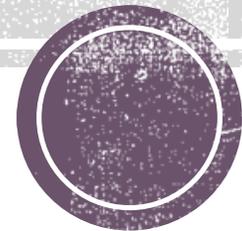


# Central Line Course

**Joanna Grudziak, MD**

**PGY4**

**General Surgery**

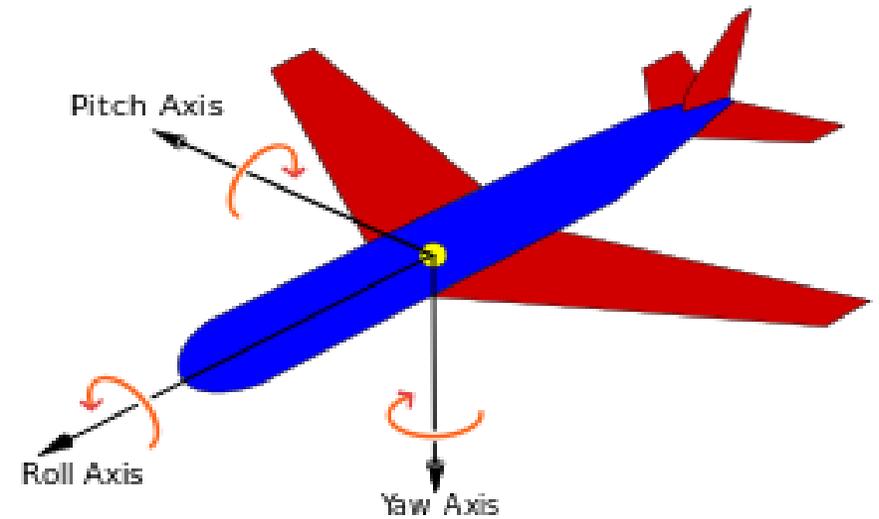




Yaw, roll, and pitch

Rudder, aileron, elevator

Takeoff, flight, landing



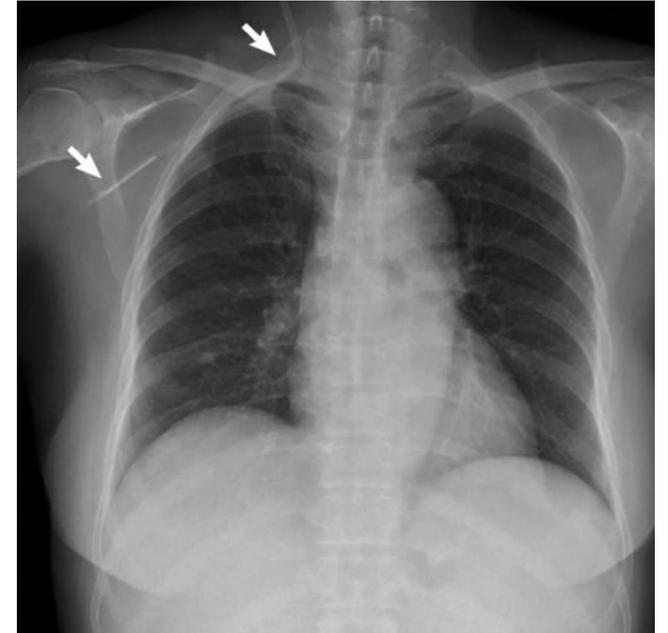
[https://en.wikipedia.org/wiki/Aircraft\\_principal\\_axes](https://en.wikipedia.org/wiki/Aircraft_principal_axes)



# Background

Central Line placement associated with potential major morbidity:

- ❖ Infection
- ❖ Arterial injury
- ❖ Hemo- and pneumothorax
- ❖ Stroke
- ❖ Cardiac tamponade



[https://openi.nlm.nih.gov/detailedresult.php?img=PMC346876\\_7\\_jkms-27-1265-g001&req=4](https://openi.nlm.nih.gov/detailedresult.php?img=PMC346876_7_jkms-27-1265-g001&req=4)



# Background

Central line complications related to placement decrease with:

- ❖ Clinicians who have performed > 50 line insertions <sup>1</sup>
- ❖ Fewer attempts (<3 needle sticks) <sup>1</sup>
- ❖ Ultrasound use <sup>2</sup>
- ❖ **Simulation-based training for clinicians** <sup>3</sup>

Previously no standardized teaching method for UNC residents

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2. McGee DC & Gould MK. (2003). Preventing complications of central venous catheterization. *NEJM*, 348: 1123-1133.

3. Barsuk JH, McGaghie WC, Cohen ER, O'Leary KJ, & Wayne DB. (2009). Simulation-based mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit. *Crit Care Med*, 37(10): 2697-701.



