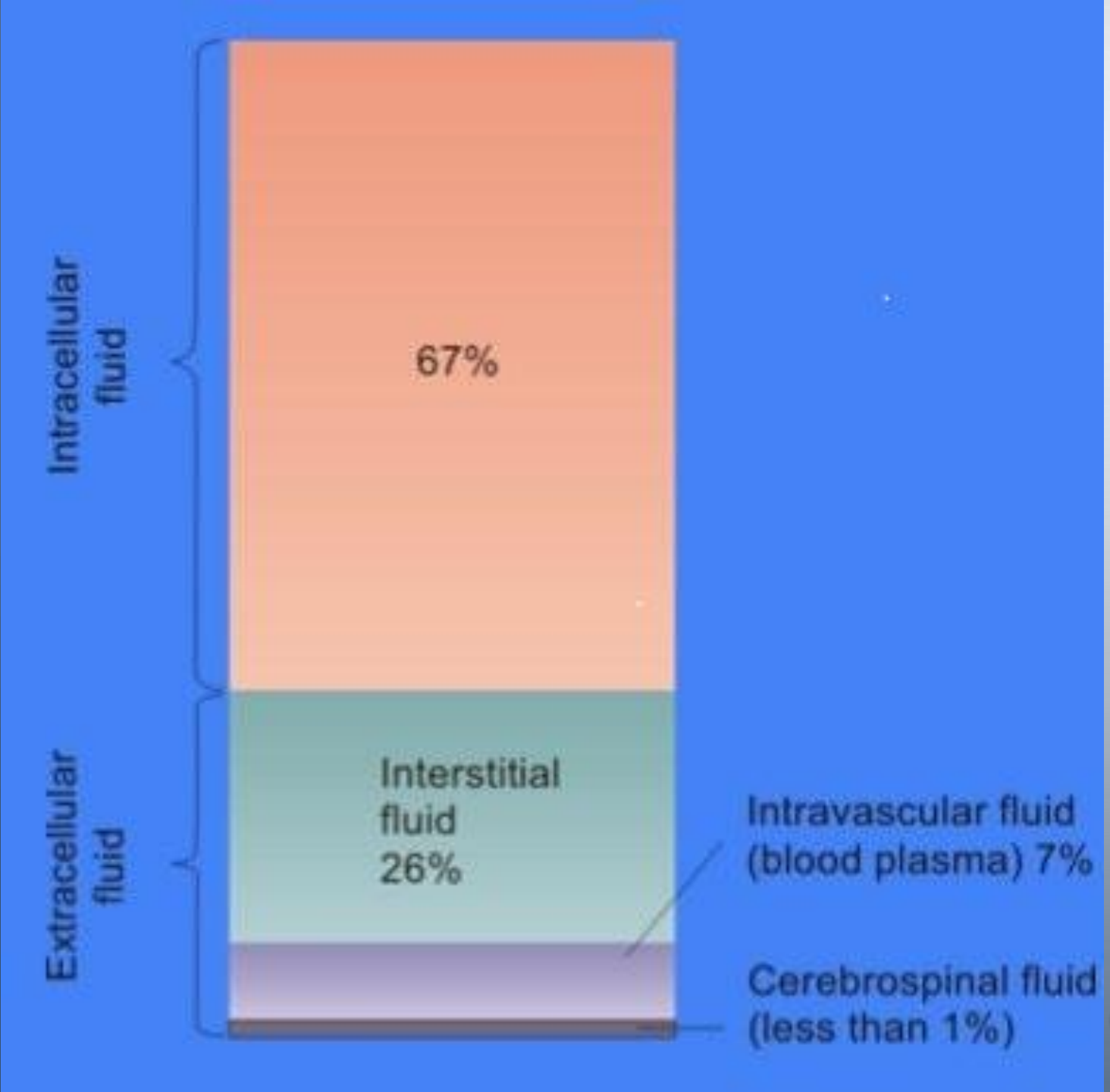
    b. Weakness

    c. Muscle cramps

    d. A & B

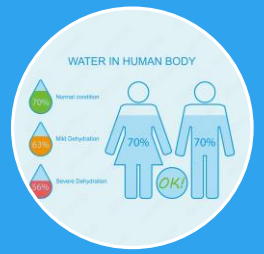
OBJECTIVES

Identify	• Identify various etiologies of volume abnormalities
Initiate	• Initiate the appropriate plan of care based on the abnormality identified
Outline	• Outline acute and chronic complications for each volume abnormality



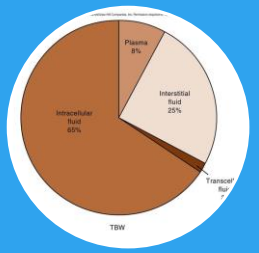
FLUID HOMEOSTASIS REFRESHER

TERMINOLOGY



Hydration

- Issue of variations in total body water
  - ALL compartments
    - Interstitial
    - Intracellular



