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Title: The Application of Point-of-Care Ultrasonography (POCUS) in the Management of Acute Respiratory Distress Syndrome (ARDS) in the Intensive Care Unit

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Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **Yes, all done**

Videographer: Please film the screen of the instrument for all shots labelled SCREEN/SCOPE as backup

3. **Filming location:** Will the filming need to take place in multiple locations? **No**

4. **Testimonials (optional):** Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **Yes**

Current Protocol Length

Number of Steps: 14
Number of Shots: 32

Introduction

INTRODUCTION:

1.1. **Pengpeng Chen:** We have organized the standardized procedures for performing POCUS on ARDS patients in the intensive care unit.

1.1.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B.roll:3.1*

What are the most recent developments in your field of research?

1.2. **Pengpeng Chen:** Bedside ultrasound technology has developed rapidly in multiple fields, yet there is a lack of standardized research specifically targeting patients with ARDS.

1.2.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

CONCLUSION:

What significant findings have you established in your field?

1.3. **Pengpeng Chen:** We have established that a comprehensive POCUS protocol enables real-time, multi-system assessment to guide personalized management of ARDS in the ICU.

1.3.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B.roll:4.1*

What research gap are you addressing with your protocol?

1.4. **Pengpeng Chen:** Our protocol addresses the gap in standardized, multi-organ POCUS guidelines for dynamic monitoring and intervention in ARDS, beyond isolated lung ultrasound scoring.

1.4.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B.roll:4.2*

What questions will future research focus on?

1.5. **Pengpeng Chen:** Future research will focus on standardizing training, validating POCUS-driven therapeutic algorithms, and exploring its utility in resource-limited settings.

1.5.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

Testimonial Questions (OPTIONAL):

Videographer: Please capture all testimonial shots in a wide-angle format with sufficient headspace, as the final videos will be rendered in a 1:1 aspect ratio. Testimonial statements will be presented live by the authors, sharing their spontaneous perspectives.

How do you think publishing with JoVE will enhance the visibility and impact of your research?

1.6. **Pengpeng Chen, SRRSH Emergency Physician** : (authors will present their testimonial statements live)

1.6.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

Can you share a specific success story or benefit you've experienced—or expect to experience—after using or publishing with JoVE? (This could include increased collaborations, citations, funding opportunities, streamlined lab procedures, reduced training time, cost savings in the lab, or improved lab productivity.)

1.7. **Pengpeng Chen, SRRSH Emergency Physician**: (authors will present their testimonial statements live)

1.7.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

Ethics Title Card

This research has been approved by the Ethics Committee at Sir Run Run Shaw Hospital, Zhejiang University School of Medicine

2. Ultrasound Assessment of Pleural Artifacts and Lung Consolidations in the Intercostal View

Demonstrator: Pengpeng Chen

Videographer: Please film the screen of the instrument for all shots labelled SCREEN/SCOPE as backup

2.1. To begin, perform a longitudinal scan in the intercostal space and locate the pleural line approximately 0.5 centimeters below the rib line, visible as a hyperechoic horizontal line **[1]**. Identify A-lines as horizontal hyperechoic artifacts of the pleural line, indicative a high gas-volume ratio beneath the pleura **[2]**.

2.1.1. WIDE: Talent performing a longitudinal ultrasound scan between the ribs to locate the pleural line.

2.1.2. SCREEN/SCOPE: 2.1-2.2.mp4 00:00-00:08
And
2.1.2Aline.png
Video Editor: Please play both files side by side in a split screen

2.2. Using M-mode, check for the presence of the seashore sign indicating normal lung sliding, or the stratosphere sign indicating absent lung sliding suggestive of pneumothorax **[1]**. Then identify B-lines as vertical hyperechoic artifacts originating from the pleural line that extend to the bottom of the screen and erase the A-lines **[2]**.