# Background

- **Inaugural Multidisciplinary M&M** – June 2014
  - ❖ Resident-led
  - ❖ Central line complication resulting in vascular surgery intervention
- **Resident Task Force** formed with assistance from faculty across five departments:
  - ❖ Anesthesia
  - ❖ Emergency Medicine
  - ❖ Family Medicine
  - ❖ Internal Medicine
  - ❖ Surgery

**Why?**



# Project Aim

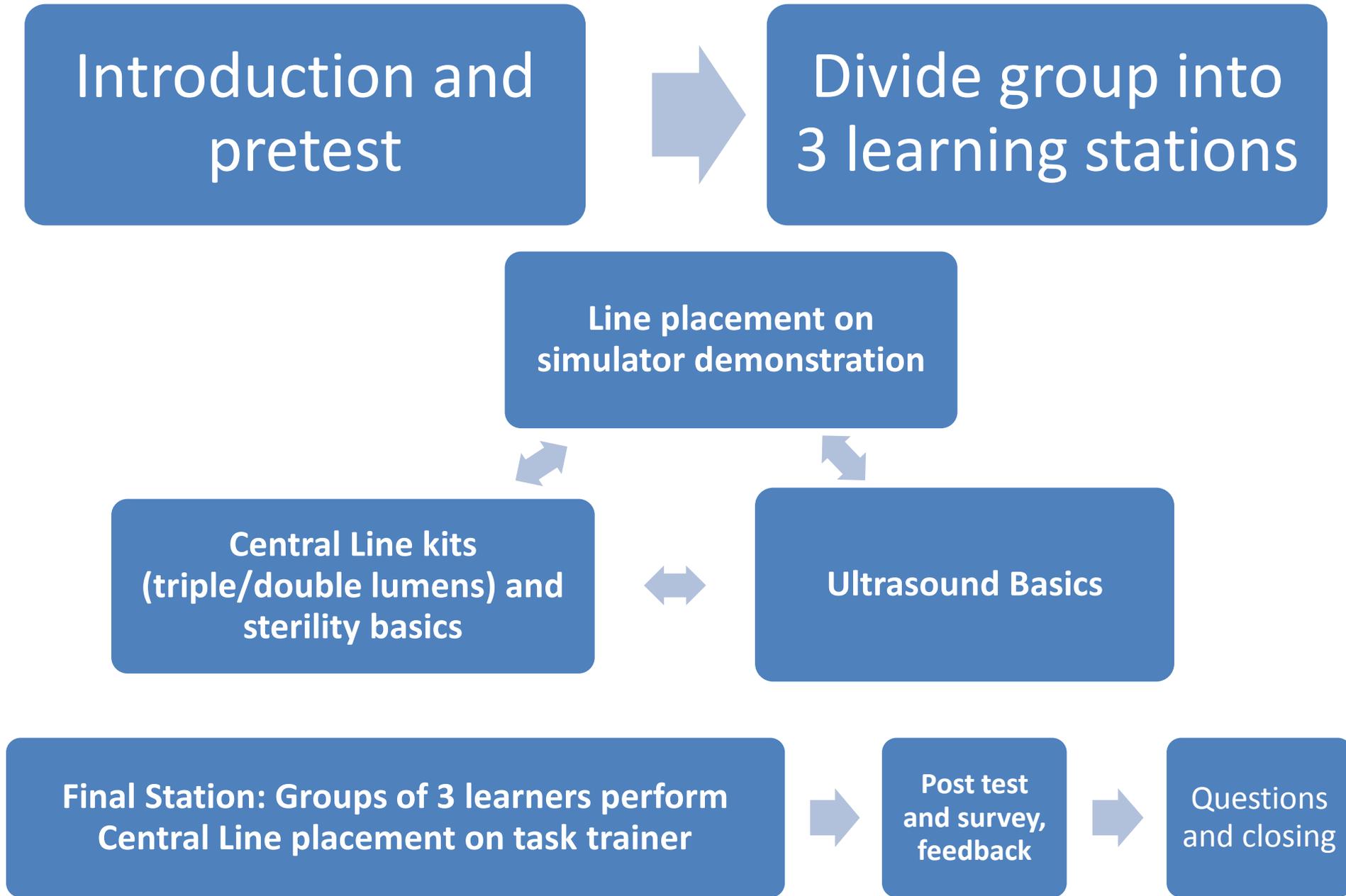
To develop and implement a standardized central line placement training for all interns with opportunity to insert central lines





We accidentally replaced your heart  
with a baked potato.