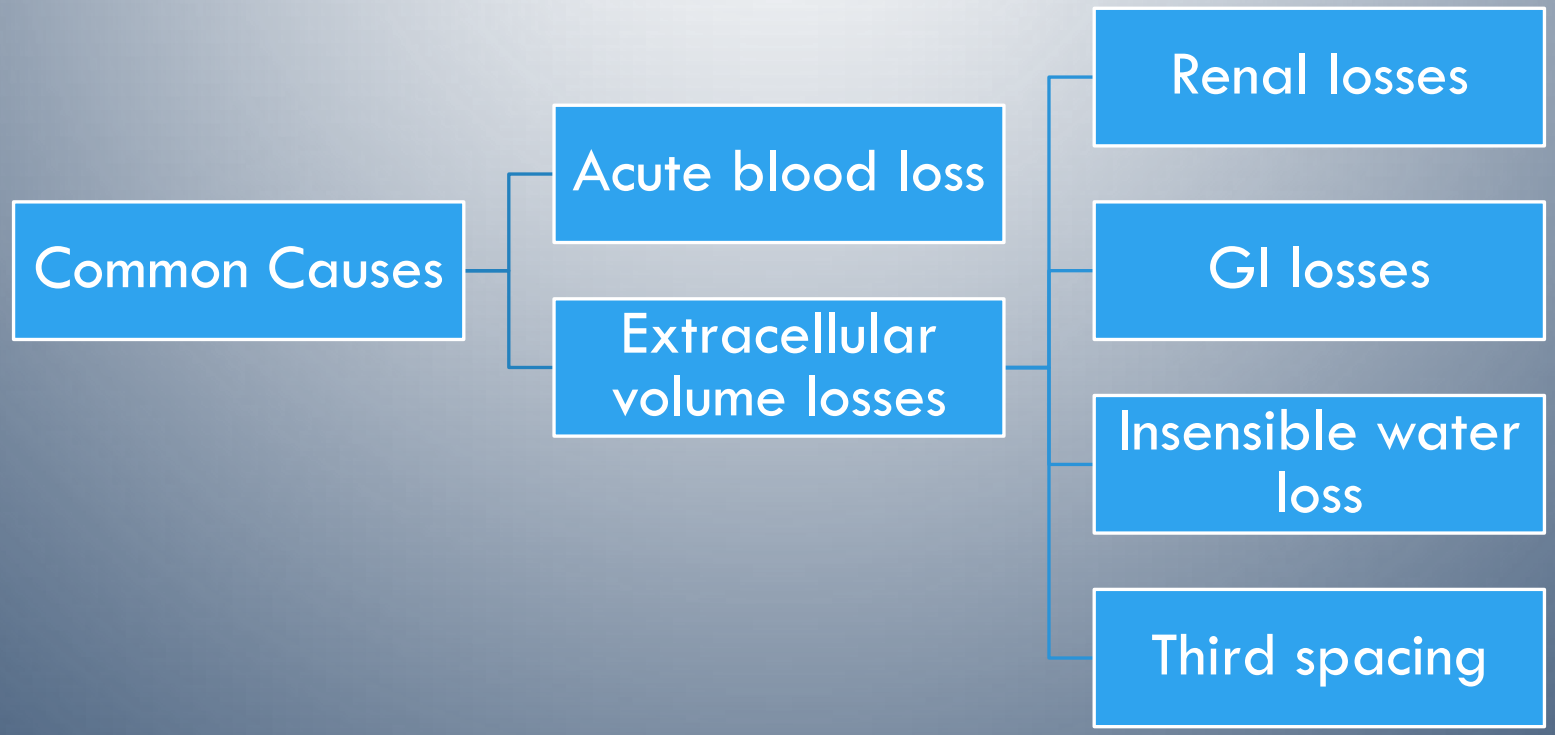
Volemia

- Volume of circulating fluid (intravascular)

PRIMARY VOLUME ABNORMALITIES

Hypovolemia	Hypervolemia
Definition: A state of low extracellular fluid volume	Definition: A state of excess extracellular volume
Etiology: 1. Renal 2. Extrarenal - GI loss - Poor intake - Insensible losses	Etiology: 1. Renal 2. Extrarenal - Iatrogenic - Cardiac - Hepatic - Sepsis

HYPOVOLEMIA



Renal

- Diuretic Excess
- Osmotic diuresis
- Ketonuria
- Mineralcorticoid deficiency
- Cerebral salt wasting syndrome
- Salt-wasting nephropathies

Extrarenal

- GI losses
  - Vomiting
  - Diarrhea
  - Pancreatitis
- Third Spacing
- Trauma
- Bleeding
- Insensible losses

HYPOVOLEMIA
HISTORY & PHYSICAL

Symptoms

- Non-specific
  - Weakness
  - Fatigue
  - Muscle cramps
  - Thirst
  - Dizziness

Physical Exam

- Dry Mucosa
- ↓ Skin turgor
- Orthostatic vital signs
- Hypotension

HYPOVOLEMIA - EVALUATION

- Vital signs
  - Arterial blood pressure
    - Supine hypotension – likely indication that patient has lost 20-25% of their arterial blood volume
      - Cardiovascular collapse can occur with a 40% loss – thus the critical nature of identifying the acuity of the situation when supine hypotension is present in the setting of hemorrhage

HYPOVOLEMIA - EVALUATION

Hemodynamic assessment

- Orthostatic vitals

  Upon standing ~500mL blood volume shifts to the lower extremities

- Positive findings include:

  ↑HR of 30 or >

  ↓ SBP of 20 or >

  ↓ DBP of 10 or >

HYPOVOLEMIA – EVALUATION

- Jugular venous pressure (JVP)
  - JVP < 5cm of water suggests hypovolemia
  - In hypovolemia the hospital bed may need to be less than 30°
  - Elevated JVP is unlikely in hypovolemia
    - Cor pulmonale
    - Acute right heart failure in setting of MI involving the right ventricle

