A Systematic Review of Simulation for Multidisciplinary Team Training in Operating Rooms

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Summary Statement: Current simulation training initiatives predominantly occur in uniprofessional silos and do little to integrate different disciplines working in the operating room (OR). The objective of this review was to determine the current status of work describing simulation for full OR multidisciplinary teams including barriers to conducting OR multidisciplinary team training and factors contributing to successful courses. We found a total of 18 articles from 10 research groups. Various scenarios and simulators were used, and training sessions were generally perceived as realistic and beneficial by participants despite rudimentary integration of surgical and anesthetic models. Measures of performance involved a variety of both technical and nontechnical ratings of the simulations. Challenges to conducting the simulations included recruitment, model realism, and financial costs. Future work should focus on how best to overcome the barriers to implementation of team training interventions for full OR teams, particularly on how to engage senior staff to aid recruitment.
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Key Words: Clinical, Simulation, Simulators, Teams, Training

Simulation is commonly used for team training in health care, including training for operating room (OR) team members from nursing,[1] anesthesia,[2] and surgery.[3] Observational research in the OR reports that failures in teamwork and communication are common and lead directly to compromised patient care and reduced productivity.[4] Furthermore, directives from the US Institute of Medicine call for teams that work together to be trained together.[5] This suggests a need for combined training of the 3 primary disciplines (the subteams of nursing, anesthesia, and surgery) that comprise an OR team.

Although there are reviews of simulation-based team training in obstetrics,[6] emergency medicine,[7,8] and the 3 individual OR subteams,[1–3] we could find no review of the literature on OR multidisciplinary team (OR-MDT) training. We therefore undertook a systematic review of the literature to determine the current status of simulation-based team training involving full OR teams. We defined OR-MDT training as an initiative involving participants from the surgical, anesthesia, and nursing teams (ie, a team consisting of at least 1 surgeon, 1 anesthetist or nurse anesthetist, and 1 nurse). We were particularly interested in the types of scenarios and training used, the environment and simulator(s) used, any outcome measures used (including participant perceptions of simulation realism and course effectiveness as well as technical and nontechnical skill measures), and barriers to undertaking this form of simulation-based training.

METHODS

Search Strategy

We searched 5 literature databases (PubMed, EMBASE, SCOPUS, PSYCHinfo, and ERIC), and the Cochrane Library for 3 categories of search terms, namely, those intended to capture articles reporting OR-MDT simulations, those involving interactions between participants from multiple disciplines, and those involving participants forming full OR teams. The resulting terms and their Boolean relationships were combined to form "Simulat* AND (team* OR interprofessional OR multiprofessional OR interdisciplinary OR multidisciplinary) AND (medical OR doctor OR clinician OR surgeon OR anaesthetist OR anesthetist OR anesthesiologist OR nurse)" as the search strategy for each database. No limits were placed on the results. Abstracts of returned articles were read and articles were excluded according to the criteria discussed later.

Exclusion Criteria

We eliminated all articles (*a*) which involved simulations in domains other than health care, (*b*) where there was no opportunity for genuine team interactions because there was only one participant working alone or with confederates (we define a *confederate* as an appropriately skilled accomplice working with the simulation faculty), and (*c*) which involved teams but not all 3 OR subteams were represented. Included articles were used as a primary source from which other publications were identified from their reference lists, and contact was made with authors for clarification of information where necessary.

Data Extraction

Data were extracted from the included articles systematically, according to the following categories: (*a*) affiliation

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of the primary author such that the number of active research groups could be estimated, (*b*) number and composition of participants and teams involved in the simulations, (*c*) types of scenarios and training provided, (*d*) the environment (in situ or at a simulation center) and details of the simulators used, (*e*) outcome measures of the study, and (*f*) indications of barriers to conducting simulation for full OR teams. The outcome measures were divided into participant ratings of the simulations and courses, procedural skills or medical management scores (technical skills), teamwork or communication scores (nontechnical skills), and other measures.

RESULTS

A total of 5359 unique articles were returned from the search terms. The number of articles excluded and reasons for exclusion are shown in Figure 1. An additional 2 articles were added from the references of included articles for a total of 18 included articles. These came from 10 different research groups. The majority (4242) of returned results did not include health care simulation. A large proportion of the remaining results (529) involved simulation with individual participants. A similar number (570) involved simulations for health care teams involving participants from disciplines outside the OR or incomplete OR teams.

