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The Current State of Fellowship Training in Pulmonary Artery Catheter Placement and Data Interpretation: A National Survey of Pulmonary & Critical Care Fellowship Program Directors

Dr. Melissa H. Tukey, MD and Dr. Renda Soylemez Wiener, MD, MPH

The Pulmonary Center, Boston University School of Medicine, Boston, MA (Drs. Wiener and Tukey); Center for Health Quality, Outcomes and Economic Research, ENRM VA Hospital, Bedford, MA (Dr. Wiener)

Abstract

Purpose—Given decreasing use of pulmonary artery (PA) catheterization, we sought to evaluate whether current pulmonary and critical care fellows have adequate opportunity to obtain proficiency in PA catheter placement and data interpretation.

Methods—All U.S. pulmonary and critical care program directors were invited to participate in an anonymous online survey regarding current training opportunities in PA catheterization.

Results—The response rate was 51% (69/136). 83% reported that the number of PA catheterizations performed by fellows within their program has decreased in the past decade. 54% estimated that their fellows currently participate in <10 supervised procedures during fellowship. The most frequently identified barriers to training were procedure volume and reluctance to place PA catheters in the medical intensive care unit. 43% of respondents agreed that training in PA catheter *placement* is currently adequate within their program and 55% agreed that training in *data interpretation* is adequate. Only 39% of respondents believe PA catheter *placement* should continue to be an ACGME training requirement.

Conclusions—Many current pulmonary and critical care fellows do not have the opportunity to gain proficiency in PA catheterization. Fellowship training programs should consider alternate means of training fellows in PA catheter *data interpretation*, such as simulation.

Keywords

Pulmonary Artery Catheterization; Medical Education; Critical Care; Pulmonary Hypertension

Introduction

Once considered a “defining element of critical care” [1], PA catheter utilization has decreased dramatically in the United States and Canada over the past few decades [2,3].

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Correspondence: Dr. Tukey at The Pulmonary Center, Boston University School of Medicine, 72 E. Concord Street, R-304, Boston, MA 02118; (617) 638-4860 (phone), (617) 536-8093 (fax), mtukey@bu.edu.

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Even before this decrease in utilization, there was considerable variability in knowledge about PA catheter insertion and data interpretation among critical care nurses and physicians [4–8]. More recent studies suggest that knowledge of use and interpretation of data from PA catheters remains a concern [9–11].

Fellowship is considered the main opportunity for pulmonary and critical care physicians to hone their skills at PA catheter placement and data interpretation. While studies suggest that the ubiquitous use of the PA catheter does not improve outcomes [12–18], the procedure remains the standard of care for the diagnosis and management of pulmonary hypertension [19] and has a role in selected critically ill patients [20]. Proficiency in pulmonary artery catheter insertion and data interpretation remains an Accreditation Council for Graduate Medical Education (ACGME) requirement for pulmonary and critical care fellowship training programs [21]. However, in light of decreasing use of the PA catheter nationally, it is unknown whether current pulmonary and critical care fellows in the United States continue to have adequate opportunity during fellowship to learn to place PA catheters and interpret their results [22]. We sought to address this question by surveying US pulmonary and critical care program directors regarding current fellowship training in PA catheter placement and interpretation.

Methods

We developed a 17-item self-administered survey consisting of both multiple choice and fill-in-the-blank items. The survey included items in three domains: 1) training program characteristics, 2) current training opportunities in PA catheterization, and 3) barriers to training in PA catheterization. Response sets for survey questions evaluating the adequacy of current fellowship training and barriers to training used a five-point Likert scale with responses ranging from 1 (strongly agree/very important) to 5 (strongly disagree/very unimportant). Ten pulmonary and critical care physicians, including both faculty and fellows, assessed the survey for face validity, content validity, and clarity of individual items; we revised the survey based on their feedback. The final version of the survey is available in online Appendix 1.

In February 2012, all adult pulmonary and critical care fellowship program directors in the United States were invited to participate in an anonymous and voluntary online survey using <http://surveymonkey.com>. A listing of current pulmonary and critical care fellowship program directors was obtained from the American Thoracic Society website (<http://www.thoracic.org>) and confirmed with the American Medical Association website (<http://www.ama-assn.org/>). To maximize response rate, a reminder email with the link to the survey was sent at 2 weeks and 4 weeks, for a total of three invitations to participate. No compensation was offered for study participation. This study was reviewed by the institutional review board at Boston University Medical Center and determined to be exempt.

We calculated descriptive statistics for continuous variables with medians and interquartile ranges. We collapsed 5-point response sets into 3 categories (e.g. “strongly agree” and “agree” were combined, “no opinion” was left as its own category, and “disagree” and “strongly disagree” were combined) for purposes of statistical analysis. Programs in which fellows were estimated to perform fewer than ten supervised PA catheter procedures during fellowship training were classified as having decreased training opportunities. Associations between training program characteristics and decreased training opportunities were analyzed using chi-square analysis and Fisher’s exact test when there were expected cell counts <5. For all statistics a two-sided p-value of <0.05 was considered statistically significant. Statistical tests were performed using the SAS version 9.1.3 statistical software (Cary, NC).

