A Longitudinal Regional Educational Model for Pulmonary and Critical Care Fellows Emphasizing Small Group- and Simulation-based Learning

Nirav G. Shah¹, Nitin Seam², Christian J. Woods³, Henry E. Fessler⁴, Munish Goyal^{3,5}, Dorothea McAreavey², and Burton W. Lee^{2,3,6}, for the DC-Baltimore Critical Care Educational Consortium

¹Division of Pulmonary & Critical Care, University of Maryland School of Medicine, Baltimore, Maryland; ²Critical Care Medicine Department, National Institutes of Health, Bethesda, Maryland; ³Division of Pulmonary, Critical Care and Respiratory Services, and ⁵Department of Emergency Medicine, MedStar Washington Hospital Center, Washington, District of Columbia; ⁴Division of Pulmonary and Critical Care, Johns Hopkins University School of Medicine, Baltimore, Maryland; and ⁶Department of Medicine, AIC Kijabe Hospital, Kijabe, Kenya

ORCID ID: 0000-0002-6161-2233 (N.G.S.).

Abstract

Recent trends have necessitated a renewed focus on how we deliver formal didactic and simulation experiences to pulmonary and critical care medicine (PCCM) fellows. To address the changing demands of training PCCM fellows, as well as the variability in the clinical training, fund of knowledge, and procedural competence of incoming fellows, we designed a PCCM curriculum that is delivered regionally in the Baltimore/Washington, DC area in the summer and winter. The educational curriculum began in 2008 as a collaboration between the Critical Care Medicine Department at the National Institutes of Health and the Pulmonary and Critical Care Section of the Department of Medicine at MedStar Washington Hospital

Center and now includes 13 individual training programs in PCCM, critical care medicine, and pulmonary diseases in Baltimore and Washington, DC. Informal and formal feedback from the fellows who participated led to substantial changes to the course curriculum, allowing for continuous improvement. The educational consortium has helped build a local community of educators to share ideas, support each other's career development, and collaborate on other endeavors. In this article, we describe how we developed and deliver this curriculum and report on lessons learned.

Keywords: medical education; pulmonary and critical care training; curriculum design; regional collaboration

(Received in original form January 8, 2016; accepted in final form February 3, 2016)

Author Contributions: N.G.S and N.S. are the guarantors of the manuscript and are responsible for the work as a whole. They drafted the initial manuscript and approved the final manuscript as submitted. C.J.W., H.E.F., M.G., D.M., and B.W.L. assisted with drafting and editing the final manuscript as submitted.

Correspondence and requests for reprints should be addressed to Nirav G. Shah, M.D., University of Maryland Medical Center, 110 S. Paca Street, 2nd Floor, Room 2-N-144, Baltimore, MD 21201. E-mail: nshah1@medicine.umaryland.edu

Ann Am Thorac Soc Vol 13, No 4, pp 469–474, Apr 2016

Copyright © 2016 by the American Thoracic Society

DOI: 10.1513/AnnalsATS.201601-027AR

Internet address: www.atsjournals.org

Several trends have driven the growing need to supplement the traditional experiential training of pulmonary and critical care medicine (PCCM) fellowship with formal didactic and simulation experience. Duty hour restriction during residency (1) has reduced exposure to emergency resuscitation (2) and limited opportunities to perform procedures (3) and may have negatively affected resident education (4). Revisions to residency procedural competence requirements and the creation

of specialty procedural services mean some graduating residents have little experience in procedures once widely practiced. Appropriately heightened attention to patient safety has stimulated the growth of simulation centers and the expectation that trainees will obtain their early experience with procedures on manikins and task trainers. Finally, the broad core curriculum of pulmonary and critical care, which fellows were once expected to master through their independent reading, is being

delivered to them increasingly in lecture or other teaching format.

