REVIEWS

A Scoping Review and Appraisal of Extracorporeal Membrane Oxygenation Education Literature

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ABSTRACT

Background: Despite a recent rise in publications describing extracorporeal membrane oxygenation (ECMO) education, the scope and quality of ECMO educational research and curricular assessments have not previously been evaluated.

Objective: The purposes of this study are *1*) to categorize published ECMO educational scholarship according to Bloom's educational domains, learner groups, and content delivery methods; *2*) to assess ECMO educational scholarship quality; and *3*) to identify areas of focus for future curricular development and educational research.

Methods: A multidisciplinary research team conducted a scoping review of ECMO literature published between January 2009 and October 2021 using established frameworks. The Medical Education Research Study Quality Instrument (MERSQI) was applied to assess quality.

Results: A total of 1,028 references were retrieved; 36 were selected for review. ECMO education studies frequently targeted the cognitive domain (78%), with 17% of studies targeting the psychomotor domain alone and 33% of studies targeting combinations of the cognitive, psychomotor, and affective domains. Thirty-three studies qualified for MERSQI scoring, with a median score of 11 (interquartile range, 4; possible range, 5–18). Simulation-based training was used in 97%, with 50% of studies targeting physicians and one other discipline.

Conclusion: ECMO education frequently incorporates simulation and spans all domains of Bloom's taxonomy. Overall, MERSQI scores for ECMO education studies are similar to those for other simulation-based medical education studies. However, developing assessment tools with multisource validity evidence and conducting multienvironment studies would strengthen future work. The creation of a collaborative ECMO educational network would increase standardization and reproducibility in ECMO training, ultimately improving patient outcomes.

Keywords:
extracorporeal membrane oxygenation; education; scoping review; curricula; Medical Education Research Study Quality Instrument

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Since the 2009 H1N1 pandemic, published articles describing extracorporeal membrane oxygenation (ECMO) education have increased by 1,200%, reflecting the exponential rise in the clinical use of ECMO (1). Despite this boom, there is significant heterogeneity in curricula, assessments, and credentialing within ECMO education. Although the Extracorporeal Life Support Organization (ELSO) provides published guidelines for training of ECMO specialists (2), these are not standardized across institutions (3). Despite existing educational resources, including ECMO entrustable professional activities (4) and validated checklists to assess ECMO skills (5), it remains unclear how best practices in ECMO education are adopted across ECMO centers worldwide. Surveys of fellowship program directors from ECMO centers noted significant variability in learning experiences and identified a need for improved educational methods (6). These findings suggest that a universal standard for ECMO education is yet to be established.

Simulation-based medical education (SBME) is effective for ECMO education, incorporating knowledge, technical skills, and interdisciplinary teamwork. Still, many U.S. ECMO centers surveyed do not have ECMO simulation program (7), and a standardized curriculum of ECMO simulation scenarios does not exist. It remains unclear how ECMO centers structure SBME, including frequency, participants (number or disciplines), scenario topics, equipment, debriefing framework, facilitator training, and performance assessments. Variability may decrease training effectiveness and prohibit comparisons among centers.

Despite the existence of many published curricula and surveys describing ECMO education, a scoping review of this literature has not been performed. A scoping review, a specific type of literature review that follows a validated, structured process (8, 9), is used to describe existing literature on a topic, identify knowledge gaps, clarify concepts, or investigate research quality (10). A comprehensive description of existing ECMO educational literature would be an important resource for establishing best practices. This is consistent with the ELSO ECMOed Taskforce consensus statement prioritizing systematic research to delineate effective methods for education and identifying valid assessment tools (11). In particular, categorization of ECMO education by established taxonomies and objective appraisal of research quality (12) are essential. This is the first scoping review to systematically categorize published ECMO education literature and assess the quality of ECMO education research using

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the Medical Education Research Quality Instrument (MERSQI) (12). Through these efforts, we identify important targets to advance ECMO education globally.

METHODS

Design

This scoping review began with the formation of a multidisciplinary research team consisting of nine individuals from two institutions in the United States with expertise in medical education and ECMO (9). ECMO experts were identified as individuals with formal training in medical education, administrative leadership of ECMO programs, and/or publications on ECMO educational research. All disciplines using ECMO from pediatric, neonatal, and cardiovascular intensive care units were represented. Collectively, the team members possess more than 131 years of clinical ECMO experience. The team collaborated to develop the research question and study protocol, including identification of search terms, selection of databases, and creation of a novel scoping review protocol.

