

Critical Care Ultrasonography

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Disclosures

None

Critical Care Ultrasonography

Why?

- Commonly used outside of the United States
- Immediate diagnostic information
- To guide ICU procedures
- Fast learning curve
- Cost advantage
- Reduces need for other imaging modality
- An extension of standard bedside assessment methods

Critical Care Ultrasonography

Who?

- All interested PCCM clinicians
- Full-time bedside intensivist
- The clinician in charge of the case
- No technician, no radiologist

Critical Care Ultrasonography Where?

- In the ICU
- In the procedure room
- For floor consults
- Portable units permit
hospital wide use

Critical Care Ultrasonography When?

- Immediately
- Repeatedly
- Whenever indicated
- With ICU based machine

Critical Care Ultrasonography

How?

- Triad of training:
- Cognitive base
- Image interpretation
- Image acquisition
- Self motivated learning

Basic Principles

- The examination is performed by the clinician at the bedside of the patient
- The examination is interpreted by the clinician at the bedside of the patient
- The results are immediately applied at the bedside of the patient
- The examination may be limited in scope and repeated as needed

The Problem With Standard Ultrasonography

- Time disassociation
- Clinical disassociation
- Static image interpretation
- One time examination

The Modular Approach to Training

- Vascular: access guidance
- Vascular: diagnostic
- Thoracic: (pleural/lung)
- Abdominal: limited
- Cardiac: basic/advanced

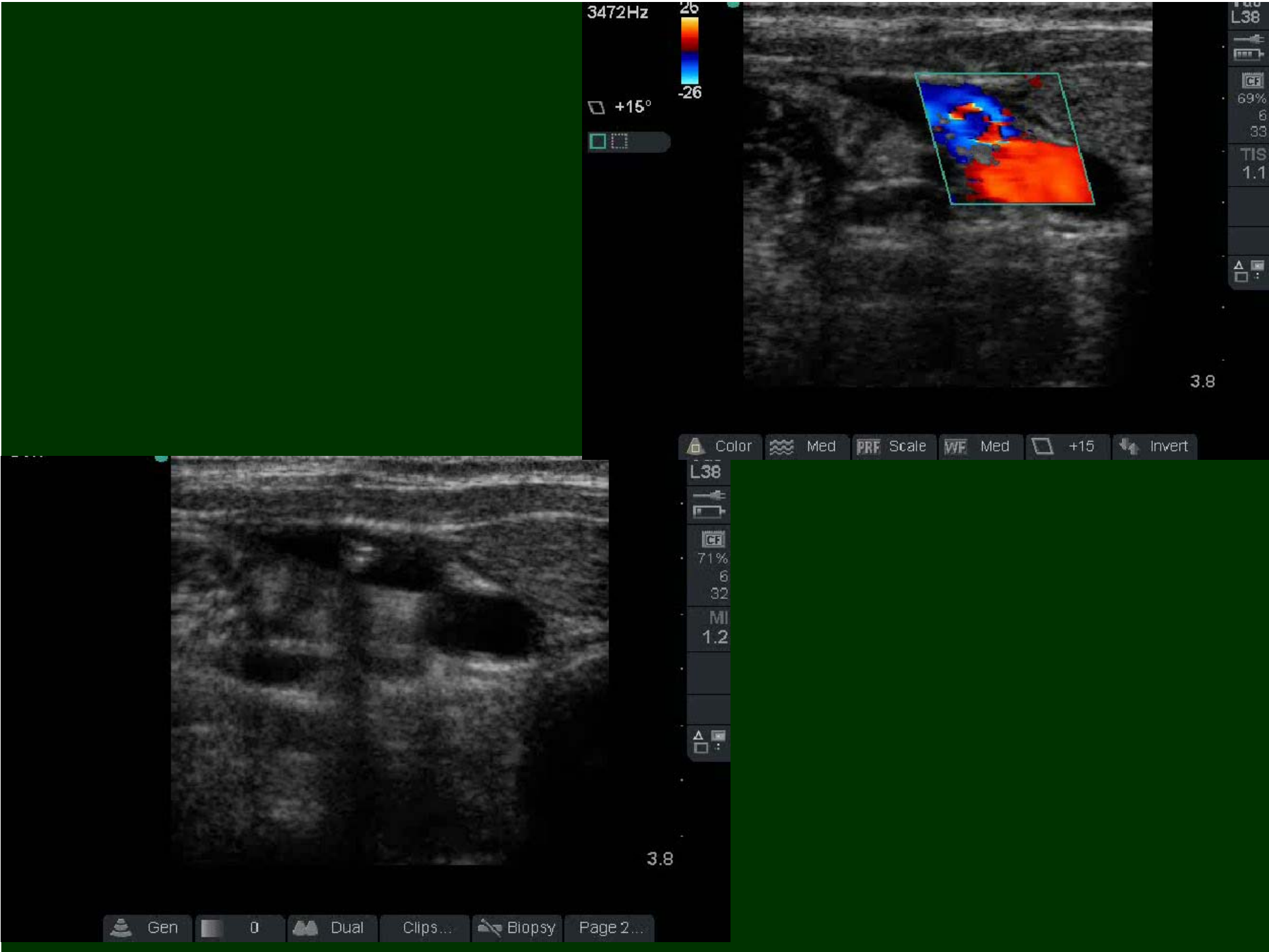
Ultrasound Guided Vascular Access

Why not identify the target vessel with ultrasonography, instead of using landmark technique?