The net effect is that incoming PCCM fellows display significant variability in their clinical training, fund of knowledge, and procedural competence. Some fellowship programs responded with more intensive introductory training, with committed time dedicated to simulation for task training as well as crisis resource management (5). This type of introductory educational program for graduate medical education is

distinct from an orientation to the hospital and is often referred to as “boot camp” (6) or an “accelerated skills course” (7). These programs satisfy the need for increased education at the beginning of the fellowship, as well as the clear patient safety need of achieving and assessing fellows for a minimal threshold of competence. However, these early and foundational training sessions do not address the need for a longitudinal core curriculum. Furthermore, both early boot camp training and longitudinal delivery of the core curriculum place substantial resource demands on individual programs. These resources include the space, equipment, and expertise for simulation exercises, and the time and broad knowledge of pulmonary and critical care needed to teach the state of the art in diverse areas.

To mitigate these demands while improving fellowship education, we designed a PCCM curriculum that is delivered jointly in summer and winter blocks through an on-going educational collaborative involving six pulmonary/critical care, one pulmonary, and six critical care programs. This allows efficient pooling of human resources to identify the regional content experts who can provide the best lectures on the core content, thereby avoiding duplicate efforts. Boot camp simulation sessions can be scheduled at the institutions with the optimal facilities. Costly task trainers used for common critical care procedures such as bronchoscopy, central lines, and chest tubes can be shared among multiple institutions. In this article, we describe how we developed and deliver this curriculum, as well as the lessons learned, to assist other programs that may wish to adopt this strategy.

Course Development and Evolution

The curriculum began in 2008 as a collaboration between the Critical Care Medicine Department at the National Institutes of Health and the Pulmonary and Critical Care Section of the Department of Medicine at MedStar Washington Hospital Center. Because fellows from both programs rotated through both hospitals, the objective was to ensure a uniform foundational introduction to critical care medicine and pulmonary diseases for all first-year fellows in July. To build on this foundation and to reinforce key concepts,

Table 1. Contributing programs to the DC–Baltimore critical care educational consortium

Type of Training Program	Name of Training Program
Critical care	National Institutes of Health
EM/IM critical care	University of Maryland
Neuro critical care	University of Maryland
Pulmonary	Howard University
Pulmonary/critical care	Georgetown University
	George Washington University
	Johns Hopkins University
	University of Maryland
	Walter Reed National Military Medical Center
	Washington Hospital Center
Surgical critical care	INOVA Fairfax Hospital
	Washington Hospital Center

Definition of abbreviations: EM = emergency medicine; IM = internal medicine; Neuro = neurology.

2 weeks were added in the winter to teach more advanced topics.

Almost annually since its inception, the program has expanded with the addition of multiple PCCM and critical care fellowship programs in the Baltimore–Washington metropolitan area. Currently, 36 incoming fellows from 13 fellowship programs participate in the collaboration (Table 1). The curriculum has been consolidated into a 3-week period during July (summer education block) for the introductory topics and 1 week in January (winter education block) for advanced topics.

The original curriculum was determined using the American Board of Internal Medicine critical care medicine examination blueprint, previous years’ in-service examination performance and breakdown of specific topics, and fellow input on desired topics. The amount of time designated for each section was determined by faculty input and was adjusted yearly on the basis of fellow and faculty feedback.

The current curriculum is planned each year with face-to-face meetings during

the course and via e-mail. Two to three faculty members direct the consortium, coordinating the topics in the curriculum as well as the modalities used to teach them. The codirectors merge any identified curricular needs from the trainees with the identified expertise at each institution to create a curriculum that is both comprehensive and engaging.

The curriculum is divided into sections, each with its own leader, reflecting important areas of educational focus that include physiology, pulmonology, critical care, radiology, pathology, ultrasound procedures, mechanical ventilation, and evidence-based medicine. Section directors provide input regarding curriculum design in their area of expertise.

A specific number of hours per education block are allocated to each section to ensure the educational needs are met (Table 2). In addition, most fellows attending the course train at programs in Washington, DC, Bethesda, MD, and Baltimore, MD. Therefore, full days are

Table 2. Allocation of time per section in summer and winter education blocks

Section	Summer (h)	Winter (h)	Total (h)
Mechanical ventilation	18.75	8	26.75
Evidence-based medicine	3.75	1	4.75
Ultrasound	13.5	8	21.5
Critical care	17.5	10	27.5
Radiology/pathology	2	2	4
Physiology	3	1	4
Pulmonary medicine	8	5	13
Procedures	6	5	11
Other topics	16	2	18

allocated to each city to distribute commute time fairly among the participants.