2.2.1. SCREEN/SCOPE: 2.1-2.2.mp4 00:08-00:29
And
2.2.1seashoresign.png
Video Editor: Please play both files side by side in a split screen

2.2.2. SCREEN/SCOPE: 2.1-2.2.mp4 00:30-00:48
And
2.2.2stratospheresign.png
Video Editor: Please play both files side by side in a split screen

2.3. Now check for the shred sign, represented by subpleural hypoechoic areas with irregular boundaries, indicating small consolidations. Look for a tissue-like pattern in areas of large consolidation, characterized by liver-like echogenicity **[1]**.

2.3.1. LAB MEDIA: 2.3shred-sign-and-liver-like-echotexture.png

~~2.3.2. SCREEN/SCOPE: Ultrasound showing large consolidation area with liver-like echotexture.~~

3. Focused Ultrasound Evaluation of Right Heart Function, Diaphragm, and Abdominopelvic Vascular Anatomy

3.1. Use a right ventricular-focused apical four-chamber view **[1]**. At end-diastole, trace the right ventricular endocardial border to measure the end-diastolic area **[2]**.

3.1.1. Talent positioning the ultrasound probe for a right ventricular-focused apical four-chamber view.

3.1.2. SCREEN/SCOPE: 3.1-3.2.mp4 00:22-00:35
AND
3.1.2RV-tracing.png
Video Editor: Please play both files side by side in a split screen

3.2. Measure the right ventricular free wall thickness at end-diastole **[1-TXT]**. Now, use the M-mode to measure tricuspid annular plane systolic excursion **[2-TXT]**. Measure the inferior vena cava diameter and collapsibility during a sniff **[3-TXT]**.

3.2.1. SCREEN/SCOPE: 3.1-3.2.mp4 00:41-00:55 **AND**
3.2.1RV-thickness.png
Video Editor: Please play both files side by side in a split screen
. **TXT: Thickness < 5 mm : Normal, > 5 mm : Hypertrophy**

3.2.2. SCREEN/SCOPE: 3.1-3.2.mp4 01:08-01:17
AND
3.2.2TAPSE.png
Video Editor: Please play both files side by side in a split screen
TXT: Normal values are ≥ 15 mm; <15 mm : Abnormal

3.2.3. SCREEN/SCOPE: 3.1-3.2.mp4 01:22-01:34
AND
3.2.3inferior-vena.png
Video Editor: Please play both files side by side in a split screen
TXT: Normal diameter < 2.1 cm or > 50% collapsibility; > 2.1 cm or < 50% collapsibility: Abnormal

3.3. Next, identify the diaphragm as a three-layered structure with a hypoechoic muscle layer between hyperechoic pleural and peritoneal lines **[1]**. Record B-mode clips or still images during end-inspiration and end-expiration **[2]**. Then measure the diaphragm thickness from the middle of the pleural line to the middle of the peritoneal line **[3]**.

3.3.1. SCREEN/SCOPE: 3.3.1-3.4.1.mp4 00:00-00:17 .

3.3.2. SCREEN/SCOPE: 3.3.1-3.4.1.mp4 00:18-00:22.

3.3.3. SCREEN/SCOPE: 3.3.1-3.4.1.mp4 00:22-00:25.
AND
3.3.1-and-3.3.3diaphragm-and-measurement.png.

3.4. Now, place the probe sagittal below the right costal margin, between the midclavicular and anterior axillary lines to scan the right diaphragm **[1]**. Then, place the probe sagittal below the left costal margin, between the anterior and mid-axillary lines to scan the left diaphragm **[2]**.

3.4.1. Talent placing the probe sagittally below the right costal margin.
AND
SCREEN/SCOPE: 3.3.1-3.4.1.mp4 00:26-00:30
Video Editor: Please play both shots side by side

3.4.2. Talent repositioning the probe sagittally below the left costal margin.
AND
SCREEN/SCOPE: 3.4.2.mp4. 00:14-00:40
Video Editor: Please play both shots side by side

3.5. For femoral vein assessment, place the patient in a supine position with hips externally rotated into the frog-leg position to optimize exposure **[1]**. For popliteal vein evaluation, maintain the knee in slight flexion between 15 and 30 degrees to avoid venous compression **[2]**. In obese patients, use lateral decubitus or prone positioning to improve acoustic access and tissue displacement when standard views are inadequate **[3]**.