The methodology of this scoping review is based on well-established frameworks (8, 9). There were five key stages *1*) identifying the research question; *2*) identifying relevant studies; *3*) selecting eligible studies; *4*) charting the data; and *5*) collating, summarizing, and reporting results. This study is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (13).

Identifying the Research Question

This scoping review was guided by the question "On the basis of assessment of taxonomies addressed in published literature on ECMO education and the quality of current ECMO education research, what are existing gaps on which to focus future curricular development and research?" To answer this question, published ECMO education literature was categorized using Bloom's educational domains (14), and research quality was assessed using the MERSQI.

Identifying Relevant Studies: Data Sources, Search Strategy, and Citation Management

Given relevance to multidisciplinary ECMO educators, a systematic search was performed using PubMed, the Cumulative Index to Nursing and Allied Health Literature, and Embase. Searches used the index terms "ECMO" or "extracorporeal life support (ECLS)," "education," "training," "teaching," and "learning." The search strategy was revised to reduce irrelevant results and limited to English-language publications after 2009. The full search strategies are shown in the data supplement. Reference lists of identified studies were screened to cross-reference additional studies for inclusion. Citations were exported to a web-based systematic/scoping review software program, Covidence 2.0 (Veritas Health Innovation).

Selecting Eligible Studies

Eligibility criteria. The authors agreed on inclusion and exclusion criteria during a prescreening meeting. Studies describing learners, educational content, Bloom's taxonomy, cognitive skills, knowledge acquisition and/or assessment, technical skills, behavioral skills, team behaviors or leadership in ECMO emergencies, teaching platform or method, curriculum, didactics, simulation, and/or online classroom were eligible for inclusion. Case reports; commentaries; studies describing cardiopulmonary bypass machines, intraoperative extracorporeal life support, or ventricular assist devices; clinical care guidelines; descriptions of ECMO program development and resource allocation; descriptions of technology and/or simulators; and conference abstracts were excluded.

Title and abstract relevance screening. A two-stage screening process was used to assess the relevance of identified studies. In stage 1, title and abstract citations were independently screened by two reviewers who were not blinded to author or journal name. If an abstract was not available, the title was included for full article review in the second phase. Eligibility criteria were displayed in Covidence to permit ease of screening. Six authors (P.K.H., N.J.P., K.W.K., K.R.R., N.L.P., and O.J.) participated in title and abstract screening, comprising 11 pairs for comparison of interrater reliability. Forty conflicts were identified (3.9%); all were resolved via consensus meeting by all reviewers. As conflict rates remained <4% throughout the screening process, a midscreening meeting to clarify eligibility criteria was not indicated.

In stage 2, four reviewers (P.K.H., N.J.P., L.C.J., and K.W.K.) independently screened full-text articles in Covidence and applied eligibility criteria for inclusion. Reasons for exclusion of full-text articles are listed in Figure 1.

Charting the Data (Data Extraction and Quality Assessment)

All relevant citations after title/abstract and full-text screening were read in full by two reviewers (P.K.H. and N.J.P.). A data collection form was developed to extract study characteristics, including specialty, region, learner groups, instructional methods, and Bloom's learning domains (14). Studies classified as education research were assessed using the MERSQI, a validated tool that assesses the quality of quantitative medical education research in six domains (study design, sampling, data type, validity of evaluation instruments, data analysis, and outcomes) (12). Each domain receives zero to three points, with higher scores denoting