Results

Overview

A total of 69 of the 136 U.S. pulmonary and critical care fellowship program directors responded to the survey (response rate = 51%). Table 1 shows the characteristics of the responding training programs. Of note, most programs rely on lectures (88.4%, 95% CI 80.9–96.0%) and clinical opportunities (82.6%, 95% CI 73.7–91.6%) for PA catheterization as the primary means of training fellows in PA catheter placement and data interpretation; alternative training mechanisms such as simulation (24.6%, 95% CI 14.5–34.8%) and web-based training (31.9%, 95% CI 20.9–42.9%) were reported far less often.

Current fellowship training opportunities

More than half (53.6%, 95% CI 41.9–65.4%) of respondents estimated that current fellows in their program perform fewer than ten supervised PA catheterization procedures during fellowship training (Figure 1). 82.6% (95% CI 73.7–91.6%) of respondents reported that training opportunities for fellows had either decreased or significantly decreased during the past ten years. Less than half of program directors (42.7%, 95% CI 30.9–54.4%) agreed that current fellowship training in PA catheter *placement* is adequate, and 55.1% (95% CI 43.3–66.8%) considered training in *data interpretation* adequate. More than half (52.2%, 95% CI 40.3–64.2%) of program directors estimated that fellows should place and interpret between 10 and 19 supervised PA catheters to be considered proficient, while 22.4% (95% CI 12.4–32.4%) felt that 20 procedures were necessary, 14.9% (95% CI 6.4–23.5%) felt that no absolute number was necessary and 10.5% (95% CI 3.1–17.8%) felt that fewer than 10 procedures were necessary. While 81.2% (95% CI 71.9–90.4%) of respondents agreed that proficiency in PA catheterization *data interpretation* should be an ACGME requirement for graduation from pulmonary and critical care fellowship, only 39.1% (95% CI 27.6–50.7%) agreed that proficiency in catheter *placement* should be a requirement.

Barriers to fellowship training

Table 2 describes barriers to training in PA catheterization. The most frequently identified barrier to training in PA catheterization was decreased volume of procedures being performed (identified as important or very important by 82.6% [95% CI 73.7–91.6%] of respondents). Reluctance to place PA catheters in the medical intensive care unit was identified as an additional barrier by 66.7% (95% CI 55.6–77.8%) of program directors.

Programs in which fellows perform fewer than 10 supervised PA catheterization procedures during fellowship were significantly less likely to report that the pulmonology department performs the majority of procedures for the evaluation of pulmonary hypertension (11.1% vs. 50.0%, $p=0.0005$). Similarly, training programs with decreased training opportunities were less likely to report that fellows have the opportunity to perform procedures in the catheterization lab (29.7% vs. 62.5%, $p=0.006$). While we had hypothesized that programs with a higher number of fellows per year might have fewer opportunities for each fellow to receive adequate training in PA catheterization, program size was not associated with training opportunities ($p=0.42$). In addition, neither the presence of a pulmonary hypertension specialist on staff ($p=0.80$) nor association with a university hospital ($p=0.37$) were significantly associated with training opportunities.

Discussion

Despite the fact that training in PA catheter placement and interpretation is a requirement for graduation from pulmonary and critical fellowship, there are no standard criteria to determine proficiency. Jeremy Swan, the inventor of the PA catheter, suggested that

physicians should place at least 50 PA catheters per year to maintain proficiency [23]. In contrast, two large surveys of internal medicine residency program directors and general internists conducted in the 1980s suggested that a minimum of 10 procedures are required to achieve mastery [24,25]. In our survey, the consensus of pulmonary and critical care program directors was that between 10 and 19 supervised procedures are necessary to achieve proficiency. Yet we found that most pulmonary and critical care fellowship programs offer fellows the opportunity to insert fewer than 10 PA catheters under supervision during their entire 3 years of fellowship training.

The most frequently identified barriers to training in PA catheterization were decreased procedure volume and reluctance to place PA catheters in medical intensive care patients. Programs in which the pulmonary department performs the majority of catheterizations for the diagnosis and management of pulmonary hypertension and in which fellows are given the opportunity to perform procedures in the catheterization lab were significantly more likely to report adequate training opportunities. Interestingly, however, other subspecialties performing PA catheterizations, low volume of pulmonary hypertension patients, and lack of access to dedicated procedure space (e.g., to perform PA catheterization for the evaluation of pulmonary hypertension) were not identified as barriers to training by most program directors.

Given limited opportunities for hands-on procedural experience in many programs, the expectation that all graduating pulmonary and critical care fellows will be proficient in PA catheter *placement* is unrealistic. More than half of all program directors who responded to the survey reported that current training in PA catheter *placement* or *data interpretation* is inadequate within their training programs. Correspondingly, while most program directors believe that proficiency in PA catheter *data interpretation* should remain a requirement for graduation from pulmonary and critical care fellowship, most believe that proficiency in catheter *placement* should no longer be a requirement.

