EVALUATION OF A SIMULATION BASED WORKSHOP TO ENHANCE LEARNING OF INSERTION AND MANAGEMENT OF CSF DRAINAGE CATHETERS IN AN ANESTHESIA RESIDENCY PROGRAM

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INTRODUCTION

Cerebrospinal fluid (CSF) drainage catheters have been increasingly used for monitoring and reduction of CSF pressure in a variety of neurosurgical and vascular procedures. [1, 2]

CSF drainage catheters have been shown to reduce the incidence of neurologic complications (paraplegia) after open and endovascular aortic surgery (references) and have been increasingly used especially with the FDA approval of thoracic endovascular stenting in 2007.

The use of lumbar CSF drainage catheters can result in serious complications, including the occurrence of bleeding, infection, over- drainage (with resultant subdural hematoma and herniation) and retained catheter fragments [3]. CSF related drainage complications can be reduced by following strict guidelines for introduction, maintenance and removal of these catheters [4].

With the expansion in the use of CSF drainage catheters, for thoracic endovascular and open aortic procedures, the need arises for anesthesia trainees to learn the correct steps in insertion and management of CSF catheters, especially that complications arising from these catheters have been linked to faulty insertion techniques.

Recent advances in educational and training technology are offering an increasing number of innovative and promising learning tools by simulation.

We thus propose to implement a simulation based training workshop for anesthesia residents to learn the technique of insertion and removal of CSF drainage catheters as well as the management of these catheters in the perioperative period. Few randomized controlled trials have been able to demonstrate the effects of simulation teaching in real-life patient care. This study aims to determine whether a simulation based workshop on CSF drainage catheters in thoracic aortic surgery prior to the cardiovascular anesthesia rotation results in better staff evaluations of residents and better patient care —a high stakes clinical setting, compared to standard operating room teaching procedure on them such as venipuncture, lumbar puncture or central lines on them after they have undergone simulation training [15].

A prospective study conducted by Heinz et al aimed to determine whether simulation based training or an interactive seminar resulted in better patient care during weaning from cardiopulmonary bypass (CPB) a high stakes clinical environment. This is one study which determined the effectiveness of simulation training in the dynamic domains of anesthesiology. The study involved 20 anesthesiology trainees, postgraduate year 4 or higher inexperienced in CPB weaning, and 60 patients scheduled for elective coronary artery bypass grafting were recruited. Each trainee received a teaching Syllabus for CPB weaning 1 week before attempting to wean a patient from CPB (pretest). One week later, each trainee received a 2-h training session with either high-fidelity simulation-based training or a 2-h interactive seminar. Each trainee then weaned patients from CPB within 2 weeks (posttest) and 5 weeks (retention test) from the intervention. Clinical performance was measured using the validated Anesthesiologists' Nontechnical Skills Global Rating Scale and a checklist of expected clinical actions. They found that compared with traditional interactive seminars, simulation-based training was superior in achieving clinical skills needed for weaning a patient from CPB [16].

Simulation in today's era of medical education provides a medium and mechanism for clinical skill instruction. The environment allows for relevant, active learning with feedback, these being important components of clinical skill development and creates a safe environment for practicing new technologies without endangering patient or practitioner safety. As simulation becomes increasingly prevalent in medical school and resident education, more studies are needed to see if simulation improves patient outcomes [17].

The procedure of CSF drainage for thoracoabdominal and thoracic aneurysm repair (open and endovascular) has been associated with improved neurological outcomes as detailed earlier in this text. However, the procedure itself is associated with morbidity and mortality. Anecdotal case reports have reported a number of complications related to directly to the CSF catheter insertion and drainage. [18] [19]Observational studies have also cited a number of complications, namely, meningitis, epidural and subdural hematomas and nerve paresis due to the spinal drain placement.[20] The CSF catheter-related complications occurred in 1.5% (17 of 1,107) of patients. No spinal hematomas were observed. The CSF leaks with spinal headache, CSF leak without spinal headache, spinal headache, intracranial hemorrhage, catheter fracture, and meningitis occurred in 6 (0.54%), 1 (0.1%), 2 (0.2%), 5 (0.45%), 1 (0.1%), and 2 (0.2%) cases, respectively. Mortality from subdural hematoma was 40% (2 of 5), and from meningitis was 50% (1 of 2). Spinal headaches resolved with conservative *management*. All CSF leaks resolved, but 71% (5/7) required blood patches [1].

The learning curve for the CSF drain placement procedure is certainly very steep and the simulator would be the best first place to commence the learning process. The consequences of complications of this procedure are far reaching on the patient in terms of neurological deficit. Frequently, misadventures with the CSF drainage catheter, leads to situations where the vascular surgical procedure is cancelled or postponed, leading to wastage of precious healthcare dollars and clinical productivity.