The Evidence

- IJ position: US guidance increases success rate and reduces complication rate
- Subclavian position: older studies showed no benefit. Newer studies show superiority of US guidance
- Femoral position: like IJ
- Peripheral veins: higher success rate for “difficult” access
- Arterial access: has utility





Diagnostic Vascular Ultrasonography for DVT

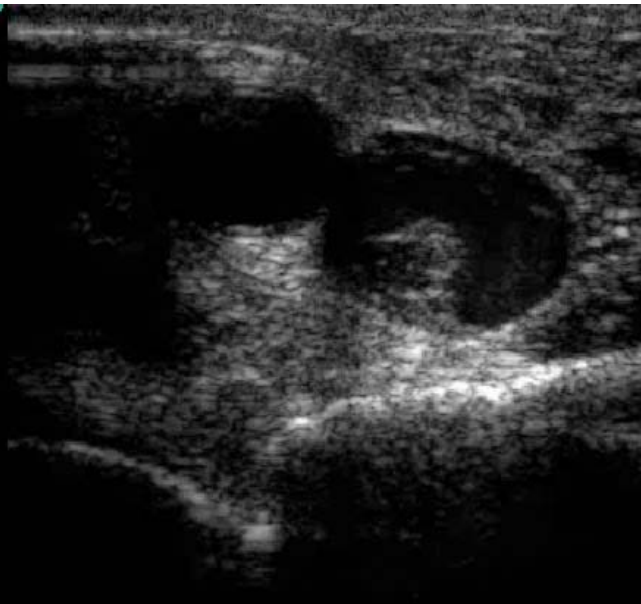
Why not determine whether the
patient has DVT yourself?

Why Would an Intensivist Want to Diagnose DVT at the Bedside?

- Useful information in patients with hemodynamic and/or respiratory failure
- Avoids delay in diagnosis
- Reduces cost
- May avoid risk of transport
- A key element to comprehensive US screening approach to the critically ill

Does the Patient Have DVT?

- Visible clot is diagnostic
- Lack of compressibility is diagnostic
- Full compressibility is strong evidence of lack of DVT
- Problems: edema, obesity, femoral vascular access, wounds
- The solution: reject suboptimal image quality



VAS
L38
60%
60
143
MI
1.2



3.8

Gen 0 Dual Clips... Biopsy Page 2...

VAS
L38
60%
60
143
MI
1.2

Gen 0 Dual Clips... Biopsy Page 2...

Pleural Ultrasonography

Easy to Learn
Immediate Clinical Application
To Guide Intervention

Is There a Pleural Effusion?

Three Cardinal Features

- An echo free space
- Typical anatomic boundaries
- Typical dynamic changes



Lung Ultrasonography

- Easy to Learn
- Strong Clinical Utility

Advantages of Lung Ultrasonography

- Immediate bedside availability
- Immediate bedside repeatability
- Rapid goal directed application
- Cost saving
- Reduction in radiation exposure

Lung

- Pneumothorax
- Consolidation
- Interstitial syndrome
- Normal aeration
- Superior to supine MICU CXR
- Competitive with CT
- Immediate bedside application

Lung Ultrasonography Compared to Chest Radiography The Evidence

- Supine chest radiographs in the ICU yield non-specific opacity pattern
- Lung ultrasonography is superior to supine portable chest radiographs for detection of PTX, normal aeration pattern, alveolar-interstitial pattern, consolidation, and pleural effusion

Lung Ultrasonography Compared to Chest CT

- Lung ultrasonography is similar in yield to chest CT for detection of PTX, normal aeration pattern, alveolar-interstitial pattern, consolidation, and pleural effusion
- Lichtenstein D et al. Comparative diagnostic performances of auscultation, chest radiography, and lung ultrasonography in acute respiratory distress syndrome. *Anesthesiology*. 2004;100:9-15.

To Clarify the Ambiguous Chest Radiograph

- Rotated, poorly penetrated, supine CXR
- Confusing summation artifact
- ? pulmonary edema, pleural effusion, consolidation, technical artifact, PTX
- Just take out the transducer

To Rule Out Pneumothorax

- Pre and post procedure
- In the rapid evaluation of the acutely dyspneic patient
- In the rapid evaluation of sudden worsening of patient on ventilatory support
- In the trauma room

Rapid Evaluation of Acute Dyspnea

Abdominal Ultrasonography

- Full competence in abdominal US is neither necessary nor practical
- Rather, the intensivist should focus on goal directed abdominal US

Abdominal CT is an Excellent Imaging Modality, but....