The implications of removing the ACGME graduation requirement are not trivial. If the graduation requirement is removed, this would imply that many future fellows will not graduate with proficiency in PA catheter placement and may need to rely on other subspecialists to place PA catheters when appropriate. However, because PA catheter utilization has decreased nationally for medical, cardiac, and surgical patients [2], other subspecialties may also be struggling to ensure sufficient opportunities for their trainees to master the skill of PA catheter insertion (although we cannot be certain as we did not survey other specialists). Thus, while there are precedents for internal medicine critical care physicians relying on skilled colleagues to perform advanced technical procedures (e.g., endotracheal intubation or placement of intra-aortic balloon pumps), a similar solution may not be pragmatic for PA catheter insertion. In addition, prior surveys of clinician's knowledge and understanding of pulmonary artery catheterization have already identified that many physicians and nurses are unable to correctly measure and interpret even the most basic information provided by the PA catheter such as the pulmonary capillary wedge pressure [8–11]. If future generations of pulmonary and critical care physicians are receiving less training in PA catheterization than their predecessors, these deficiencies are likely to worsen, which may further decrease the effectiveness of the test for use in appropriate clinical situations. Correspondingly, complementary educational modalities for learning PA catheterization, such as simulation, would likely need to be relied upon more broadly (only 25% of respondents reported that they currently use simulation in their fellowship program for PA catheter training). High fidelity mannequins are increasingly used for training in central venous catheter insertion [26–28]. Expansion of high fidelity simulation to include waveform interpretation and identification and management of complications of PA catheters such as arrhythmias could supplement hands-on-training. Alternatively, if the

graduation requirement is maintained, our results suggest that one option to increase proficiency more broadly would be for programs to increase opportunities for fellows to participate in procedures performed by other specialties for the diagnosis and management of pulmonary hypertension as well as procedures performed in the catheterization lab.

This study has limitations. First, our response rate was 51%, which introduces the possibility that our respondents are not representative of the entire population of US pulmonary and critical care program directors. For example, our results may be biased if the subset of program directors who responded to the survey were disproportionately from programs with decreased training opportunities in PA catheterization. However, even if we assumed that all non-responders had ample opportunity for training in PA catheterization, our results suggest that more than a quarter of current fellowship programs do not offer sufficient training. Second, we surveyed fellowship program directors to estimate current fellowship training opportunities instead of directly surveying pulmonary and critical care fellows. While we assumed that program directors are generally knowledgeable about the opportunities for procedural training within their fellowship programs, this may not be the case. Third, by not surveying fellows directly, this survey cannot address whether decreased opportunities to train in PA catheterization correlates with decreased knowledge and understanding of this technique as would be expected. Finally, as we surveyed only adult combined pulmonary and critical care fellowship program directors it cannot be assumed that our findings reflect the experience in other types of critical care fellowships.

Conclusions

As the frequency of PA catheterization has decreased over the past few decades, so have training opportunities for pulmonary and critical care fellows. At this time, many current fellows no longer have the opportunity to obtain proficiency by the end of standard fellowship training. Given these findings, and reflecting the opinion of many current fellowship program directors, the ACGME should consider changing the requirement that all pulmonary and critical care fellows be proficient in PA catheter insertion. At the very least, in light of the reality that clinical opportunities for PA catheterization are decreasing, fellowship programs must begin to transition to other modes of training to ensure proficiency in PA catheter data interpretation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1.
Number of Supervised Pulmonary Artery Catheterization Procedures Performed by Fellows During Fellowship Training

Table 1**Characteristics of Responding Training Programs**

	Respondents (n)	Percent (%)
Number of fellows per year (median/interquartile range)	4.0 (2.0 to 5.0)	
Primary Training Site Location		
Community Hospital	6	8.7
University Hospital	55	79.7
Other	8	11.6
Presence of Pulmonary Hypertension Subspecialist	60	87.0
Affiliation of Pulmonary Hypertension Subspecialist		
Pulmonary	52	86.7
Cardiology	8	13.3
Location of Catheterization Training		
MICU	66	95.7
CCU	15	21.7
Catheterization Lab	31	44.9
SICU	20	29.0
Operating Room	4	5.8
Educational Modalities Utilized		
Lectures	61	88.4
Hands on Procedural Experience	57	82.6
Web-based Modules	22	31.9
Simulation	17	24.6

Table 2**Barriers to Training in Pulmonary Artery Catheterization**

Barrier	Respondents (n)	Percent (%)
Volume of catheterizations performed	57	82.6
Reluctance to perform procedures in the MICU	46	66.7
Decreased knowledge among nurses	31	44.9
Procedures being performed by other subspecialties	24	34.8
Availability of faculty to supervise procedures	14	20.3
Low volume of pulmonary hypertension patients	12	17.4
Lack of access to procedural space	10	14.5