### Hemodialysis Dry weight Detection:

Can POCUS Takes the Lead?

The 19th International Congress of Nephrology, Dialysis and Transplantation (ICNDT)

12-15 December 2023 Homa Hotel, Tehran Hamidreza Badeli, M.D Pediatric Nephrologist Professor of Guilan University Medical sciences

### Conflict of interest

# I do not have an affiliation (financial or otherwise) with a pharmaceutical, medical device company





### **OBJECTIVES**

- What is Dry weight
- Importance of dry weight
- Clinical assessment of Dry weight
- Current objectives methods of detecting dry weight
- POCUS





### Impact of dry weight

- Sodium and fluid retention in end-stage kidney disease is associated with hypertension and cardiovascular morbidity and mortality(Circulation. 2009;119:671-679)
- Several studies have reported that 20%-30% of dialysis patients did not achieve an adequate fluid volume status even after dialysis, leaving the patient in persistent chronic volume overload



Passauer et al,. Nephrol Dial Transplant. 2010;25:545-551



# What is dry weight?

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### During a week, fluid volume status

- The fluid surface of the ebb: set by nephrologist
- The flow, represented interdialytic weight gain which dependent on patient
  - 1. Oral sodium and water intakes
  - 2. Residual urine output
  - 3. Insensible fluid losses



<u>J Bras Nefrol.</u> 2019 Oct-Dec; 41(4): 550–559.



# What are the Current Assessment methods of Dry Weight



### The main, current, and widely used method for determining dry weight are

- Edema
- Blood Pressure level
- Chest X-ray findings
- Blood volume monitoring to assess dry weight
- Vena cava ultrasound
- Lung ultrasound
- N-terminal probrain natriuretic peptide
- Relative plasma volume (RPV) monitoring uses photooptical technology



Agarwal R. Hypervolemia is associated with increased mortality among hemodialysis patients. Hypertension. 2010;56:512-517



### Physical Examination

- Firstly, it remains insensitive to fluid overload until it reaches around 10% of the patient's body weight
- Secondly, pre-dialytic blood pressure is not exclusively determined by intravascular volume; it is influenced by factors like:
  - 1. Vascular stiffness
  - 2. Cardiac dysfunction
  - 3. Hypoalbuminemia
  - 4. Multiple comorbidities
- Thirdly, within the pediatric population, a portion of the interdialytic weight gain should account for nutritional weight gain



## Can POCUS Takes the Lead for Assessment of Dry Weight



### Point of Care of Ultrasound (POCUS)

### This method involves clinicians utilizing portable ultrasound systems directly at a patient's bedside for both diagnostic and therapeutic purposes.



#### KIDNEY DISEASES

#### Point-of-Care Ultrasonography Is It Time Nephrologists Were Equipped With the 21th Century's

Stethoscope?

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Keywords, ultrasonography, nephrology, kidneys, point-ofIn the past 3 decades, ultrasonography has gifted internal organs visualization to physicians to have a better detection of various diseases. Previously performed solely by radiologists as a method with high feasibility and accuracy, recently ultrasonography is being recommended and used by many other physicians in practice. Ultrasonography not only can be used to diagnose and manage kidney diseases, but also is an essential tool in nephrology for the guidance of invasive procedures. This method of bedside ultrasonography by physicians in real time is called point-of-care ultrasonography (POCUS). Given the limitations of collecting information by routine physical examination in kidney diseases and the simplicity of performing ultrasonography to examine kidney location, architecture, and restricted pathologies, nephrologists that have been lagging in this area, should join the spectrum of clinicians using the POCUS to provide safe and rapid diagnosis of common renal abnormalities. Although physicians may imagine POCUS as a difficult tool to use and there has been an initial resistance and reluctance to use ultrasonography by nonradiologists, investigations have shown that learning and doing POCUS was possible even for undergraduate medical students during a short course. According to the collected evidence in the field of POCUS in different branches of medicine, it seems that it should be added to nephrology examination room in the near future.

> IJKD 2017;11:259-62 www.ijkd.org

#### IJKD 2017;11:259-62



### The Main organs affecting by overload

- Lung Ultrasound
- Focused Cardiac assessment including:
  - 1. Ejection fraction assessment
  - 2. Ventricular filling pressures
  - 3. Presence of pericardial effusion
  - 4. The relative heart chamber size
  - 5. The estimated right-atrial pressure
- Venous congestion(hepatic, portal and renal veins)



Gregorio Romero et al; Clinical Kidney Journal, Volume 16, Issue 2, February 2023



### Lung Ultrasound

- Organ filled with air (
- old edition Harrison's Book)
- In 1994 that Daniel Lishestein introduced the BLUE protocol
- The ultrasound can detect:
  - Pleural Effusion
  - Pneumonia
  - Pneumothorax
  - Pulmonary Edema