The summer curriculum focuses on developing a foundation in PCCM by devoting considerable time to mastering the core concepts and skills related to the areas of ventilator management, bedside ultrasound and echocardiography, organ physiology, radiology, and evidence-based medicine. These concepts are also integrated into the educational content related to important critical care clinical disorders such as sepsis and adult respiratory distress syndrome. The winter curriculum builds on the concepts taught in the summer and devotes time to advanced concepts in the core topic areas. To maximize learning, learners in the summer and winter blocks are taught many of these concepts through

simulation and hands-on training (8).

Table 3 lists the didactic lectures and the small group and simulation-based learning for the mechanical ventilation and ultrasound sections of the course. In addition, task-training sessions for airway management, fiber optic bronchoscopy, thoracentesis, and chest-tube insertion are provided. Although the overall curriculum emphasizes critical care, topics in pulmonary medicine are also taught. These often focus on special patient populations, such as patients undergoing lung transplant and hematopoietic stem cell transplant, who are unique to one or another institution.

The curriculum was modified over the year in response to fellow feedback. Each of the lectures and the small group and

simulation sessions was rated by the fellows at the end of the summer block, using the Likert scales survey. The highest scoring content was consistently small group teaching of ventilator concepts with a test lung, ultrasound hand-on practice, and simulation scenarios. On the basis of this feedback and consistent with modern learning theories, we integrated more of this active learning content into the education blocks (9–11). In contrast, outpatient pulmonary medicine lectures were the lowest scoring content, likely because some of the fellows trained in nonpulmonary fellowships. In response to this feedback, we revised the pulmonary curriculum to focus on pulmonary topics that also had relevance to the intensive care unit, such as “intensive care unit management of asthma” or

Table 3. Mechanical ventilation and ultrasound topics presented at summer and winter education blocks

Topic	Summer		Winter	
	Lectures	Small Groups/Simulation	Lectures	Small Groups/Simulation
Ventilation	Ventilator physiology: Ohms law, Equation of motion & wave forms	Test lung praxis: peak/plateau pressure, autoPEEP, time constants	Initiating and terminating breaths	Praxis I: simulations & small groups
	Ventilator physiology: Boyles law, natural decay equation & PV curve	Test lung praxis: modes of ventilation and breath types	Ventilator wave forms & patient-ventilator asynchrony	Praxis II: simulations & small groups
	Modes of mechanical ventilation, breath types, and sensitivity	Test lung praxis: goals of mechanical ventilation & normal wave forms	Work of breathing, Pmus, & Campbell diagram	Small Groups: ventilator management of the noncompliant lung
	Ventilator-associated lung injury	Test lung praxis: normal wave forms and patient ventilator synchrony	Airway pressure release ventilation	
	Goals of oxygenation and ventilation	Test lung praxis: ventilator wave forms	Noninvasive ventilation	
	Normal ventilator wave forms			
	Mechanical ventilation in adult respiratory distress syndrome			
	Introduction to patient-ventilator synchrony and dyssynchrony			
Ultrasound	Physics and basic information	Groups focused cardiac assessment (cases) or practicum	Basic LV assessment	Clip/case review and skill stations I
	Focused cardiac assessment: standard views	Lung practicum	Additional LV and valve assessment	Clip/case review and skill stations II
	Procedure guidance, vascular access	Groups integrative case review; practicum	Cardiac tamponade	
	Lung parenchyma and pleura		Abdominal US for the intensivist	
	DVT assessment		RV assessment	
	FAST examination		Cardiac echo: interactive cases	
	Putting it all together			
	Use of US in ACLS			

Definition of abbreviations: ACLS = advanced cardiac life support; autoPEEP = auto positive end-expiratory pressure; DVT = deep vein thrombosis; FAST = focused assessment with sonography for trauma; LV = left ventricle; Pmus = muscle pressure; PV = pressure-volume; RV = right ventricle; US = ultrasound.

