Title

Position Paper on Global ECMO Education and Educational Agenda for the Future: A Statement from the Extracorporeal Life Support Organization ECMOed Taskforce

Authors

Bishoy Zakhary, Kiran Shekar, Rodrigo Diaz, Jenelle Badulak, Lindsay Johnston, Peter Paul Roeleveld, Guillaume Alinier, Peter Chi Keung Lai, Kollengode Ramanathan, Elizabeth Moore, Ibrahim Hassan, Cara Agerstrand, Wallace NGAI Chun-wai, Leonardo Salazar, Lakshmi Raman, Melania M. Bembea, Mark Davidson, Rene D. Gomez-Gutierrez, Jose Alfonso Rubio Mateo-Sidrón, Jeannie Kukutschka, Marta V Antonini, Matthieu Schmidt, Darryl Abrams, Mark T Ogino on behalf of the ELSO ECMOed Taskforce

Affiliations

Bishoy Zakhary, MD
Chair of Education and Logistics, ELSO
Assistant Professor of Medicine, Division of Pulmonary and Critical Care, Oregon Health and Science University, Portland OR, USA
ORCiD 0000-0002-8662-5911

Kiran Shekar, MD
Adult Intensive Care Services and Critical Care Research Group, the Prince Charles Hospital, Brisbane, Queensland, Australia
University of Queensland, Brisbane, Queensland, Australia and Bond University, Gold Coast, Queensland, Australia

Rodrigo Diaz, MD
ELSO Global Education Director
ECMO Unit Director, Clinica Las Condes, Santiago, Chile
ORCiD: 0000-0001-8046-2229

Jenelle Badulak, MD
Acting Assistant Professor of Emergency Medicine, University of Washington, Seattle WA, USA

Lindsay C. Johnston, MD, MEd
Associate Professor of Pediatrics (Neonatal-Perinatal Medicine), Yale School of Medicine, New Haven, CT, USA
ORCiD 0000-0003-0428-0479

Peter Paul Roeleveld, MD
Pediatric Intensivist, Leiden University Medical Center, Leiden, The Netherlands
ORCiD 0000-0001-5491-9408

Guillaume Alinier, PhD, MPhys, PGCert
Director of Research, Hamad Medical Corporation Ambulance Service, Doha, Qatar
Professor of Simulation in Health Care Education, School of Allied Health Professions, Midwifery, and Social Work, University of Hertfordshire, Hatfield UK
Adjunct Professor of Education in Medicine, Weill Cornell Medicine – Qatar, Doha, Qatar
Visiting Fellow, Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, UK
ORCiD 0000-0003-4255-4450

Peter Chi Keung Lai, MN, PGDip (ICN), RN, FHKAN (Critical Care)
Education Co-chair, AP ELSO
Nurse Consultant (Intensive Care), Queen Mary Hospital/Hong Kong West Cluster, Hospital Authority, Hong Kong
ORCiD 0000-0003-3715-8162

Kollengode Ramanathan, MD

Cardiothoracic Intensive Care Unit, National University Heart Centre, Singapore
ORCiD 0000-0003-1822-9455

Elizabeth A. Moore, BSN, RN, MBA
Associate Director - Heart and Vascular Center, University of Iowa Hospitals and Clinics, Iowa City IA, US

Ibrahim Hassan, MD
Chairmain, SWAAC ELSO
Director of ECMO and Critical Care, Hamad Medical Corporation, Doha, Qatar
Weill Cornell Medical College, New York NY, USA

Cara Agerstrand, MD
Division of Pulmonary, Allergy, and Critical Care, Columbia University College of Physicians and Surgeons / NewYork-Presbyterian Hospital, New York NY, USA

Wallace NGAI Chun-wai, MBChB
Associate Consultant, Adult Intensive Care Unit, Queen Mary Hospital, Hong Kong

Leonardo Salazar, MD
President, LA ELSO
Department of ECMO and VAD, Fundación Cardiovascular de Colombia, Bucaramanga, Colombia

Lakshmi Raman, MD
Associate Professor of Pediatrics, University of Texas Southwestern Medical Center, Dallas TX, USA
ORCiD 0000-0002-7676-1346

Melania M. Bembea, MD, MPH, PhD
Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore MD, USA
ORCiD 0000-0003-4984-520X

