

5-31-2017

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John Madara, MD
Thomas Jefferson University Hospital

Christoph Hutchinson, MD, MA
Thomas Jefferson University

Frances Mae West, MD, MS
Thomas Jefferson University

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Recommended Citation

Madara, MD, John; Hutchinson, MD, MA, Christoph; and West, MD, MS, Frances Mae, "Improving Proficiency in Central Venous Catheter Insertion: Standardized Simulation Based Training for Internal Medicine House Staff" (2017). *House Staff Quality Improvement and Patient Safety Conference (2016-2019)*. Poster 45.

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Improving Proficiency in Central Venous Catheter Insertion: Standardized Simulation Based Training for Internal Medicine House Staff

John Madara MD, Christoph Hutchinson MD MA, and Frances Mae West MD MS
Division of Pulmonary and Critical Care Medicine, Thomas Jefferson University Hospital

Background

Central venous catheter (CVC) placement is often a necessary procedure in critically ill patients. In the U.S. alone over 5 million CVCs are placed annually. Frequently, there is no standardized training program for house staff and CVC placement training is done “on the job” under the guidance of another resident deemed to be competent to perform the procedure. Even in programs where simulation training is utilized, there is a lack of standardization of this training. This lack of systematic training can lead to significant variation in procedural technique and ability to place CVCs. Complications have been reported in 15-20% of patients, which leads to significant increases in hospital cost, morbidity and even mortality [1,2]. The American Board of Internal Medicine strongly recommends utilization of simulation training to obtain competency in CVC placement, prior to performing the procedure on a patient [2], and the Accreditation Council for Graduate Medical Education mandates that internal medicine residents demonstrate competence in this procedure.

Recent literature suggest that a standardized simulation-based training workshop can improve proficiency in CVC insertion [2]. Training includes both an online pre-test module that reviews anatomy and procedural techniques, hands-on training, and a post-test simulation practical for proficiency. Skills acquired include adherence to sterile technique, familiarity of the CVC kit, and the use of ultrasound in real-time placement of a CVC. Some simulation based programs also include education on dealing with unforeseen complications, as well as the proper procedure for removing a CVC

Methods

House staff, including internal medicine residents and critical care fellows, will be complete a formalized training program including an online module, a simulation training session, and a proficiency simulated exam to assess competency in CVC placement. The curriculum will include a series of didactic lectures and videos, as well as simulation center training models.

First, house staff will undergo a pre-test to assess their ability to safely place a CVC. This will involve a monitored simulated CVC insertion under the supervision of a faculty member or critical care fellow who had previously demonstrated proficiency in this technique. They will be graded on a pass/fail metric using a predefined checklist of critical steps assessing sterility, safety, and success.

Then house staff here will be a dedicated simulation curriculum to teach multiple aspects of the CVC insertion. The first component will be an online component which reviews anatomy, informed consent, sterile gowning and technique, and a review of the procedure highlighting critical steps of the procedure. The hands-on portion of the training will focus on sonographic acquisition of a safe location and real-time guidance of the needle tip into the vessel, choosing the appropriate equipment, insertion using a series of universal checkpoints, and confirmation of placement.

Finally, after completing the curriculum, house staff will then be assessed for competency with a post-test practical demonstration on a simulation model again using a pass/fail metric.

Figure 1: CVC Training Checklist

CENTRAL LINE SIMULATION PRACTICAL	
Name: _____	Date: _____
STERILE TECHNIQUE:	
<input type="checkbox"/> Wears mask and cap prior to chloroprep <input type="checkbox"/> Chloropreps for 30 sec in rigorous back and forth motion <input type="checkbox"/> Hands do not come out of the gown for gloving <input type="checkbox"/> Places probe cover correctly	
KIT PREP:	
<input type="checkbox"/> Chooses correct needle and places on non-luerlock syringe <input type="checkbox"/> Ensures wire is ready for use <input type="checkbox"/> Identifies the other equipment that they will need to use (dilator, scalpel) <input type="checkbox"/> Preps the catheter with saline <input type="checkbox"/> Either locks or caps the proximal and medial ports, leaves distal port open	
US	
<input type="checkbox"/> Correct Probe used <input type="checkbox"/> Probe marker lined up with marker on screen <input type="checkbox"/> Vessel identified	
STICK TECHNIQUE	
<input type="checkbox"/> Needle held perpendicular <input type="checkbox"/> Vessel Accessed <input type="checkbox"/> Angle lowered while drawing back blood <input type="checkbox"/> Confirms wire in vessel with needle out	
NICK and DILATE	
<input type="checkbox"/> Nick is made in parallel with vessel <input type="checkbox"/> Dilator is held at the end closest to skin/distal end <input type="checkbox"/> Dilates in the plane of the vessel	
PLACE and SECURE CATHETER	
<input type="checkbox"/> R II advanced to 15cm <input type="checkbox"/> Never lets go of wire <input type="checkbox"/> Sutures both the line and the blue/white piece	

