

# Resident Perception of Standardization and Credentialing for High Risk Bedside Procedures in Cardiothoracic Surgery: Results from an Institutional Pilot Study

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## Abstract

**Objectives:** Though guidelines are set by the American Board of Thoracic Surgery for the operative cases that cardiothoracic surgery residents must perform to be board-eligible, no such recommendations exist to assess competency for the wide range of high-risk bedside procedures. Our department created and implemented a multi-disciplinary developed course designed to standardize common high-risk bedside procedures and credential our residents. The aim of this study was to survey the attitudes of residents to and query the efficacy of such a course. **Methods:** The course was designed with the goal of standardizing endotracheal intubation, arterial line insertion (radial and femoral), central venous line insertion, pigtail tube thoracostomy and nasogastric tube placement. The course consisted of an online module followed by a 4-hour hands on simulation session. Knowledge based pre and post evaluations were administered as well as Likert based survey regarding multiple aspects of the residents' perceptions of the course and the procedures. **Results:** Twenty-three (7 traditional and 16 integrated) cardiothoracic surgical residents participated in the course. Residents reported that 48% of the time, bedside procedures were historically taught by other trainees rather than faculty. All residents endorsed increased standardization of all procedures after the course. Likewise, residents showed increased confidence in all procedures except for pigtail and thoracentesis as well as nasogastric tube placement. 43.5% of the participants demonstrated improvement in the pre and post-test knowledge-based evaluations. **Conclusion** Cardiothoracic residents have favorable attitudes towards standardization and credentialing for high risk bedside procedures and utilizing such courses may help standardize procedural techniques.

## Introduction

The Accreditation Council of Graduate Medical Education (ACGME) and American Board of Thoracic Surgery mandate operative proficiency through tabulation of key procedures throughout residency, aimed at ensuring a level of surgical competency prior to graduation<sup>1-3</sup>. The impetus being that through familiarization of the cadence of procedures as well as the necessary skill set, the trainee will be able to perform these procedures safely and independently by the end of training. While the operating room (OR) is a controlled environment with faculty supervision, procedures carried out at the bedside can have significantly less oversight<sup>4</sup>. These procedures including chest tube placement, central line cannulation have intrinsic risk and can be morbid or mortal if done improperly. However, there are no current number of procedures that a trainee needs to perform and no clear-cut guidelines exist for assessing bedside procedure competency<sup>4-7</sup>. There is limited instruction from faculty on these procedures, often resulting in instruction from senior residents instead<sup>8,9</sup>. While this follows the see one, do one, teach one mantra integral to surgery, it can lead to high variability in procedural competence and no clear delineation of privileges in trainees.

Our institution had no set mechanism for the delineation of bedside procedures for our residents. Given the overall potential for harm and with a directive from the local Graduate Medical Education (GME) office we developed a training and credentialing program for our resident. The course was designed and implemented by a small working group of attending physicians, advanced practice providers (APP) and residents. More so as, integrated teams continue to change the landscape of surgical training, it is important to recognize that other practitioners; nurse practitioners, physician assistants and physicians in other sub-specialties play a critical role in the education and training of residents. This can be especially pointed in the realm of bedside procedures. Thus, in developing the curriculum a multifaceted approach to the curriculum was used. The goal of this study was to evaluate the development and execution of a high-risk bedside procedures credentialing program for trainees by surveying resident on their previous experiences, attitudes and knowledge on each procedure.

## Methods

The concepts of a two-phase training program was created by consensus between key teaching faculty, APPs and the residents in our department of cardiothoracic surgery. The specific procedures were determined by the local Graduate Medical Education office and our department. The specific curriculum was developed by a working group of trainees, advance practice providers and faculty. The course was divided into an online session followed by a hands-on simulation course. The online curriculum was a requirement to participate in the live course. The online curriculum contained the didactic information for each of procedures and was accompanied by videos, instruction guides and departmental policies created by the teaching faculty (**Supplement**). During the four-hour interactive session, trainees broke up into several groups and were instructed on and observed doing several high-risk bedside procedures. The stations were precepted by cardiothoracic faculty, senior APPs, critical care faculty and certified registered nurse anesthetists (CRNA). The defined procedures were central venous cannulation, radial and femoral arterial line placement, thoracentesis and pigtail catheter insertion, nasogastric and DUO tube placement (Cortrak 2 Avanos Medical Devices, Alpharetta, Georgia) and endotracheal tube intubation. The course faculty instructed and demonstrated the procedures to the trainees on high fidelity simulation models, after which they were evaluated and if competent, received a pass by the attending. Successful credentialing required attending approval of all high-risk procedures on a binary scale.