Mark Davidson, MD
Clinical Lead for ECMO & Cardiac Intensive Care, Department of Paediatric Intensive Care, Royal Hospital for Children, Glasgow, UK

Rene D. Gomez-Gutierrez, MD
Vice-president, LA ELSO
Director of Pediatric Critical Care Department, Christus Muguerza Hospital Alta Especialidad, Universidad de Monterrey, Mexico

Jose Alfonso Rubio Mateo-Sidrón, M.D.
University Hospital Foundation Jiménez Diaz, Madrid, Spain

Jeannie M. Kukutschka, MD
Education Director, ECMO Center, Christus Muguerza Hospital Alta Especialidad, Universidad de Monterrey, Mexico

Marta Velia Antonini CCN, CCP, MS
ICU I° Department of Anesthesia and Intensive Care, University Hospital of Parma, Parma, Italy
Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy
ORCiD 0000-0003-4276-3404

Matthieu Schmidt, MD, PhD

Sorbonne Université, UPMC Univ Paris 06, INSERM UMRS_1166-iCAN, Institute of Cardiometabolism and Nutrition, Assistance Publique–Hôpitaux de Paris, Pitié–Salpêtrière Hospital, Medical Intensive Care Unit, 75651 Paris Cedex 13, France

Darryl Abrams, MD
Division of Pulmonary, Allergy, and Critical Care, Columbia University College of Physicians and Surgeons / NewYork-Presbyterian Hospital, New York NY, USA

Mark T. Ogino, MD
President, ELSO
Chief Partnership Officer, Nemours Alfred I duPont Hospital for Children, Wilmington DE, USA
Chief Neonatology, Nemours Partnerships, Wilmington DE, USA
Clinical Professor of Pediatrics, Sydney Kimmel Medical College, Thomas Jefferson University, Philadelphia PA, USA

Corresponding Author
Bishoy Zakhary MD
bzakhary@gmail.com
Phone: +1 917 386-5403
Fax: +1 888 386-3231
ORCiD 0000-0002-8662-5911

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Abstract

Objective

The purpose of this position paper is two-fold: first, to describe the state of extracorporeal membrane oxygenation (ECMO) education worldwide, noting current limitations and challenges; and second, to put forth an educational agenda regarding opportunities for an international collaborative approach towards standardization.

Design and Setting

In 2018, the Extracorporeal Life Support Organization Education (ECMOed) Taskforce organized two structured, face-to-face meetings and conducted a review of published literature on ECMO education. Taskforce members generated a consensus statement using an iterative consensus process through teleconferences and electronic communication.

Measurements and Main Results

The ECMOed Taskforce identified seven educational domains that would benefit from international collaborative efforts. Of primary importance, the taskforce outlined actionable items regarding: (1) the creation of a standardized ECMO curriculum; (2) defining criteria for an ECMO course as a vehicle for delivering the curriculum; (3) outlining a mechanism for evaluating the quality of educational offerings; (4) utilizing validated assessment tools in the development of ECMO practitioner certification; and (5) promoting high-quality educational research to guide ongoing educational and competency assessment development.

Conclusions

Significant variability and limitations in global ECMO education exist. In this position paper, we outline a road map for standardizing international ECMO education and practitioner certification. Ongoing high-quality educational research is needed to evaluate the impact of these initiatives.

Introduction

Use of extracorporeal membrane oxygenation (ECMO) has grown dramatically over the past 15 years with 10- and 4–fold increases in adult and pediatric ECMO cases, respectively (1, 2). Although the number of global ECMO centers is unknown, the number of hospitals reporting data to the Extracorporeal Life Support Organization (ELSO) registry has increased from 83 in 1990 to 375 in 2018 (3). While advancements in circuit technology (4, 5), experience during the 2009 H1N1 pandemic (6, 7), and encouraging results from two modern trials (8, 9) and a post-hoc Bayesian analysis (10) have helped fuel this increased uptake, the management of patients requiring ECMO support remains technically challenging (11, 12) with variability in global complications and outcomes (13). Such variability likely reflects differences in patient selection, ECMO application, and patient management, factors well suited to standardization through education.