“massive and submassive pulmonary embolism.”

Our surveys also indicated that learners were more attentive when didactic lectures were given in the morning, followed by the more interactive sessions in the afternoon, so we modified our schedule accordingly. Key prereadings have been provided to supplement most of the teaching sessions, and slide sets have been posted in an online repository.

Although the course directors set ground rules and oversee the composition of each day of the education blocks, there is flexibility afforded to each site. For example, the start and end times of each day are altered by the host institution on the basis of traffic patterns to minimize travel time for the fellows. Given the difference in focus of the various training programs, as well as external constraints such as research and training grant requirements, the option to participate in the summer block, winter block, or both is determined by the program directors. In addition, although the course is designed for first-year fellows, the level of trainee participating is left to the discretion of the program director to optimize the experience, learning, and participation.

Some participating programs require attendance by all clinical fellows while senior fellows provide clinical coverage. Others offer participation as an option to fellows during nonclinical blocks. Each host site tracks attendance to ensure that learners in small groups and simulation sessions are distributed evenly, as well as to increase fellow accountability and participation. Participating fellows are required to attend all sessions at all the contributing centers.

Learner Assessment and Course Evaluation

A posttest is administered to all fellows on the last day of the summer block. The posttest is composed of written testing for radiology, ultrasound, and pulmonary/critical care topics and a hands-on/simulation test for ventilator management. The test serves several purposes: it motivates fellow learning, it uses group scores on individual topics to identify curriculum gaps, and it provides the fellows with formative feedback on where to focus their study as they begin clinical fellowship training.

Although program directors have not used the posttest scores as an evaluation tool, we are interested in whether test scores

Figure 1. Comparison of first-year fellows' critical care test scores from end-of-summer education block with spring APCCMPD critical care examination scores. Scores from DC–Baltimore Educational Consortium critical care examination taken at the end-of-summer education block (x axis) and scores from the APCCMPD spring critical care examination (y axis) from the following spring were compared for 38 first-year fellows who started their fellowship in either 2013 or 2014. Linear regression analysis did not show a significant correlation between the two scores ($r^2 = 0.07$), suggesting that modification of clinical training for fellows with low summer scores was not necessary. APCCMPD = Association of Pulmonary and Critical Care Medicine Program Directors.

may reflect a need for modification of clinical training for those fellows with a low score. We studied the relationship of end-of-summer-block posttest scores to scores on the in-service critical care examination provided by Association of Pulmonary and Critical Care Medicine Program Directors taken the following spring by 38 first-year fellows in 2013 and 2014 who had available data from both tests (Figure 1). Linear regression analysis (SAS version 9.3; SAS Institute, Cary, NC) did not show a significant correlation between end-of-summer test and spring in-service examination scores ($P = 0.11$, $r^2 = 0.07$), suggesting that modification of clinical training after the summer education block for fellows with a low score on the end-of-summer examination was not required to ensure those fellows gained appropriate clinical knowledge by the completion of their first year of fellowship.

Curriculum evaluation is obtained by several means. Participants evaluate each lecture with a comprehensive written survey using a five-point scale as well as free-text comments. Survey completion is required before sitting for the examination, which results in an appreciable amount of feedback. These evaluations are shared with each instructor to improve their future lectures or to choose different faculty. In

addition, an open feedback session is held on the last day of the summer education block after the written and simulation examinations. These evaluations and open feedback sessions have led to substantial changes to the course curriculum (Table 4), feeding a cycle of continuous improvement.