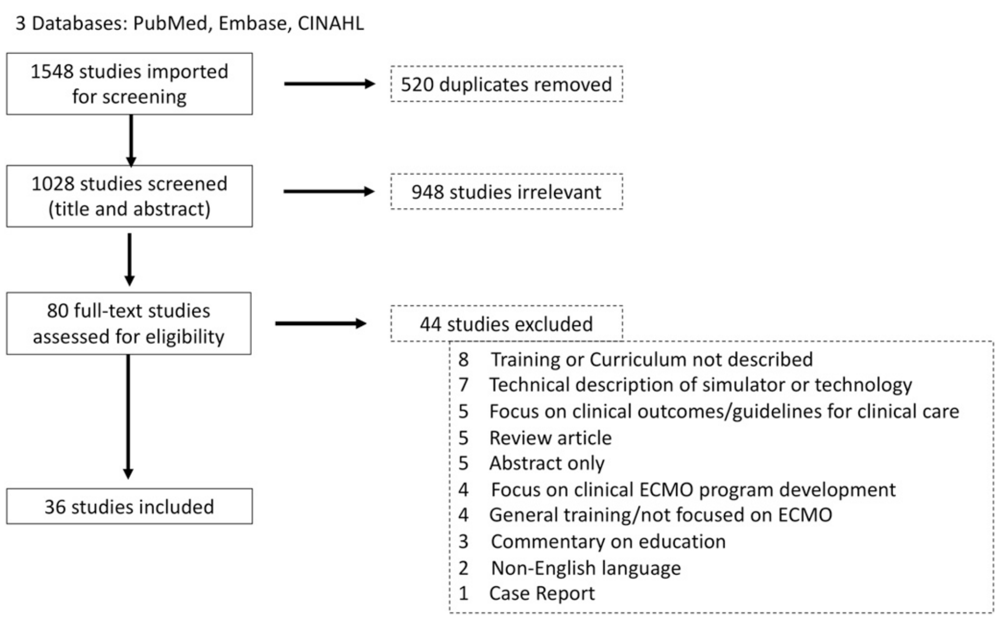

Figure 1. Screening diagram and Preferred Reporting Items for Systematic Reviews and Meta-Analyses data from three databases (PubMed, Embase, and CINAHL) representing the flowchart of the study selection process. CINAHL = Cumulative Index to Nursing and Allied Health Literature; ECMO = extracorporeal membrane oxygenation.

higher research quality. Four reviewers (P.K.H., N.J.P., L.C.J., and K.W.K.) defined study characteristics in both tools and entered all data into Covidence.

Application of the data extraction tool and MERSQI was performed independently by P.K.H. and N.J.P. in batches of five studies. Meetings were held within 48 hours of individual data extraction and MERSQI scoring to obtain consensus. Educational experts (K.W.K. and L.C.J.) conferred with both reviewers on three occasions early in data extraction to ensure consistency, resolve conflicts, lend expert perspective on MERSQI scoring, and maintain focus on the research question. Data presented represent consensus between two reviewers, who were guided by two educational experts.

Collating, Summarizing, and Reporting the Results

Data were exported into Excel (Microsoft Corporation) for descriptive analysis. Percentages were used to describe nominal data, and median values with interquartile ranges were reported for nonnormal data distribution.

RESULTS

A total of 1,548 studies were identified in the initial search. Duplicate entries were removed, leaving 1,028 studies for screening. Title and abstract screening excluded 948 studies. Kappa statistics for interrater reliability (15) for 11 pairs of reviewers ranged from 0.61 to 1. Full-text reviews were conducted for 80 studies, with kappa statistics for three pairs of reviewers of 0.54–1. Thirty-six studies met criteria for data extraction and quality assessment (Figure 1).

General Characteristics of Included ECMO Education Studies

General characteristics of the studies included are reported in the data supplement. Adult and pediatric specialties were equally represented, with 42% adult studies, 42% pediatric studies, 11% combined specialties, and 5% unspecified. Thirty studies described educational interventions; the remainder described original ECMO curricula. Learning objectives were clearly stated in 72%. Most studies were published from North America (61%) and Europe (30.5%), with fewer from the Middle East (5.5%) and Asia (3%).

Targeted Learner Groups

Half of the studies (50%) included multiple disciplines (16–33), most frequently including physicians and nurses. More than one-third (36%) of studies included trainee physician (16, 19, 21, 24, 25, 29, 33–39), and four studies included healthcare students (26, 40–42). Of uniprofessional studies listing target audiences, 11% targeted ECMO specialists (43–46), 8% targeted nurses (47–49), 3% targeted paramedics (50), and 14% targeted physicians (34, 36–39).

Educational Content Delivery

Although not a requirement for inclusion in this scoping review, simulation-based training was used in 97% of studies. Specifically, mannequin-based SBME was used in 83% of studies. Among the remainder, one study used a screen-based simulator (21), three studies used simulator models (37, 40, 46), one study used an animal model (51), and one study did not specify how simulation was used (49). Eighteen studies described realistic, multidisciplinary simulation scenarios, focused on ECMO emergencies (16–20, 22–33, 42). Of these, nine also incorporated "water drills" (16–20, 24, 26, 27, 42).