Details of the center affiliations, participants and teams, scenarios and training provided in the included articles are listed in Table 1. Some centers published more than 1 article from the same scenarios and training, leaving 11 distinct training programs. These ranged from a single simulated scenario, to half-day courses, to a series of 8 scenarios over multiple days. Where reported, all programs involved simulations of crisis scenarios, the most common of which were cardiac arrhythmias or arrest (5 reports), malignant hyperthermia (3 reports), and massive bleeding (3 reports).

The simulation environment and simulators used are reported in Table 2. Of the 11 different programs, 6 were conducted in a simulation center and 5 were carried out in the workplace (in situ). There were 7 different combinations of simulators used for anesthesia and surgical teams reported, but 3 articles did not describe the simulators used. The simulators used for anesthesia were all full-body manikins, and the surgical simulators were either part-task trainers or laparoscopic simulators. Two articles did not report the use of a specific simulator for the surgical team in their simulations.[9,10] In 3 of the 5 articles where simulators for both anesthesia and surgical teams were used, the simulators were arranged for practical reasons rather than anatomic realism.[11–13] For example, 1 article[13] showed the laparoscopic simulator positioned separately from the manikin such that one might believe there to have been 2 patients laying side by side. Five articles reported integrating anesthetic and surgical simulators in an anatomically plausible manner (anatomic integration).[14–18] That is, the combined simulator enabled the participants to position themselves physically as they would in the clinical environment. None of the research groups integrated the physiology of anesthesia and surgical simulators such that changes to the physiology of one of the simulators would automatically lead to corresponding physiologic changes in the other (physiologic integration)—for example, major blood loss from the model used by the surgical team leading to cardiovascular instability in the model used by the anesthesia team.

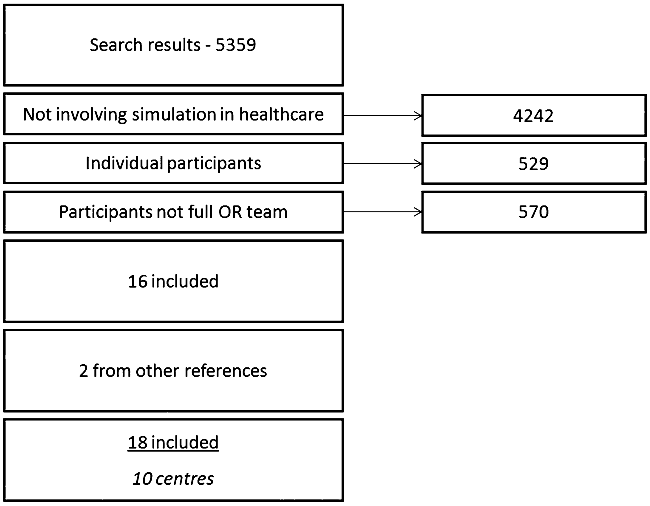

FIGURE 1. Reasons for exclusion from review.

Eleven studies included measures of participant perceptions of the simulations (Table 3). Participants generally rated the scenarios as realistic (reported in 7 articles[9,10,12,14,18–20]) and believed that they behaved in a similar manner in the simulations as they did in the clinical environment (reported in 5 articles).[12,14,18,19,21] One article[14] asked a more detailed question about the participants' perception of model realism, and their responses were relatively negative in comparison with the ratings of other elements (Table 3). Participants in the same study and 1 other[18] rated the scenarios as appropriately challenging. Participants in 10 studies[9,11–14,18,19,21–23] regarded the simulations as useful for learning. There were conflicting results to the question of whether the simulations would result in a change to practice (reported in 4 articles).[13,18,22,23] No articles reported measuring objective measures of behaviors in the clinical environment.

Four articles reported measurements of technical skills (Table 4). Three focused on surgical and nursing skills (all from the same research group).[14,16,17] One compared overall medical management of the "patient" with and without the aid of a checklist.[18] Five articles from 2 research groups reported measurements of nontechnical skills (Table 4). For both technical and nontechnical skill ratings, the simulations were used to evaluate interrater reliability of the measurement tools,[15,16] compare participant self-ratings with expert ratings,[15–17,24] measure differences over time,[14,20,24] and measure differences between disciplines.[14,17] Other measures included participants' attitudes to safety before and after training,[14,22,23] participants' perception of the use of checklists,[18] and policy changes resulting from the simulations.[9] Only 1 article[9] reported an objective measure of any sort in the clinical environment.