Each procedure had a set of criteria established by the working group that represented a combination of both safety and competency. Trainees were required to meet all these criteria before being approved on a procedure. In addition to this metric, pre and post tests were administered to assess trainee knowledge base for each procedure. Furthermore, pre and post surveys were also administered to gauge the trainees' attitude and response on the creation and execution of the credentialing course. All subjective responses were graded on a Likert scale from 1 to 5, which 1 being strongly disagree, 3 being neutral, and 5 being strongly agree. Surveys were administered on local computers and were proctored by the local staff at the simulation facility. by Paired student's T tests were done to evaluate the pre and post-test and survey results. Approval was granted by the University of Pittsburgh IRB (PRO19040405)

## Results

There were 23 cardiothoracic surgery trainees in attendance, six of whom had completed general surgery residency and the remaining 17 were integrated six year cardiothoracic surgery residents (**Table 1**) . All participants took the pre and post experience survey. The majority (13 trainees) were within their first two years of cardiothoracic surgical training, with the remaining trainees spread between their 3<sup>rd</sup> and 7<sup>th</sup> years of training. Twenty two (96%) of trainees felt that standardization of bedside procedures is necessary. However, when asked if they felt these procedures were currently institutionally standardized, the average Likert response was 3.5. The most familiar procedure among residents was placement of a nasogastric tube or duo tube while the least familiar procedure was performing endotracheal intubation. When asked if teaching beside procedures in a simulation environment was beneficial, the average Likert score was 3.7. On testing, 43% of residents improved from pre to post test (87.5% vs 91.6%, p=0.025) (**Central Figure**) .

### *Central Venous Cannulation and Arterial Line placement*

Frequency of central venous cannulation (CVC) was assessed, with 11 individuals performing over 25 cases in the last year, 6 performing between 0 and 5, and 3 performing between 6 and 10 as well as between 11 and 25 cases (**Table 2**). Twelve trainees reported that they were taught CVC placement from a senior resident, and the rest were taught by an attending (52.2% vs 47.8%). There was a significant increase in the standardization of CVC placement (4.17 vs 4.74,  $p=0.008$ ) as well as trainee confidence to successfully place an CVC (4.3 vs 4.70,  $p=0.046$ ) (**Figure 1**). Thirteen trainees had performed over 25 radial arterial lines and 12 trainees had performed over 25 femoral lines. The rest of the trainees were similarly distributed with 4 individuals having between 0 and 5 radial and femoral lines, 3 trainees having between 6 and 10 radial lines while 4 had between 6 and 10 femoral line placements. Three trainees had between 11 and 25 radial and femoral line placements. The instructors for arterial line placements were evenly split, with 13 trainees being taught by a senior resident and 13 being taught by an attending. There was a significant increase after the course in the Likert scores for standardization of arterial line placement (4.09 vs 4.63,  $p=0.01$ ) as well as the residents perceived ability to place an arterial line (4.22 vs 4.68,  $p=0.02$ ).

### *Thoracentesis, Pigtail Catheter, Nasogastric Tube, and Duo Tube Placement*

Thoracentesis and pig tail placement had a bimodal distribution. The majority of trainees performed over 25 thoracentesis (13 residents) and pig tail catheters (14 residents). The next highest grouping at 5 and 4 trainees performing between 0 and 5 thoracentesis and pig tail insertions respectively. Three residents had between 11 and 25 thoracentesis and 4 performed that many pig tails. The smallest number of trainees (3 individuals) performed between 6 and 10 thoracenteses as well as pig tail insertions. The majority of residents (13) were taught by an attending with 9 trainees being taught by a senior resident (59.1% vs 40.9%). There was a significant improvement in the standardization of these procedures (4.13 vs 4.64,  $p=0.03$ ) but no significant difference on resident perceived ability to perform them. Nasogastric and duo tube insertion were the most frequently performed procedures with 17 trainees having done 25 or more within the last year. Two residents have done between 6 and 10 as well as between 11 and 25 tube placements. Only 1 individual had done between 0 and 5 of these procedures. The majority of trainees (14) were taught by senior residents, with the remaining 8 taught by an attending (63.6% vs 36.4%). The standardization of this procedure significantly improved (4.14 vs 4.61,  $p=0.03$ ) after the course. However, the trainee's perceived ability remained unchanged ( $p = 1$ ).

