Point-of-Care Ultrasound in Office Practice

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October 24, 2019
Outline

• Evolution of Ultrasound
• What is Point-of-Care Ultrasound (POCUS)?
• Point of Care Ultrasound in Nephrology
  • Anatomy Scans
  • Vascular US for volume assessment – IVC and IJ
  • Lung US
  • Limited Echo
  • Access Assessment
Evolution of Ultrasound

http://www.ob-ultrasound.net/posakony_life.html
Outline

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What is Point-of-Care Ultrasound?

**What it is**
- A way to rapidly answer focused, yes/no clinical questions.
- Generally regarded as safe.
- Gives a snapshot into the immediate clinical situation

**What it isn’t**
- A replacement for comprehensive or radiological studies.
Point-of-Care Ultrasonography

Christopher L. Moore, M.D., and Joshua A. Copel, M.D.
Current Concepts

Point-of-Care Ultrasonography

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Nephrology  Vascular access for dialysis
Outline

• Evolution of Ultrasound
• What is Point-of-Care Ultrasound (POCUS)?
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Mr. Simpson is a 47M with PMH/o hypertension, diabetes, and kidney stones presenting to your clinic. He reports fatigue, nausea, and left-sided flank pain.

Vitals are 101 F, BP 110/30, and HR 102. Exam is normal except left sided costovertebral angle tenderness.
Kidney/Bladder Windows

Kaptein and Kaptein, Int J Nephro 2017
Slide Courtesy Dr. Cameron Baston.
Severity of Hydronephrosis

Soni 2014

Slide courtesy Dr. Cameron Baston.
Detection of stones – US vs CT

Ultrasonography versus Computed Tomography for Suspected Nephrolithiasis

Clogged Indwelling Urinary Catheter

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• Future Directions
Ms. Hyland is new to dialysis after a failed kidney transplant. You are meeting her for the first time today. She complains of generalized edema from steroids.

Her vitals are BP 110/50, HR 72, and saturating well on RA. She weighs 50 kg. She has significant anasarca and complains of some dyspnea. She is started with a goal to remove 2L of fluid. 30 minutes later she becomes hypotensive.
IVC ultrasonography

http://emergencyultrasoundteaching.com/narrated_lectures.html
IVC ultrasonography

**FIGURE 3.** Regression line of right atrial pressure versus end-inspiratory inferior vena caval diameter showing regression equation. \( r = 0.71 \); standard error of the estimate = 4.8 mm Hg.
IVC ultrasonography

$$IVCCI = \left[ \frac{IVCD_{\text{max}} - IVCD_{\text{min}}}{IVCD_{\text{max}}} \right] \times 100\%$$
IVC ultrasonography

\[ \text{IVCDI} = \left( \frac{\text{IVCD}_{\text{max}} - \text{IVCD}_{\text{min}}}{\text{IVCD}_{\text{max}}} \right) \times 100\% \]
IJ ultrasonography

Linear
- IV's
- Nerve Blocks
- Lung (Best)

Kaptein and Kaptein, Int J Nephro 2017
Clip courtesy Dr. Cameron Baston
## Caveats of IVC and IJ ultrasonography

<table>
<thead>
<tr>
<th>Underestimate intravascular volume</th>
<th>IVC CI</th>
<th>IVCmax</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased tidal volume (ventilated)</td>
<td>Increased?</td>
<td>No change?</td>
<td>Midaxillary or midclavicular line views [23]. Cross-sectional view [18]</td>
</tr>
<tr>
<td>Increased inspiratory effort moving probe “in &amp; out” of field (diaphragmatic breathing) [18]</td>
<td>Increased</td>
<td>No change</td>
<td>Large IVCmax with no collapse indicates being not hypovolemic</td>
</tr>
<tr>
<td>Increased inspiratory effort/deep breathing (sniff) [22, 28, 35]</td>
<td>Increased</td>
<td>No change</td>
<td>Large IVCmax with no collapse indicates being not hypovolemic</td>
</tr>
<tr>
<td>Valsalva maneuver [19]</td>
<td>Increased</td>
<td>Decreased</td>
<td>Large IVCmax with no collapse indicates being not hypovolemic</td>
</tr>
<tr>
<td>Intra-abdominal HTN [23, 36]</td>
<td>?</td>
<td>Decreased</td>
<td>Large IVCmax with no collapse indicates being not hypovolemic</td>
</tr>
<tr>
<td>Off-center scan (cylinder tangent effect) [37]</td>
<td>Minimal changes</td>
<td>Decreased</td>
<td>Attempt to maximize IVC diameter. Cross-sectional view [18]</td>
</tr>
</tbody>
</table>
## Caveats of IVC and IJ ultrasonography