In an effort to improve clinical outcomes, ELSO has promoted specialized education for ECMO practitioners, health care professionals involved in the bedside care of the ECMO patient, by putting forth training guidelines for ECMO centers (13) and suggesting certification standards for ECMO practitioners (14). Despite these recommendations, ECMO education and certification remain limited and variable (15). In particular, lack of a standardized ECMO curriculum, course structure, and certification criteria have hindered a systematic implementation by ECMO centers. To address these concerns, the ELSO ECMOed Taskforce was created and charged with identifying global ECMO educational needs and outlining mechanisms for international collaboration and standardization.

ECMOed Taskforce

The ECMOed Taskforce is composed of a nominated group of 40 health care practitioners and educators from 19 countries with expertise in caring for the ECMO patient and in ECMO education (Figure 1). All five international ELSO chapters are represented, including the North American, Latin American, European, South and West Asian and African, and Asian-Pacific chapters, imparting a global perspective on ECMO education. Membership is broadly multidisciplinary representing the different specialties and disciplines involved in ECMO care. Among the adult, pediatric, and neonatal practitioners are intensivists, surgeons, anesthesiologists, pulmonologists, cardiologists, emergency physicians, ECMO specialists, nurses, perfusionists, and simulation experts.

This consensus statement is the result of two face-to-face meetings, teleconferences, and electronic communication among the ECMOed Taskforce members. A phased approach to identifying and addressing educational needs and gaps was planned. During Phase I, based on a review of published literature, the current state of ECMO education was assessed and described, key educational domains were identified, and preliminary recommendations were made. Workgroups were constituted to evaluate each of these domains and consensus was arrived at using the nominal group technique (16). Phase I proceedings with the taskforce's recommendations and rationales are presented in this paper. During Phase II, workgroups will utilize structured surveys, focus group discussions, and Delphi panel methodology (16) across ELSO Chapters to achieve further insight into these domains.

The purpose of this position paper is two-fold: first, to describe the state of ECMO education worldwide as it pertains to each workgroup domain noting current limitations and challenges; and second, to put forth an educational agenda regarding opportunities for an international collaborative approach towards standardization within each domain. The paper is aimed towards ECMO practitioners, ECMO program directors and coordinators, hospital directors, and regional health care organizers with the goal of ensuring that ECMO care is delivered safely and proficiently in a manner that is consistent and of high quality across the globe.

The Key Domains of ECMO Education

The ECMOed Taskforce identified educational domains that would benefit from international collaborative efforts. Domains were chosen to be sufficiently comprehensive to capture important elements of ECMO education whilst minimizing overlap. The Taskforce prioritized (1) creating a standardized ECMO curriculum, (2) defining criteria for an ECMO course as a vehicle for delivering the curriculum, (3) outlining a mechanism for evaluating the quality of educational offerings, (4) utilizing these tools in the development of ECMO practitioner assessment and certification, and (5) promoting high-quality educational research to guide ongoing educational and competency assessment development.

Based on these priorities, the Taskforce listed the following seven domains: ECMO Curriculum, ECMO Courses, ECMO Workshops, Endorsement, ECMO Certification, Online ECMO Education, and ECMO Educational Research. ECMOed members were divided into the seven workgroups, based on experience and expertise, to assess

and make recommendations within each domain. Workgroup summaries with recommendations and associated rationales are presented below and summarized in Table 1.

ECMOed Workgroup Summaries

ECMO Curriculum

Recommendations

1. Organize an international and multidisciplinary expert group to develop a standardized ECMO curriculum incorporating both knowledge and psychomotor skill learning objectives defining minimal competency of the ECMO practitioner.

Rationale

The foundational elements of ECMO education are dependent on the development of a rigorous and standardized curriculum. Standardization of curricula is widely accepted and employed by governing medical education organizations including the American College of Graduate Medical Education (17) and the Liaison Committee on Medical Education (18). As ECMO use grows and clinical practice guidelines are outlined, a standardized curriculum can help ensure best practices are being met.

Many institutions have published their experiences with ECMO curriculum development and assessment (19-24) while others have advertised ECMO courses and curricula online (25-32). Limitations of current curricula include the inherent lack of generalizability, being subject to regional variations in practice and lacking international input. Moreover, published works have not used the rigorous methodology necessary for curriculum development and application (33, 34).