# Intern Central Line Training Course

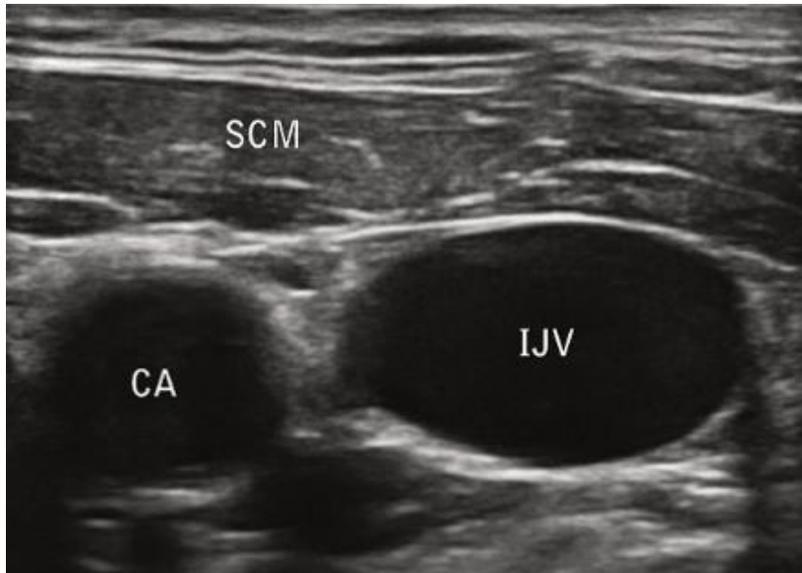


# Sterile Technique and Kit Familiarization



# Vascular ultrasonography

Teaching interns how to use ultrasound to determine site for central line placement



<http://www.ultrasonix.com/blog/internal-jugular-vein-vascular-access-line-placement>



# Line Placement on Simulators

CLeAR lab designed and built custom-made simulator

- perfused, ultrasound-compatible neck model
- pressurized liquid mimics arterial/venous pressures
- capable of multiple sticks without wear and tear
- very affordable compared to market alternatives (\$5K for 3 vs \$6K for 1)



# Line Placement – Instructor Example



# Individual Line Placement by Interns



# Numbers Trained

## Interns Trained

- **99 interns in 11 classes**
  - Anesthesia – 12
  - Emergency Medicine – 10
  - Family Medicine – 10
  - Internal Medicine – 35
  - Surgery – 29
  - Also, 3 from Neuro