Twenty-two studies included didactics. Of these, 11% provided reading materials or written guides (27, 32, 38, 50), and 11% provided online instruction (21, 38, 40, 47). Multimedia was used infrequently, with video instruction in 11% (31, 35, 38, 41), video-assisted simulation feedback in 8% (20, 39, 44), and augmented reality in 3% (40).

Targeted Learning Domains Based on Bloom's Taxonomy

Bloom's taxonomy organizes learning using three domains: cognitive (knowledge acquisition), psychomotor (technical skills/behaviors), and affective (attitudes/values/interests) (14). In this scoping review, three studies addressed only the cognitive domain (16, 42, 49), and six studies targeted psychomotor skills (20, 21, 37, 40, 41, 45) (*see* the data supplement). No studies focused solely on the affective domain. Thirteen studies targeted cognitive and psychomotor domains (17–19, 33–36, 43, 46–48, 50, 51), and 2 studies addressed technical skills and behaviors (22, 23). Twelve studies (33%) targeted all three domains (24–32, 38, 39, 44).

Assessment of Medical Education Research Quality

Thirty-three studies met the original criteria for application of MERSQI (12). The median MERSQI score was 11 (range, 6–14.5), with domain-specific scores reported in Table 1.

Study Design

For MERSQI scoring, "single group" referred to a cohort of ECMO providers assessed at the same time point. Ten studies examined single groups using cross-sectional or posttest only, and 14 studies incorporated pre-/posttesting (16, 18–20, 24, 27, 34, 35, 38, 39, 44, 47, 49, 50). Fewer studies examined multiple cohorts, with five using two-group nonrandomized designs (e.g., case-control, cohort studies with two or more defined cohorts) (23, 40–42, 48) and four using randomized controlled designs (21, 33, 36, 45).

Sampling

Most studies reported sampling from one institution (82%). Only six studies reported data from three or more institutions, with assessments occurring at conferences or recruited from multiple centers (21) or government-sponsored networks (17). Overall, studies had high response rates, with 19 studies at ⩾75%, 4 studies at 50–75%, 7 studies at <50%, and 3 studies "nonapplicable."

Data Analysis

Many included studies (70%) achieved maximal scores for data analysis by using statistical inference of objective data from assessment tools. Descriptive analyses were reported in remaining studies.

Validity

Overall, studies had low scores for assessment tool validity, with a median of one point total for content validity, internal structure, and relationship to other variables. Operational definitions for validity evidence are shown in Table 2. Evidence of content validity was present in 16 studies (5 studies referred to ELSO guidelines; 2 specified frameworks for simulation/debriefing [21, 48]; 5 referenced existing questionnaires, assessments, or outcome measures [29, 34, 36, 37, 44]; and 1 used expert consensus refined by simulation debriefing content [30]). Two studies demonstrated evidence for internal structure and relationships to other variables (45). Only one study scored maximal points for validity (43).

Outcomes

Evaluations of original ECMO curricula or educational interventions were reported in 33 studies (92%). MERSQI score outcomes are

Table 1. Medical Education Research Study Quality Instrument domains and item scores for 33 extracorporeal membrane oxygenation education studies

Domain	MERSQI Item	Studies, *n (%)**	Scores		Median (IQR) Scores	
			Possible Item Score	Maximum Domain	Median (IQR) Item	Median (IQR) Domain
Study design	1. Study design	—	—	3	1.5 (1)	1.5 (1)
	Single-group cross-sectional or single-group posttest only	10 (30)	1	—	—	—
	Single-group pretest and posttest	14 (42)	1.5	—	—	—
	Nonrandomized, two group	5 (15)	2	—	—	—
	Randomized controlled trial	4 (12)	3	—	—	—
Sampling	2. Number of institutions studied	—	—	3	0.5 (0)	2 (0.5)
	1	27 (82)	0.5	—	—	—
	2	0	1	—	—	—
	>2	6 (18)	1.5	—	—	—
	3. Response rate	—	—	—	1.5 (1)	—
	Not applicable, <50%, or not reported	10 (30)	0.5	—	—	—
	50–74%	4 (12)	1	—	—	—
	⩾75%	19 (58)	1.5	—	—	—