To meet the goal of a rigorously developed and widely generalizable ECMO curriculum, the ECMOed Curriculum Workgroup has put forth a proposal based on Kern's methodology (35) for an expert panel consensus curriculum with validity and reliability testing (Figure 2) covering the appropriate levels of Bloom's taxonomy (36). A thoughtfully developed curriculum is the ideal vehicle to deliver excellence in ECMO education and practitioner

training. In particular, the curriculum will form the foundation for ECMO courses, allow for endorsement criteria of ECMO educational offerings, facilitate the development of online ECMO content, and set the structural framework for an ECMO practitioner certification process.

ECMO Courses

Recommendations

2. Define Comprehensive ECMO Courses to (1) meet all ECMO knowledge and psychomotor skill curricular objectives and (2) achieve a minimal educational quality level.

Rationale

The growth in the number of ECMO centers has mandated the need to train large numbers of ECMO practitioners and has been associated with numerous ECMO educational offerings. ECMO courses and workshops are currently being organized throughout the world and are offered by ELSO (25), by academic institutions (26, 27, 32, 37-39), by industry (40, 41), and in concert with societal meetings (42-45). Target learner groups are variable and include nurses (22), residents and fellows (20, 23, 24), and inter-professional groups (19, 21).

While each educational offering aims to provide an overview of ECMO support, there is variability in training methods, curricular coverage, training duration, instructor qualifications, target learners and participants, and course assessment. While the need to define an ECMO curriculum is of paramount importance, the method by which the curriculum is subsequently delivered must also be delineated. This is particularly important given local credentialing requirements typically incorporate a form of initial and on-going ECMO education (15) such that ECMO courses have an inherent high-stakes value attached.

Defining a Comprehensive ECMO course, therefore, is needed both to ensure curricular requirements are met and appropriate educational quality is achieved. To this end, ECMO courses should meet all ECMO curricular knowledge and psychomotor skill learning objectives, should target all health care professionals involved in providing direct bedside ECMO care, and incorporate a rigorously developed learner assessment and course evaluation. Other elements that make up course structure, including center and course director experience, training

methods, role and fidelity of simulation, course duration, instructor qualifications, learner-to-instructor ratio, commercial relationships, and advertising regulations will also need delineation.

ECMO Workshops

Recommendations

3. Supplement Comprehensive ECMO Courses with workshops that enrich and expand on the curriculum.

Rationale

Workshops are focused educational offerings outside the curricular criteria of a Comprehensive ECMO Course. Since the ECMO curriculum aims to define learning objectives applicable to all ECMO practitioners, advanced topics and discipline-specific topics may not be fully addressed in the courses. ECMO workshops can be tailored to the needs of specific learners to enrich the ECMO curriculum by offering focused didactic and simulation training.

Workshops are typically limited in scope and duration and can be offered in collaboration with other societies at national or international meetings. Examples include the ECMO Overview (31, 47) and Advanced Veno-venous ECMO (44, 48) workshops. Alternatively, workshops can be offered as standalone events addressing advanced and focused principles of ECMO management such as the ECMO Cannulation (28, 29) and Extracorporeal Cardiopulmonary Resuscitation (49, 50) workshops. Workshops can also be developed within the context of a broader physiologic topic. A mechanical circulatory support workshop utilizing advanced hemodynamic physiology simulation software presents the role of veno-arterial ECMO among other mechanical devices in supporting cardiogenic shock (30). Workshops integrating ECMO within a broader management paradigm are likely to become more common as ECMO indications expand.

Endorsement

Recommendations

4. Outline a procedure for evaluating and endorsing ECMO courses and workshops.

Rationale

With the increase in ECMO educational offerings, and with the development of a standardized ECMO curriculum and course structure, there will be a need for objective assessment of ECMO courses. An endorsement process is a means for standardization of educational content while ensuring educational quality. Endorsement of educational activities is well established among societal institutions (51-53) and can be adapted for ECMO use.

There are many potential benefits of endorsement. First, a centralized endorsement process will allow for dissemination of a standardized ECMO curriculum at an international level while ensuring educational standards and quality are met. Second, by ensuring a universal standardized curriculum and minimal educational standards, an endorsement process sets the stage for an ECMO certification program. Modelling the certification process after the American Heart Association for basic life support and advanced cardiac life support courses (54, 55), where training and testing are widely distributed throughout the world, having multiple centers offer a Comprehensive ECMO course is a necessary framework for a similar program. Finally, an endorsement process offers a direct benefit to course providers by ensuring that the curriculum is complete and that gaps in educational quality are identified.

