Critical Care Ultrasound

Seeing is Believing

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Objectives

• Integrate ultrasound into routine critical care practice
• Introduce HOLA (Holistic Approach)
• Explore Technology, Concepts and Capability
• Discuss procedural Vs diagnostic applications
• Training and competence in critical care ultrasound
The Power Of Context

"A newspaper is better than a magazine. A seashore is a better place than a street. At first it is better to run than to walk. You may have to try several times. It takes some skill, but it is easy to learn. Even young children can enjoy it. Once successful, complications are minimal. Birds seldom get too close. Rain, however, soaks in very fast. Too many people doing the same thing can also cause problems. One needs lots of room. If there are no complications it can be very peaceful. A rock will serve as an anchor. If things break loose from it, however, you will not get a second chance."
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Consent

• Compliance in or approval of what is done by or proposed by another
• Agree
• Agreement as to action or opinion

Webster’s New Collegiate Dictionary
Informed

• Based on possession of information
• Educated
• Intelligent

Webster’s New Collegiate Dictionary
Landmark

• An anatomical structure used as a point of orientation in locating other structures
• A structure (as a building) of unusual and usually aesthetic interest; esp: one that is designated and set aside for preservation

Webster’s New Collegiate Dictionary
Blind

- A place of concealment; a concealing enclosure from which one may shoot …
- Something to hinder sight or keep out of light
- To withhold light from
- Sightless

Webster’s New Collegiate Dictionary
Desiderius Erasmus (1466-1536)

In the kingdom (country) of the blind, the one-eyed man is king
Evaluation of an ultrasound-guided technique for central venous access via the internal jugular vein in 493 patients
Mey,U.; Glasmacher,A.; Hahn,C.; Gorschlä ter,M.; Ziske,C.; Mergelsberg,M.; Sauerbruch,T.; Schmidt-Wolf,I.G.H.

- The success rate achieved and the frequency of complications are decisively influenced not by the experience of the physician performing the puncture, but by the experience of the physician acting as sonographer.
Ultrasound Questions?

• Cost
  • ROI
• Convenience
  • Time to completion
  • Availability of equipment
• Complications
  • Significance and reduction
  • Non-insertion related
Ultrasound Guidance/Diagnosis

Conclusions

- Practice and experience necessary
- Subclavian access difficult with ultrasound
- Most significant catheter complications unrelated to insertion
- Expensive
- Ultrasound education required
Basic Ultrasound Physics

- Mechanical pressure waves with periodic propagation through matter.
- Infrasound >16Hz
- Audible sound 20Hz - 20KHz
- Ultrasound 20KHz – 10 GHz
Terminology

• Piezo-electric = pressure electric
  – Compression
  – Rarefaction

• Capable of sending-pausing-receiving

• Basic ultrasound physics knowledge necessary to manage equipment and process images
Characteristics of Sound

- **f** - Frequency: number of oscillations per second.
- **λ** - Wavelength: Distance between two nearest points of equal pressure.
- **v** – Velocity: The speed of propagation of the waves through a medium. Velocity is determined by the type of the medium. For soft tissues it approximates 1520 m/sec

\[ v = f \lambda \]
Attenuators

- Water
- Blood
- Soft tissue (fat)
- Muscle
- Bone
- Air

Frequency = 2 Mhz

- 380 cm
- 15 cm
- 1-5 cm
- 0.6-1.0 cm
- 0.2-0.7 cm
- 0.08 cm
Appearance

- Fluid
  - Transudate, blood
- Exudate, Solid Organ
  - Empyema, thrombus
- Dense tissue
  - Diaphragm
  - Pericardium
  - Bone

- Black (Anechoic)
- Grey (Hypoechoic) (Isoechoic)
- White (Hyperechoic)
Transducers

• **Phased Array**
  – Wide frequency range
  – Good far field imaging
  – Cardiac, Abdominal, trans-cranial
  – Small window with accessible footprint

• **Linear Array**
  – Near field imaging
  – Small parts: vessels, nerves, organs

• **Curved Array**
  – Poor in small acoustic windows
  – Frame resolution rate slower
Transducer Arrays

- **Proximal**
  - Near field
  - Converging beam
- **Focal Zone**
  - Parallel beam
- **Far field**
  - Diverging beam

*Key structures visualized best in Focal Zone*
Why Ultrasound?

• Improved reliability
• Decreased complications
• Standard of care
• Specialty definition ?
• Specialty prerogative !
Abdominal Examination

- An important aspect of a clinical ICU evaluation
- Time sensitive
Thoracic Examination

- Lung Injury
  Lung consolidation with air-bronchogram and associated Pleural effusion.
Pneumothorax

- Lung Point/HFO
Point of Care Diagnosis

- Takotsubo Cardiomyopathy
Point of Care Diagnosis

- Ruptured Papillary Muscle
FOcused Cardiac Ultrasound Study

Scanning performed from 3 main areas:
1. Parasternal (long-axis and short axis views)
2. Apical (four-chamber view)
3. Subcostal (four-chamber view)

Proceed with the 1-2-3 sequence in a systematic, clockwise fashion.

Basic echocardiographic views

Courtesy ICCU Imaging
HOLA / Critical Care Ultrasound

• Head to Toe assessment of the critically ill
• Specific techniques discussed; generic opportunities available
• Standardized tests for basic exams
• Institutional effort required
  – Education
  – Archiving
  – Interpretation
Education and Training

• Teaching Rounds
  – Safety
  – Availability
  – Time Efficiency – rapid confirmation clinical diagnosis
  – CCU Clinically Useful – immediately relevant
  – Teaching Tool – differential diagnosis
Education and Training

• Didactic
  – Ultrasound Physics
  – Sonographic Anatomy
  – Knobology
  – Procedural Competence

• Simulation

• Continued Learning & Skill Maintenance

• Training Costs
Sparse Data Available on Value of Bedside Physical Exams in ICU

Authors emphasize value of comprehensive physical examination in the ICU despite lack of data

MONDAY, Aug. 17, 2015 (HealthDay News) -- Data relating to the value of bedside physical examinations in the intensive care unit (ICU) are sparse, according to a review published online Aug. 4 in the *Annals of the American Thoracic Society*.

Thomas S. Metkus, M.D., and Bo Soo Kim, M.D., from Johns Hopkins Hospital in Baltimore, examined the clinical utility of bedside diagnosis in the modern ICU.

*Experience with CCU demonstrates a positive benefit if used routinely as an adjunct to daily rounds and for specific questions.*
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P Lumb, D Karakitsos; Elsevier 2015
P. 301
References

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  – Anthony McLean and Stephen Huang
  – Publisher: Churchill Livingstone Elsevier © 2012
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• **FOCUS Pocket Guide**
  – Focused Cardiac Ultrasound Study
  – © 2007 ICCU Imaging, Inc.