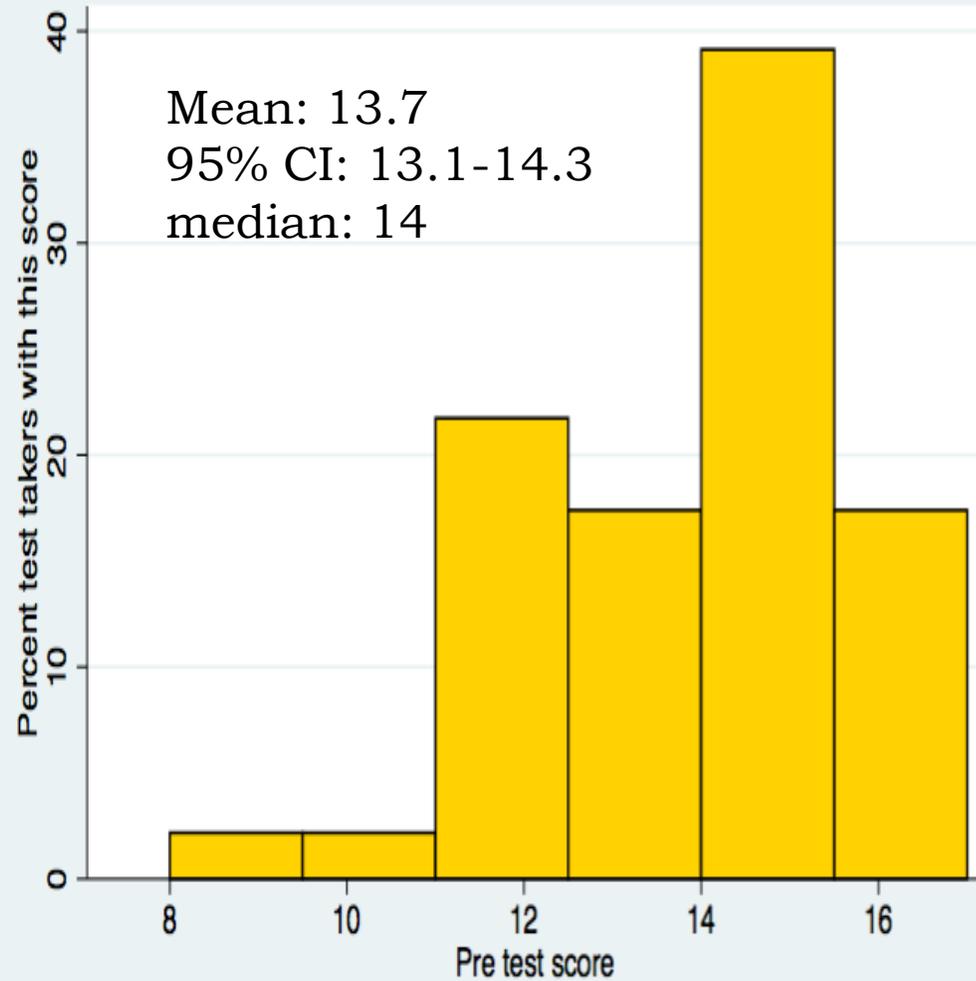
## Instructors Trained/Scheduled

- **12 instructors in 4 “Train the Trainer” classes**

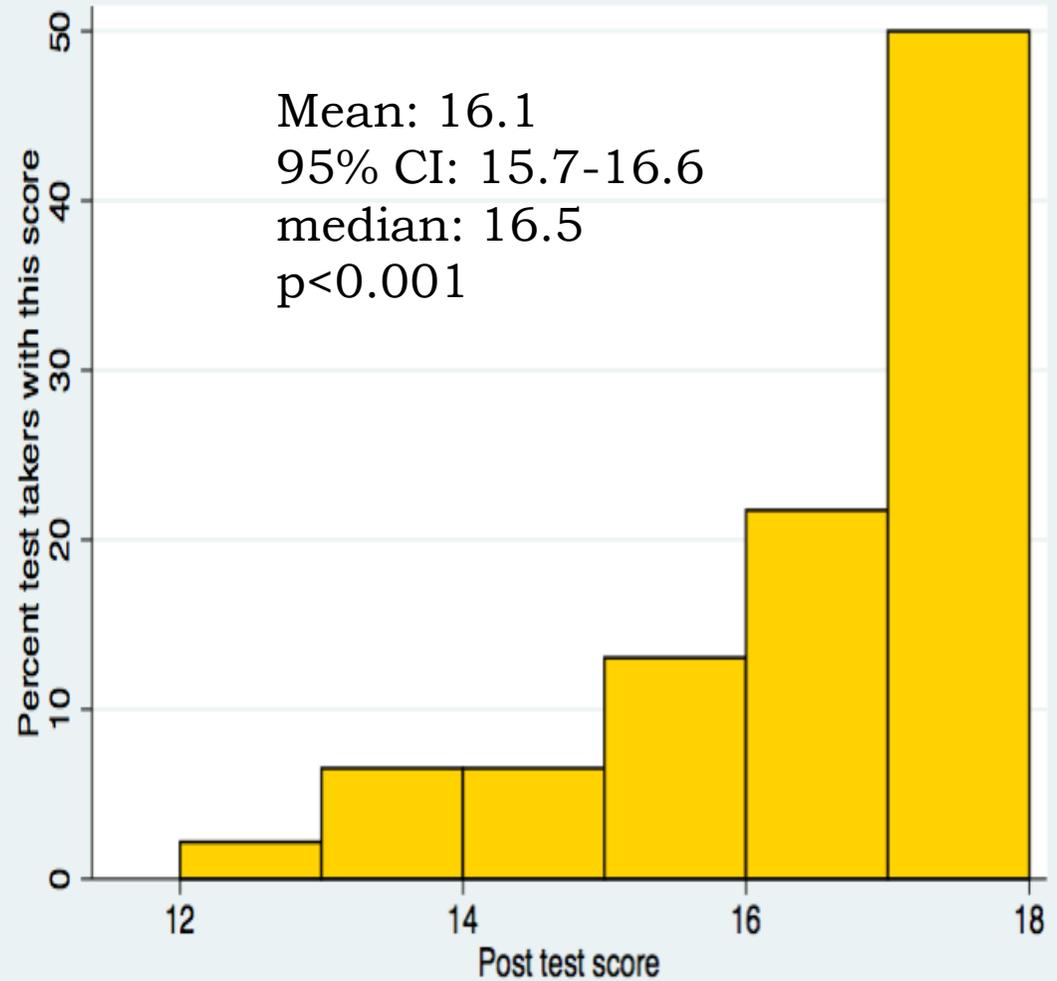


# Pre and Post-Test Scores

Pretest scores

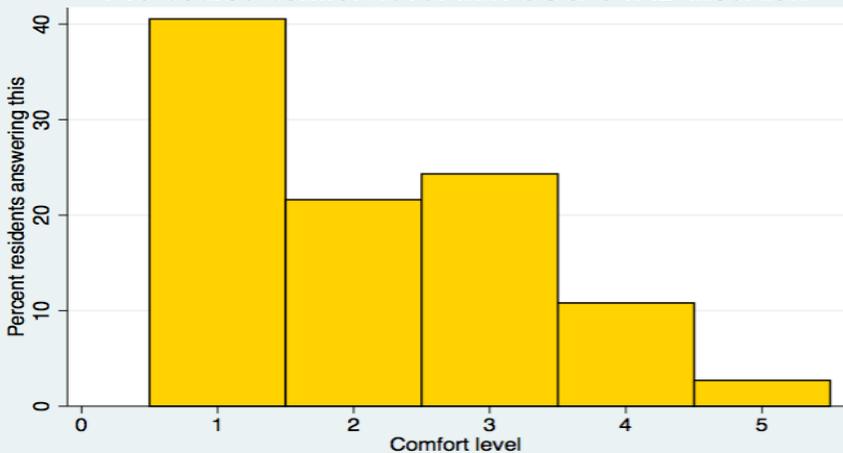


Posttest scores

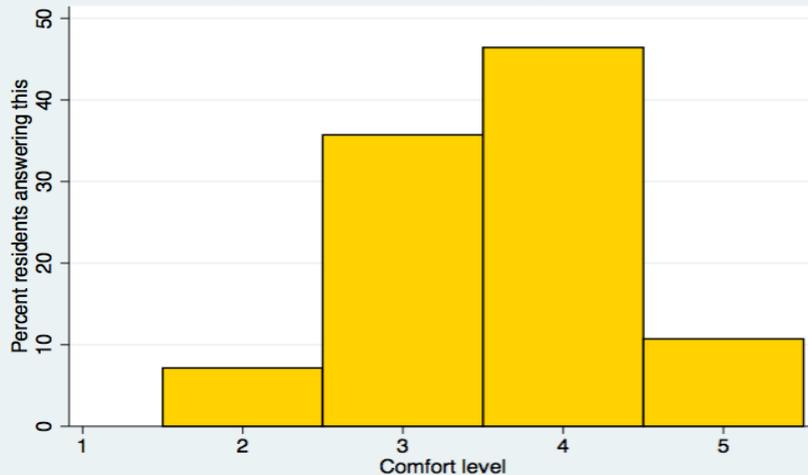


# Intern Comfort with Use of Ultrasound

Pre-course comfort level with USG CVAD insertion

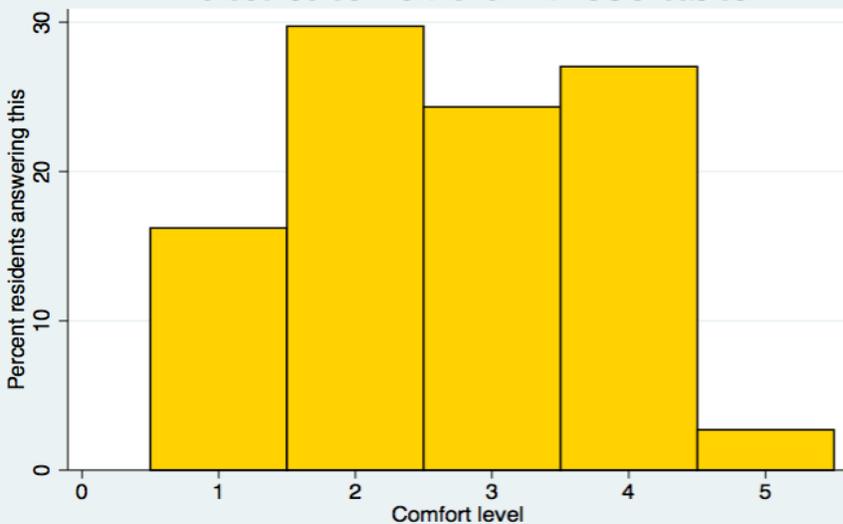


Post-course comfort level with USG CVAD insertion

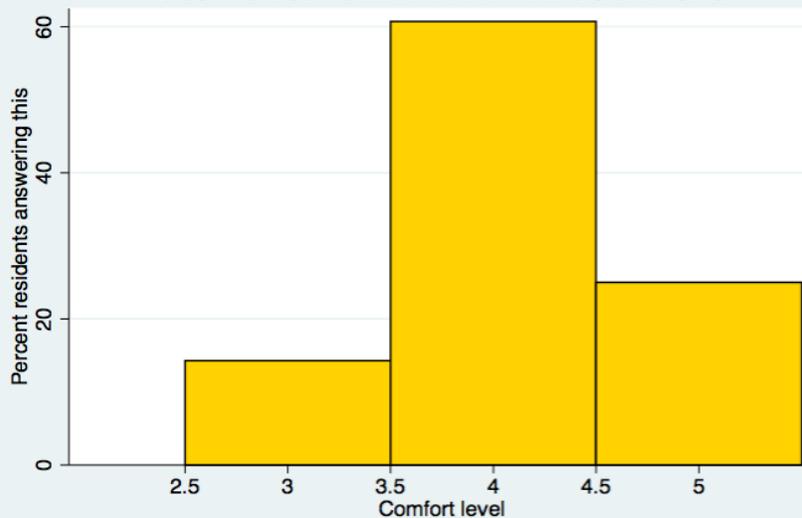


**Comfort increased for line placement with ultrasound, from 2.29 +/- 1.18 to 3.61 +/- 0.79, p<0.001**

Pre-course comfort level with USG basics



Post-course comfort level with USG basics

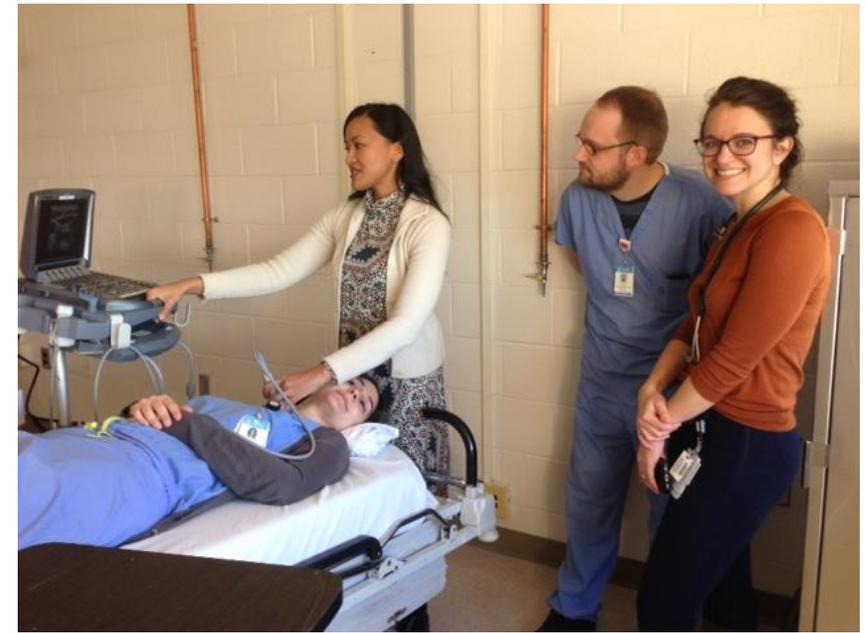


**Comfort increased for ultrasound basics, from 2.70 +/- 1.13 to 4.10 +/- 0.6, p<0.001**



# Intern Perspective

- Thank you very much - this was a great experience!
- This was very helpful – I feel better prepared and more knowledgeable.
- **Thank you for taking the time to go over this early in our training.**
- This was a great training. Maybe we could do this twice during our intern year.
- This was an excellent course. Even though I've had some experience with lines before, I found this very helpful.[I liked] getting to handle the line kit and get more ultrasound experience.