STUDY OBJECTIVES

Our goal is to evaluate if a simulation based workshop on CSF drainage catheters would enhance learning based on STAFF EVALUATIONS at the end of their cardiac/vascular rotation. We will compare with a group of residents who did not undergo this training but underwent standard teaching in the operating room.

Primary Outcome

Staff evaluation after first spinal drain placement by the resident during the rotation based on an Anesthesiologist's Nontechnical Skills Global Rating Scale (scored from 1-4). The number of staff evaluating will be 5-6 staff who have expertise in vascular anesthesia.

Secondary outcome- Descriptive outcome

We will document the complications occurring due to the placement of CSF drainage catheters. We will not compare between the groups but use it just as a descriptive outcome.

METHODOLOGY

This study will be to evaluate the benefit of addition of a simulation based workshop on CSF drainage systems in the curriculum of anesthesia residents and compare it with residents who undergo the standard teaching and training program during their cardiovascular rotation.

TYPE OF STUDY

This is a parallel group randomized controlled trial which would allocate each resident into either the simulation or no simulation group.

RANDOMIZATION:

The study design allocates the whole group of residents in the vascular rotation (CA2s and CA3s), during a particular month, into one of the two groups (stimulation or no-stimulation). This would be achieved by randomizing each month into- simulation or no-simulation group. Randomization would be achieved by computed generated random number and would be communicated to the PI, who would facilitate the decided group specific educational plan for that month's resident group.

METHODS

During the first week of the vascular rotation, the residents randomized to the simulation group will be taken to the SIM center. There will be initial orientation and debriefing at the sim center.

The scenario consists of a patient requiring perioperative CSF drainage prior to undergoing thoracic aortic aneurysm surgery. The simulation will involve step by step instructions on insertion of the CSF drainage catheter including aseptic technique, position of patient (lateral vs. sitting), site of insertion. The simulation training will be done on a mannequin to simulate actual conditions. We plan to use a simulation model, which is basically a torso with the ability to palpate the back and spinous processes and use the epidural needle with loss of resistance technique with haptic feedback. The trainees would be able to actually perform the procedure on the manikin.

Various commercial CSF drainage kits are available. We will use the Medtronic lumbar drainage kit, which is available in the OR. Sterile technique, including chlorhexidine prep, full gown, sterile drape, sterile gloves, mask, hat. Insertion is typically at L3-L4 or L4-L5.The Touhy needle will be inserted with the bevel facing cephalad in incremental fashion with loss of resistance technique until the epidural space is reached and then inserted further till a distinct pop is felt and the subarachnoid space entered. This will be confirmed by free flow of CSF from the Touhy needle. The CSF catheter will then be inserted through the Touhy needle, taking care to avoid marked seepage of CSF by minimizing the duration between trocar withdrawal and catheter introduction. The technique of using wire reinforced catheters as opposed to ordinary catheters will be demonstrated (available on Integra CSF drainage catheters). The catheter will be threaded approximately 5 to 7 cm past the needle into the intrathecal space, the needle will be gently removed and the catheter secured with a clear occlusive dressing. Confirmation of free CSF drainage is obtained prior to dressing.

The simulation would continue needing assembly and attachment of the catheter to the monitor through a transducer and learning how to drain the CSF at a particular preset value. **The following would be discussed**

- Initial CSF pressure goal 10-12 mmHg
- Zeroing the transducer at the level of the right atrium
- Do not drain more than 20 ml/hr – risk of subdural or sub-arachnoid hematoma or brain stem herniation
- If CSF turns bloody - turn off drain and do not use it
- Patients should be transported with the drain turned off and catheter closed at two locations.
- Complications would all be addressed at this point
- New onset weakness: drain as above
- Optimize MAP
- If there is no demonstrable neurologic weakness for 72 hours of lower extremities, drainage is stopped and the CSF drainage catheter capped.

Lumbar Puncture & Epidural Trainer at the Sim center

<u>Lumbar Puncture / Epidural Trainer (3)</u>

This model is an ultrasound compatible trainer that includes the lumbar vertebrae, iliac crest, spinous process, ligamentum flavum, the epidural space and dura.

