

Development of the Adult ECMO Specialist Certification Examination

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Abstract: The American Society of Extracorporeal Technology Board of Directors, consistent with the American Society of Extracorporeal Technology's safe patient care improvement mission, charged the International Board of Blood Management to write a knowledge and skill certification examination for healthcare personnel employed as adult extracorporeal membrane oxygenation (ECMO) specialists. Nineteen nationally recognized ECMO subject-matter experts were selected to complete the examination development. A job analysis was performed, yielding a job description and examination plan focused on 16 job categories. Multiple-choice test items were created and validated. Qualified ECMO specialists were identified to complete a pilot examination and both pre- and post-examination surveys. The examination item difficulty and

candidate performance were ranked and matched using Rasch methodology. Candidates' examination scores were compared with their profession, training, and experience as ECMO specialists. The 120-item pilot examination form ranked 76 ECMO specialist candidates consistent with their licensure, ECMO training, and clinical experience. Forty-three registered nurses, 28 registered respiratory therapists, four certified clinical perfusionists, and one physician assistant completed the pilot examination process. Rasch statistics revealed examination reliability coefficients of .83 for candidates and .88 for test items. Candidates ranked the appropriateness for examination items consistent with the item content, difficulty, and their personal examination score. The pilot examination pass rate was 80%. The completed examination product scheduled for enrollment

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in March 2020 includes 100 verified test items with an expected pass rate of 84% at a cut score of 67%. The online certification examination based on a verified job analysis provides an extramural assessment that ranks minimally prepared ECMO specialists' knowledge, skills, and abilities (KSA) consistent with safe ECMO patient care and circuit management. It is

anticipated that ECMO facilities and ECMO service providers will incorporate the certification examination as part of their process improvement, safety, and quality assurance plans. **Keywords:** extracorporeal life support, ECMO, ECLS, certification examination, Rasch analysis. *J Extra Corpor Technol.* 2020;52:96-102

BACKGROUND

In 2019, the American Society of Extracorporeal Technology's (AmSECT, www.AmSECT.org) International Board of Blood Management (IBBM, www.IntBBM.org) developed and validated a certification examination for adult ECMO specialists. The certification is titled Certified Adult extracorporeal membrane oxygenation (ECMO) Specialist (CES-A[®]; International Board of Blood Management, Chicago, IL). AmSECT believes that the certification process will help to standardize and assess ECMO specialist knowledge and job skills, enhance patient safety and care, help protect the public, and improve patient outcomes.

The Standards for Educational and Psychological Testing state that job analysis by a group of experts is the primary basis for creating validity evidence for credentialing examinations (1). The IBBM identified and recruited adult ECMO subject-matter experts (SMEs). SMEs have a proven history of serving as ECMO educators, coordinators, and managers. SMEs have peer-reviewed publication and are recognized for their scientific presentations. The IBBM board members and SMEs completed three main duties by consensus: 1) created knowledge, skill, and ability statements from the job analysis to define the job description to build the examination plan, 2) reproducible online survey forms were used to determine which test items would be used to follow the examination plan, and 3) test items (questions) were selected based on the performance and feedback by a reference group of adult ECMO specialist candidates completing the first pilot examination form.

During the examination development process, the Extracorporeal Life Support Organization's (ELSO.org) ECMO Education Committee published their ECMO education plan which includes governance steps to create a certification examination based on their proposed educational curriculum (2,3). A 2017 survey reported the common collaboration of registered nurses, respiratory therapists, and perfusionists at the ECMO patient's bedside where perfusionists provide technical support and are equally qualified to perform specialist duties (4,5).

We report on AmSECT's process for obtaining expert consensus to build and offer a certification examination for adult ECMO specialists. The purpose for this project is to describe the process used for developing the 2020 adult ECMO specialist certification examination and to report the results of the pilot examination. The adult

ECMO specialist certification is currently available to health professionals qualified by their employment and training in the role of adult ECMO specialist.

