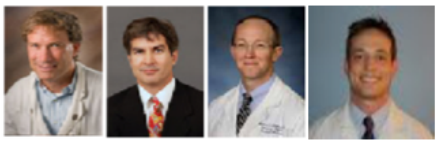
critical care perspectives in emergency medicine



Is This Patient Volume Overloaded?

Key Article

- *Drum B, et al. Does this patient have volume overload? The Rational Clinical Examination. JAMA. 2026; published online February 23, 2026.*

Background

- Intravascular volume overload is a state of abnormal expansion of the intravascular compartment.
- Diagnosed clinically when patients have dyspnea, weight gain, edema and signs of excess such as rales, JVD, and peripheral edema.
- Conditions that increase the risk of volume overload include heart failure, CKD, cirrhosis, and excess fluid administration.
- Accurate assessment of volume affects clinical decision making for ED and ICU patients.
- Accurate assessment and management may prevent complications such as pulmonary edema and eventual intubation.

Pathophysiology

- Intravascular volume overload is caused by sodium and water retention, with subsequent plasma volume expansion and increased hydrostatic pressure.
- Volume overload is driven by arterial underfilling (low effective circulating volume) – the body perceives the volume is low even if they are normo- or hypervolemic.
- Leads to activation of the RAA system, sympathetic nervous system, and arginine vasopressin.

Peripheral Edema

- Occurs when capillary filtration exceeds the limits of lymphatic drainage, resulting in accumulation of fluid in the interstitial space.
- Increased intravascular hydrostatic pressure, increased vascular permeability, and increased plasma oncotic pressure also contribute to peripheral edema.
- Can also occur even in the absence of overt volume overload in patients with VTE or venous insufficiency.
- Peripheral edema is gravity dependent. Begins in the feet and ascends the legs.
- Calcium channel blockers and gabapentinoids can also cause peripheral edema.

Pulmonary Edema

- Rales occur when small airways pop open during inspiration after being obstructed in expiration due to fluid accumulation.
- B-lines are US artifacts that are caused by interstitial edema and increased fluid.
- Interstitial edema and pulmonary edema also cause Kerley B lines, peribronchial cuffing, and perihilar hazy opacities on CXR.

Elevated RAP

- With volume overload, increased venous fluid return elevates RAP and causes JVD.
- Dilation of the IVC can also occur.
- JVD and IVC dilation can also result from other conditions such as pericardial effusion, PE, and pulmonary HTN.

Labs

- BNP is a hormone secreted by cardiomyocytes in the ventricles in response to stretching caused by increased blood volume.
- Both BNP and NT-proBNP can be higher with older age, female sex, CKD, and pulmonary HTN and are lower in patients with DM and obesity.

Symptoms

- Patients with volume overload often have dyspnea, orthopnea, peripheral edema, weight gain, and PND.
- Additional symptoms include early satiety, abdominal discomfort, and bloating.

Signs

- Lower extremity edema is a common exam finding but is nonspecific.
- Pulmonary vascular congestion – exam reveals rales.
- Elevated cardiac filing pressures – JVP
    - Performed with the patient reclined at 30-45 degrees
    - Head turned at a slight angle to expose the IJ venous pulsation between the heads of the SCM.
    - Determine the highest point of venous pulsation (the meniscus).
    - Measure the vertical distance from the sternal angle.
    - A JVP or more than 3 cm above the sternal angle (> 8 cm to the RA) suggests elevated RAP
- POCUS
    - Assess the IVC, IJ, and lung parenchyma.
    - Lung parenchyma
        - Perform in a supine or semi-recumbent position
        - A phased array probe is preferred to reduce rib shadowing and increase penetration of US waves.
        - Scan in a longitudinal orientation across multiple anterior and lateral intercostal spaces bilaterally.
        - Pathological B-lines are defined as the presence of 3 or more B-lines within 1 intercostal space.
        - Lung POCUS does not directly estimate CVP but bilateral B-lines in a symptomatic patient suggests pulmonary vascular congestion.
        - B-lines can also be seen in ARDS, pneumonia, and pulmonary contusion.
    - JVP
        - Examination of the IJ with the patient reclined at 30-45 degrees.
        - Use a high frequency linear probe in a transverse orientation at the base of the neck just above the clavicle.
        - Measure maximal and minimal IJ anteroposterior diameters during the respiratory cycle.
        - Large diameter with < 30% variation suggests elevated RAP.