Five articles reported possible barriers to conducting OR-MDT simulations.[11,14,17,19,22] Three common themes emerged as follows: problems recruiting participants, fidelity of the models, and the financial cost involved. The logistical

TABLE 1. The Participants, Team Composition, and Scenarios and Training Reported in the Articles

First Author Affiliation	Reference	Participants and Teams	Scenarios and Training Provided
Southern Health Simulation and Skills Centre, Australia	Flanagan et al,[22] 2007	Total of 59 participants. Teams included surgeon, surgical assistant, surgical nurse, scout nurse, anesthetist, anesthetist nurse, and operating theatre technician.	Half-day training including 2 unspecified simulations.
Oklahoma University Medical Center[10]	Forsythe,[26] 2009	Total of 62 participants from cardiac, general, and orthopedic surgical teams. Teams included physicians, nurses, OR technologists, one physician assistant, OR surgical assistants, and anesthesia aides.	Simulations included cardiac balloon pump insertion, general trauma, and emergent orthopedic trauma.
University of Basel	Helmreich and Davies,[11] 1996	Unspecified number of teams comprising surgeons, anesthetists, anesthetic nurses, surgical nurses, and orderlies.	Training included lectures and various simulations including excessive bleeding and pneumothorax.
	Sexton et al,[12] 1998	Total of 128 participants from 22 teams. Teams included surgical consultant, surgical resident, scrub nurse, anesthesia consultant, anesthesia resident, anesthesia nurse, orderly.	
Imperial College	Undre et al,[17] 2007	Total of 80 participants from 20 teams. Teams included surgeon, anesthetist, operating department practitioner, and scrub nurse.	Half day training including one simulation of femoral bleed leading to cardiac arrest. Other challenges, such as unsterile sets and faulty equipment, were also part of scenarios.
	Koutantji et al,[14] 2008	Total of 34 participants from 9 teams. Teams included surgeon, surgical assistant, scrub nurse, circulating nurse, anesthetist, and operating department practitioner.	Two simulations were conducted either side of an interactive workshop on briefings and checklists. Simulations comprised uncontrolled bleeding, septic shock, perforated gallbladder, and cardiac arrest conducted in simulation center.
	Sevdalis et al,[15] 2008	Teams and scenarios from simulations in Koutantji, McCulloch et al. 2008 and Undre, Koutanjti et al. 2007.	
	Sevdalis et al,[16] 2009	Teams and scenarios from simulations in Undre, Koutanjti et al. 2007.	
Louisiana State University	Paige et al,[13] 2007	Total of 10 participants in 3 teams. Teams included surgeon, nurse anesthetist, circulating nurse.	Simulation involved an intraoperative cardiac arrhythmia.
	Kozmenko et al,[19] 2008	Total of 39 participants from 11 teams. Teams included surgeons, nurse anesthetists, circulating nurses, and scrub technologists.	Half-day training including simulation of laparoscopic cholecystectomy with one of 4 crises (cardiac arrhythmia, malignant hyperthermia, anaphylaxis, and septic shock).
	Paige et al,[25] 2008	Teams and scenarios from Kozmenko, Paige et al. 2008.	
	Paige et al,[21] 2008	Teams and scenarios from Kozmenko, Paige et al. 2008 and 3 pilot simulations with a total of 17 participants.	
	Paige et al,[44] 2009	Total of 38 participants from 11 teams. Teams included surgeon, nurse anesthetist, circulating nurse, and surgical technologist.	
	Paige et al,[24] 2009	Teams from Kozmenko, Paige et al. 2008 and Paige, Kozmenko et al. 2009. These were 2 modules separated by 1 mo.	
Memorial University of Newfoundland	O'Regan,[9] 2010	Total of 6 participants forming 1 team. Team included anesthesia, general surgery, respiratory therapy and nursing.	Malignant hyperthermia scenario.
University Hospital of Montreal	Stevens et al,[23] 2012	Total of 27 participants from 5 teams. Teams included cardiac surgeon, cardiac anesthetist, perfusionist, nurses, anesthesia nurse.	Two simulations including suspected stroke or suspected pheochromocytoma.
Children's Hospital Boston	Volk et al,[10] 2011	Total of 59 participants in 9 teams. Teams comprising surgeons, anesthetists, nurses, and nurse anesthetists.	Half-day course including a lecture and 3 scenarios involving a distressed patient.
Harvard Medical School	Ziewacz et al,[18] 2011	Total of 11 participants from 2 teams. Teams included surgeons, anesthetists, circulating nurses, and surgical technologists.	Each team completed 4 different simulations twice. Simulations were malignant hyperthermia, tachycardia, hemorrhage, ventricular fibrillation, bradycardia, air embolism, asystole, and anaphylaxis.