METHOD

The following specific examination development tasks were completed: 1) perform a job analysis, 2) write a job description, 3) construct an examination content plan matrix, 4) write and validate test items, and 5) validate the first examination form for spring 2020. The IBBM studied the validity and reliability of the test form items and candidate performance in a reference group of consenting ECMO specialists.

The 19 SMEs and IBBM board members developed a model of professional knowledge competence based on their experience and clinical practice. Numerous job descriptions were gathered from employer postings, and SMEs submitted their specialist job descriptions. Many knowledge, skill, and ability (KSA) statements were collected from the job descriptions. SMEs rated the statements for frequency of use in the job, importance to know for the job, and whether the statement belongs to the job description. The board went on to validate the job analysis and construct test specifications based on the job KSA (6,7). SMEs ranked each group of KSA to prioritize the statements that made the final lists.

Test questions (items) were submitted and evaluated by the SME with four sets of characteristics or rules. The items are as follows: 1) must be relevant to practice and the job description KSA, 2) must cover knowledge content used with high frequency in the practice, 3) must have content important to patient safety in the practice, and 4) an acceptable percent of the minimally prepared successful candidates must be able to answer the item correctly. The SME drafted a pool of test items that met these criteria.

At this time in the process and as part of the examination development plan, AmSECT engaged the ELSO Education Committee requesting a collaborative partnership for the continued development, deployment, and ongoing maintenance of the examination. Unfortunately, ELSO deemed their plan incompatible with AmSECT's examination development and declined the offer of equal partnership.

The SME recruited adult ECMO specialists from their institution to take the 120-question pilot certification examination.

Table 1. Four domains and 16 categories for adult ECMO specialist certification examination.

Anatomy, Physiology		Pathology, Pharmacology		Clinical Management		Catastrophic Events, Device Failure	
1.4 Modes of ECLS, cannulation	22	2.4 Organ preservation	35	3.4 QA/documentation	10	4.4 Team communication	36
1.3 Physiology	15	2.3 Coagulation and hemostasis	14	3.3 Initiation and weaning	49	4.3 Policies and procedures	38
1.2 Anatomy	20	2.2 Pharmacology	16	3.2 Monitoring patient and circuit	11	4.2 Safety and failure modes	45
1.1 Terminology	18	2.1 Pathology	16	3.1 Lab analysis and POCT	28	4.1 Devices	27
	75		81		98		146

The number of the 100 test items that relate to each category is listed and totaled.

The specialists signed consent agreement to take a pre-examination survey, rate each test item as they completed the examination, and complete a post-examination survey.

Rasch item and candidate analysis (Winsteps 3.91.2.1., www.winsteps.com) were used to rank and match item difficulty and candidate performance on the pilot examination (8,9). The volunteer pilot examination candidates rated each test item as to its appropriateness and frequency of use to include in the examination. The IBBM used the pilot examination results and volunteers' item rating to select and edit 100 questions for the first examination form for spring 2020. The SME completed the spring 2020 examination form, and their feedback was used to further refine and verify the final test form items.

RESULTS

The KSA statements revealed in the job analysis are published at the IBBM website (<http://intbbm.org/certification/>). The statements are ranked in the order of importance, belongingness, and frequency of conduct. The statements are listed on the Internet in the order in which the statements were ranked.

Table 1 lists the four main examination item domains and 16 categories identified in the job analysis from the KSA statements. The number of test items related to each domain in the first published 2020 examination form is included in the table.

The SME recruited 43 registered nurses, 28 registered respiratory therapists, four certified clinical perfusionists (CCPs), and one physician assistant working as adult ECMO specialists (n = 76) to complete the 120-question pilot examination. Figure 1 displays the Rasch person rank-item difficulty map for the pilot examination. The pilot examination form ranked person performance with a reliability coefficient = .84 and ranked item difficulty with a reliability coefficient = .88.

Table 2 presents the pilot examination test items that were rated by the pilot test group as not appropriate to the examination form and their job description. The pilot test group earned a mean score of 74 ± 10% (1 SD).