# Sustainability Plan

- GME to take over administration of central line course for 2016-17 and beyond
- Data collection continuing
- Central Line Video
  - Filmed this spring
  - Will be used for future classes

- **Outstanding issues:**

- protected time for faculty
- simulation home
- budget for supplies beyond coming year
- resources for continued data collection





# Dissemination Plan

- ❖ Multidisciplinary M&M
  - UNC, Sept. 2015
- ❖ International Meeting for Simulation & Health Care
  - San Diego, Jan. 2016
- ❖ House Staff Council Meeting
  - UNC, Feb. 2016
- ❖ Southeastern Surgical Congress
  - Atlanta, Feb. 2016
- American Surgeon (publication pending)
- ❖ NC American College of Physicians meeting
  - Greensboro, Feb. 2016
- ❖ Surgery Grand Rounds
  - UNC, Jun. 2016

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## Standardization of Central Venous Catheter Placement Training for Improved Patient Safety at University of North Carolina Hospitals

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### Introduction

Complications related to central venous catheter placement are highest among clinicians who have performed fewer than 50 catheterizations, and when more than 2 needle passes are made! Therefore, sufficient practice and demonstration of competence are needed to minimize patient risk. We describe the creation of a simulation-based central venous catheter (CVC) placement training course and the results of our successful pilot courses.

### Hypothesis and Goals

- University of North Carolina (UNC) resident physicians in surgery, anesthesiology, internal medicine, family medicine, and emergency medicine place CVCs during training, but there is no institutionally standardized placement method or defined process to ensure procedural competence.
- CVC placement is associated with potential major morbidity, including infection, vascular injury and pneumothorax.<sup>1,2</sup>
  - Multidisciplinary morbidity and mortality conference highlighted a concerning number of arterial cannulations.
- A CVC Safety Committee comprised of faculty and trainees from several specialties was formed.
  - Primary aim: examine current practices, develop a standardized CVC placement training method for all incoming residents, and set performance standards for the purpose of improving patient safety.
  - Secondary aim: reduce the rate of arterial cannulations that result in a surgical consultation or the need for invasive intervention to near zero.