Obstacles to Implementation

We faced several obstacles in growing the education block. As the program expanded, some fellows spent 3 hours commuting to and from lectures. To shorten the long commuting times between DC and Baltimore, we shifted start and end times to

Table 4. Curriculum changes on the basis of oral and written feedback

More even split between Washington, DC and Baltimore
Additional hands-on/simulation sessions
Increased use of small groups and flipped classroom models
Fewer pulmonary-specific topics
Inclusion of more nonmedical critical care topics (surgical, trauma, cardiac)
Increase in ultrasound training
Addition of airway training
Shift of some topics from summer to winter

avoid peak traffic and distributed lecture locations between Washington, DC, Bethesda, MD, and Baltimore, MD, thus giving participants more time to complete prereading assignments.

Securing space, educators, parking, and food comes with considerable cost and logistical challenges, especially in July when other training programs need similar resources. By decentralizing the lectures, individual programs have a lower cost to bear. Scheduling often starts 6 to 12 months in advance, particularly for reserving conference rooms and large simulation space. Each program has one or more champions responsible for coordinating local logistics. By developing this large network, program directors are able to lean on local leaders to support the program.

As the program has grown in popularity, we have received requests for other learners (i.e., physician extenders, resident physicians) to participate. We have chosen to limit the program to fellows to meet space constraints and to focus on content appropriate for those who have completed residency training.

Some existing faculty members were skeptical about the value of allowing their fellows protected, nonclinical time for 4 weeks. Demonstrating value continues to be one of our challenges; however, to date, no fellowship program that has joined has decided to withdraw. Fellow feedback continues to be overwhelmingly positive.

Benefits of a Regional Curriculum

This educational consortium was originally intended to efficiently leverage the specialized expertise at each of the participating institutions to provide a unique, high-quality educational experience to our fellows. However, a number of unexpected, intangible benefits have resulted. Arguably, the most valuable has been the increased camaraderie between fellows and faculty from the various PCCM and critical care fellowships. This has lubricated internal patient transfer between critical care units within a given institution and interfacility transfer for subspecialized care such as transplant, advanced lung disease management, and cardiac surgery. The interaction of faculty and fellows from different programs that occurs during the education

blocks has also made it easier to facilitate external rotations at participating institutions. The consortium has also helped build a local community of educators who can share ideas, support each other's career development, and collaborate on other endeavors.

Lastly, an unanticipated but appreciated benefit is the use of the educational consortium as a recruiting tool for the participating programs. The summer block reduces the stress associated with assuming the new responsibilities of a critical care fellowship (12). In addition, fellows can choose a training program that best fits their goals, knowing that they will all have exposure to the best educators and to unique expertise in the region through the educational consortium.

Future Directions

Our plans focus on systematic documentation of the educational outcomes and the value added of our regional program. Although we are confident that our regional approach to fellow orientation improves preparedness for clinical training and is beneficial for patient safety, the evidence base supporting the usefulness of such a program is limited. Published evidence for efficacy of boot camps in improving learning comes largely from papers describing the transition from medical school to residency. A recent metaanalysis found 15 studies that involved medical education boot camps involving learners entering new clinical roles in North American programs (14 studies involved surgical trainees and one involved internal medicine interns) with data reporting on effectiveness (13). The metaanalysis concluded that learners who completed boot camps showed great improvements in clinical skills, knowledge, and confidence. Considering the investment of resources, it would be important to document an improvement in learner skills and confidence after regional orientation programs.

Now that the core curriculum, participating sites, and core faculty are established, we plan to use the Education Consortium as an educational laboratory to test which teaching modalities provide enhanced educational value. The winter education block provides opportunities to

test knowledge retention or the value of reinforcement and review. There is evidence that repeated simulation exposure may improve learning compared with a single exposure (14). The participation of a large heterogeneous group of fellows with varied backgrounds allows educational interventions to be tested with larger numbers and greater generalizability than could be achieved by a single program. In addition, although we believe that an effective introductory pulmonary critical care educational course is important for both patient safety and fellow education, this has not been studied systematically; however, we plan to do so in the future.