TABLE 2. The Anesthetic and Surgical Simulators Used in the Reports, Study Objectives, Environment, and How the Simulators Were Integrated (See Text)

Reference	Study Aim	Environment	Simulator(s) Used: Anesthesia	Simulator(s) Used: Surgical	Integration*
Flanagan et al,[22] 2007	Improve attitudes toward safety and teamwork	In situ	METI HPS		
Forsythe[26] 2009	Improve team communication	In situ		Unspecified "mix of low and high-fidelity simulators"	
Helmreich and Davies,[11] 1996	Assess participant perceptions of an ORMDT training course	Simulation center	Wilhelm Tell	Laparoscopic simulator	None
Sexton et al,[12] 1998	Assess participant evaluation of OR-MDT				
Koutantji et al,[14] 2008	Promote understanding of teamwork and safety	Simulation center	SimMan (Laerdal)	Saphenofemoral junction model (Limbs&Things)	Anatomic
Sevdalis et al,[15] 2008	Assess the reliability of a revised measurement scale				
Sevdalis et al,[16] 2009	Develop an observational tool to capture OR nursing skills				
Undre et al,[17] 2007	Create an OR-MDT course and explore nontechnical skills across professions				
O'Regan,[9] 2010	Identify latent weaknesses in Malignant hyperthermia management processes	In situ	Basic CPR manikin	None	NA
Paige et al,[13] 2007	Assess participant perceptions of an OR-MDT training course	Simulation center	METI HPS	Cholecystectomy model torso trainer (Simbionix)	None
Kozmenko et al,[19] 2008	Assess participant perceptions of an OR-MDT training course	In situ	METI ECS with proprietary software	Simulab Torso Trainer (Simulab)	None
Paige et al,[25] 2008	Assess participant perceptions of an OR-MDT training course				
Paige et al,[21] 2008	Improve teamwork competencies				
Paige et al,[44] 2009	Improve attitudes toward teamwork				
Paige et al,[24] 2009	Improve teamwork competencies				
Stevens et al,[23] 2012	Assess participant perceptions of an OR-MDT training course	Simulation center	SimMan 3G (Laerdal)	Orpheus simulator (Ulco Technologies) and custom models	
Volk et al,[10] 2011	Teach teamwork and crisis resource management skills	In situ	SimMan (Laerdal)	None	NA
Ziewacz et al,[18] 2011	Improve adherence to critical management steps	Simulation center	3G (Laerdal)	Tumor model and various Limbs&Things models	Anatomic

TABLE 3. Results of Participant Perceptions of the Simulations

				Realism of Simulations			Effectiveness of Simulation		
Article	No. Participants	No. Respondents	Highest Possible Score	Simulation was Realistic	Simulation Elicited Realistic Responses	Model was Realistic	Simulation was Appropriately Challenging	Simulation was Useful for Learning	Simulation Would Change Practice
Flanagan et al,[22] 2007	59	18	100% agreement					94	94
Helmreich and Davies,[11] 1996	Unspecified		10					8.0	78
Sexton et al,[12] 1998	128	128	10	7.1 (1.3)	7.7 (1.5)			8.4 (1.9)	
								9.1 (1.1)	
Koutantji et al,[14] 2008								4.7	
				4.6				5.2	
	34	34	6	4.6	4.2	3.9	4.5	4.9	
				4.7				5.0	
								5.2	
Kozmenko et al,[19] 2008	39	47*	6	5.6 (0.7)	4.9 (1.2)			5.7 (0.4)	
								5.5 (0.8)	
Paige et al,[21] 2008	56	55	6	5.6 (0.5)	5.1 (1.0)			5.6 (0.6)	
				5.5 (0.8)	4.9 (0.9)			5.8 (0.5)	
Paige et al,[13] 2007	10	10	5					4.5(0.5)	80% agreement
								4.7 (0.5)	
								4.4(0.7)	
O'Regan,[9] 2010	6	6	5	4.7				5	
Stevens et al,[23] 2012	27	27	100% agreement					63%	37%
							74%	41%	
Volk et al,[10] 2011	59	59	100% agreement	91%					
Ziewacz et al,[18] 2006	88		5	4.5 (0.8)	4.3 (0.9)		4.7 (0.6)	4.2 (0.9)	4.4 (0.77)

*This number was taken from the sum of responses and is larger than the total number of participants.