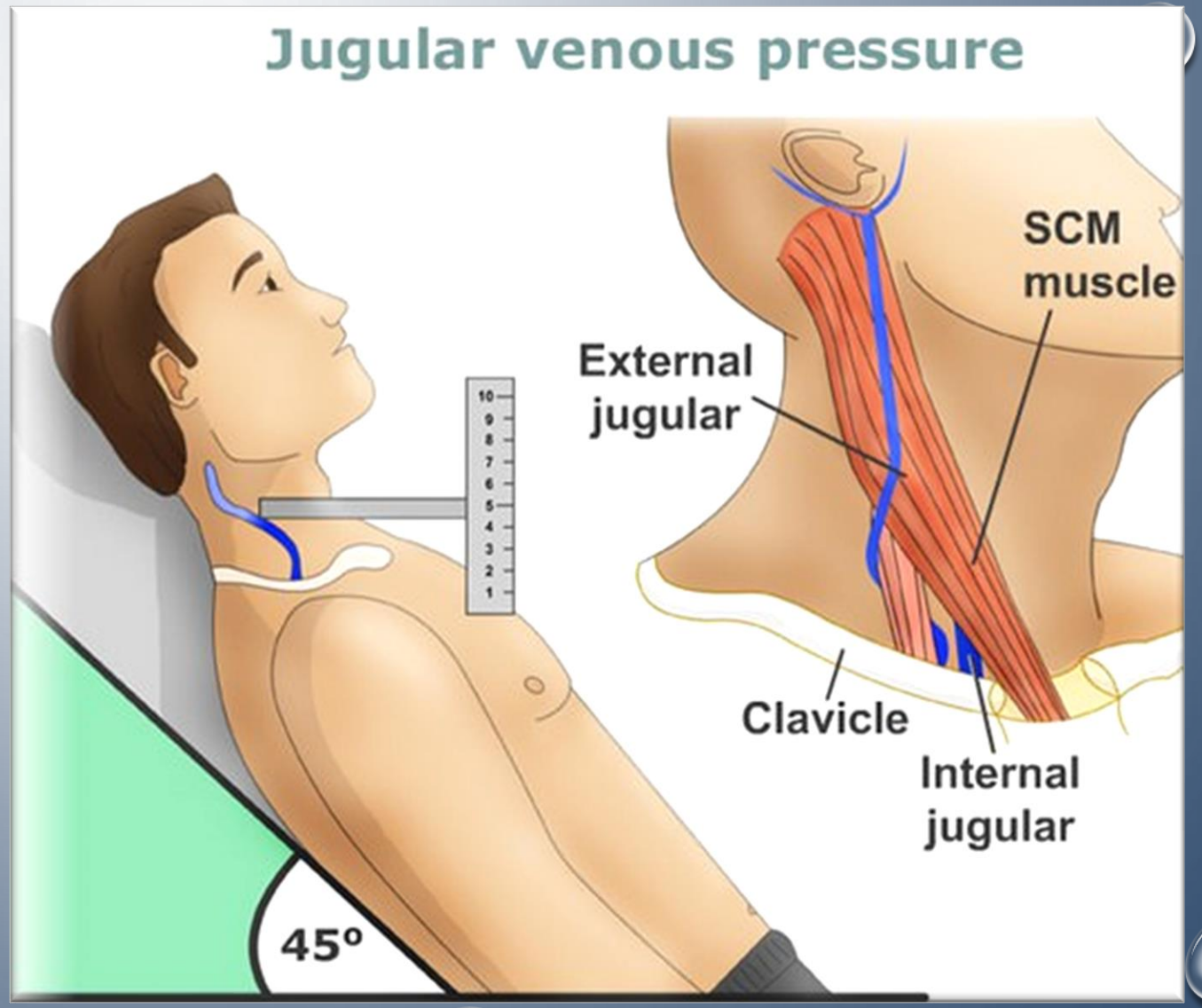
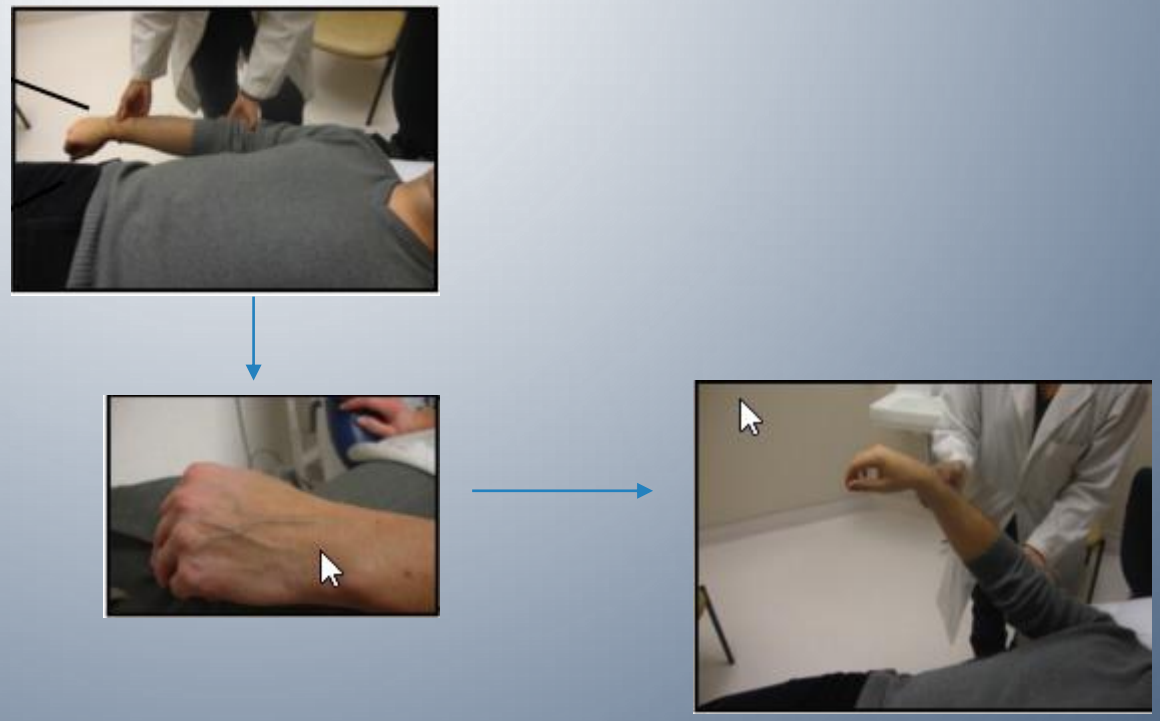


Image courtesy of Epomedicine: https://epomedicine.com/clinical-medicine/clinical-examination-jugular-venous-pulse-pressure-jvp/

HYPOVOLEMIA – EVALUATION
ALTERNATIVE PHYSICAL EXAMINATION MANEUVERS

- Hand vein collapse
  1. Patient should be supine
  2. One arm is placed below the level of the body to allow for engorgement of hand veins
  3. Slowly lift the hand, observing 7palpating the veins to see at what level they collapse, this level is measured against the estimated level of the right atrium



HYPOVOLEMIA – EVALUATION

POCUS

- Inferior vena cava (IVC)
  - Measure 2cm from junction of IVC and right atrium
    - < 2cm correlates to CPV < 10 mmHg
      - Sensitivity 85% and specificity 87%
  - Measurement during inspiration (spontaneously breathing)
    - ↓in IVC diameter of 50% can predict CVP < 8 mmHg
      - Sensitivity 91% and specificity 94%

HYPOVOLEMIA – TREATMENT/MANAGEMENT

Dependent on chronicity and severity

- **Acute**
  - Requires urgent fluid resuscitation
  - Possible need for vasopressor support
- **Chronic**
  - Compensatory mechanism have developed allowing for a more gradual fluid resuscitation

IV fluids

- Crystalloid – standard of care
- Some instance support colloid fluids
  - Hemorrhagic shock
  - Burns
  - Need for massive fluid resuscitation
  - Hepatorenal syndrome

HYPOVOLEMIA – TREATMENT/MANAGEMENT

Monitoring of fluid resuscitation

- Intake/output
  - Indwelling or external urinary catheters
  - Strict I/O monitoring without urinary catheter
- Hemodynamics
  - Arterial line (ICU)
  - Frequent vital signs – including orthostatic when indicated

