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Original Article

Simulation-Based Education Can Help Resident's Readiness in Critical Care and Medical Ethical Issues

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SUMMARY

Aim: Pandemic emerging infectious disease threatened to old people with severe mortality, so advanced ICU core ability is urgent needed for residents through a simulation-based education. This study aims to assess the ICU core abilities of R2 residents through video-learning and practice in simulated intensive care scenarios to solve future tasks.
Methods: A workshop was created including pre-course test, discussion of video-learning, five simulated participatory learning scenarios with critical care and ethical issues. All participants were able to read the teaching material and online instructions before discussion and to manipulate the simulation-based scenarios. A post-course feedback questionnaire was conducted for self-evaluation.
Results: Workshop participants included 33 R2 residents, six trainers, four nurses and three standardized patients. The scores of the written tests in the IABP/TPM and abdominal echo scenarios were worse than those in the simulation test ($p < 0.01$), while the scores of written tests in the hypothermia, chief resident leadership were better than those in the simulation test ($p < 0.01$). Not only did the training workshop earn their satisfaction with discussion of video learning class (4.85/5) and simulation-based education (4.76/5), but it also fostered their core abilities to function in the medical intensive care unit (Likert scale values ranged from 2.97 to 3.42, $p < 0.01$).
Conclusion: In this workshop, combination of the video-learning with written-test, simulation-based education with assessment not only improved the validity of integrated critical care, but also highlighted individual deficiencies. In the future, teachers can more easily provide preliminary remediation before students qualify as R3 residents.

1. Introduction

Advanced critical care training with medical ethics is important that help residents navigate common ethical challenges encountered in practice such as shared decision making and end-of-life care,[1] but didactic lectures have traditionally been the means to introduce basic knowledge to residents, there is still a gap between residents' knowledge and their clinical performance. Previous evidence supports the use of multiple learning strategies and individualized learning can improve the learning gap in simulation-based education.[2] Bonnes et al. reported that residents who participated in flipping classrooms demonstrated improved quality of knowledge compared to the control group.[3] Simulation-based education (SBE) is also a very advantageous strategy as it involves deliberate practice, comprehensive assessment of learning, absence of risk to patients, reproducibility, and opportunities to encounter uncommon events.[4] Cindryani et al. successfully incorporated simulation of anesthesia crisis management into chief resident competencies modules and practiced it in examinations.[5] Khandelwal et al. demonstrated that the innovative flipped classroom format in combination with simulation-based education allows the easy inclusion of contemporary professional issues surrounding social media.[6]

In recent years, simulation-based education has been widely used for resident intensive care unit (ICU) training. Concerning critical care, Saavedra et al. verified that simulation programs have improved the comfort of residents in important aspects of the care of critically ill pediatric patients.[7] On the acquisition of communication skills in the ICU, Bullard et al. reported that the implementation of simulation in the educational curriculum has increased learner confidence in select critical care topics, procedures, and communication skills, and has resulted in a high level of learner satisfaction.[8] Markin et al. demonstrated that brief simulation-based interventions can produce lasting improvements in residents' confidence to discuss end-of-life care with family members of ICU patients.[9] Simulations also help develop advanced communication skills needed by chief residents to talk about death and declaration of brain death. Miller et al. reported that a thirty-minute simulation-based training improves self-reported comfort and preparation of internal medicine residents to talk about death and dying in the ICU.[10] Shank et al. reported that the involvement of residents in the process of declaring brain death can be successful, valuable to the institution, and beneficial to patient care.[11]

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In our previous works, we used workshop-based assessment to evaluate the ACGME general competencies of PGY residents in internal medicine,[12] Blum et al. also used a multi-scenario simulation-based assessment to obtain reliable and valid information on the performance of anesthesia residents.[13] Keller et al. used three important simulation cases as a comprehensive neurologic emergencies curriculum for critical care training.[14] The year three residents have the responsibility to care the most critical patients including resuscitation by therapeutic hypothermia, the using of intra-aortic balloon pump, do echo-guided paracentesis and have the ability of good communication and leadership. This program aimed to train and assess the initial core ICU abilities of internal residents whom from R2 to R3, and using a workshop which incorporated interactive learning class with SBE in advanced critical care and then presented these residents' scores as a valid reference for the ICU teaching faculty.