Responses are expressed as mean (SD) and the highest possible score is indicated. Items are representative of the questions asked as wordings were different between articles. Multiple response means indicate similar questions were asked or they are responses for different simulations.

TABLE 4. Results of Measures of Performance and Other Measures Conducted in the Articles

Reference	Outcome Measure	Findings
Technical skills		
Ziewacz et al,[18] 2011	Adherence to checklist of critical steps.	Checklist use resulted in a 6-fold reduction in failure of adherence to critical steps in management
Undre et al,[17] 2007	A modified Objective Structured Assessment of Technical Skill for Surgeons and Imperial College Assessment of Technical Skills for Nurses.	Surgeons' self-assessed scores matched that of the trainers, whereas the trainee nurses seemed to overrate their technical skills.
Koutantji et al,[14] 2008	Modified Objective Structured Assessment of Technical Skill for Surgeons	Surgeons' technical skills improved significantly from the first to second simulations.
Sevdalis et al,[16] 2009	Imperial College Assessment of Technical Skills for Nurses	Reliability (Cronbach $\alpha > 0.70$) was obtained for trainers and trainees. However, trainers' and trainees' ratings did not correlate.
Nontechnical skills		
Sevdalis et al,[15] 2008	A modified nontechnical skills scale	Reliability (Cronbach $\alpha > 0.70$) was obtained across professional groups and between trainers and trainees.
Undre et al,[17] 2007	A modified nontechnical skills scale	The specific skills of leadership and decision making were scored lower than the other 3 skills. In comparing the scores between disciplines, surgeons scored lower than nurses on communication; surgeons scored lower than nurses and ODPs on teamwork skills; and surgeons scored lower than all other specialties on vigilance. Surgeons and anesthetists also scored lower than nurses on leadership.
	Surgeons and anesthetists self-rated scores matched that of the trainers, whereas the nurses significantly overrated and ODPs tended to underrate their nontechnical skills.	
Paige et al,[21] 2008	Teamwork competency questionnaire.	Participants significantly improved their self-rated scores in teamwork competency questionnaires after training compared with those before the training.
Paige et al,[24] 2009	Self-efficacy questionnaire targeting teamwork competencies.	There were significant improvements in 4 of 15 items of a self-efficacy questionnaire administered before and after the modules. Nine of 15 items significantly improved after the second module. These findings were confirmed by direct observation by instructors during training.
Koutantji et al,[14] 2008	Modified nontechnical skills human factors rating scale	There were significant differences in the nontechnical skills of different professions with surgeons scoring lower than anesthetists and ODPs. Surgical performance improved after training and anesthetic performance deteriorated.

Other

Reference	Findings
Flanagan et al,[22] 2007	There was no significant difference in the percentage of positive responses to teamwork climate or safety climate items on the Safety Attitudes Questionnaire 3 months after training compared with before the course.
O'Regan,[9] 2010	Policy and equipment changes were made as a result of reflective learning from the scenarios.
Ziewacz et al,[18] 2011	Participants scored the checklist as being helpful for feeling better prepared during the scenario and easy to use as 4.2 (1.0) and 4.1 (1.0) of 5 respectively.
	Participants scored their perception that they would use the checklist in real life and wanting the checklist to be used if they required treatment as 4.3 (0.8) and 4.4 (0.7) of 5 respectively.
Koutantji et al,[14] 2008	Participant scores on a safety climate survey were equivalent across disciplines and comparable to other survey cohorts.
	The training program led to significant improvements in scores on some items of a briefing attitudes questionnaire.
Stevens et al,[23] 2012	There were no significant differences in the scores of a safety climate survey after training compared with those before the training.

difficulty of recruitment was the most cited challenge to be overcome, especially of senior surgical staff.[11,17,19,22] The need to achieve organizational and leadership support for the courses was considered vital to overcoming some of the recruitment challenges.[11,14,21,22] Achieving participant interest in the training was linked in some articles to the limited technology available to create realistic and engaging simulators for the participants,[14,21,22] particularly for the surgical subteam. Two articles also cited the large financial cost and time commitment involved to conduct the courses as a challenge to running simulations for whole OR teams.[17,21]