### Methods

- We conducted a multidisciplinary survey of Post-Graduate Year 1 residents (PGY1s) current practices of CVC placement.
- Informed by best practice literature review and multidisciplinary modified Delphi method consensus, we developed a 4 station, simulator-based CVC training course (Figure 3) and a procedural competency checklist (Figure 5) which included manometry for secondary confirmation of venous placement.<sup>3,4</sup>
- Two pilot courses were conducted for two sets of PGY1s from different specialties.
  - The intervention consisted of interactive learning stations addressing sterility, ultrasound use, and CVC placement technique.
  - Along with written pre- and post-intervention assessments, learners were evaluated by a simulator based, objective practical exam.
  - Learners performed ultrasound-guided CVC placement on task trainers, and were scored according to the checklist.
  - Paired samples t test was used to evaluate significance of the difference in scores pre and post-intervention.

### Figure 1 Training Methods at UNC

### Figure 2 Methods for confirmation of venous placement

### Figure 3 CVC Placement Pilot Training Course

### Figure 4 Results

### Figure 5 Components of Procedural Checklist

Identify indications/contraindications to procedure?
Obtain informed consent?
Verify procedure time-out?
Position patient in Trendelenburg position?
Explain each step to patient and ensure patient's comfort?
Ensure a member of nursing staff is in the room and available for entire procedure?
Select the least artery probe to identify internal jugular vein and carotid artery?
Demonstrate compressibility of the vein throughout course in neck?
Measure from skin to target vessel?
Demonstrate maximal sterile barrier precautions in prepping and draping patient and probe?
Flush all lumens of catheter with sterile saline and clamp or attach clamps?
Anesthetize skin, being careful not to inject in a vessel?
Introduce needle into vein under direct ultrasound guidance? (Most experienced operator in room takes over after 2 unsuccessful steps)
Confirm nonpulsatile bleeding? Attach manometry tubing to angiostat to confirm venous placement?
Insert less than 20 cm of guidewire and retain control of guidewire at all times while threading wire and removing angiostat/needle?
Visualize guidewires in vein with ultrasound in transverse and longitudinal view before sliding and threading the catheter? Document with ultrasound image (frames at ports, aortic and both lines)?
Place Sengstaken and then subcut line?
Place sterile dressing?
Safely dispose of all sharps/contaminated equipment?
Confirm placement with CXR?

### Results

- The preliminary survey showed:
  - Widely varying instruction methods (Figure 3)
  - No standard for confirmation of venous placement (Figure 4)
- Post-intervention written assessment accuracy was significantly increased in both cohorts (N16)=3.47, p=0.0028) compared to the identical 15 question pre-intervention assessment.
  - The number of correctly answered questions increased by 1.8 (95% confidence interval 0.7 to 2.9)

### Conclusion

- Validated tools for instruction and evaluation of procedural competency are vital to consistency and patient safety.<sup>1,4</sup>
- There has been significant positive feedback on the course from UNC leadership, as well as the participants.
  - The course has sparked a process change at UNC.
  - All incoming residents will be required to attend the course, use the checklist, and keep a log of all their CVC placements and complications.
- Hospital-wide implementation of this simulation course for all residents, along with the competency checklist, may enhance safety and quality of care for critically ill patients.

### Impact

- Project brings together representatives from the following departments:
  - general surgery, burn surgery, cardiovascular surgery, vascular surgery, cardiology, internal medicine, emergency medicine, family medicine and anesthesiology
- Positive feedback from UNC leadership, epidemiology, and course participants
- UNC Institute for Healthcare Quality Improvement seed grant awarded (\$50,000 for 2015-2016)
  - Learn Six Sigma training completed, project charter created, project manager hired and hospital-wide ethics training is underway
  - Supplies and perfused, synthetic, ultrasound-compatible neck simulators designed and funded by UNC through 2016
- Secondary outcome for this course has grown to include reduction of Central line-associated blood stream infection (CLABSI) and antibiotic pneumothorax rates
  - Procedure kits updated to include all necessary equipment for maximal sterile barrier technique and manometry
- Confirmation of venous placement with manometry tubing now required at UNC
- Currently finalizing standardized process for each specialty to judge resident competency and grant privileges
- The most important result from the pilot course is the paradigm shift to simulation-based training for CVC placements at UNC Hospitals.
  - Previously only 7% of PGY1s from participating departments received simulation-based training → now 100% simulation-based training

### Figure 7 Photos from pilot course

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# Lessons Learned

“Nobody argues with a flight simulator”  
-Tina Willis, MD

- **Power of and challenges in interdisciplinary collaboration**
- Learning from mistakes
  - Original simulators
  - Teaching suturing
- The blood, sweat, and tears of data collection
- **Structural support essential**
- Importance of residents driving improvement
- Persistence key to sustainability





1. Before routine insertion of a central venous catheter all of the following steps must be done EXCEPT?

- Obtain consent from the patient or their family or guardian etc.
- Perform a site survey with the ultrasound to ensure the vessel is present and patent.
- Cleanse the skin with chlorhexidine (if the patient is not allergic) and allow to dry.
- Use maximal barrier precautions, including hat, mask, gloves, sterile gown and sterile full body drape.
- Call your attorney.