2. Methods

2.1. Problem identification and target needs assessment before residents become R3s

In order to be able to care for patients in the intensive care unit, second year (R2) internal residents need to acquire leadership skills and the ability to communicate with different departments before becoming R3s. To this end, simulation-based education was recommended by the Taiwanese Residency Review Committee. According to the policy of student participation in teaching decisions, a questionnaire on chief residents' ability opinions was conducted from all residents to determine the key abilities required for ICU R3s. The questionnaire results were considered and discussed with internal medicine teaching physicians in developing the topics for this workshop.

2.2. Educational objectives

An integrated pre-medical intensive care unit (MICU) training program was conducted and approved by the Institutional Review Board. Thirty-three internal medicine residents from R2 to R3 attended the workshop. The integrated advanced critical bundle workshop included a 240-minute training course comprising a pre-course test, interactive learning class, SBE (five scenarios), discussions, and a post-course feedback questionnaire (Table 1).

The instructional staff included six teachers, four nurses, and three standardized patients (SPs). The educational goals of the workshop were to introduce an integrated advanced intensive care training program in the R2 program and help residents in acquiring core ICU care and leadership abilities (Table 2).

2.3. Workshop

2.3.1. Pre-course written test

Each teacher was responsible for a specific scenario and a set of five multiple-choice questions about the simulated operation. The

Table 1
Schedule of advanced ICU simulation-based education workshop for resident.

Time	Subject Steps	Elements
30 mins	Pre-course written test	Evaluate the knowledge score from video learning achievement
40 mins	Discussion of video learning	Resolve the residents' problems during video learning
10 mins	Break	
105 mins	Participatory learning, assessment, and feedback in Scenarios 1 to 5	#Scenarios 1 to 5 including IABP/TPM, Echo, Hypothermia, Procurement, and Leadership
5 mins	Break	
30 mins	Panel discussion and reflection	Teachers, residents, and standardized patients shared their experience in the workshop and identified 3 things to do
20 mins	Post-course satisfactory questionnaire	Satisfactory questionnaire for reviewing simulation learning and self-evaluating the difficulty in MICU care

#IABP/TPM: intra-aortic balloon pump and temporary pacemaker; Echo: abdominal echo in ICU treatment; Hypothermia: hypothermia treatment; Procurement: organ procurement; Leadership: chief resident leadership.

Table 2
Educational objectives in each scenario.

Scenarios	Educational objectives (content and methods)
1. IABP/TPM	a. Understand the indication, contraindication, complication, and the mechanisms for IABP/TPM use. b. Evaluate the ability of reading the EKG of patients on IABP/TPM. c. Show the ability of trouble shooting through simulation and artificial models.
2. Echo	a. Understand the indications, complication and alternative methods for ascites tapping. b. Evaluate the ability to diagnose ascites by ultrasound. c. Show the ability to do an aseptic hands-on paracentesis procedure, analyze the ascites data and explain the critical condition to the family with good communication skills.
3. Hypothermia	a. Understand the indications of hypothermia treatment according to ACLS Guideline. b. Evaluate the ability to practice hypothermia treatment. c. Show the ability of trouble shooting by using simulation and artificial models.
4. Procurement	a. Understand the definition, diagnosis flow chart of brain death and indication for organ procurement. b. Evaluate the ability of telling the bad news and empathy. c. Show the ability of organ procurement with the associated communication skills.
5. Leadership	a. Understand the indications and principles of managing ICU admissions. b. Evaluate the ability of basic ICU care skills and consultations. c. Show the ability of negotiating with another department doctor to train the communication skills by simulation.

IABP/TPM: intra-aortic balloon pump and temporary pacemaker; Echo: abdominal echo in ICU treatment; Hypothermia: hypothermia treatment; Procurement: organ procurement; Leadership: chief resident's leadership.

pre-course test encompassed 25 questions and the test results were compared with the students' SBE performance.

2.3.2. Discussion of video learning

Each teacher provided the teaching materials for each scenario, namely 50 PowerPoint slides that included an essential outline and central ideas. In addition, one teacher recorded a 60-minute lecture that residents were able to access to preview the five major topics. Residents were asked to carefully read the handouts before participating in the subsequent training and interactive learning with discussion in the workshop.

2.3.3. Simulation-based education

Residents were arbitrarily divided into the five simulated scenarios to meet the demands of micro-teaching and faculty availability. The simulations included 1) scenario 1: intra-aortic balloon pump (IABP) and temporary pacemaker (TPM); 2) scenario 2: use of abdominal echo in ICU treatment; 3) scenario 3: hypothermia treatment; 4) scenario 4: organ procurement; and 5) scenario 5: chief resident leadership. Residents had 16 minutes to practice each scenario and five minutes for real-time feedback and reflection. For each scenario, the examiners completed a checklist with behaviorally anchored rubrics according to individual performance in terms of knowledge, skill, and professionalism, and conducted debriefings afterward. The five ICU bundle scenarios were designed to enhance residents' core ICU abilities.