Kasper D, Fauci A, Hauser S et al. Harrison's Principles of Internal Medicine, 19e. Vol. 1. New York, NY:Mcgraw-Hill, 2015





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Gargani, L et al,. Cardiovasc Ultrasound 9, 6 (2011). https://doi.org/10.1186/1476-7120-9-6



### Lung ultrasound for Dry weight

- Lung US which quantified the B-lines and integrated by echocardiography can help for dry weight reduction
- The result indicated that reducing the number of B-lines linked to decreased cardiac chamber dimensions and LV filling pressure
- But no difference in systolic performance compared with usual care in hypertensive hemodialysis patients

Randomized Controlled Trial > Am J Kidney Dis. 2020 Jan;75(1):11-20. doi: 10.1053/j.ajkd.2019.07.025. Epub 2019 Nov 12.

Lung Ultrasound-Guided Dry Weight Assessment and Echocardiographic Measures in Hypertensive Hemodialysis Patients: A Randomized Controlled Study

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### The Heart



- Focused Cardiac assessment:
  - 1. Ejection fraction
  - 2. LV Filling pressures
  - 3. Presence of pericardial effusion
  - 4. The relative chambers size
  - 5. The estimated right-atrial pressure





# Ejection Fraction(EF)







Advances in Chronic Kidney Disease 2021 28208-217DOI: (10.1053/j.ackd.2021.04.001)

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### E-point septal separation (EPSS)

- The mitral-valve waveform on M-mode contains two E and A peaks:
- *E-peak" is larger one and corresponds to the maximal mitral-valve opening in early LV diastole.*
- The second, smaller peak is called the "A-point" and corresponds to atrial contraction later in LV diastole

https://sjrhem.ca/advanced-cardiac-echo-a-review-of-e-point-septal-separation/ https://doi.org/10.1053/j.ackd.2021.04.001







### EPSS

- A study comparing the EPSS-derived EF with the EF measured by MRI, derived the following equation:
- $LVEF = 75.5 (2.5 \times EPSS)$  with a correlation of r = 0.80
- Moreover, an EPSS measurement > 7 mm demonstrated 100% sensitivity for detecting severely reduced EF (<30%)</li>



McKaigney, C.J.; Krantz, M.J.; La Rocque, C.L.; Hurst, N.D.; Buchanan, M.S.; Kendall, J.L. E-point septal separation: A bedside tool for emergency physician assessment of left ventricular ejection fraction. Am. J. Emerg. Med. 2014, 32, 493–497.



### Mitral annular plane systolic excursion (MAPSE) for EF estimation

- The displacement of the mitral valvular plane in the z-direction and reflects left-ventricular longitudinal contraction or shortening
- The EF can be derived by using the following formula:  $EF = 4.8 \times MAPSE (mm) + 5.8$ .
- A MAPSE  $\geq$  10 mm is considered normal EF

#### SCHEMATIC OF THE MAPSE METHOD



MAPSE = MITRAL ANNULUS SYSTOLIC PLANE EXCURSION



### Left -ventricular filling pressures (LVFPs)

- This is an important issue for all dialysis patients: if LVFPs are found to be elevated, then the dry weight should be reduced
- In the absence of hypertension, LVFP elevation is an important finding to guide the clinical assessment of volume status.
- For POCUS examinations, the trans-mitral flow Doppler is commonly used.
- The normal tracing consists of E (early rapid filling period) and A (atrial systole corresponding to the end of diastole) waves, respectively. Normally, the E-wave peak velocity exceeds that of the A wave (E/A ratio >1).



Agarwal, R. Hypervolemia is associated with increased mortality among hemodialysis patients. Hypertension 2010, 56, 512–517



### Pericardial effusion

- Parasternal long axis
- Parasternal short axis
- Apical four chambers
- Subcostal four chambers







### The relative chamber size

- In the apical four-chamber view, the right atrium is equal to 1/3 of the right heart while the right ventricle represents the other 2/3.
- To assess for right-ventricular dilatation, the use of the "rule of thirds" can be applied:
- Normally, the size of the right ventricle is equal to 2/3 of the left ventricle.
- Failure to adhere to the rule of thirds indicates a dilated state of the related cardiac chamber, prompting the need to investigate the underlying patholog



Georgios Tsangaris et al, Kidney Dial. 2022, 2(2),



### **Venous congestion assessment**







VExUS Ultrasound Score Protocol PDF <u>William Beaubien</u> et al; *Ultrasound J* **12**, 16 (2020)



### A case: How did POCUS help me to assess volume status

- A 14-year-old boy
- A guest ESRD case
- Respiratory distress
- No edema





### B Lines in Lung





### **Ejection Fraction**







### Pleural Effusion & Ascites





Pediatric Nephrology (2023) 38:1733–1751 https://doi.org/10.1007/s00467-022-05729-5

EDUCATIONAL REVIEW



TEHRA

#### Point-of-care ultrasound in pediatric nephrology

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# The End