        - Can also locate the IJ collapse point – most cephalad point along the vein that collapses with respiration) – can be used as a surrogate for the top of the venous column and is analogous to the meniscus identified on bedside exam. The vertical height from the collapse point to the sternal angle is measured, and 5 cm is added to estimate the total jugular venous height.
    - IVC
        - Perform with the patient in the supine position.
        - Measure approximately 2 cm distal to the RA junction at the end of expiration.
        - A dilated IVC (> 2.1 cm) with < 50% inspiratory collapse suggests elevated central venous pressure.
        - A small IVC with collapse > 50% suggests normal central venous pressure.

Methods

- Authors conducted a search of MEDLINE to Jan 2026
- Studies - Included
    - Peer-reviewed
    - English language
    - Adults greater than or equal to 18 years of age with conditions that predispose to volume overload
    - Evaluated diagnostic accuracy of components of the clinical exam, labs, CXR, and/or POCUS and compared to reference standard in assessing and diagnosing volume overload
- Studies – Excluded
    - Patients with sepsis, chronic lymphedema, or pregnant were excluded.

Results

- 40 included articles – 11,490 patients
    - 26 studies in ED patients with dyspnea
    - 8 studies in patients admitted to the floor or ICU
    - 4 studies in patients presenting prior to RHC
    - 1 study in outpatient clinic
    - 1 study in urgent care
- Clinical exam
    - 10 studies – 5,041 patients
    - JVD
        - High specificity – 92% with LR 4.1
        - Low sensitivity – 35% with LR 0.72
    - Pulmonary rales
        - High specificity – 81% with LR 2.7
        - Low sensitivity – 56% with LR 0.56
    - Lower extremity edema
        - Specificity – 80% with LR 2.2
        - Sensitivity – 44% with LR 0.67
- Radiographic findings
    - Pulmonary vascular congestion on CXR
        - Specificity – 91% with LR 5.9
        - Sensitivity – 51% with LR 0.53

- POCUS
    - B-lines: Specificity – 77% with LR 4.0
    - Absence of B-lines: Sensitivity – 93% with LR 0.09
    - Abnormal IVC collapsibility index: Specificity – 79% with LR 3.9
    - Normal IVC collapsibility index: Sensitivity – 82% with LR 0.22
    - Increased US JVP: Specificity – 71% with LR 2.8
    - No increased JVP by US: Sensitivity – 81% with LR 0.26
- Lab Findings
    - Elevated BNP: Specificity – 87% with LR 6.9
    - Normal BNP: Sensitivity – 87% with LR 0.14

Authors Discussion

- Physical examination, while associated with specificity ranging from 80-95%, has lower sensitivity for detecting volume overload – cannot be used along to exclude volume overload.
- B-lines had the highest sensitivity for identifying volume overload – has a high degree of reliability in excluding volume overload.
- BNP has high sensitivity – useful for identifying patients at lower risk of volume overload.
- Congestion on CXR has high specificity for identifying patients at higher risk of having volume overload.

Limitations Identified by Authors

- Most studies used expert opinion to determine if volume overload was present.
- Patient acuity varied substantially across studies.
- Exclusion criteria varied across studies.
- Techniques for exam maneuvers and POCUS varied among studies.
- BNP data did not adjust for age, obesity, or CKD.

Take Home Points

- **An elevated BNP and the presence of vascular congestion on CXR were the most useful tests to identify volume overload.**
- **A low BNP and the absence of B-lines on POCUS were the most useful in excluding volume overload.**