### *Endotracheal Intubation*

Endotracheal tube insertion was the least performed procedure with 9 residents performing between 0 and 5 within the last year. Five trainees performed between 6 and 10 and 3 performed between 11 and 25. Four residents performed more than 25 within the last year. Nineteen residents were taught how to perform this procedure by attendings. Both the standardization of this procedure (4.0 vs 4.6,  $p=0.03$ ) and the trainees' perceived ability to perform this procedure (3.36 vs 4.41,  $p<0.001$ ) increased significantly after the course.

## **Discussion**

The see one, do one, teach one paradigm has been a key tenant in surgical education, allowing more autonomy of the trainee with each step<sup>10,11</sup>. However, public reporting and increased scrutiny of outcomes and surgical practices have hindered this training model, reducing senior resident experience over the past decade<sup>12-14</sup>. While the majority of technical learning for residents occurs directly by faculty in the operating room, this occurs to a lesser extent for bedside procedures. Moreover, the residents in this study reported that 48% were taught a bedside procedure by a senior resident instead of an attending or senior independent practitioner is not uncommon finding<sup>4,15,16</sup>. However, bedside procedures are far more routine procedures that cardiothoracic residents are expected to perform safely and independently. Unsurprisingly, the average Likert score for standardization of bedside procedures was 3.5. Unlike some other surgical subspecialists, the bedside procedures performed by cardiothoracic residents have an elevated risk for morbidity and mortality thus making the need for appropriate teaching and standardization even more pointed. This represents the impetus behind this study, to standardize and credential all cardiothoracic residents on the routine high risk

beside procedures they will encounter, increasing their confidence in the procedure and ultimately improve patient safety. Also, residents had no reference point for what the agreed upon way was to do any bedside procedure. Now the course materials including video, power point presentation and the departmental policy in text are all available online.

With increasing scrutiny on surgical outcomes comes a focus on the standardization of teaching and evaluation practices. However, recent literature has shown a concerning lack of standardization in training<sup>4-6</sup>. In an order to address standardization and increase frequency of training, simulations are utilized to facilitate trainee practice in a no risk environment<sup>17-23</sup>. For bedside procedures, groups have shown a benefit of simulation training prior to patient procedures<sup>17-20</sup>. For thoracentesis, Barsuk et al. showed in a randomized trial that standardized simulation-based learning decreased complication rates<sup>17</sup>. This study echoes this finding, while not assessing complication rates, by showing an increase in the standardization of performing a thoracentesis after the credentialing course. In fact, we demonstrated an increase of standardization across all the high-risk bedside procedures included in this credentialing program. Standardization is crucial in areas of surgery where supervision is lacking. Through a credentialing course, standardization and competency can be enforced, ensuring a common skillset for bedside procedures.

Along with increases in standardization came increases in trainee confidence to safely perform these high-risk bedside procedures. Interestingly, we found a dependence of this increase on the initial confidence of the residents. The most commonly performed and most comfortable procedure for the residents was a nasogastric tube/duo tube insertion. Likewise, the least commonly performed and least endorsed procedure was an endotracheal tube intubation. There was no change in resident confidence for performing an NG/duo tube insertion while the greatest improvement in confidence was for endotracheal intubation. This suggests that institutional training and exposure patterns need to be considered to better assess which of these bedside procedures warrant more rigorous standardization and frequent exposure to ensure trainee competency. In fact, a recent meta-analysis showed that junior residents in cardiac surgery benefitted most from simulation-based skill training, implying that the less exposure and experience a resident has with a particular skill set, the more effective and prudent a simulation-based training session will be<sup>20</sup>.

An important part of this work is the fact that this curriculum was created and executed in a multidisciplinary fashion. This allowed for the development of the online curriculum in as broad and widely applicable a manner as possible. Also, the CVC and endotracheal intubation hands on sessions were proctored by CRNPs, CRNAs and critical care physicians demonstrating the importance of the residents learning procedures from the most skill. Also, this course has the potential given how it was structured to be repeated specifically for APPs and other learners.

While the standardization and confidence metrics were assessed subjectively, it is important to emphasize that each resident was assessed and approved by an attending following a predetermined set of criteria for each bedside procedure. By doing so, we ensured a common competency baseline for our residents. Moreover, a knowledge-based test was taken by each resident before and after the training session, of which a large portion showed improvement. This test was aimed at assessing knowledge surrounding indications, complications, and maneuvers key in each procedure. Along with initial assessments on simulations as well as attending's assessment of competency, knowledge based tests are a key component of suggested credentialing paradigms<sup>24</sup>.