2. Ultrasound guidance decreases mechanical AND infectious complications of central line infection.

- True
- False

3. The best probe for vascular access guidance is

- A HIGH frequency probe a with a FLAT footprint
- A LOW frequency probe a with a FLAT footprint
- A HIGH frequency probe a with a CURVED footprint
- A LOW frequency probe a with a CURVED footprint
- A phased array probe

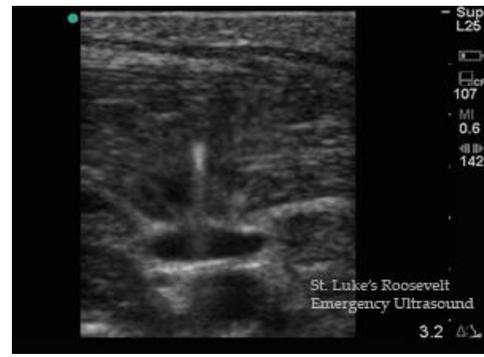
4. Which of the statements below is CORRECT regarding ultrasound guided vascular access? (single best answer)

- Using ultrasound only to identify landmarks without visualizing needle entry is just as safe and effective as using ultrasound throughout needle entry
- Ultrasound decreases the complication rate with central venous access.
- A written note is sufficient documentation of ultrasound guided vascular access, no images need to be saved or printed for billing or QA purposes
- It is unnecessary to put sterile gel inside and outside the probe cover sleeve for ultrasound guided venous access

5. Antiseptic disk (BioPatch) at the skin puncture site is required for central lines at UNC.

- True
- False

6. This image of a central venous access procedure shows:



- The jugular vein is about 2.2 cm deep according to the depth scale
- The needle has penetrated the carotid artery
- An "in-plane" or "along-the-needle view"
- A non-compressible internal jugular vein due to intraluminal clot

7. Which of the following are possible complications of a central line insertion?

- Pneumothorax.
- Wire or catheter embolization.
- Stroke (cerebrovascular accident).
- Air embolism.
- Arrhythmia including ventricular tachycardia or fibrillation.
- All of the above.

8. Ultrasound guidance for central venous line insertion has been shown to do all of the following EXCEPT?

- Reduces infectious risk
- Reduces number of attempts to successfully place catheter
- Reduces time required for inserting the central line
- Reduces number of assistants needed for the procedure

9. Betadine is preferred over chlorhexidine for skin antisepsis:

- True
- False

10. When advancing the catheter into the vein with the Seldinger wire, it is critical that the catheter is slid over the wire, and the wire and catheter are not advanced together

- True
- False

11. Blood return into the syringe can occur while the needle is being withdrawn instead of being advanced.

- True
- False

12. Medicare and many insurers will not pay for infections and pneumothoraces associated with central venous catheter placement (CLABSI).

- True
- False

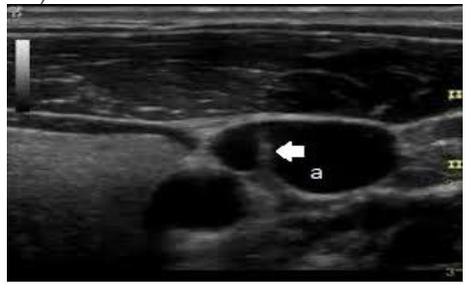
13. After applying the chlorhexidine to the insertion site, one should wait until the site is completely dry without fanning or blotting before proceeding.

- True
- False

14. Regarding central line insertions: (single correct answer)

- Pneumothorax is not a hazard of the internal jugular approach.
- The internal jugular vein is accessible by a needle inserted at the level of C6 aimed towards the contralateral nipple.
- A chest X-ray is unnecessary to confirm central line placement if the ultrasound documents the line inside the vein.
- When using 2D mode with the ultrasound, the lumen of vessels should appear dark.

15. This arrow in image below is showing: (single best answer)



- Needle seen in the internal jugular vein in an "in-plane" approach
- Needle seen in the internal jugular vein in an "out of plane" approach
- Needle seen in the carotid artery in an "in-plane" approach
- Needle seen in the carotid artery in an "out of plane" approach

16. The correct way to sterilize skin with chlorhexidine is to (single answer)

- Use a scrubbing motion for at least 30 seconds
- Cleanse the skin in a concentric circular pattern
- Use at least 2 swabs/sticks

17. Use of a checklist to adhere to infection-control practices as part of a central line bundle has decreased CLABSI rates in prospective trials.

- True
- False

18. The following practices help ensure that the carotid artery (CA) is not injured during central line placement: (single answer)

- Choosing a site in which the CA is just deep to the internal jugular vein.
- Using manometry to estimate the pressure in the vessel before dilating.
- Viewing the guidewire in the vessel in the short axis, out-of-plane view before dilating