Figure 1. CVC Training Checklist. The CVC is broken in a series of components which allows learners to compartmentalize the procedure, learning critical steps throughout the procedure. This checklist focuses on sterile technique, preparation of equipment, ultrasound handling, needle access and wire placement, nick/dilation technique, and catheter placement, securement and dressing. These steps are highlighted in the online component and also during the hands-on training portion during which time they can practice each step until a certain comfort level and familiarity is achieved.

Figure 2. Post-Test Proficiency Evaluation

Central Line Assessment Checklist			
Resident:	Observer:	Date:	
Step	Observed	Not Observed	
1. Properly positioned patient.	-----	-----	
2. Accurately described potential risks of the procedure during obtaining consent (PTX, bleeding, infection, cannulation of an incorrect vessel).	-----	-----	
3. Set up the procedure sterilely.	-----	-----	
A) Use of hand sanitizer. Mask _____ Gown _____ gloves _____			
B) Chloroprep: circular / low vigor _____ Back and forth / vigorous _____			
C) US probe cover: use technique _____ imitative technique _____			
4. Lined Kit Set up on another table with all necessary equipment including fluids.	-----	-----	
A) Flashed catheter ports _____ did not flush catheter ports _____			
B) Clamped additional ports _____ did not clamp additional ports _____			
5. Perfused time out.	-----	-----	
6. Identified patient vessel.	-----	-----	
7. Identified safe location with the ultrasound.	-----	-----	
8. Demonstrated appropriate stick technique.	-----	-----	
A) Angle between US probe & hand: none (parallel) _____ 0-45 _____ 46-90 _____			
9. Demonstrated wire memo (hand NEVER comes off the wire).	-----	-----	
10. Identified the wire in the vessel.	-----	-----	
11. Demonstrated satisfactory skin nick.	-----	-----	
12. Placed dilator at the appropriate angle.	-----	-----	
13. Technique for placing the catheter over the wire.	-----	-----	
14. Checked firmness of blood.	-----	-----	
15. Care while handling sharps during the entire procedure.	-----	-----	
16. Placed catheter at appropriate length.	-----	-----	
17. Double checked the device: (white and blue pieces)	-----	-----	
18. Demonstrated proper secure technique.	-----	-----	
19. Used sterile dressing placement.	-----	-----	
20. Disposed of sharps appropriately.	-----	-----	
21. Ordered post-procedure CXR.	-----	-----	
22. Procedure note and adjacency.	-----	-----	

Figure 2. Post-Test Proficiency Evaluation. This form is used when evaluation trainees for CVC placement proficiency. It focuses on the critical steps required for CVC placement including positioning, informed consent, pre-procedure time out, real-time ultrasound guidance of the needle into the vessel (assessing the probe/needle angle), wire confirmation in the vessel, dilation, catheter placement, blood return, securement and dressing. This assessment is used both before and after the comprehensive online and simulated training course.