ECMO Certification

Recommendations

5. Outline an ECMO certification process incorporating validated assessment tools mapped to the curricular knowledge and psychomotor skill learning objectives of the ECMO curriculum.

Rationale

Despite the growth of ECMO course offerings, no professional medical board or society offers ECMO certification. While ELSO recommends that ECMO centers include staff training with individual certification of practitioners (13), a survey of US ECMO centers determined that, of responding centers, only 57% have institutional ECMO certification programs for ECMO physicians with recertification required at only 16% (15). International practices are largely unknown. Likely contributing to this low-level of institutional certification is that available ECMO assessment tools have lacked significant validity evidence (19, 21, 23, 24) and do not reach the high standard of rigor employed in other published medical education assessment tools (56, 57).

There is therefore a need to define and establish a certification process for ECMO practitioners. As described by the Institute for Credentialing Excellence (58), such a process would outline minimal knowledge and skills required to provide ECMO care, allow for standardization of ECMO practice across sites and disciplines, and establish recognition of the unique skill set required for competent ECMO provision.

There are currently no agreed upon criteria for certification of ECMO practitioners. To address this important gap, there is an urgent need to develop and validate assessment tools mapped to the ECMO curriculum. Further consensus on the role of ECMO courses, online education, instructor and assessor qualifications, and certification infrastructure will also require delineation.

Online ECMO Education

Recommendations

6. Create an online ECMO course targeting ECMO practitioners and meeting all ECMO curricular knowledge learning objectives.

Rationale

Online learning has become an integral component of medical education with web-based journals, webinars, blogs, and social media increasingly adopted to supplement or replace traditional learning methods (59, 60). Online education allows for greater reach and dispersion of standardized content, promotes self-directed and asynchronous learning, and offers interactive and real-time feedback (61, 62). Current online ECMO educational offerings include video voiceover lectures (63, 64), case-based modules (65, 66), webinars (67), and blog articles and editorials (49, 66). While innovative, they are limited in scope, covering select portions of an ECMO curriculum, and not always subject to peer review. Authors are typically from a single institution, restricting applicability as an international resource, and content is primarily designed for physician learners, with limited material available for other ECMO practitioners.

The benefits of a comprehensive high-quality online ECMO course are evident. First, a web-based educational program can expand global reach while promoting widespread implementation of a standard ECMO curriculum.

Second, an online course meeting all learning objectives of the knowledge curriculum can prepare learners ahead of in-person ECMO courses. Such a flipped classroom strategy can allow a greater focus on psychomotor skills during courses. Finally, online education can facilitate and expand the deployment of an ECMO practitioner certification program in a manner analogous to the online courses offered for cardiopulmonary resuscitation training as part of the American Heart Association certification (55).

ECMO Educational Research

Recommendations

7. Perform systematic research incorporating both qualitative and quantitative methods to delineate effective teaching methods and tools, reliable outcome measures, and successful educational programs.

Rationale

Standardized ECMO education has the potential to positively impact ECMO outcome and it is on this basis that ELSO promotes specialized training for ECMO practitioners (13). Recommendations, however, are primarily based on expert opinion and it remains unclear which elements enhance ECMO practice and clinical outcome. Filling this knowledge gap requires a better understanding of current training infrastructures, assessing and validating educational curricula, and calibrating existing training programs to participant needs. Data describing the quality and variability of ECMO education worldwide, however, is lacking and the effectiveness of different ECMO educational initiatives is unknown.

To this end, international structured surveys and focus group interviews are needed to better define current practices within each of the educational domains. Such data can further inform international educational needs and clarify effective educational systems and teaching methods. Subsequently, with the recommendations put forth by ECMOed in this document, a responsibility exists to evaluate the impact of these recommendations and to ensure they achieve their intended goals.

Areas of Uncertainty

Several elements of ECMO education remain to be defined and the ECMOed Taskforce has highlighted important opportunities for future research. The recommendations made in this paper are primarily based on expert opinion and, despite having representation from all ELSO chapters, may not fully reflect the views of the global ECMO community. Further optimization from external surveys, focus groups interviews, and continued consensus methodology among experts will be beneficial.