HYPOVOLEMIA - PROGNOSIS

Dependent on underlying etiology and promptness of fluid resuscitation

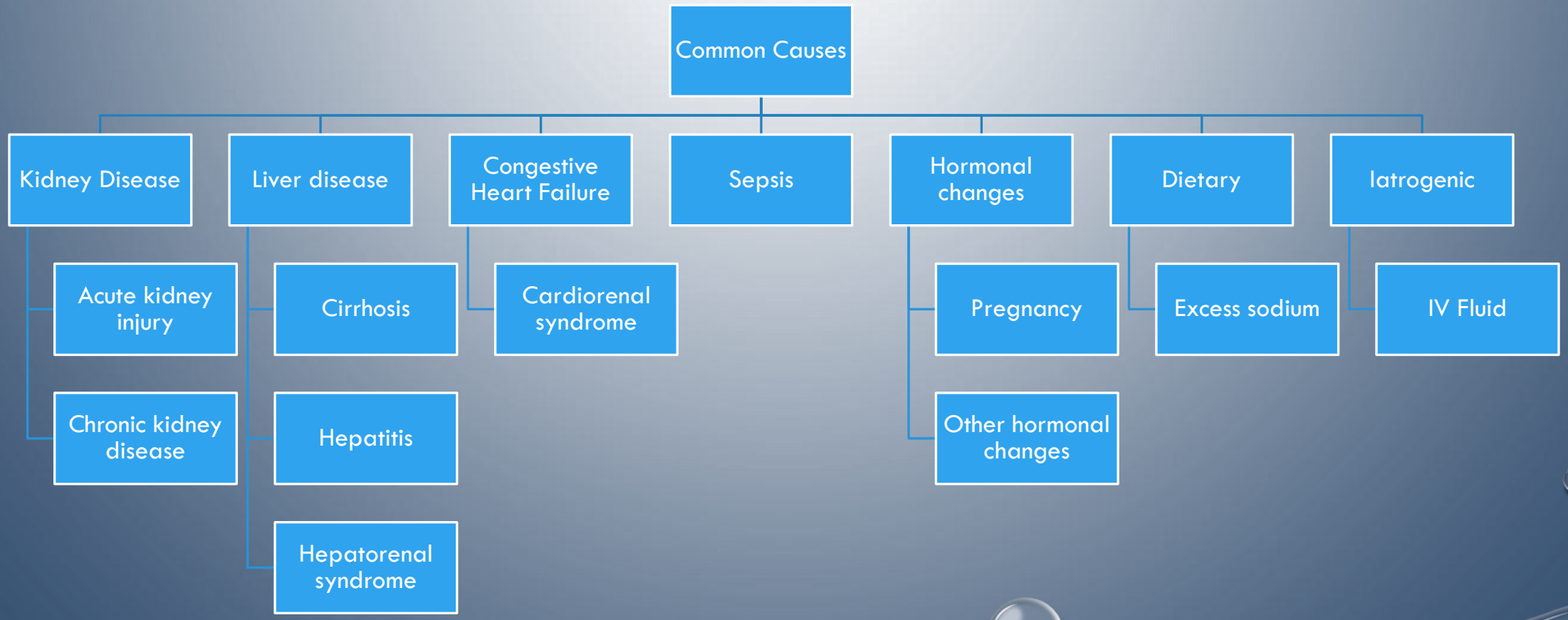
High risk of permanent damage if left untreated

- Cardiac arrhythmias
- Cerebral hypoperfusion
- Multi-organ failure

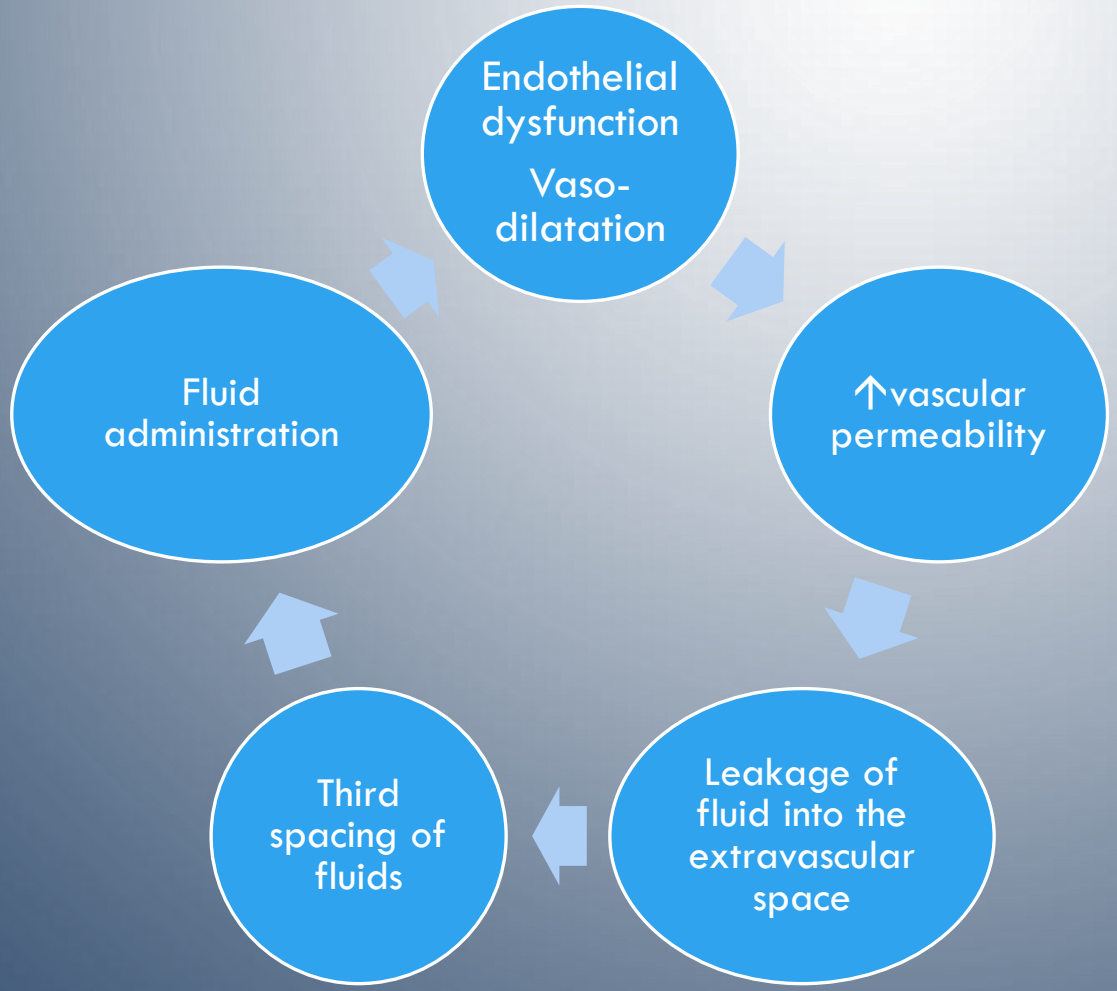
Prompt recognition and proper management usually results in a favorable outcome