Table 1. *Continued.*

Domain	MERSQI Item	Studies, *n* (%)*	Scores		Median (IQR) Scores	
			Possible Item Score	Maximum Domain	Median (IQR) Item	Median (IQR) Domain
Type of data	4. Type of data	—	—	3	3 (2)	3 (2)
	Assessment by study participant	9 (27)	1	—	—	—
	Objective measurement	24 (73)	3	—	—	—
Validity of evaluation instrument	5. Internal structure	—	—	3	0 (0)	1 (1)
	Not applicable or not reported	31 (94)	0	—	—	—
	Reported	2 (6)	1	—	—	—
	6. Content	—	—	—	1 (1)	—
	Not applicable or not reported	17 (52)	0	—	—	—
	Reported	16 (48)	1	—	—	—
	7. Relationships to other variables	—	—	—	0 (0)	—
	Not reported	31 (94)	0	—	—	—
	Reported	2 (6)	1	—	—	—
Data analysis	8. Appropriateness of analysis	—	—	3	1 (1)	3 (1)
	Data analysis inappropriate for study design or type of data	5 (15)	0	—	—	—

Table 1. *Continued.*

Domain	MERSQI Item	Studies, *n (%)**	Scores		Median (IQR) Scores	
			Possible Item Score	Maximum Domain	Median (IQR) Item	Median (IQR) Domain
	Data analysis appropriate for study design and type of data	28 (85)	1	—	—	—
	9. Complexity of analysis	—	—	—	2 (1)	—
	Descriptive analysis only	10 (30)	1	—	—	—
	Beyond descriptive analysis	23 (70)	2	—	—	—
Outcomes	10. Outcomes	—	—	3	1.5 (0)	1.5 (0)
	Satisfaction, attitudes, perceptions, opinions, general facts	7 (21)	1	—	—	—
	Knowledge, skills	19 (58)	1.5	—	—	—
	Behaviors	2 (6)	2	—	—	—
	Patient/healthcare outcome	4 (12)	3	—	—	—
Total score		—	—	18	—	11 (4)

Definition of abbreviations: IQR = interquartile range; MERSQI = Medical Education Research Study Quality Instrument.
*The MERSQI includes 10 items within six domains of study quality. Scores can range from 8 to 18, with a higher score indicating a study of higher research quality (12, 61).

Table 2. Operational definitions of Medical Education Research Study Quality Instrument* validity evidence for evaluation instrument scores

Evidence Type	Content	Internal Structure	Relationships to Other Variables
Explanation	Ensures that creation of assessment instrument is guided by • Theory, conceptual models, and frameworks for learning • Guidelines or position papers from organizations • Expert opinion • Use of existing or previously published instruments	Ensure that creation of an assessment instrument has • Internal consistency • Interrater reliability • Interstation reliability • Undergone refinement after test–retest analysis in a sample population • Factor analysis	Ensure that creation of an assessment instrument could discern relationships between variables: • Discern between expert and novice learners • Accurately predict correlations • Establish concurrent correlations between variables
Example	The assessment tool used was developed according to expert consensus via the Delphi process, is consistent with published ELSO guidelines, and is rooted in Ericsson's deliberate practice theory (65).	The assessment tool used was tested for internal consistency using the kappa (66) agreement test for categorical variables and intraclass correlation coefficient (67) for continuous quantitative variables.	The assessment tool used showed a difference in score between expert and novice participants.

Definition of abbreviation: ELSO = Extracorporeal Life Support Organization.
*In total, the Medical Education Research Study Quality Instrument has six domains comprising 10 items; the maximum possible score is 18. The three sources for validity evidence (content, internal structure, and relationships to other variables) are counted as separate items (12, 61).

based on Kirkpatrick's levels of learning evaluation (Figure 2) (52). Eight studies reported learner reactions (level 1) (17, 22, 24–26, 37, 49, 51), 19 reported knowledge/skill acquisition (level 2) (16, 18–21, 27, 33–36, 38, 40–43, 45, 47, 48, 50), 2 reported behavioral changes (level 3) (23, 39), and 4 reported patient/health care impact (level 4) (28–30, 44).

DISCUSSION

To our knowledge, this is the first scoping review describing existing literature on ECMO education, systematically categorizing it by educational domain, and applying MERSQI scoring for quality appraisal. Using recommended strategies for synthesis and analysis, this review is an important resource for ECMO educators and aligns with ELSO's ECMOed Taskforce's charge for quality education research (11). Using the MERSQI, we provide a unique framework to highlight strategies to optimize future study design.