**Overestimate intravascular volume**

<table>
<thead>
<tr>
<th>Condition</th>
<th>IVC</th>
<th>JUG</th>
<th>Preload Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac tamponade</td>
<td>Decreased</td>
<td>Increased</td>
<td>Preload dependent</td>
</tr>
<tr>
<td>Severe valvular stenosis</td>
<td>Decreased</td>
<td>Increased</td>
<td>Preload dependent</td>
</tr>
<tr>
<td>Massive pulmonary embolism [18]</td>
<td>Decreased?</td>
<td>Increased</td>
<td>Preload dependent</td>
</tr>
<tr>
<td>Right ventricular myocardial infarction [38]</td>
<td>Decreased</td>
<td>Increased</td>
<td>Preload dependent, decreased venous return to LV</td>
</tr>
<tr>
<td>Severe tricuspid regurgitation</td>
<td>Decreased</td>
<td>Increased</td>
<td></td>
</tr>
<tr>
<td>High PEEP [39]</td>
<td>Minimal change</td>
<td>Increased</td>
<td>No difference between PEEP 0 and 5 cm H\textsubscript{2}O [39]</td>
</tr>
<tr>
<td>Decreased tidal volume</td>
<td>Decreased</td>
<td>No change?</td>
<td></td>
</tr>
<tr>
<td>Decreased inspiratory effort/shallow breathing [22, 40]</td>
<td>Decreased</td>
<td>No change?</td>
<td>Highly collapsible IVC indicates being not hypervolemic</td>
</tr>
</tbody>
</table>

IVC = inferior vena cava, IVC CI = IVC collapsibility index, IVCmax = IVC maximum diameter, PEEP = positive end-expiratory pressure, LV = left ventricle, and HTN = hypertension, cm H\textsubscript{2}O: centimeters of water.
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Lung US

Cartoon courtesy Dr. Cameron Baston
Lung US – A-lines
Lung US – B-lines

- Pulmonary edema
- Acute Lung Injury
- Pneumonia
- Pulmonary fibrosis/ILD
Ultrasound Assessment for Extravascular Lung Water in Patients Undergoing Hemodialysis*

Time Course for Resolution

Vicki E. Noble, MD, RDMS; Alice F. Murray, MBCB; Roberta Capp, MD; Mary H. Sylea-Bochum, RN; David J. R. Steele, MD; and Andrew Lisepo, MD, RDMS