3.5.1. Talent positioning the patient in the frog-leg posture.

3.5.2. Talent slightly flexing the patient's knee for popliteal vein scanning.

3.5.3. Talent adjusting the patient into lateral decubitus position for better ultrasound access.

3.6. Start scanning the femoral zone at the inguinal crease to identify the common femoral vein **[1]**. Move the probe distally to visualize the junction of the femoral vein and the deep femoral vein **[2]**. Compress the vein every centimeter along its course to assess venous compressibility **[3]**.

3.6.1. SCREEN/SCOPE: 3.6-3.7.mp4. 00:04-00:19

3.6.2. SCREEN/SCOPE: 3.6-3.7.mp4. 00:20-00:34

3.6.3. Talent compressing the vein incrementally every 1 centimeter while scanning.

3.7. Scan the popliteal zone from the popliteal vein to the confluence of the anterior tibial, posterior tibial, and peroneal veins **[1]**. Compress the vein every 1 centimeter to confirm full compressibility **[2]**.

3.7.1. SCREEN/SCOPE: 3.6-3.7.mp4. 00:38-00:51

3.7.2. Talent applying compression at 1-centimeter intervals along the scanned region.

3.8. Identify the liver as the cephalad structure located on the left side of the screen **[1]**. Locate the aorta or inferior vena cava and adjust the imaging depth to visualize their posterior boundaries or the vertebral body **[2]**. Sweep the probe laterally from left to right while keeping it perpendicular to the skin **[3]**.

3.8.1. SCREEN: 3.8-3.11.mp4. 00:00-00:11

3.8.2. LAB MEDIA: 3.8.2.JPG.

3.8.3. Talent sweeping the probe laterally across the abdomen while maintaining vertical probe orientation.

3.9. Identify the stomach, liver, pancreas, superior mesenteric artery, aorta, and inferior vena cava **[1]**. Use the supine position to assess gastric fullness, noting that it cannot exclude the presence of contents **[2]**.

3.9.1. LAB MEDIA: 3.9.1.JPG

3.9.2. Talent scanning the patient in supine position to assess gastric antrum.

3.10. Place the patient in the right lateral decubitus position to allow gravitational flow of gastric contents into the antrum for more accurate volume measurement **[1-TXT]**.

3.10.1. Talent repositioning the patient into right lateral decubitus position. **TXT: Repeat scan and adjust imaging depth if necessary**

3.11. Measure the cross-sectional area of the gastric antrum at the level of the aorta, to avoid underestimation of volume **[1]**. Ensure the aorta is correctly identified during measurement **[2]**.

3.11.1. SCREEN: 3.8-3.11.mp4 00:12-00:29

3.11.2. LAB MEDIA: 3.11.JPG

Results

4. Results

4.1. Representative ultrasound images showed normal pulmonary findings, including visible pleural lines, A-lines, and the seashore sign **[1]**. The presence of fewer than three B-lines per intercostal space was observed **[2]**, but the concurrent appearance of a shred sign indicated focal pulmonary consolidation **[3]**.

4.1.1. LAB MEDIA: Figure 1A-C *Video editor: Please highlight A, B and C sequentially.*

4.1.2. LAB MEDIA: Figure 1D. *Video editor: Highlight the vertical line labeled "B-line" in the ultrasound image.*

4.1.3. LAB MEDIA: Figure 1D. *Video editor: Highlight the label "Shred sign" in the upper region of the image.*

4.2. A stratosphere sign was observed, characterized by static horizontal lines and absence of the seashore sign, indicating pneumothorax **[1]**. Ultrasound imaging showed pleural effusion with accompanying pulmonary consolidation as evidenced by air bronchogram signs **[2]**. Varying degrees of pleural effusion accumulation were observed in two cases **[3]**.