Requires a multidisciplinary approach ot management to optimal patient outcomes

HYPERVOLEMIA



HYPERVOLEMIA – ETIOLOGY
SEPSIS



HYPERVOLEMIA-ETIOLOGY ACUTE KIDNEY INJURY

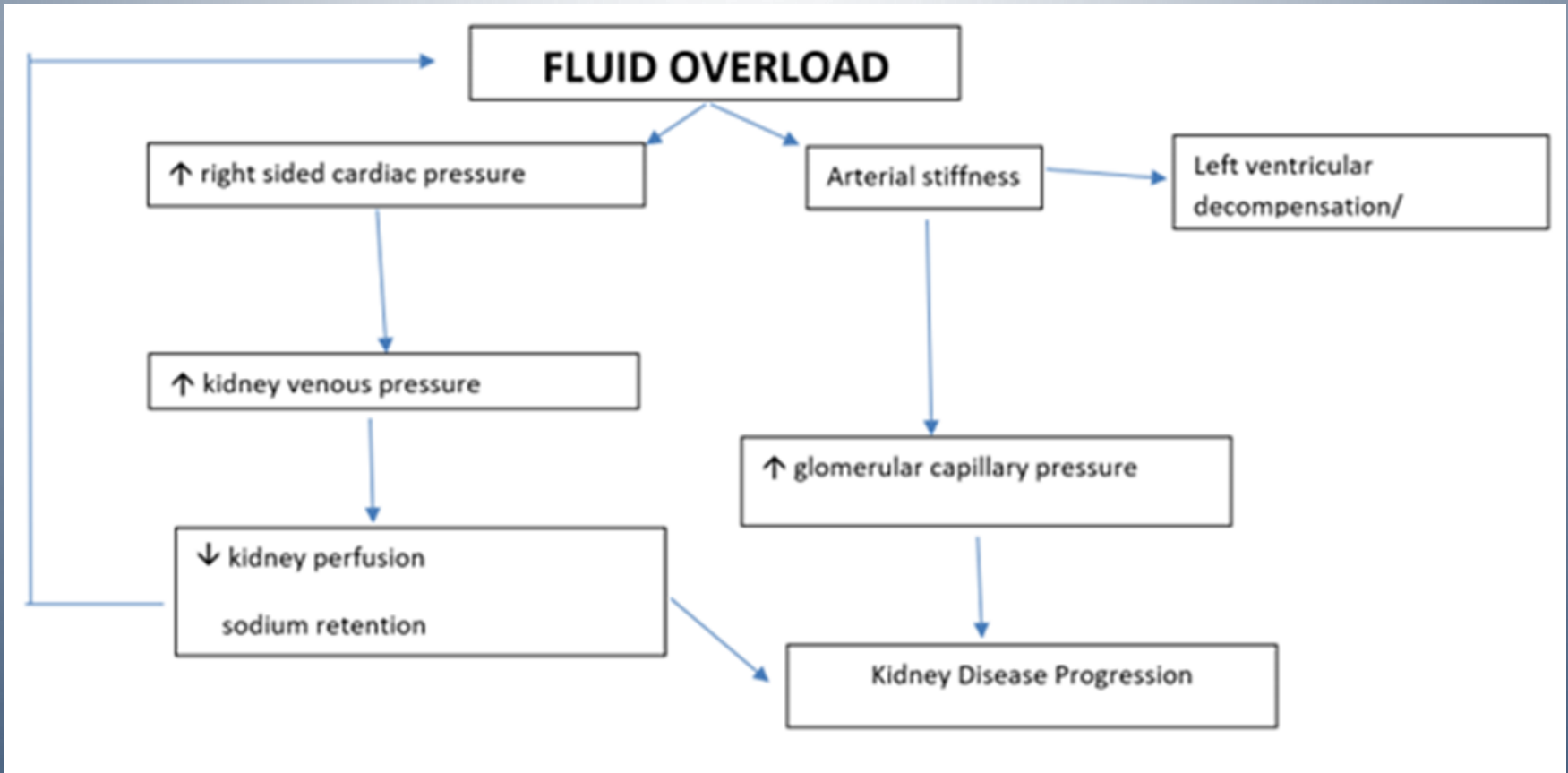
Endothelial dysfunction in the setting of ischemia →reperfusion injury and inflammation

damage to glycocalyx → capillary leakage → interstitial edema

reduced diffusion of oxygen and metabolites from the capillaries to the tissues

increase tissue pressure and decrease lymphatic drainage secondary to obstruction

HYPERVOLEMIA-ETIOLOGY CHRONIC KIDNEY DISEASE



HYPERVOLEMIA-ETIOLOGY CONGESTIVE HEART FAILURE

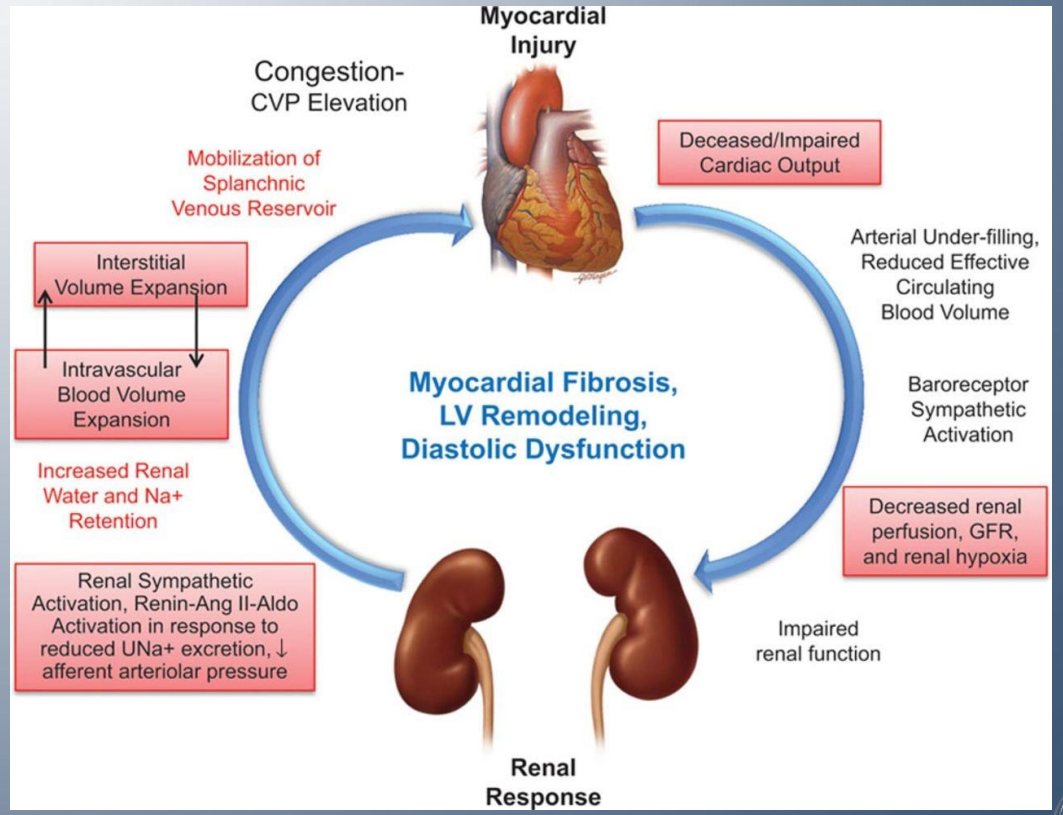
Chronic congestive heart failure

Renal retention of sodium and water

resulting intravascular and interstitial fluid volume expansion and redistribution