Figure 3. Ultrasound Images during CVC Insertion

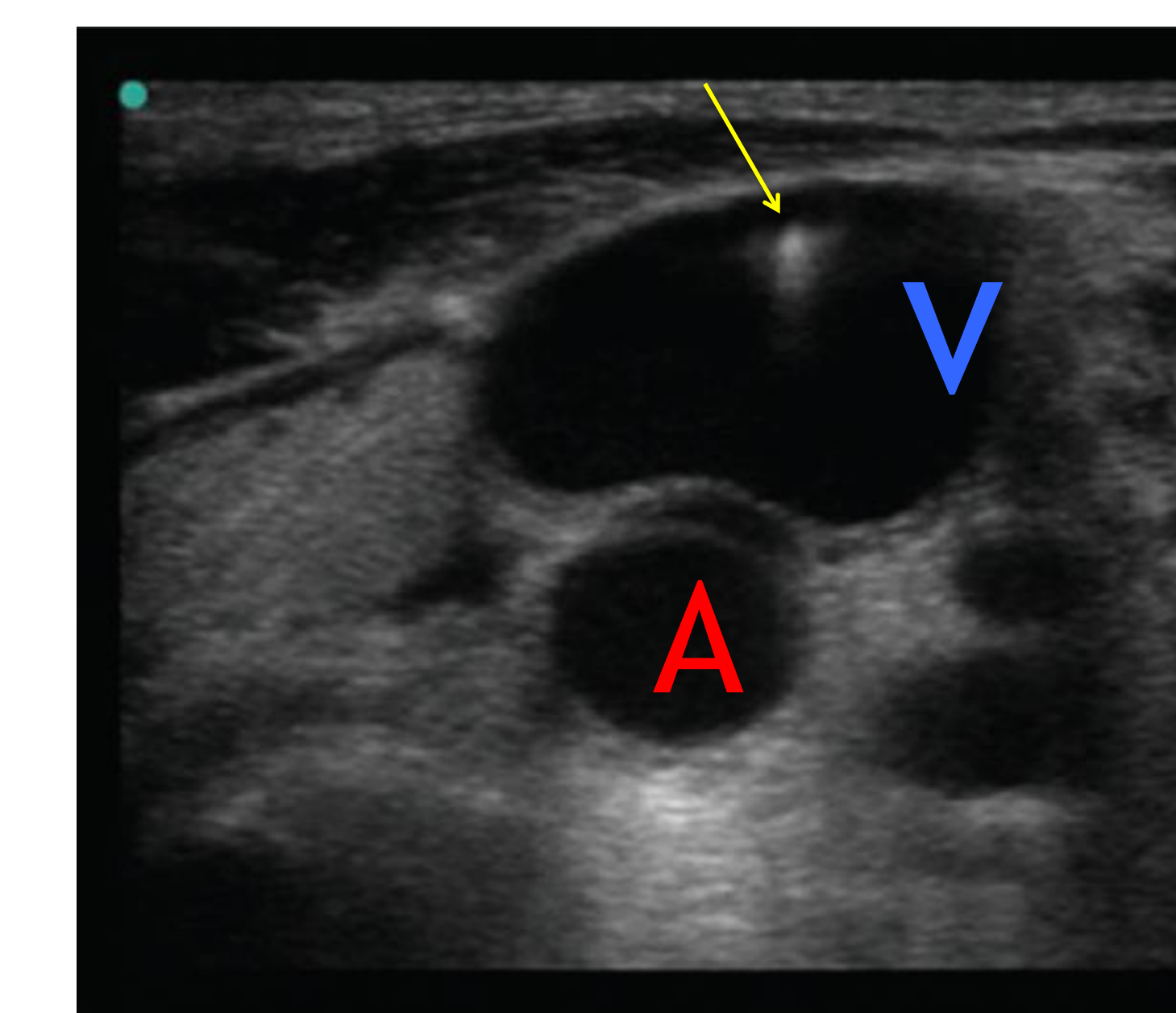


Figure 3a. Transverse sonographic image of the internal jugular vein (V), adjacent to the carotid artery (A). The tip of introducer needle (arrow) is seen inside of lumen of the internal jugular vein. This visualization utilizes an ultrasound technique which includes holding the probe at a narrow angle with the needle, and fanning the probe so that the needle tip is seen entering the vessel in real time.