Despite the barriers mentioned previously, a number of factors contributed to the success of the reported OR-MDT training and research. Prescenario familiarization to appreciate limitations of the models and environment and clarification of the course objectives were reported as important in 6 articles.[10,13,17,21,22,25] One study[26] of OR-MDT using action research methodology identified 2 aspects of the training that contributed to its success, namely, allowing enough time for participants to learn and ensuring the environment was "psychologically safe,"[27] allowing nurses and physicians to feel a sense of equality. Furthermore, all courses were designed and debriefed by experienced personnel, the authors appearing to have made the assumption that experience is important for success. Didactic lectures were used in some courses and not others, as was video playback of the simulations during debriefing. These aspects were not elaborated on in the success of courses and did not seem to affect the results of participant ratings (Table 3). Many of the features previously mentioned adhere to expert guidance for simulation-based training in general.[28]

DISCUSSION

This systematic review has identified 18 articles from 10 research groups reporting the use of simulation for OR-MDT training. Simulations were conducted in simulation centers or in situ, and, where reported, all involved crisis scenarios. Different combinations of models were used in many reports for the surgical and anesthesia teams, with limited anatomic and no physiologic integration. Participants generally found the simulations to be realistic and of high educational value, whereas the potential for transfer of learning to the clinical environment was less clear. A range of outcome measures were used, including technical and nontechnical skills, and attitudes to safety.

One might expect more reports of OR-MDT training, especially given the number of surgeries performed each year throughout the world[29] and the extent to which simulation is used in the separate disciplines of anesthesia, surgery, and nursing.[1–3,30,31] It is also surprising that OR-MDT simulations have not been more extensively researched as evidence suggests failures in whole-team communications lead to compromised patient care.[4] Possible reasons for the lack of OR-MDT simulation were found as part of this review. They included the difficulties of recruitment, lack of surgical model fidelity, and financial cost of running the simulations.

All reviewed articles used manikins for the anesthesia team and either part-task trainers or laparoscopic simulators for the surgical team. This is not surprising because these are currently the most widely available models for training uniprofessional teams in anesthesia and surgery.[32,33] There is interest from some researchers in the use of completely virtual reality–based or screen-based OR simulation[34,35] and even combining modalities,[36–39] but these are technical reports only and did not involve participants. None of the studies included in this review integrated the physiology of the simulators used for the anesthesia and surgical teams. It is unclear how much fidelity or integration of simulators for anesthetic and surgical teams is required to engage participants in an authentic clinical experience or for effective learning. It is possible that, if there is no integration, conflicting anatomic or physiologic indicators may emphasize the artificial nature of the simulation and lead to participants to reject the simulation as unrealistic. However, the realism of the models may not be as important as the overall realism of the simulation. More work is required to identify how much fidelity is required because this impacts the cost of the simulations and will help to standardize simulations.[40]

There were a number of outcome measures used in the reviewed articles with little standardization of the wording of questions or scale for answers to questions about participant perceptions. Likewise, there was a variety of measurement tools used for technical and nontechnical skills. This makes results hard to compare between studies. The lack of standardization is not surprising, given the relative infancy of some of these measures and the active work currently being conducted in validating tools.[41,42]

A limitation of this study is that it focused on reports of OR-MDT in the literature. There may be many more centers around the world actively involved in OR-MDT simulations but not formally reporting their work. An international survey of simulation centers conducted in 2002 found that only 22% of the estimated active centers had published work related to their simulation activities.[43] Conducting a similar survey to update these results would be a valuable contribution to understanding the tools and measures used by those who are practicing but not publishing. A further limitation of this review is that articles were not excluded based on the quality of the study. We decided to include all articles to give as broad an overview as possible of what had been done in the past. Moreover, a meta-analysis was not performed on the data retrieved from included articles. To compare studies requires some consistency in the chosen outcome measures and, because the questions differed between articles in wording and in scale, it was not possible to meaningfully combine the data. Standardization of outcome measurement tools is an area for future research. There are challenges to be met, in creating valid measurement tools,[44] but these are required to allow comparison of results from different interventions. Future work should also focus on measurement in the clinical environment to verify transfer of training or to verify that the simulations are genuine analogs of the clinical environment and to measure any impact on patient outcomes.

CONCLUSIONS

There is a lack of research being conducted involving simulation-based OR-MDT training despite the clear need for such initiatives. This review found that previous work has included a variety of scenarios, all involving crises, multiple combinations of simulators for anesthesia and surgical subteams, and several different measurement tools. This makes comparison of the studies and results difficult. Standardization of simulations and tools was not mentioned as a challenge to carrying out the simulations. Barriers to OR-MDT training initiatives include recruitment, fidelity of surgical models, and cost. The first of these barriers is linked to engagement of senior staff and hospital management. More work is required to convince organizational leaders of the mandate for OR-MDT training, so that initiatives can address issues of teamwork between OR subteams.

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