Becker's Drainage System-Medtronics

Anesthesiologist's Nontechnical Skills Global Rating Scale

Despite worldwide adoption of patient simulation in anesthesiology, there remains a lack of validated and reliable simulation performance assessment tools. Although most of the literature has focused on assessment of knowledge and technical skills during anesthesia simulation, research on nontechnical skills has become a recent area of interest. A comprehensive and reliable nontechnical skills assessment tool called the *Anaesthetists' Non-Technical Skills (ANTS) system* has recently been developed.
The hierarchical ANTS scoring system consists at the highest level of four basic skill categories, namely task management, team working, situation awareness, and decision making. These skill categories are further divided up into 15 skill elements. Each element is anchored for rating with examples of behaviors indicating good and poor practice. These skills are not necessarily acquired through clinical experience and may need to be specifically taught. Hence our primary outcome is based on this scale with a rating of 1-4.

Sub scores	Elements	Partial Rating	Global Category Rating
Task management	Planning and preparing		
	Prioritizing		
	Providing and maintaining standards		
	Identifying and utilizing resources		
Team working	Coordinating activities with team		
	Exchanging information		
	Using authority and assertiveness		
	Assessing capabilities		
	Supporting others		
Situation awareness	Gathering information		
	Recognizing and understanding		
	Anticipating		
Decision-making	Identifying options		
	Balancing risks and selecting options		
	Reevaluating		

Rating Options Descriptor

4—Good Performance was of a consistently high standard, enhancing patient safety; it could be used as a positive example for others

3—Acceptable Performance was of a satisfactory standard but could be improved

2—Marginal Performance indicated cause for concern, considerable improvement is needed

Check List

Test Items	Test Items	Done	Partially done	Not done	Max Score possible
Task management	Obtained all the correct equipment for the setup	2	1	0	2
Task management	Observed sterile precautions	2	1	0	2
Team working	Appropriate communication with patient and assistants at the time of the procedure	2	1	0	2
Team working	Appropriate care of the catheter during shifting to ICU	2	1	0	2
Situation awareness	Identifies indications and advantages of CSF drainage catheter placement	2	1	0	2
Situation awareness	Appropriate leveling of the catheter to the right atrium.	2	1	0	2
Decision-making	Insertion techniques, identification of landmarks	2	1	0	2
Decision-making	Appropriate trouble shooting(redirection if bone is encountered, bloody CSF etc)	2	1	0	2

Analogous methods will be used to compare the interventions on secondary outcomes. No inference will be made comparing groups on complications due to low power – data will be descriptively reported.

The significance level will be 0.05. SAS or R statistical software will be used for all analyses.

Sample size considerations.

All available residents for a 18-month period will be approached for enrollment in this study, giving a potential enrollment of 30-40 residents. Assuming a standard deviation of 1 point (with a range of 1 – 4) we will have 90% power at the 0.05 significance level to detect differences (and effect sizes = difference in means / SD) of 1.53 with 20 residents, 1.23 with 30 residents and 1.05 with 40 residents. Since a difference of 1 would be clinically important, we plan to enroll as close to 40 residents as we can. Effective power will be about 85% since we plan to use non-parametric analyses instead of t-tests.

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Title: **Evaluation of a Simulation Based Workshop to Enhance Learning of Insertion and Management of CSF Drainage Catheters in an Anesthesia Residency Program**

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Following Institutional review board approval, CA-3 residents rotating through the vascular rotation at the Cleveland Clinic main campus in the period between December 2014 and June 2017 were randomly allocated to simulation based learning versus problem based learning using computer generated randomization. The learning activity (whether simulation based or problem based) was scheduled to occur in the first week of the vascular rotation and the content of the educational activities (simulation based and problem based) was designed to cover the same educational material.

The primary outcome was the composite score (modified Anesthesiologist's Nontechnical Skills Global Rating Scale) achieved by participating residents during their first CSF drainage catheter insertion and management as evaluated by their supervising cardiothoracic anesthesiologists. Evaluating staff anesthesiologists were blinded to the residents' allocation group and were not involved in the study.

Baseline and outcomes data were prospectively collected on 28 residents and respective patients undergoing thoracic aortic vascular procedure requiring CSF drainage catheters at the Cleveland Clinic main campus during the study period.

First, balance on potential confounding variables between two study groups were evaluated by using standard univariable summary statistics as well as by using absolute standardized difference scores (absolute difference in means, mean ranking, or proportions, divided by a pooled estimate of standard deviation among the two groups). Potential confounding variables exhibiting a standardized difference score of 0.20 or greater are supposedly imbalance and used for adjustment in primary analysis.

As the primary analysis, the effect of simulation versus problem based learning on staff evaluation outcome was assessed using multivariate proportional odds logistic regression model adjusting for imbalanced baseline variables. The odds ratio (along with 95% the confidence interval) estimated the odds of a better score with simulation versus traditional training in the operating room.