Ultrasound Simulators

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Objectives

• Give a brief history of simulation in medicine

• Describe the types of ultrasound simulators

• Show how ultrasound simulation can be used in medical education
What is a simulator?

• An educational tool which imitates real life scenarios

• Provides trainees a means to practice a task with the aim of improving performance in the real life setting
History of Simulation in Medicine

- Resusci-Anne mannequin developed in the 1950’s by Dr. Peter Safar and Dr. Bjorn Lind to simulate artificial ventilation and chest compressions
History of Simulation in Medicine

- Simulators to practice surgical procedures
History of Simulation in Medicine

- Simulators for ultrasound which is a highly operator dependent imaging modality
Types of Ultrasound Simulators

- Online
- Mannequin
- Phantoms
Online Simulators

• Web based programs that use mouse-operated controls to change scan planes and simulate probe manipulations

• Displays an ultrasound image corresponding to the particular scan plane
Mannequin Based Simulators

- Mannequin
- Simulated ultrasound probe
- Computer
- Monitor or TV
Mannequin Based Simulators

• Display
  1. Virtual anatomic model image
     • Augmented reality
  2. Ultrasound image
     • Rendered image or
     • Actual ultrasound image from a stored dataset
Mannequin Based Simulators
Phantom Type Simulators

• Use a real ultrasound unit to image a phantom

• Examples
  – Phantom containing a non-beating solid heart model to demonstrate cardiac anatomy and scan planes
  
  – Phantoms to practice ultrasound guided procedures
    • Vascular access
    • Thoracentesis
    • Paracentesis
Phantom Type Simulators
Phantom Type Simulators

Vascular Access
Phantom Type Simulators

Paracentesis Phantom
Phantom Type Simulators

Paracentesis Phantom

Needle

Fluid
US Simulator Uses in Medical Education

1) Teaching Tool

2) Assessment Tool
Teaching Tool for Anatomy

• Demonstrate in situ anatomic relationships

• Demonstrate cross sectional anatomy
  – B mode
  – Augmented Reality

• Complement the gross lab dissections
Teaching Tool for Anatomy
Teaching Tool for Physiology

• Demonstrate direction of blood flow with color doppler

• Demonstrate motion of cardiac walls and valves at different points in the cardiac cycle

• Correlate this motion with ECG tracing
Teaching Tool for Physiology
Teaching Tool for Physiology
Teaching Tool for Physiology
Teaching Tool for Pathology

• Some simulators offer pathology in addition to normal scans

• Examples
  – Pericardial effusion
  – Thrombus in left ventricle or left atrium
  – Dilated cardiomyopathy
  – Aortic dissection
Teaching Tool for Pathology

• Allows students to image pathology they may not otherwise get a chance to directly scan

• Similar to baseball players getting to practice hitting a 100 MPH fastball
Teaching Tool for Image Acquisition

• Ultrasound is very operator dependent

• Some views are more difficult than others and require manual dexterity to obtain
Teaching Tool for Image Acquisition

• Simulators can help students develop their image acquisition skills through practice

• Some simulators can give visual feedback about how to properly manipulate the probe to obtain a high quality image
Teaching Tool for Image Acquisition

- Similar to pilots practicing their skills on a flight simulator
Teaching Tool for Procedural Skills

• Students can practice performing invasive ultrasound guided procedures
  – Vascular access
  – Thoracentesis
  – Paracentesis

• Students can sharpen their skills in a no risk setting before attempting the procedures on a real patient
Teaching Tool for Procedural Skills

- Similar to practicing on this guy before getting on the back of a 2,000 pound rodeo bull
US Simulator as an Assessment Tool

1) Target scan planes
   – Measure the time it takes to obtain the desired scan plane
   – Track the probe manipulations the student uses to achieve the target plane
US Simulator as an Assessment Tool

2) Proper Measurement Technique
US Simulator as an Assessment Tool

3) Incorporate ultrasound simulator pathology into an OSCE

- Students obtain a history and physical exam on a standardized patient

- Then they acquire images on the simulator which displays that particular pathology

- Finally they formulate a diagnosis
Summary

• Various types of ultrasound simulators are available

• Provide the opportunity for more hands-on training

• Can be incorporated into medical education as both training and assessment tools