It is clear that a more in-depth description of the current state of ECMO education is required. Most data forming the basis of this position paper are derived from published literature from North American and European ECMO programs. Comparatively little is known about educational efforts in South America, Africa, and Asia. Moreover, ECMO is being delivered in diverse geographic, socioeconomic, linguistic, and cultural settings. Although standardization of global ECMO education is desirable, local adaptions based on needs, resources, and experience will be necessary. Similarly, in implementing ECMO practitioner certification, centers will have to consider local accreditation processes, governance, legal and quality control mechanisms, and ECMO care delivery models.

Finally, the ultimate goal of the ECMOed Taskforce is to improve the quality of ECMO care and patient outcomes. Establishing a causal relationship between effective ECMO education and ECMO practitioner certification with clinically relevant performance or patient outcome measures is much needed and should be a focus of future research efforts. The goals set forth here are analogous to those of the International ECMO Network, a consortium of ECMO-proficient centers and ECMO experts dedicated to supporting high-quality clinical research (68). ECMOed aims to fill a similar role through a collaborative approach to promote best educational practices and set the framework for ongoing high-quality educational research.

Conclusion

The ECMOed Taskforce, an international and multidisciplinary group of health care practitioners and educators with expertise in ECMO care and education, outlines an educational agenda with recommendations promoting an international collaborative approach towards standardization of ECMO education. Of primary importance is the need for a standardized and rigorously developed ECMO curriculum, defining the structure of a Comprehensive ECMO course, developing complimentary ECMO workshops, outlining a process for evaluating external ECMO

courses, implementing an ECMO practitioner certification process, and developing online ECMO education platforms. High quality educational research is needed to assess the impact of the recommendations and inform ongoing educational opportunities.

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ELSO ECMOed Taskforce Members

Group Information: Authors contributing for the ELSO ECMOed Taskforce are:

Oversight

Bishoy Zakhary, MD
Chair of Education and Logistics, ELSO
Assistant Professor of Medicine, Division of Pulmonary and Critical Care, Oregon Health and Science University, Portland OR, USA
ORCiD 0000-0002-8662-5911

Rodrigo Diaz, MD
ELSO Global Education Director
ECMO Unit Director, Clinica Las Condes, Santiago, Chile
ORCiD: 0000-0001-8046-2229

Mark T Ogino, MD
President, ELSO
Chief Partnership Officer, Nemours Alfred I duPont Hosptial for Children, Wilmington DE, USA
Chief Neonatology, Nemours Partnerships, Wilmington DE, USA
Clinical Professor of Pediatrics, Sydney Kimmel Medical College, Thomas Jefferson University, Philadelphia PA, USA

ECMO Curriculum Workgroup

Jenelle Badulak, MD
Acting Assistant Professor of Emergency Medicine, University of Washington, Seattle WA, USA

Lindsay C. Johnston, MD, MEd
Associate Professor of Pediatrics (Neonatal-Perinatal Medicine), Yale School of Medicine, New Haven, CT, USA
ORCiD 0000-0003-0428-0479

Peter Paul Roeleveld, MD
Pediatric Intensivist, Leiden University Medical Center, Leiden, The Netherlands
ORCiD 0000-0001-5491-9408

Guillaume Alinier, PhD, MPhys, PGCert
Director of Research, Hamad Medical Corporation Ambulance Service, Doha, Qatar
Professor of Simulation in Health Care Education, School of Allied Health Professions, Midwifery, and Social Work, University of Hertfordshire, Hatfield UK
Adjunct Professor of Education in Medicine, Weill Cornell Medicine – Qatar, Doha, Qatar
Visiting Fellow, Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, UK.
ORCiD 0000-0003-4255-4450

Peter Chi Keung Lai, MN, PGDip (ICN), RN, FHKAN (Critical Care)
Education Co-chair, AP ELSO
Nurse Consultant (Intensive Care), Queen Mary Hospital/Hong Kong West Cluster, Hospital Authority, Hong Kong
ORCiD 0000-0003-3715-8162

Ali Ait Hssain, MD MSc
ECMO simulation Team of Doha ECSiTeD Lead, Medical ICU, ECMO Team, Hamad General Hospital, Doha, Qatar
ORCiD 0000-0002-7764-5793

ECMO Courses Workgroup

Kollengode Ramanathan, MD
Cardiothoracic Intensive Care Unit, National University Heart Centre, Singapore
ORCiD 0000-0003-1822-9455

Elizabeth A. Moore, BSN, RN, MBA
Associate Director, Heart and Vascular Center, University of Iowa Hospitals and Clinics, Iowa City IA, US.