Figure 2 illustrates the pilot test groups' response to the post-survey questionnaire (n = 75/76) regarding their perceptions of the pilot examination; 87% agreed that the examination content was consistent with their job description; 84% agreed that the examination questions were written at the right level of difficulty; 96% of the pilot test-takers rated the examination appropriate; 89% of the specialists reported they would recommend the examination to their peers; 34% reported there should be 2 years before recertification is required and 44% stated 3 years; and 69% reported they would pay \$150 or more for the credential.

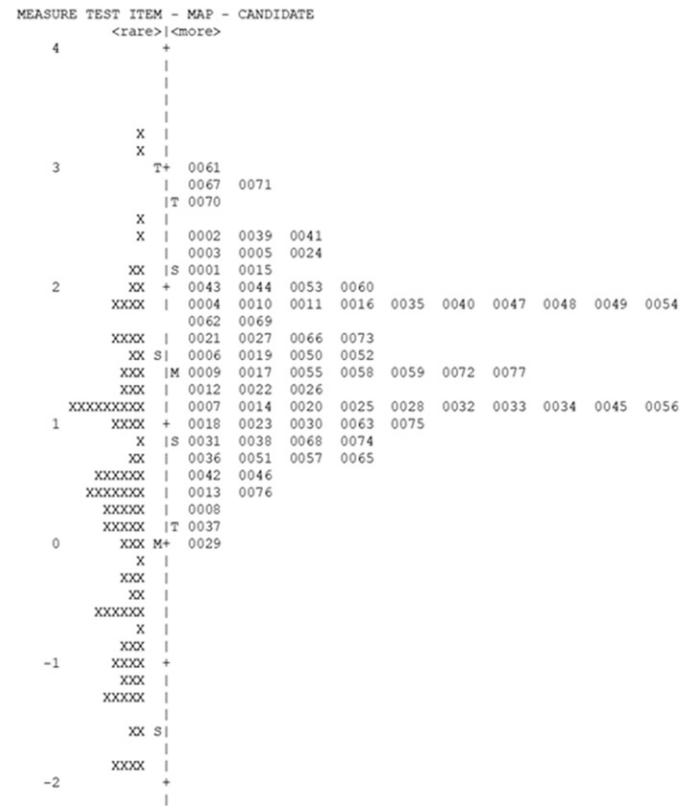


Figure 1. Rasch measure item-person map for the 76 adult ECMO specialists' performance on the 120 questions. The map plots which items are matched to specific candidates. M = mean, S = ±1 SD, and T = ±2 SD.

Table 2. Rasch table lists some of the test items that the test-takers rated as not belonging to the examination.

Entry Number	Total Score	Total Count	Measure	Model S.E.	Infit		Outfit		PTMeasural		Exact OBS%	Match EXP%	Test Item
					MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.			
84	13	61	3.82	.34	.92	-.4	.73	-.8	.49	.39	82.0	80.5	V-A gross arterial air
114	19	60	3.18	.31	.87	-.9	.79	-1.0	.55	.43	80.0	74.5	V-V ECMO, art desaturation
51	21	61	3.01	.30	.92	-.6	.96	-.1	.49	.43	77.0	73.2	Cardiohelp V-A ECMO
61	30	61	2.25	.28	.97	-.3	.95	-.3	.46	.43	68.9	68.4	Rotem clotting time
113	31	61	2.17	.28	1.18	1.7	1.26	1.7	.26	.43	57.4	68.2	Sweep ratio at ECMO start
50	33	61	2.01	.28	1.09	.9	1.07	.5	.35	.42	65.6	68.1	Cannula pressure-flows
96	33	61	2.01	.28	.94	-.6	.90	-.6	.49	.42	72.1	68.1	V-V to V-A conversion
83	33	60	1.94	.29	.85	-1.4	.84	-1.0	.55	.42	78.3	67.9	HITT syndrome
1	34	61	1.93	.28	1.42	3.6	1.54	3.0	.04	.42	49.2	68.1	Decreased venous drainage
6	34	61	1.93	.28	1.25	2.3	1.49	2.8	.16	.42	59.0	68.1	Centrifugal pump hemolysis
59	34	61	1.93	.28	1.10	.9	1.11	.7	.33	.42	62.3	68.1	V-V support for high CO patient
56	36	61	1.76	.29	.91	-.8	.83	-1.0	.50	.41	67.2	68.6	Cardiohelp V-A ECMO
116	36	61	1.76	.29	.84	-1.6	.93	-.4	.54	.41	77.0	68.6	DEHP and ECMO statements