4.2.1. LAB MEDIA: Figure 2. *Video editor: Please highlight A*

4.2.2. LAB MEDIA: Figure 2. *Video editor: Please highlight B*

4.2.3. LAB MEDIA: Figure 2. *Video editor: Please highlight C and D*

4.3. Echocardiography revealed clear visualization of cardiac chambers including both atria and ventricles **[1]**.

4.3.1. LAB MEDIA: Figure 3. *Video editor: Please sequentially highlight the images from A to E*

4.4. Diaphragm motion patterns were evaluated **[1]**. Ultrasound assessment of the lower extremity veins showed compressibility testing at the common femoral vein and the popliteal vein **[2]**.

4.4.1. LAB MEDIA: Figure 4

4.4.2. LAB MEDIA: Figure 5 *Video Editor: Please sequentially highlight A and B*

4.5. Ultrasound of the stomach showed an empty stomach with a bulls-eye appearance and minimal clear basal secretions **[1].** Repositioning the patient in right lateral decubitus allowed the gastric contents to gravitate toward the antrum **[2].**

4.5.1. LAB MEDIA: Figure 6 A

4.5.2. LAB MEDIA: Figure 6 B

Pronunciation Guide:

- **POCUS (Point-of-Care Ultrasound)**

Pronunciation link: https://www.howtopronounce.com/pocus How To Pronounce
IPA: /ˈpoʊkəs/
Phonetic Spelling: POH-kus

- **ARDS (Acute Respiratory Distress Syndrome)**

Pronunciation link: https://dictionary.cambridge.org/us/pronunciation/english/ards Cambridge Dictionary
IPA: /ˌeɪˈɑrdiːˈɛs/ (or /ˌeɪˌɑrdiːˈɛs/)
Phonetic Spelling: AY-AR-DEE-ES

- **Intercostal**

IPA: /ˌɪntərˈkɒstəl/
Phonetic Spelling: in-ter-KOS-tuhl

- **Hyperechoic**

IPA: /ˌhaɪpərˈɛkoʊɪk/
Phonetic Spelling: hy-per-ECK-oh-ik

- **Seashore sign**
  - ***Seashore* IPA: /ˈsiːˌʃɔr/**
    Phonetic: SEE-shore
  - ***Sign* IPA: /saɪn/**
    Phonetic: sign
- **Stratosphere sign**
  - ***Stratosphere* IPA: /ˈstrætəˌsfɪr/**
    Phonetic: STRAT-uh-sfear
  - ***Sign* as above**
- **Shred sign**
  - ***Shred* IPA: /ʃrɛd/**
    Phonetic: SHRED
  - ***Sign* as above**
- **Consolidation**

IPA: /kənˌsɒlɪˈdeɪʃən/
Phonetic Spelling: kun-SOL-i-DAY-shuhn

- **Echogenicity / Echotexture**
  - ***Echogenicity* IPA: /ˌɛkoʊdʒəˈnɪsɪti/**
    Phonetic Spelling: eh-koh-juh-NISS-ih-tee
  - ***Echotexture* IPA: /ˌɛkoʊˈtɛkstʃər/**
    Phonetic Spelling: eh-koh-TEK-sture
- **Tricuspid annular plane systolic excursion (TAPSE)**
  - ***Tricuspid* IPA: /traɪˈkʌspɪd/**
    Phonetic Spelling: try-KUS-pid
  - ***Annular* IPA: /ˈænjələr/**
    Phonetic Spelling: AN-yu-ler

- ***Plane*** **IPA: /pleɪn/**
  Phonetic Spelling: plane
- ***Systolic*** **IPA: /sɪˈstɒlɪk/**
  Phonetic Spelling: sis-TOL-ik
- ***Excursion*** **IPA: /ɪkˈskɜrʒən/**
  Phonetic Spelling: ik-SKUR-zhun