Conclusions

A cooperative, regional, multiinstitutional program for incoming critical care fellows integrating lectures, small group sessions, and simulation-based learning is feasible and time efficient. By sharing human and physical resources, the regional program provides an educational experience that is superior to those the individual programs composing the consortium would be able to provide on their own. A winter program that builds on content initially taught in the summer and introduces advanced concepts has been well received by learners. We hope that our experience may be useful to other groups of training programs whose geographic proximity would allow similar collaboration. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

Acknowledgment: The DC–Baltimore Educational Consortium would not be possible without the tireless effort and teamwork of the training program directors from the contributing institutions and the section content leaders: Georgetown University Hospital: Charles A. Read Jr, M.D., and Cristina A. Reichner, M.D.; George Washington University Hospital: Jalil Ahari, M.D.; Howard University Hospital: Vishal Poddar, M.D.; INOVA Fairfax Hospital: Christopher P. Michetti, M.D.; Johns Hopkins Hospital: Ramana Sidhaye, M.D., and Natalie West, M.D.; MedStar Washington Hospital Center: Jessica S. Wang Memoli, M.D., and Christine Trankiem, M.D.; University of Maryland Medical Center: Neeraj Badjatia, M.D., Janaki A. Deepak, M.D., Michael T. McCurdy, M.D., Kathryn S. Robinett, M.D., Nevins W. Todd III, M.D., and Michael E. Winters, M.D.; and Walter Reed National Military Medical Center: LTC John Sherner, M.D.

References

- 1 Philibert I, Amis S. The ACGME 2011 Duty Hour Standards: enhancing quality of care, supervision, and resident professional development. Chicago: ACGME Task Force on Quality of Care and Professionalism; 2011.
- 2 Mickelsen S, McNeil R, Parikh P, Persoff J. Reduced resident "code blue" experience in the era of quality improvement: new challenges in physician training. *Acad Med* 2011;86:726–730.
- 3 Peets AD, Stelfox HT. Changes in residents' opportunities for experiential learning over time. *Med Educ* 2012;46:1189–1193.
- 4 Bolster L, Rourke L. The effect of restricting residents' duty hours on patient safety, resident well-being, and resident education: an updated systematic review. *J Grad Med Educ* 2015;7:349–363.
- 5 Lucarelli MR, Lucey CR, Mastronarde JG. Survey of current practices in fellowship orientation. *Respiration* 2007;74:382–386.
- 6 Nishisaki A, Hales R, Biagas K, Cheifetz I, Corriveau C, Garber N, Hunt E, Jarrah R, McCloskey J, Morrison W, *et al*. A multi-institutional high-fidelity simulation "boot camp" orientation and training program for first year pediatric critical care fellows. *Pediatr Crit Care Med* 2009;10:157–162.
- 7 Brunt LM, Halpin VJ, Klingensmith ME, Tiemann D, Matthews BD, Spitler JA, Pierce RA. Accelerated skills preparation and assessment for senior medical students entering surgical internship. *J Am Coll Surg* 2008;206:897–904, discussion 904–907.
- 8 Lam G, Ayas NT, Griesdale DE, Peets AD. Medical simulation in respiratory and critical care medicine. *Lung* 2010;188:445–457.
- 9 Tainter CR, Wong NL, Bittner EA. Innovative strategies in critical care education. *J Crit Care* 2015;30:550–556.
- 10 McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Acad Med* 2011;86:706–711.
- 11 Schroedl CJ, Corbridge TC, Cohen ER, Fakhraan SS, Schimmel D, McGaghie WC, Wayne DB. Use of simulation-based education to improve resident learning and patient care in the medical intensive care unit: a randomized trial. *J Crit Care* 2012;27:219.e7–219.e13.
- 12 Jellinek MS, Todres ID, Catlin EA, Cassem EH, Salzman A. Pediatric intensive care training: confronting the dark side. *Crit Care Med* 1993;21:775–779.
- 13 Blackmore C, Austin J, Lopushinsky SR, Donnon T. Effects of postgraduate medical education "boot camps" on clinical skills, knowledge, and confidence: a meta-analysis. *J Grad Med Educ* 2014;6:643–652.
- 14 Springer R, Mah J, Shusdock I, Brautigam R, Donahue S, Butler K. Simulation training in critical care: does practice make perfect? *Surgery* 2013;154:345–350.