These items were omitted from the spring 2020 form or rewritten based on detailed feedback from the pilot examination volunteers.

The pilot examination volunteers' results were used to simulate the results of the proposed spring 2020 100-item examination form. Table 3 compares the 76 pilot examinees simulated performance on the 2020, 100-question test form results to the original pilot examination 120-question results. The SME average performance on the spring 2020 examination form was 91.2 ± 3.5% (1 SD). The SME and IBBM further verified and refined multiple test items for the spring 2020 final test form.

Using a modified Angoff method, the SME rated each test question's difficulty (percent correct) for a safe-practicing,

minimally prepared ECMO specialist. When all the difficulty scores were averaged, the cut score for the spring 2020 examination was 67%, which in the pilot test group resulted in a Rasch measure = .97 ± .25 (model SE).

DISCUSSION

It is a “show what you know world”(10). AmSECT and the IBBM have constructed a conceptual framework for assessment of training and safety for adult ECMO specialists.

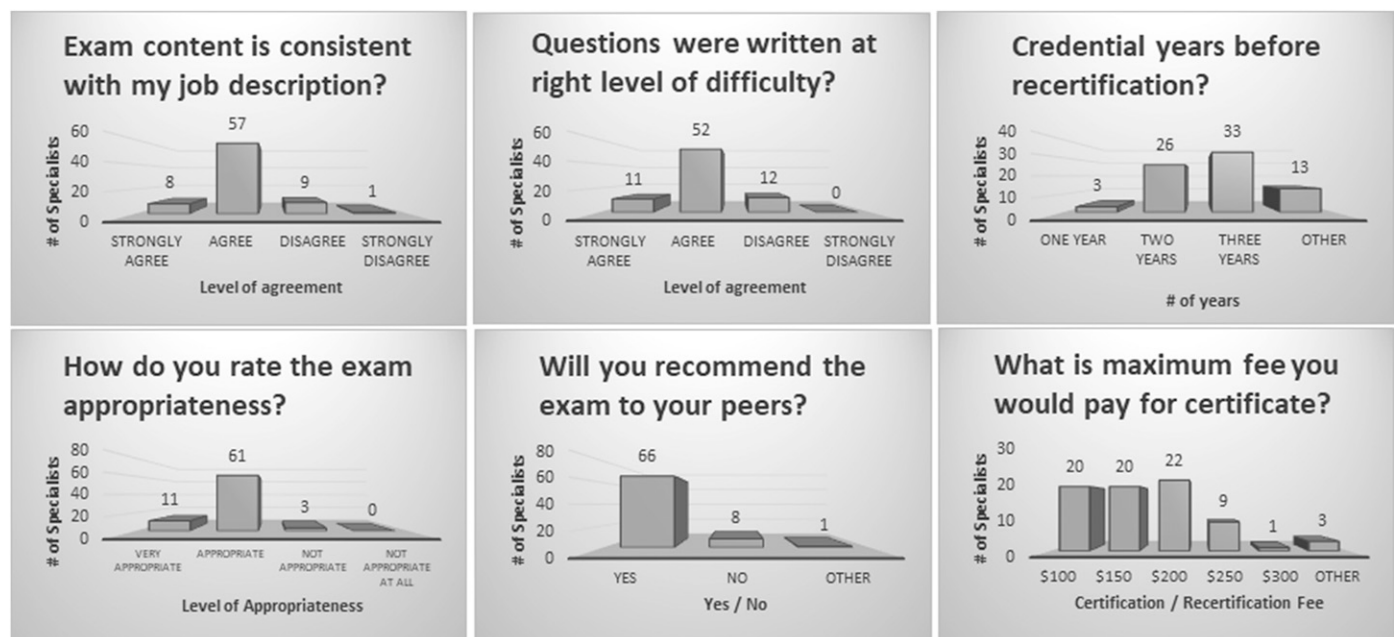


Figure 2. Volunteer adult ECMO specialist response to post-pilot examination survey items. Data labels are number of specialists.

Table 3. Results of the simulated volunteer ECMO specialist 100-item examination compared with the pilot examination results.

Parameter	Pilot Examination Form	March Examination Form*	Notes
Candidates (n)	76	77	1 incomplete pilot test
Items (n)	120	100	Revised by pilot candidates
Candidate reliability	.84	.81	Reliability coefficient
Item reliability	.88	.89	Reliability coefficient
Candidate separation	2.26	2.06	Candidate groups by correct scores
Item separation	2.75	2.81	Item groups by difficulty scores
Candidate mean score	89/120 (74%)	74/100 (74%)	Fraction correct responses
Candidate score standard deviation	10.4	10.1	Standard deviation for candidate scores
Item difficulty mean score	56.4/76 (74.2%)	56.7/77 (73.6%)	Mean difficulty (percent correct) per item
Item difficulty score standard deviation	16.0	15.8	Standard deviation for item difficulty mean
Candidate % score at $R = 1.00$	81–82/120 (67–68%)	67–68%	% Score at candidate Rasch measure = 1.00
Candidate pass rate	80.3%	84.4%	SME cut score = 67% (R Measure >.98)