Ibrahim Hassan, MD
Chairman, SWAAC ELSO
Director of ECMO and Critical Care at Hamad Medical Corporation, Doha, Qatar
Weill Cornell Medical College, New York NY, USA

Jayne Sheldrake, RN
ECLS Clinical Nurse Consultant, The Alfred Hospital, Melbourne, Australia

Phillip Mason, MD
Medical Director, Adult ECMO Program, Department of Surgery, San Antonio Military Medical Center

Felipe Henriques Alves da Silva, MD
Adult Intensive Care Unit, Americas Medical City, Rio de Janeiro, Brazil

ECMO Workshops Workgroup

Cara Agerstrand, MD
Division of Pulmonary, Allergy, and Critical Care, Columbia University College of Physicians and Surgeons / NewYork-Presbyterian Hospital, New York NY, USA

Wallace NGAI Chun-wai, MBChB
Associate Consultant, Adult Intensive Care Unit, Queen Mary Hospital, Hong Kong

Leonardo Salazar, MD
President, LA ELSO
Department of ECMO and VAD, Fundación Cardiovascular de Colombia, Bucaramanga, Colombia

Vitor Salvatore Barzilai, MD
Intensive Care, MCS and Heart Transplant Unit, Instituto de Cardiologia do Distrito Federal, Brasília, Brazil
ORCID 0000-0001-5116-5655

Chirine Mossadegh, RN
Médecine Intensive et Réanimation Pr Combes, Hôpital de la Pitié–Salpêtrière, Assistance Publique–Hôpitaux de Paris, Paris, France

Endorsement Workgroup

Lakshmi Raman, MD
Associate Professor of Pediatrics, University of Texas Southwestern Medical Center, Dallas TX, USA
ORCiD 0000-0002-7676-1346

Leen Vercaemst, Nurse Specialist ECLS, Perfusionist ECCP
Perfusion Delegate, EuroELSO
University Hospital Leuven, Belgium

Simon Finney, MD
Registry Chair, Euro-ELSO

Consultant in Intensive Care and Cardiothoracic Anaesthesia, St Bartholomew's Hospital, London UK
ORCiD 0000-0001-8219-1952

Assad Miguel Sassine, MD
Coordinator of Heart Failure and Mechanical Circulatory Support, Coordinator of Cardiovascular Surgery Team of Santa Casa de Misericordia de Vitoria Hospital
Telemedicine / Tecmedicine Adjunct Professor at Emescam University

ECMO Certification Workgroup

Melania M. Bembea, MD, MPH, PhD
Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore MD, USA
ORCiD 0000-0003-4984-520X

Mark Davidson, MD
Clinical Lead for ECMO & Cardiac Intensive Care, Department of Paediatric Intensive Care, Royal Hospital for Children, Glasgow, UK

Rene D. Gomez-Gutierrez, MD
Vice-president, LA ELSO
Director of Pediatric Critical Care Department, Hospital Christus Muguerza AE, Universidad de Monterrey, Mexico

Jose Alfonso Rubio Mateo-Sidrón, MD
University Hospital Foundation Jiménez Diaz, Madrid, Spain

Nicholas A Barrett, MD
At-large Steering Committee Member, Euro-ELSO
Department of Critical Care, Guy's and St Thomas' NHS Foundation Trust
Department of Medicine, Division of Immunology, King's College London
ORCID: 0000-0002-4641-8192

Jae Seung Jung, MD, PhD
At-large Steering Committee Member, APELSO
Director of ECMO team and Bloodless Medicine Center, Department of Thoracic & Cardiovascular Surgery, Korea University Medical Center, Seoul, Republic of Korea
ORCiD 0000-0002-8848-4112

Lars Falk, MD
ECMO Centre Karolinska, Department of Pediatric Perioperative Medicine and Intensive Care, Karolinska University Hospital, Stockholm, Sweden.