- It may be delayed
- It is not a bedside technique and requires transport of the unstable patient
- It involves radiation exposure
- It is costly
- It cannot performed frequently
- It may require contrast

What to Learn?

Goal Directed Abdominal US

- Identification of intrabdominal fluid
- Rule out free air: sliding gut
- Rule out peritonitis/ischemic bowel
- Identify AAA
- Identify urinary tract obstruction
- Identify gross abnormality of intrabdominal organs















Critical Care Cardiac Ultrasonography

- Hemodynamic failure is a common problem in the ICU
- Respiratory failure may be a manifestation of cardiac failure
- Echocardiography has obvious application in evaluation of the critically ill with cardio-pulmonary failure

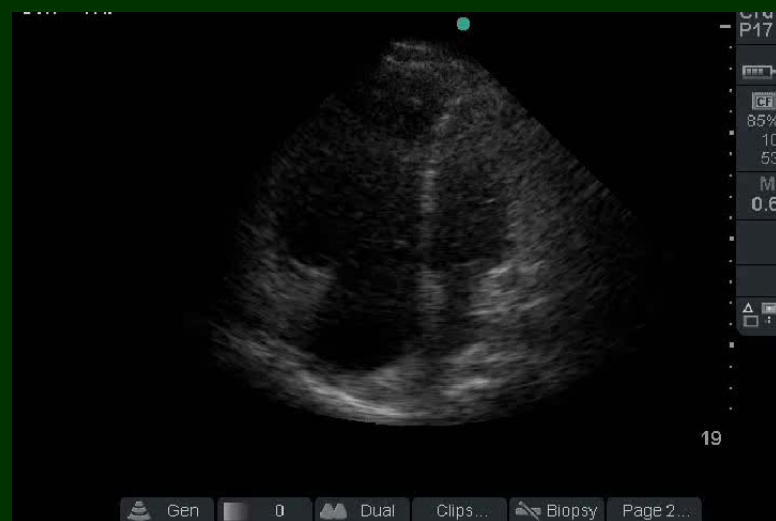
Peri-Resuscitation Echocardiography

- Limited examination to evaluate etiology of shock state: LV function, LV/RV size, tamponade, major valve failure
- Emphasis on ruling out causes of shock that are life threatening
- Guiding volume/inotrope use
- Full echo may still follow
- May be combined with rapid US of other organ systems

Evaluation of Shock

- Obstructive: tamponade/ACP
- Hypovolemic: preload sensitivity
- Cardiogenic: LV fxn/valves
- Distributive
- Inotropes/pressors/volume
- Repeated examination to guide ongoing management

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Training In CCUS

- The triad: cognitive, interpretation, and image acquisition
- Cognitive: courses, journals, books
- Image interpretation: requires review of multiple studies with expert guidance
- Image acquisition: requires heavy hands on scanning training
- Favors autodidactic self motivated learning

CHEST

Official publication of the American College of Chest Physicians



American College of Chest Physicians/La Societe de Reanimation de Langue Francaise Statement on Competence in Critical Care Ultrasonography

Paul Mayo, Yannick Beaulieu, Peter Doelken, David Feller-Kopman, Christopher Harrod, Adolfo Kaplan, John Oropello, Antoine Vieillard-Baron, Olivier Axler, Daniel Lichtenstein, Eric Maury, Michel Slama and Philippe Vignon

Chest; Prepublished online February 2, 2009;
DOI 10.1378/chest.08-2305

The online version of this article, along with updated information and services can be found online on the World Wide Web at:
<http://www.chestjournal.org/content/early/2009/02/02/chest.08-2305>

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CCUS Training in USA

- Probably 6,000-8,000 “frontline” attending intensivists in need of training
- About 1000 fellows per year for training
- Marked increase in number of machines
- Very strong interest in training from attendings and fellows

Two Populations

- Fellows: training under control of program directors
- Competence assumed if program director approves
- The challenge is to train the trainers
- Attendings: in great need of effective training to assure competence and to obtain hospital credentials

A Unique Opportunity in HK

- A cooperative community of intensivists
- A relatively small group of fellows
- A highly motivated core faculty group
- A strong tradition of pragmatic critical care: bedside clinicians rule!

Step 1

- Equipment acquisition
- Every ICU needs a portable machine
- That can be dropped, cleaned, carried, and replaced under no cost warranty
- No high end Doppler needed
- With vascular and cardiac transducer

Step 2

- Train an attending in each hospital to high skill level
- You have this capability

Step 3

- Mandatory training in CCUS for all fellows
- Starting with comprehensive 3 day course for all fellows
- Followed by hospital based training throughout fellowship

Step 4

- Smooth introduction of ultrasonography into clinical operations
- 2-3 years: maximum