Competence in practice may be measured by licensure or certification examinations after a period of training (11). Similar to how credentialing guidelines are nonexistent for ECMO physicians, no specific national certification or licensure exists for ECMO specialists (12). ELSO has published guidelines for local healthcare facility training for ECMO specialists. However, when asked to join the effort for construction of a comprehensive examination, the organization declined. In addition, ECMO principles and practices are included in the consensus perfusion education curriculum (Accreditation Committee for Perfusion Education, www.ACPE.org). The American Board of Cardiovascular Perfusion (ABCP.org) includes principles of ECMO in the certified CCP examinations. The CES-A examination has been developed for non-perfusionist candidates; however, CCPs may choose to take the examination.

Wang advocates for the job analysis as a standard tool to define test content as outlined by the Standards for Educational and Psychological Testing (AERA, APA, and NCME, 1999) (1,8). Wang emphasizes the importance to establish a clear link between the job task analysis and examination content as verified by the SME. The IBBM used a discrete consensus process to identify the KSA in the job tasks for an adult ECMO specialist and then had the SME confirm and rank the job tasks and associated KSA. The certification examination questions were built from the SME-ranked job tasks and KSA. The IBBM adheres to principles for test offering cited in the Standards for Educational and Psychological Testing (1).

The adult ECMO specialist examination development happened to follow the approach recommended by ELSO's 2019 ECMO education plan (2). However, the authors followed a job task KSA analysis model in contrast to ELSO's published plan to develop an educational curriculum for ECMO practitioners and then construct certification examinations. We used several consensus-based Delphi methods to rank the most important and relevant KSA that belong in the task-based examination.

Mid-2019 AmSECT offered to collaborate with ELSO to offer the certification examination. Unfortunately, ELSO deemed their plan not compatible with AmSECT's examination development process. It is most ideal if ELSO, ABCP, AmSECT, and other professional perfusion organizations work together to deliver education collaboratively. AmSECT welcomes the opportunity to explore joint opportunities which aim to improve patient safety during extracorporeal life support with certification (3).