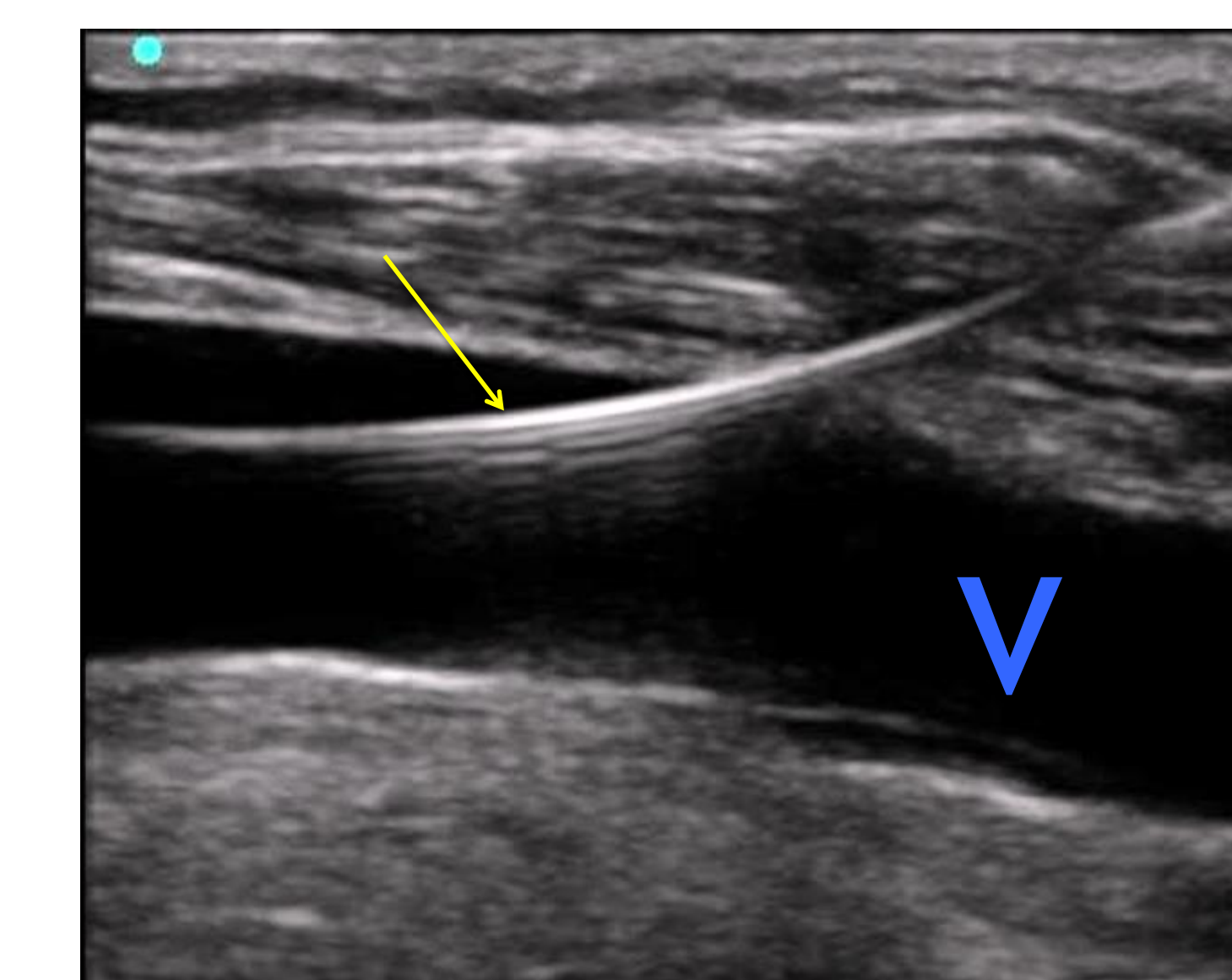


Figure 3b. Longitudinal sonographic image of the guidewire in the internal jugular vein. The guidewire (arrow) is visualized entering internal jugular vein (V), using a linear ultrasound probe. This “confirmation of the wire” is one of the critical and often missed steps in CVC placement. Proceeding to dilation before confirming venous placement could lead to profound complications if the carotid artery is unintentionally cannulated.

Objectives

The objectives of this study are to assess residents’ pre-workshop ability and comfort with CVC placement, undergo a standardized online didactic and hands-on clinical training simulation workshop, and subsequently undergo a proficiency test using simulation models to assess competency. The goal of a standardized training module is to create a universal approach to CVC placement in our institution and improve comfort and technical ability of house staff. We hypothesize that this will reduce complications and improve patient care and safety.

References

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