This work demonstrates that a bedside procedural credentialing course is effective at raising resident knowledge, increase confidence and standardizing performance of procedures in a cardiothoracic surgery training program.

### *Limitations*

This study is limited by a lack of evaluation of the bedside procedures on patients after the course, to fully assess the impact of the training and credentialing. Furthermore, there is a small sample size of residents, although it represents the entire cardiothoracic department. A multicenter study with a large amount of cardiothoracic surgery residents may be needed to fully explore the utility of a bedside course for

standardization and credentialing.

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Table 1.

Table 1. Baseline Characteristics	Table 1. Baseline Characteristics	Table 1. Baseline Characteristics
Trainee Make up	Trainee Make up	Trainee Make up
	Resident	17 (73.9%)
	Fellow	6 (26.1%)
Level of Training	Level of Training	Level of Training
	< 2 years	13 (56.5%)
	> 2 years	10 (43.5%)
Pathway	Pathway	Pathway
	Integrated I6	17 (73.9%)
	Traditional	6 (26.1%)
Answered yes to necessity of standardization	Answered yes to necessity of standardization	22 (96%)
Answer to level of institutional standardization	Answer to level of institutional standardization	3.5 (Likert Scale)
Pre-Course familiarity with procedures	Pre-Course familiarity with procedures	Likert Scale
	Central Venous Catheter Cannulation	4.3
	Femoral and Arterial Line Placement	4.2
	Pigtail and Thoracentesis	4.3
	Nasogastric and DUO tube placement	4.7
	Endotracheal Intubation	3.4

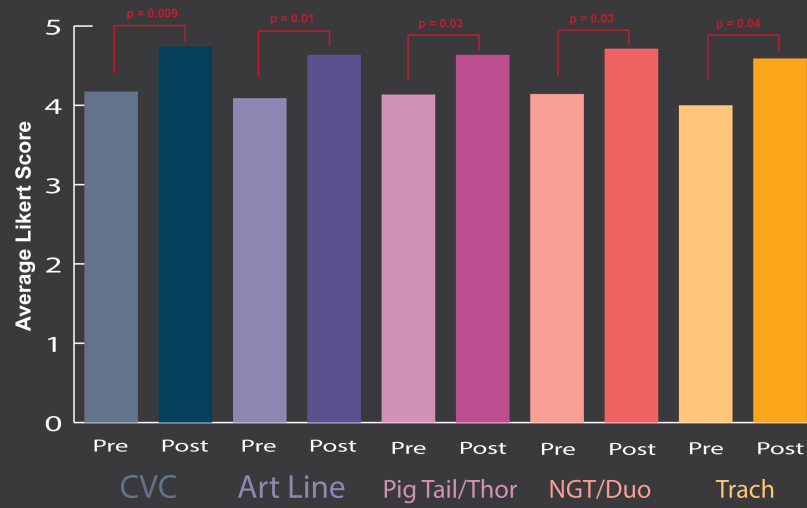
Table 2. Procedure Baseline	Table 2. Procedure Baseline	Table 2. Procedure Baseline	Table 2. Procedure Baseline
Frequency of Procedure in Last Year	Frequency of Procedure in Last Year	0 to 5	6 to 10
	Central Venous Catheter Cannulation	6 (26.2%)	3 (13.0%)
	Femoral Line Placement	4 (17.5%)	3 (13.0%)
	Arterial Line Placement	4 (17.5%)	4 (17.5%)
	Thoracentesis	5 (22.8%)	1 (4.5%)
	Pigtail	4 (17.5%)	1 (4.3%)
	Nasogastric and DUO tube placement	1 (4.5%)	2 (9.1%)
	Endotracheal Intubation	9 (42.9%)	5 (23.8%)
Type of Instructor	Type of Instructor	Senior Resident	Senior Resident
	Central Venous Catheter Cannulation	12 (52.2%)	12 (52.2%)
	Femoral and Arterial Line Placement	13 (50.0%)	13 (50.0%)
	Pigtail and Thoracentesis	9 (40.9%)	9 (40.9%)
	Nasogastric and DUO tube placement	14 (63.6%)	14 (63.6%)
	Endotracheal Intubation	2 (9.5%)	2 (9.5%)

Central Figure. Pre and Post Test Results

Figure 1. Standardization of Procedures and Resident Confidence



## Standardization of Bedside Procedures



## Ability to Preform Bedside Procedure

