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Title: Ultrasonographic Assessment During Cardiopulmonary Resuscitation

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Author Questionnaire

1. Microscopy: Does your protocol involve video microscopy? **N**

2. Software: Does the part of your protocol being filmed demonstrate software usage? **N**

3. Filming location: Will the filming need to take place in multiple locations (greater than walking distance)? **N**

NOTES from Videographer:
The room had all green walls and so had a very green tint to everything, tried to compensate for it as much as I could.
Client was in a rush, so had to try to get everything done in just 2h

Introduction

1. Introductory Interview Statements

REQUIRED:

1.1. **Wan-Ching Lien**: The US-CAB protocol is a simple, structured ultrasonographic protocol that can be performed during resuscitation. It was named after the C-A-B steps in the advanced life support guidelines **[1]**.

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

REQUIRED:

1.2. **Wan-Ching Lien**: The US-CAB protocol can be used in real resuscitation scenarios, as it is easy to perform and has a positive impact on patient outcomes **[1]**.

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

Introduction of Demonstrator on Camera

1.3. **Wan-Ching Lien:** Demonstrating the procedure will be Chih-Hsien Wu, a physician from my hospital.

1.3.1. INTERVIEW: Author saying the above.

1.3.2. The named demonstrator(s) looks up from workbench or desk or microscope and acknowledges the camera.

Ethics Title Card

1.4. Procedures involving human subjects have been approved by the Institutional Review Board (IRB) at National University Taiwan Hospital.

Protocol

2. Personnel and Roles

2.1. Ideally, a resuscitation team should be comprised of a leader **[1]**, a member for airway management and ventilation **[2]**, a member for chest compressions **[3]**, a member for defibrillation **[4]**, a member for intravenous catheterization and medication **[5]**, and a recorder **[6]**.

2.1.1. WIDE: Leader raising hand/waving or nodding head or similar

2.1.2. Airway management member checking ventilator and/or waving or nodding near ventilation equipment

2.1.3. Chest compression member doing mock chest compression and/or waving or nodding

2.1.4. Defibrillation member checking defibrillator and/or waving or nodding near defibrillator

2.1.5. Intravenous management member checking i.v. lines or similar and/or nodding or waving near i.v. pole

2.1.6. Recorder with tablet or similar nodding and/or waving **TEXT: If personnel limited, overlap roles**

2.2. A sonographer should also be present as an independent member of the team who is well trained and experienced in resuscitation ultrasound **[1-TXT]** and who can intervene and interpret the ultrasound images in a timely manner without interrupting or delaying the resuscitation efforts **[2-TXT]**.

2.2.1. Sonographer nodding or waving near US equipment **TEXT: Use portable US equipped with 2-5 MHz curvilinear probe**

2.2.2. Sonographer at US, looking at/indicating images, with monitor visible in frame **TEXT: Leader can also be sonographer**

3. Cardiopulmonary Resuscitation (CPR): Ultrasound, Circulation/Airway/Breathing (US-CAB)

3.1. When ultrasound is to be integrated into the CPR process, place a portable ultrasound

machine in the caudal region of the patient **[1]** and set an alarm for every 2 minutes for CPR and every 10 seconds for pulse checks **[2]** to restrict the hands-off interval for pulse checks-rhythm analysis and simultaneous ultrasound evaluation to no longer than 10 seconds **[3-TXT]**.

3.1.1. WIDE: Talent placing machine caudal to Patient
3.1.2. Talent setting timer
3.1.3. Talent performing/demonstrating CPR **TEXT: Perform all resuscitation procedures according to ALS guidelines**

3.2. At the start of CPR and at the end of the first five cycles of chest compressions **[1-TXT]**, use the subxiphoid four-chamber view to check for pericardial effusion, the size of the right and left ventricles, and sonographic cardiac activity **[2]**.

3.2.1. Talent placing probe onto chest *Videographer: Important step* **TEXT: US-C** Videographer NOTE: File A0007766 is slated as 3.2.1A but is actually shot 3.3.1
3.2.2. LAB MEDIA: 3.2.2 subxiphoid view

3.3. Then turn the probe 90 degrees parallel to the long axis of the Patient **[1]** to measure the diameter of the inferior vena cava **[2]**.

3.3.1. Probe being turned. Videographer NOTE: File A0007767 is slated as 3.3.1 but is actually shot 3.4.1
3.3.2. LAB MEDIA: 3.3.2.IVC *Video Editor: please add diameter measurements as in 3.2.2.IVC diameter*

3.4. To check the endotracheal tube location after intubation, place the probe transversely at the suprasternal notch **[1-TXT]** and note the one air-mucosal interface with one comet-tail artifact for tracheal intubation **[2-TXT]**.

3.4.1. Probe being placed *Videographer: Important step* **TEXT: US-A**
3.4.2. LAB MEDIA: 3.4.2.trachea **TEXT: Single tract sign**

3.5. Move the probe to the lateral side of the neck **[1]** to reconfirm the single tract sign **[2]** and reintubate if there are two air-mucosal interfaces with two comet-tail artifacts **[2-TXT]**.