Role of Simulation in ECMO Education Scholarship

The vast majority of ECMO education in the post-H1N1 era incorporates hands-on SBME, occasionally integrating video instruction/feedback (31, 35, 39, 41, 44), augmented reality (40), or online simulators (21). This is consistent with findings that 72% of recently surveyed ELSO centers reported having or developing ECMO simulation programs (7). Similarly, 50% of critical care program directors expressed desire for enhanced simulation curricula (6). The role of simulation, however, is not reflected in ELSO's guidelines for ECMO specialist training (2), as only didactics, water drills, animal laboratory sessions, and bedside training are specifically recommended.

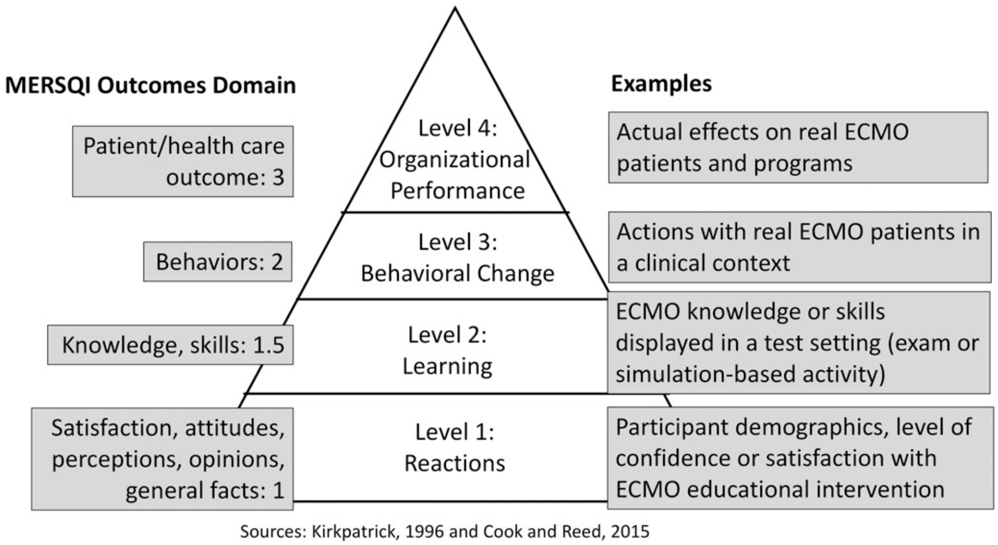

Figure 2. MERSQI outcomes domain reflective of Kirkpatrick's levels of learning evaluation. Numbers in the left column represent the points for each outcomes domain, with higher scores implying more robust outcomes. ECMO = extracorporeal membrane oxygenation; MERSQI = Medical Education Research Study Quality Instrument.

Among studies using ECMO simulation, few described the structure of simulation activities, including briefing, scenario progression, equipment fidelity, and debriefing techniques (19, 32, 33, 39, 45). Although substantial benefits of ECMO simulation exist, including standardization of exposure, adaptability of content, ability to practice technical skills, and teamwork, there remains uncertainty regarding optimal fidelity for ECMO simulators, instrument validity, and ideal debriefing methods (53). Continued work to establish ideal strategies for scenario design, optimal participant composition, and frameworks for debriefing/feedback remains a priority.

Bloom's Learning Domains, Methods of Content Delivery, and Kirkpatrick's Outcomes

Organizing educational domains according to Bloom's framework can ensure that instructional methods are selected appropriately (54). Studies targeting the cognitive domain typically used lecture-based didactics paired with pre- and posttests to assess knowledge acquisition (16, 42, 49). Many authors used water drills and scenario-based simulations to facilitate knowledge transfer using critical thinking and hands-on skills application (16, 42), suggesting a role for SBME in the cognitive domain. Among 33 studies addressing psychomotor domains (alone or in combination), only 10 demonstrated improvement in technical skills using simulation alone (22, 23, 25, 28–30, 33, 37, 43, 45). Although SBME is considered an excellent strategy for skills training, additional rigor (including application of frameworks [55], deliberate practice [56], and mastery learning [57]) is necessary.