*Figures 4. Percentage of B-lines vs time.
<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Year</th>
<th>n</th>
<th>Dialysis modality</th>
<th>Other measurement of volume assessment</th>
<th>Exclusion criteria</th>
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<tbody>
<tr>
<td>Noble et al. [11]</td>
<td>USA</td>
<td>2009</td>
<td>40</td>
<td>HD</td>
<td>Subjective dyspnea</td>
<td>None</td>
</tr>
<tr>
<td>Mallamaci et al. [14]</td>
<td>Italy</td>
<td>2010</td>
<td>75</td>
<td>HD</td>
<td>NYHA Class, BIA</td>
<td>None</td>
</tr>
<tr>
<td>Trezzi et al. [12]</td>
<td>Italy</td>
<td>2013</td>
<td>41</td>
<td>HD</td>
<td>IVC</td>
<td>Interstitial lung disease, NYHA class IV</td>
</tr>
<tr>
<td>Panuccio et al. [15]</td>
<td>Italy</td>
<td>2012</td>
<td>88</td>
<td>PD</td>
<td>NYHA class, BIA</td>
<td>None</td>
</tr>
<tr>
<td>Basso et al. [16]</td>
<td>Italy</td>
<td>2013</td>
<td>30</td>
<td>HD</td>
<td>BIA, NYHA, pro-BNP</td>
<td>Interstitial lung disease, NYHA class IV</td>
</tr>
<tr>
<td>Siriopol et al. [17]</td>
<td>Romania</td>
<td>2013</td>
<td>96</td>
<td>HD</td>
<td>BIA, NYHA</td>
<td>Cancer, pacemakers, cardiac stents, amputation, decompensated cirrhosis</td>
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<tr>
<td>Zoccali et al. [18]</td>
<td>Italy</td>
<td>2013</td>
<td>392</td>
<td>HD</td>
<td>NYHA</td>
<td>None</td>
</tr>
<tr>
<td>Vitturi et al. [19]</td>
<td>Italy</td>
<td>2014</td>
<td>71</td>
<td>HD</td>
<td>BIA, IVC</td>
<td>Interstitial lung disease, NYHA class III/IV</td>
</tr>
<tr>
<td>Donadio et al. [20]</td>
<td>Italy</td>
<td>2015</td>
<td>31</td>
<td>HD</td>
<td>BIA, pro-BNP</td>
<td>Interstitial lung disease</td>
</tr>
<tr>
<td>Paudel et al. [21]</td>
<td>UK</td>
<td>2015</td>
<td>27</td>
<td>PD</td>
<td>BIA, pro-BNP</td>
<td>None</td>
</tr>
<tr>
<td>Saad et al. [22]</td>
<td>USA</td>
<td>2015</td>
<td>41</td>
<td>HD</td>
<td>NYHA class</td>
<td>None</td>
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<tr>
<td>Siriopol et al. [23]</td>
<td>Romania</td>
<td>2016</td>
<td>173</td>
<td>HD</td>
<td>BIA</td>
<td>Cancer, pacemakers, cardiac stents, amputation, decompensated cirrhosis</td>
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</table>
Persistent pulmonary congestion before discharge predicts rehospitalization in heart failure: a lung ultrasound study


Fig 2 Kaplan-Meier survival curves in HF patients stratified according to the number of B-lines before discharge, at 6-months follow-up
Lung US – Base
Lung US – Effusion
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PSLA

- Qualitative assessment of LV function
- Effusion
• Qualitative assessment of LV function
• LV vs. RV wall thickness
• Can fan probe to view wall motion of apex, mitral valve, and aortic valve.
Apical 4-Chamber

- Effusion and Tamponade
- Chamber size Comparison
- Advanced Doppler studies
- Chamber size evaluation
- TV and MV evaluation
Subcostal

- Effusion and Tamponade
- Chamber size Comparison (with correct axis)
Pericardial Effusion
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Mr. Jones presents to the dialysis unit for his regularly scheduled treatment. He has been doing well overall and has not missed treatments. While getting him set up, the nurse calls you over to examine his fistula, which she notes has a weaker thrill than usual. He is otherwise feeling well and vitals are stable.
Current Concepts

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Nephrology

Vascular access for dialysis
Access Assessment

- Maturity
- Flow/Obstruction
- Topography
- Real-time cannulation
- Fluid collection
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Questions?
Acknowledgement and Gratitude

- Dr. Cameron Baston, Department of Pulmonary and Critical care, University of Pennsylvania
- Dr. Nova Panebianco, Department of Emergency Medicine, University of Pennsylvania
- Penn Emergency Ultrasound (@PennUltrasound)
- Dr. Kambiz Kalantari, Department of Nephrology, UVA