3.5.1. Probe being moved
3.5.2. LAB MEDIA: Shot of single tract sign NOTE: Uploaded to project page
3.5.3. LAB MEDIA: 3.5.3_double tract sign **TEXT: Double tract sign**

3.6. To check for proper ventilation, place the probe on both sides of the chest at the 4th to 5th intercostal spaces over the midaxillary line **[1-TXT]** and look for lung sliding to

evaluate the pulmonary ventilation **[2]**.

3.6.1. Talent placing probe *Videographer: Important step* **TEXT: US-B**
3.6.2. LAB MEDIA: 3.6.2_3.7.2_lung sliding: 00:00-00:06

3.7. If lung sliding is absent on one side, adjust the depth of the endotracheal tube **[1]** until bilateral lung sliding is noticed **[2]**.

3.7.1. Tube being adjusted
3.7.2. LAB MEDIA: 3.6.2_3.7.2_lung sliding: 00:07-00:13

3.8. Then repeat the cardiac ultrasound every 2 minutes when chest compression is stopped for pulse checks **[1]**.

3.8.1. Talent stopping compression, then other Talent immediately placing probe

3.9. Continue to repeat the airway and breathing ultrasounds after patient transport and bed transfer **[1]**.

3.9.1. Talent placing probe, with portable ultrasound visible in frame

Protocol Script Questions

A. Which steps from the protocol are the most important for viewers to see?

3.2., 3.4., 3.6.

B. What is the single most difficult aspect of this procedure and what do you do to ensure success?

n/a

Results

4. Results: Representative US-CPR Assessment

4.1. If compression of the right atrium and ventricle is noted during cardiac ultrasound with subxiphoid evaluation **[1]**, pericardiocentesis is indicated and should be performed immediately **[2]**.

4.1.1. LAB MEDIA: Figure 3A *Editor: please add white arrow as in original Figure*
4.1.2. LAB MEDIA: Figure 3A

4.2. Pericardial effusion is also of diagnostic value **[1]**. If the echogenicity is high or blood clots are present in the pericardial sac, the etiology could indicate serious complications **[2]**.

4.2.1. LAB MEDIA: Figure 3A *Video Editor: please add white text or emphasize area indicated by white text as in original Figure*
4.2.2. LAB MEDIA: Figure 3A

4.3. Cardiac ultrasound with subxiphoid evaluation of the inferior vena cava can be demonstrated by a vertical approach **[1]** and visual identification of the inferior vena cava diameter helps assess the fluid status of the patient **[2]**.

4.3.1. LAB MEDIA: Figure 3B
4.3.2. LAB MEDIA: Figure 3B *Video Editor: please add IVC text as in original Figure*

4.4. The inferior vena cava can also be evaluated in the subxiphoid transverse view **[1]**.

4.4.1. LAB MEDIA: Figure 3C *Video Editor: please add IVC text as in original Figure*

4.5. Cardiac ultrasound with subxiphoid verification of the descending abdominal aorta can be approached via a vertical **[1]** or transverse view **[2]**.

4.5.1. LAB MEDIA: Figures 3C and Figure 3D *Video Editor: please add white text and arrow as in original Figure 3D*
4.5.2. LAB MEDIA: Figures 3C and 3D *Video Editor: please add white text and arrowhead as in original Figure 3C*

4.6. This optional evaluation is recommended if aortic dissection is suspected from clinical presentation **[1]** or when hemopericardium is observed by cardiac ultrasound cardiac evaluation **[2]**.

4.6.1. LAB MEDIA: Figure 3A
4.6.2. LAB MEDIA: Figure 3A *Video Editor: please add/emphasize white as in original Figure*

4.7. Endotracheal intubation is confirmed if a single tract sign is observed **[1]**. If there is a double tract sign, esophageal intubation is highly likely **[2]**.

4.7.1. LAB MEDIA: Figure 4A *Video Editor: please add white star as in original Figure 4A*
4.7.2. LAB MEDIA: Figure 4A

4.8. Breathing ultrasound is usually performed immediately after airway ultrasound when auscultation or capnography is being performed **[1]**, but it can also be performed any time during CPR when displacement of the endotracheal tube with one lung intubation is suspected **[2]** or when specific etiologies, such as pneumothorax or hemothorax, need to be ruled out **[3]**.

4.8.1. LAB MEDIA: Figure 4B
4.8.2. LAB MEDIA: Figure 4B *Video Editor: please emphasize left image*
4.8.3. LAB MEDIA: Figure 4B *Video Editor: please emphasize right image*

Conclusion

5. Conclusion Interview Statements

5.1. **Wan-Ching Lien**: Although the scanning sequence is arbitrarily organized, the order can be changed according to the experience of the sonographer **[1]**.

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

5.2. **Wan-Ching Lien**: Focused training and continued practice are essential to minimizing pauses in the chest compressions during ultrasound. Maintaining a good image quality during resuscitation is important issue for future study **[1]**.

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