In addition to cognitive domains, ECMO education may effectively address psychomotor and affective objectives (58). However, of 14 studies addressing the affective domain, only 2 reported level 3 outcomes (Figure 2; improved time to cannulation or emergency management) (23, 39). Four studies reported level 4 outcomes, including improved adherence to clinical checklists and creation of clinical protocols (28–30, 44). Although relationships between educational scholarship and patient/healthcare effects are often associations, ECMO SBME has great promise in optimizing outcomes. Similarly, aligning Bloom's learning domains to methods of content delivery and, ultimately, to outcomes significantly improves research quality.

Assessment of Existing Research Quality

As need for rigor within medical education is highlighted, including adherence to conceptual frameworks (59) and rigorous curriculum design (60), the MERSQI allows objective assessment of education quality and permits comparison between methodologies (12). Higher MERSQI scores have been associated with publications in higher impact journals and more frequent citations (12). Studies in our scoping review had a median MERSQI score similar to those observed in other SBME studies (61).

In our assessment, domain-specific MERSQI scores, including outcomes, study design, and validity, highlighted areas for improvement in ECMO education scholarship. The median score for study design was 1.5, as most studies described single cohorts with pre-/postintervention assessment. Compared with other SBME research, ECMO education studies were lower in this domain (61). Most studies (82%) scored only 0.5 for sampling from one institution. The four randomized controlled trials earned high MERSQI scores (21, 33, 36, 45), suggesting that ECMO education research can be performed rigorously. In the future, randomized multicenter interventions may establish best educational practices across geographic regions, institutions, and learner groups.

Instruments with robust validity evidence for ECMO education scholarship are lacking, as the median score in this domain was only 1. Many studies addressed content validity related to tool development, frequently through local expert opinion (20, 21, 29, 30, 43, 47, 48, 50). This could be strengthened by incorporating diverse expert opinions through methods such as a modified Delphi process (62) and using published guidelines or existing tools (5, 16). This is critical to address geographic variations in practices or equipment, encouraging evidence-based management. Similarly, internal structure can be addressed through rater training, calibration (43, 45), and test/retest techniques assessing for reliability and agreement (30). Development of assessment tools that discern expert versus novice learners (39), or correspond to expert performance (43), provides evidence for relationship to other variables. Use of assessment tools with strong validity evidence, as demonstrated by several authors in our review (30, 39, 43, 45), is essential. In addition, Abulebda and colleagues published their methodology for developing validated checklists for clinical specialists addressing ECMO emergencies (5); such rigorously created tools should become more widely used across institutions.

The development and standardization of assessment tools and quality metrics for ECMO education remain areas of significant opportunity for collaboration. Just as ELSO's registry was established to track clinical outcomes, a similar network could be established to determine optimal training methodologies, validate assessment tools, standardize curricula, and identify best practices in ECMO education. Ultimately, educators seek to demonstrate that teaching improves clinical outcomes. This has been difficult for the ECMO community, given variability in training, practice, and multiple confounders. Sharing assessment tools, evaluating the validity of educational metrics in different contexts, and standardizing training methodologies would improve education and potentially improve patient outcomes globally.

Last, standardizing ECMO course curricula would add necessary rigor to ECMO education scholarship. Curricula should follow the framework described by Johnston and colleagues and include conceptual frameworks, consider adult learning theories and learning styles, and align learning objectives with content delivery and assessments (63). Similarly, although improving performance in a simulated environment is important, improving patient care is the true target for ECMO education. Lack of standardization across centers and unclear best educational practices remain barriers to attaining provider behavioral change and patient-level outcomes. Standardization of both management and educational strategies, locally and through organizations such as ELSO, is essential.

Strengths and limitations

Despite efforts to be comprehensive, our search parameters may have excluded important studies. Commentaries and editorials, which provide valuable insights, were not included. Most studies in this scoping review were published in North America and Europe, where the majority of high-resourced ELSO centers are located (64), and may not describe the education occurring in emerging centers. Interestingly, our scoping review identified a relatively small number of published studies in a 13-year span, suggesting that ECMO educational scholarship is likely underreported. Last, MERSQI scores were assigned by reviewer consensus rather than using a blinded method and evaluating scores for interrater reliability.

Conclusions

In published data on ECMO education identified in a scoping review, SBME was the most commonly used methodology. Identified studies had similar quality to other SBME studies assessed using MERSQI scores. Domain-specific MERSQI scores demonstrate potential areas to increase the rigor of future studies related to validity of assessment tools and study design. Development of a collaborative network for ECMO education represents a significant opportunity for the global ECMO community.

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

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