Online ECMO Education Workgroup

Jeannie M Kukutschka, MD
Education Director, ECMO Center Christus Muguerza Alta Especialidad, Universidad de Monterrey, Mexico

Marta Velia Antonini, CCN, CCP, MS
ICU I° Department of Anesthesia and Intensive Care, University Hospital of Parma, Parma, Italy
Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy
ORCiD 0000-0003-4276-3404

Marc L Dickstein, MD
Professor of Anesthesiology, Columbia University College of Physicians and Surgeons / NewYork-Presbyterian Hospital, New York NY, USA

Shingo Ichiba, MD PhD
Department of Surgical Intensive Care Medicine, Nippon Medical School Hospital, Tokyo, Japan

Björn Frenckner, MD, PhD
Professor of pediatric surgery, ECMO Center Karolinska, Karolinska University Hospital, Stockholm, Sweden
ORCiD 0000-0002-4804-4673

ECMO Educational Research Workgroup

Kiran Shekar, MD
Adult Intensive Care Services and Critical Care Research Group, the Prince Charles Hospital, Brisbane, Queensland, Australia
University of Queensland, Brisbane, Queensland, Australia and Bond University, Gold Coast, Queensland, Australia

Matthieu Schmidt, MD
Medical-Surgical Intensive Care Unit, iCAN, Institute of Cardiometabolism and Nutrition, Hôpital de la Pitié–Salpêtrière, Assistance Publique–Hôpitaux de Paris, Paris, France

Darryl Abrams, MD
Division of Pulmonary, Allergy, and Critical Care, Columbia University College of Physicians and Surgeons / NewYork-Presbyterian Hospital, New York NY, USA

Tài Pham, MD
Interdepartmental Division of Critical Care Medicine, University of Toronto, Toronto, ON, Canada
Keenan Research Centre, St Michael's Hospital, Toronto, ON, Canada
ORCID 0000-0002-4373-0711

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Figure Legends

Fig. 1 ECMOed Membership. The ECMOed Taskforce is composed of an international group of 40 health care practitioners and educators with expertise in caring for the ECMO patient and in ECMO education. Membership is broadly international, representing all five international ELSO chapters, and broadly multidisciplinary, representing the different specialties and disciplines involved in ECMO care

ECMO extracorporeal membrane oxygenation, *ELSO* Extracorporeal Life Support Organization, *NA* North American, *LA* Latin American, *Euro* European, *AP* Asian-Pacific, *SWAC* South and West Asian and African

Fig. 2 ECMOed Curriculum Workgroup proposal for the development of a rigorously developed and widely generalizable and standardized ECMO curriculum. The proposal is based on Kern's methodology for an expert panel consensus curriculum with validity and reliability testing. After compiling knowledge and hands-on learning objectives, an external international and multidisciplinary expert panel will utilize iterative consensus methodology to define the curricula. Development of knowledge and hands-on assessment tools mapped to their respective learning objectives will subsequently be subject to validity and reliability testing to ensure they achieve their task of differentiating ECMO competency level

ECMO extracorporeal membrane oxygenation

Tables

Table 1. Summary of ECMOed Taskforce Recommendations

ECMO Curriculum
1. Organize an international and multidisciplinary expert group to develop a standardized ECMO curriculum incorporating both knowledge and psychomotor skill learning objectives defining minimal competency of the ECMO practitioner.
ECMO Courses
2. Define Comprehensive ECMO Courses to (1) meet all ECMO knowledge and psychomotor skill curricular objectives and (2) achieve a minimal educational quality level.
ECMO Workshops
3. Supplement Comprehensive ECMO Courses with workshops that enrich and expand on the curriculum.
Endorsement
4. Outline a procedure for evaluating and endorsing ECMO courses and workshops.
ECMO Certification
5. Outline an ECMO certification process incorporating validated assessment tools mapped to the curricular knowledge and psychomotor skill learning objectives of the ECMO curriculum.
Online ECMO Education
6. Create an online ECMO course targeting ECMO practitioners and meeting all ECMO curricular knowledge learning objectives.
ECMO Educational Research
7. Perform systematic research incorporating both qualitative and quantitative methods to delineate effective teaching methods and tools, reliable outcome measures, and successful educational programs.

ECMO extracorporeal membrane oxygenation