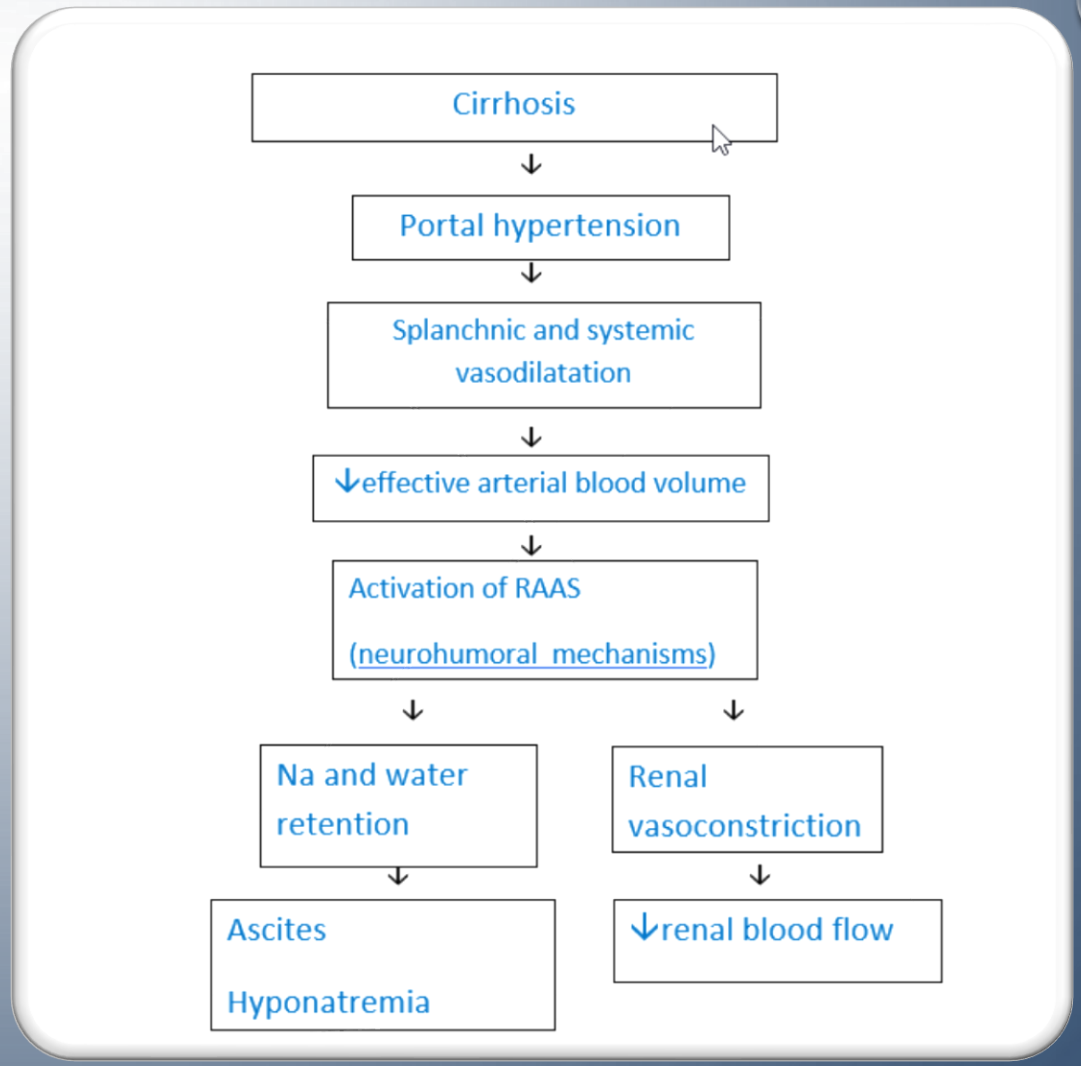
concurrent barrow receptor activation and neuro hormonal stimulation

prompting further retention of sodium and water



https://www.ahajournals.org/journal/circheartfailure

HYPERVOLEMIA- ETIOLOGY LIVER DISEASE



HYPOVOLEMIA-ETIOLOGY HORMONAL CHANGES

Pregnancy

- Enlarging uterus resulting in pressure on blood vessels in the pelvis
  - resulting in lower extremity congestion

Menstruation

- Hormonal fluctuation resulting in sodium and water retention

HYPERVOLEMIA EVALUATION

Symptoms

Dyspnea
- Activity related
- Positional

Fatigue

Anxiousness

Bloating

Headaches

Physical Exam

Edema
- Dependent areas
- Face

Abnormal lung exam
- Crackles/rales
- Diminished air exchange

Jugular Venous Distension
- Hepatojugular Reflex

Abnormal vitals

HYPERVOLEMIA – EVALUATION

- Jugular venous pressure (JVP)
  - JVP > 10 cm of water suggests hypervolemia
  - In hypervolemia the head of the hospital bed is elevated 30°-45°