Rasch statistical models are used to rank candidate ability and examination item difficulty, and to match candidate abilities to a particular test item score (13). Rasch models can be used to rate SMEs and specialist verification of job task and KSA statements (8). The IBBM uses Rasch models to help validate test items and monitor candidate ability from test form to test form. The pilot specialist examination dataset fits the Rasch model well, and the results are helpful to calibrate cut scores for the population of RNs and RRTs working as ECMO specialists. The item reliability estimates such as the model SEM, and item and candidate reliability scores were acceptable for a high-stake examination.

Sources of error in this approach to establishing a high-stake certification examination are fundamentally affected by SME bias and the pilot test group bias where the experts and test-takers do not represent the population of adult ECMO specialists and their educators. We relied on the feedback from the pilot test-takers regarding their ranking of the belongingness of the test item to their job as a specialist. The continued Rasch modeling of future ECMO specialist's ability on the examination will reveal if bias existed in the pilot group. Other sources of error would be the omission of KSA in the consensus process to build the job analysis. Future test-takers will be asked for feedback at the end of the examination to help identify important missing KSA.

We envision ECMO service facilities and employers of adult ECMO specialists using the specialist examination score as part of their quality assurance, training, and safe practice confirmation.

CONCLUSION

AmSECT and the IBBM have constructed and verified a reliable examination to confirm minimal safe mastery of the knowledge, skills, and abilities that make up the adult ECMO specialist job description. AmSECT believes that the adult ECMO certification process will help to standardize ECMO specialist knowledge and job skills, enhance patient safety and care, help protect the public, and improve patient outcomes. The examination is now available for specialists and their employers to use as a patient safety tool to confirm adult ECMO specialist education and training.

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Appendix 1. Subject Matter Expert list with credentials, years of ECMO experience and ELSO Award of Excellence application experience.

Subject Matter Expert	ECMO Facility	ECMO Years	ELSO Award of Excellence
Thomas J. Preston RRT, CCP, FPP	Innovative ECMO Concepts, Inc., Arcadia OK	18	No
Ashley B. Hodge, MBA, CCP, FPP	Nationwide Children's Hospital, Columbus OH	18	Yes
Kevin A. Charette, CCP	Seattle Children's Hospital, Seattle WA	27	Yes
Joseph G. Timpa CCP, FPP	Children's of Alabama, Birmingham AL	26	Yes
James A. Reagor MPS, CCP, FPP	Cincinnati Children's Hospital Medical Center, Cincinnati OH	25	Yes
Edward m. Darling MS, CCP, LP	SUNY Upstate Medical University, Syracuse NY	34	No
Bruce E. Searles MS, CCP, LP	SUNY Upstate Medical University, Syracuse NY	25	No
Robert C. Groom CCP, FPP	Main Medical Center, Portland ME and Tenwek Hospital, Bomet, Kenya	31	Yes
David C. Fitzgerald DHA, MPH, CCP	Medical University of South Carolina, Charleston SC	20	Yes
Christopher N. Pierce MS, CCP	University of Colorado, Aurora CO	17	Yes
Justin R. Slesman CCP	Lucile Packard Children's Hospital, Palo Alto CA	14	Yes
Cory M. Alwardt PhD, CCP	Mayo Clinic Hospital, Phoenix AZ	33	Yes
William E. Harris CCP	Perfusion.com, New Orleans LA	35	No
Desiree K. Bonadonna MPS, FPP, CCP	Duke University, Durham NC	18	Yes
Robert D. Longenecker BS, FPP, CCP, LP	Mercy Hospital, St. Louis MO	5	No
Mark P. Shepard RN, MHA, CCP	St. Louis Children's Hospital, St. Louis MO	13	Yes
Mark T. Lucas RRT, MPS, CCP	University of Colorado, Aurora CO	31	Yes
Keith A. Samolyk BS, RRT, PBMS, CCP Emeritus	Global Blood Resources, Somers CT	8	No
Jeffrey B. Riley MHPE, CCP Emeritus, CCT, LP	SUNY Upstate Medical University, Syracuse NY	35	Yes