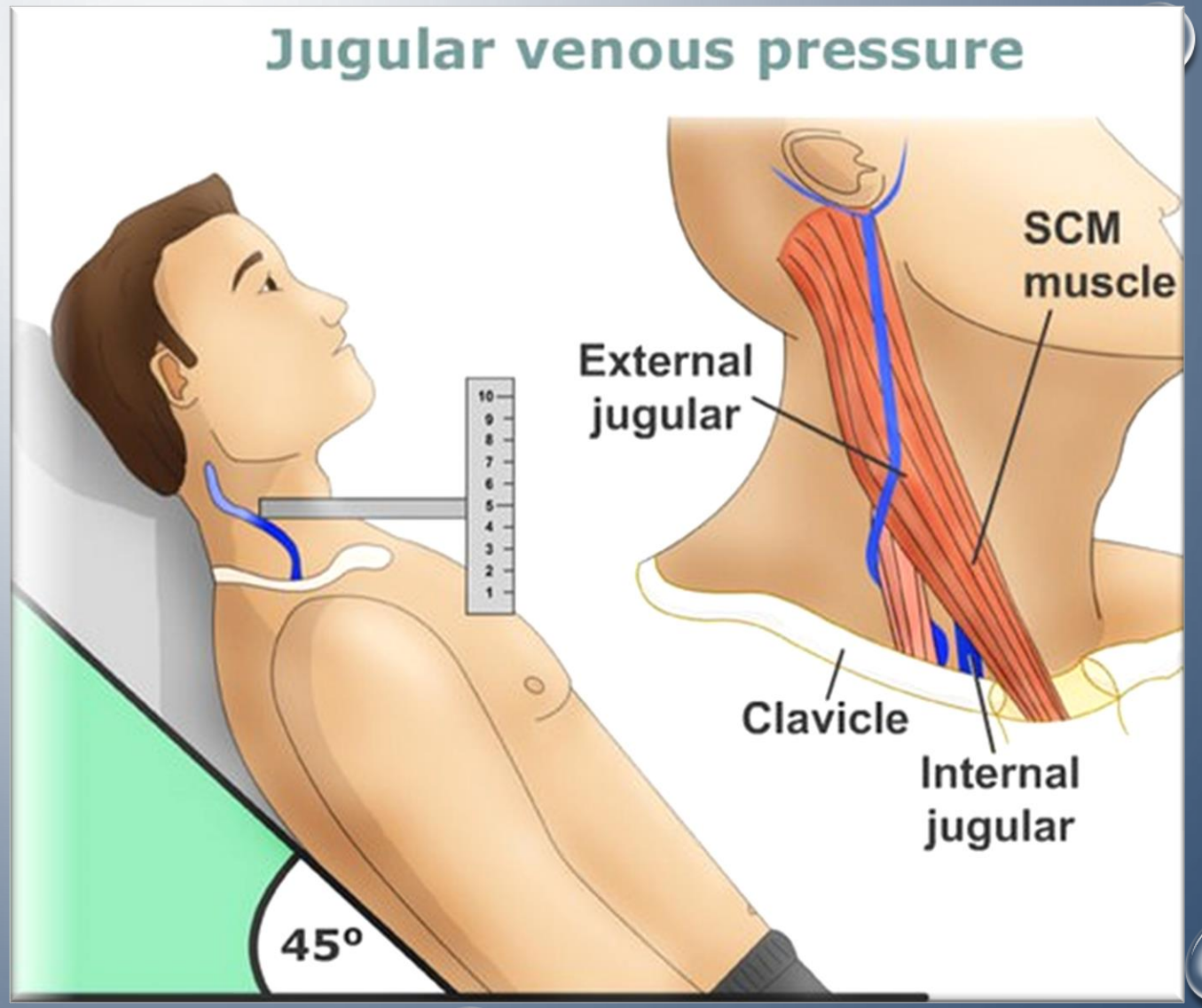
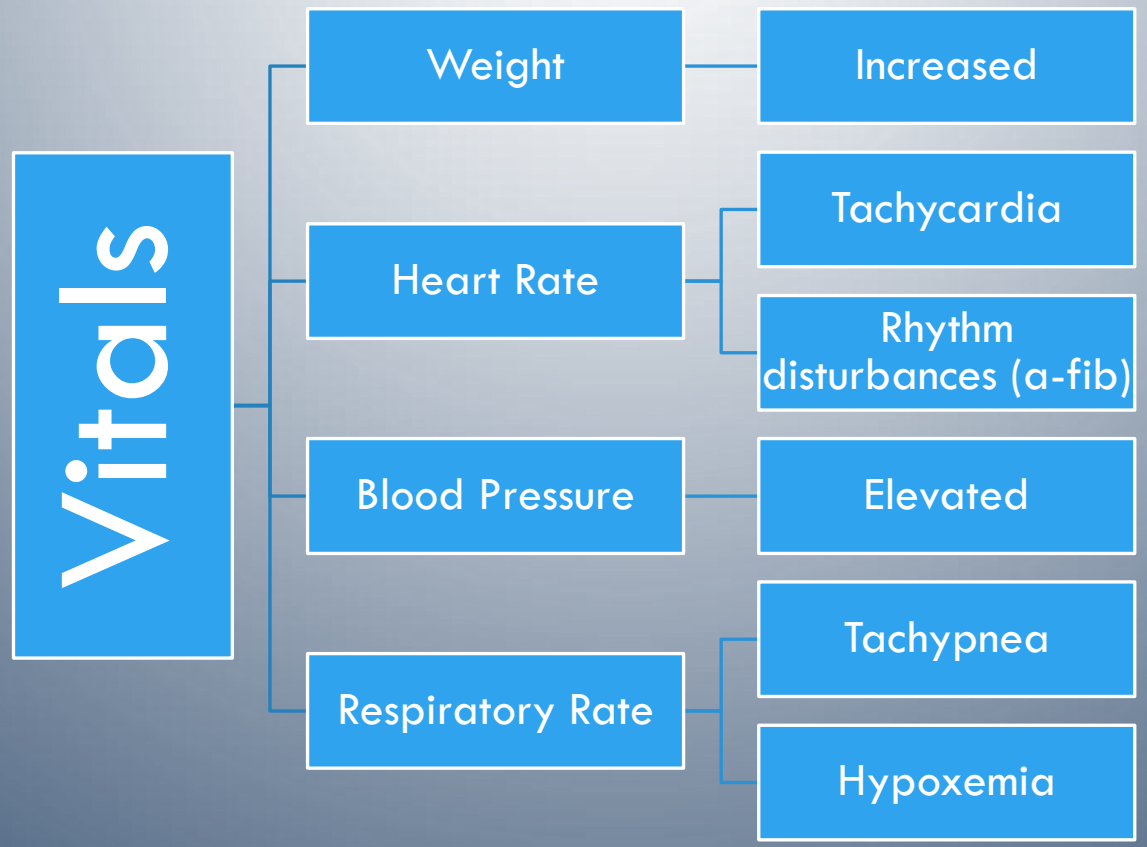


Image courtesy of Epomedicine: https://epomedicine.com/clinical-medicine/clinical-examination-jugular-venous-pulse-pressure-jvp/

HYPERVOLEMIA EVALUATION



HYPERVOLEMIA – TREATMENT/MANAGEMENT

The most effective and primary treatment is to manage the underlying condition

HYPERVOLEMIA – TREATMENT/MANAGEMENT

Sepsis

- Goal directed therapy with careful monitoring for evidence of fluid overload and prompt cessation of aggressive IV fluids once he more dynamic targets have been met
  - MAP 65-70 mmHg
  - SBP > 90 mmHg
  - Central Venous Pressure (CVP) =/> 8 mmHg
  - $SCVO_2$ =/>70%
  - normalization of lactic acid
  - improvement in renal indices, electrolytes and/or acid-base Abnormalities

HYPERVOLEMIA – TREATMENT/MANAGEMENT

ACUTE KIDNEY INJURY

- Vasopressors to enhance hemodynamics and renal perfusion
- Loop diuretic
  - an initial IV loading dose is often needed
  - urine output is utilized to determine response and dose adjustment
- Thiazide diuretic
  - at times activation of a different level of the loop of Henle can result in improved diuresis
  - potential to worsen AKI and exacerbate underlying electrolyte abnormalities
- Extracorporeal therapy
  - various dialysis modalities

HYPERVOLEMIA – TREATMENT/MANAGEMENT

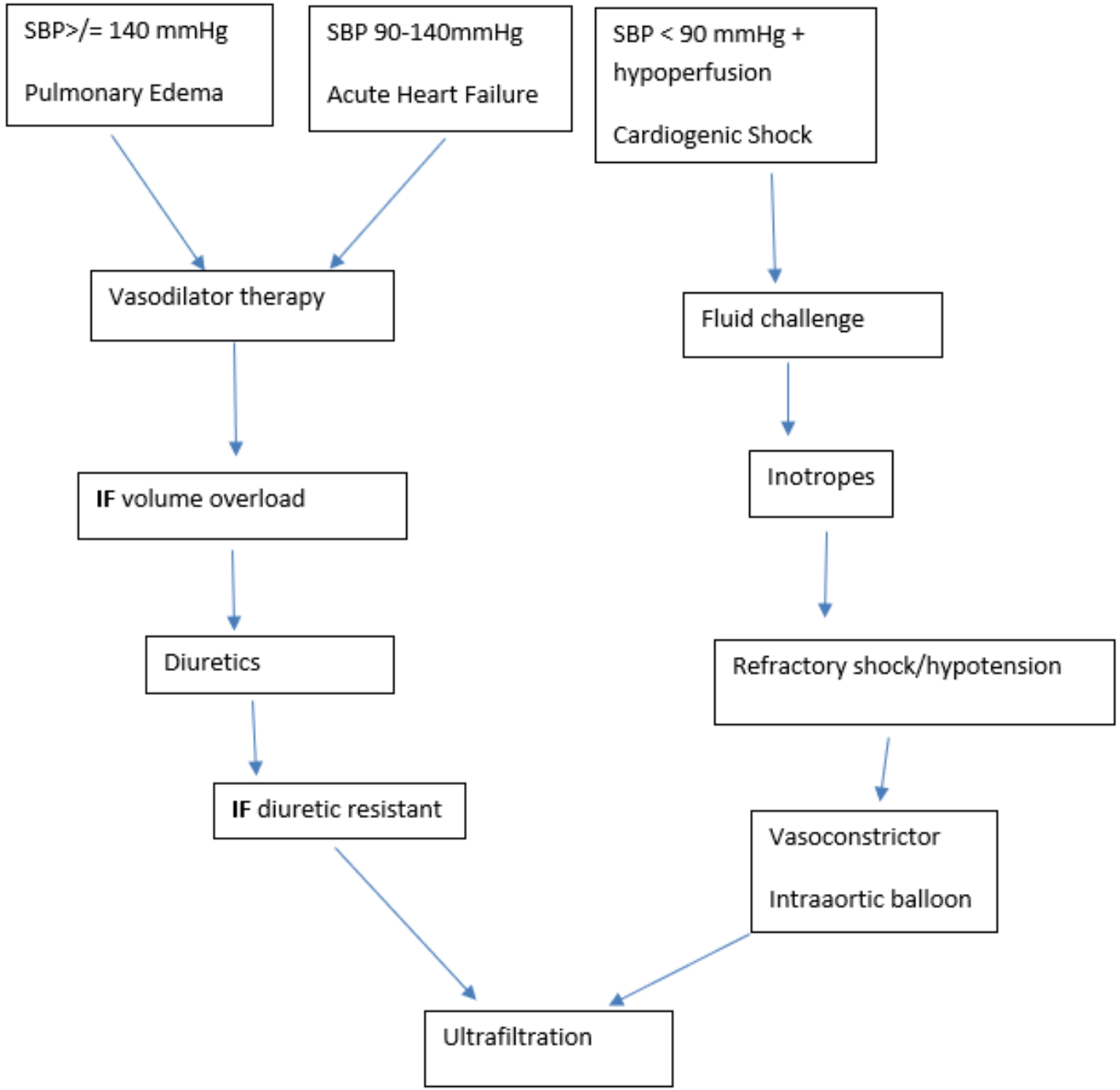
LIVER DISEASE

- Ascites
  - Paracentesis
  - Aldosterone antagonist - spironolactone
  - Loop diuretic
  - 1.5-2 g sodium restricted diet
- Hepatorenal syndrome
  - Volume expansion usually albumin 25% crystalloid IV fluid
  - Octreotide and midodrine to help improve hemodynamics through vasoconstriction

HYPERVOLEMIA – TREATMENT/MANAGEMENT

HEART FAILURE

Acute decompensated



HYPERVOLEMIA – TREATMENT/MANAGEMENT

HEART FAILURE - Chronic

1. HFrEF (< 40%)
    i. Diuretic – start or titrate
    ii. Classify per NYHA - and follow recommendations

2. HRpEF (EF > 50%)
    i. Control blood pressure
    ii. Control ventricular heart rate with underlying arrhythmias
    iii. Diuretic therapy in volume overload
    iv. SGLT 2 inhibitor

HYPERVOLEMIA - PROGNOSIS

Dependent on underlying etiology and promptness of initiation of appropriate treatments

High risk of permanent damage if left untreated

- Cardiac arrhythmias
- Multi-organ failure
- ↑ Risk of cardiovascular morbidity and all –cause mortality

Prompt recognition and proper management usually results in a favorable outcome

Requires a multidisciplinary approach ot management to optimal patient outcomes

POST-TEST QUESTIONS

1. What is the correct balance for body fluids?

    a. Intracellular 26%, Interstitial 67%, intravascular 1%, and cerebrospinal fluid 7%

    b. Intracellular 67%, Interstitial 26%, intravascular 7%, and cerebrospinal fluid 1%

    c. Intracellular 50%, Interstitial 40%, intravascular 5%, and cerebrospinal fluid 5%

    d. None of the above

POST-TEST QUESTIONS

1. What is the correct balance for body fluids?

   a. Intracellular 26%, Interstitial 67%, intravascular 1%, and cerebrospinal fluid 7%

   b. Intracellular 67%, Interstitial 26%, intravascular 7%, and cerebrospinal fluid 1%

   c. Intracellular 50%, Interstitial 40%, intravascular 5%, and cerebrospinal fluid 5%

   d. None of the above

POST-TEST QUESTIONS

1. Both hypovolemia and hypervolemia can be caused by renal dysfunction

    a. True

    b. False

POST-TEST QUESTIONS

1. Both hypovolemia and hypervolemia can be caused by renal dysfunction

    a. True

    b. False

POST-TEST QUESTIONS

1. Which symptoms can be seen with both hypovolemia and hypervolemia?

    a. Fatigue

    b. Weakness

    c. Muscle cramps

    d. A & B

POST-TEST QUESTIONS

1. Which symptoms can be seen with both hypovolemia and hypervolemia?

    a. Fatigue

    b. Weakness

    c. Muscle cramps

    d. A & B

QUESTIONS???

THANK YOU

Becky Ness MPAS, PA-C, DFAAPA, FNKF

Instructor of Medicine, Mayo College of Medicine

American Academy of Nephrology PA

ness.becky@mayo.edu

REFERENCES

- Koniari K, Parissis J, Paraskevaidis I, Anastasiou-Nana M. Treating volume overload in acutely decompensated heart failure: established and novel therapeutic approaches. *Eur Heart J Acute Cardiovasc Care*. 2012 Sep;1(3):256-68. doi: 10.1177/2048872612457044. PMID: 24062916; PMCID: PMC3760543.
- Ask Mayo Expert
- Ness BM, Brown SE. Fluid Overload. *Crit Care Nurs Clin North Am*. 2022 Dec;34(4):409-420. doi: 10.1016/j.cnc.2022.07.001. Epub 2022 Oct 12. PMID: 36336431.
- Pellicori P, Kaur K, Clark AL. Fluid Management in Patients with Chronic Heart Failure. *Card Fail Rev*. 2015 Oct;1(2):90-95. doi: 10.15420/cfr.2015.1.2.90. PMID: 28785439; PMCID: PMC5490880.
- Melendez Rivera JG, Anjum F. Hypovolemia. [Updated 2022 Nov 14]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK565845/
- BENEŠ J. DIAGNOSING HYPOVOLEMIA AND HYPERVOLEMIA: FROM CLINICAL EXAMINATION TO MODERN METHODS. *VNITR LEK*. 2019 SPRING;65(3):170-176. ENGLISH. PMID: 31088093.