In scenario 1, the internal R2 was informed that a patient with myocardial infarction was suffering from bradycardia and hypotension after undergoing coronary catheterization. The resident was expected to interpret the electrocardiogram and review the indications for IABP and TPM. Basic TPM troubleshooting was included in this scenario.

Scenario 2 involved a 57-year-old man with a history of chronic hepatitis C and alcoholism who experienced poor appetite the prior week and developed fever two days before admission. He was sent to the hospital after showing consciousness disturbances. Acute respiratory failure and shock were noted in the emergency department, and he was transferred to the ICU after intubation. The following day, an abdominal echo revealed liver cirrhosis with a large amount of ascites. The resident was expected to explain the condition to the patient's family and perform paracentesis.

In scenario 3, a patient had a cardiac arrest at a swimming pool. The lifeguard performed cardiopulmonary resuscitation (CPR) and executed cardioversion twice, which was followed by another six minutes of CPR and three instances of cardioversion in the emergency department. After the return of spontaneous circulation, the patient was sent to the ICU. In this case, the resident was expected to initiate hypothermia therapy and learn to manage cold tremors, hypotension, bradycardia, and seizures.

In scenario 4, a 26-year-old woman was sent to the ICU with an acute stroke complicated by generalized convulsions and acute respiratory failure. Three days later, her consciousness became unclear and computed tomography (CT) scan indicated severe brain swelling and brain herniation. The resident was expected to explain the current situation to the patient's family members, discuss the options of either withholding or withdrawing medical treatment, and explore their willingness to consider organ donation.

In scenario 5, the resident was presented with a patient with diabetes mellitus (DM) foot and cellulitis who was receiving antibiotic therapy in the surgical general ward. The following day, he presented severe chest pain followed by a cardiac arrest. After CPR, spontaneous circulation was restored. The surgical duty doctor then consulted the resident for further recommendations regarding patient management.

2.3.4. Assessment and feedback

Following the integrated critical bundle simulations, the residents were granted a short break, after which they proceeded with a 30-minute panel discussion and feedback session. Finally, a post-course questionnaire was conducted including degree of satisfaction with the discussion of video learning and simulations, difficulty in caring for MICU patients, and perceived advantage for the future. Both the rubrics and questionnaire were based on a five-point Likert scale for level of satisfaction. Degree of satisfaction with interactive learning class was measured according to the items "very satisfied" (5); "satisfied" (4); "unsure" (3); "dissatisfied" (2); and "very dissatisfied" (1); while self-evaluation ability in advanced SBE by level of quality was measured according to the items "excellent" (5); "very good" (4); "good" (3); "fair" (2); and "poor" (1) (Supplement 1).

We divided the residents' educational objectives into three subitems, the first is understanding the indication, contraindication, complication, the alternative methods and mechanisms for the five scenarios, the second is to evaluate the ability to diagnose or practice in the five scenarios and the third is to show the ability of trouble shooting or communication skills through simulation or artificial models (Table 2). The scores were recorded according to achievement rate of the check lists subitems.

We wanted to evaluate the residents' ICU core ability before R3 according to these three educational objectives and as the reference for individual remedial teaching. The radar chart and Match-Mismatch Highlight were built according to individual simulation and written scores. Good performance for written test and simulation test match to group (A); bad performance for written test and simulation test match to group (B); high in written test and low in simulation (group C) or high in simulation and low in written test (group D) were belong to mismatch performance (Figure 1). This individual report is for different individual future training programs.

2.3.5. De-rolling for SPs in the organ procurement scenario and work summary

A consultant psychologist introduced psychodrama skills in the SP training program, which comprised the following steps: (1) warming-up by running test scenarios and reviewing past experiences; (2) intuitive reasoning by developing new strategies and role play; and (3): de-rolling by integrated reflection and application of the feedback for corrections.

2.4. Statistical analysis

Data from the post-course feedback questionnaire and simulation scores were shown as mean $\pm$ standard deviation (SD). The correlations observed between the before-training and after-training questionnaire scores were used in the Wilcoxon signed-rank test. The statistical analyses were performed using the SPSS 23.0 statistical package (SPSS, Chicago, IL). All statistical analyses were based on two-sided hypothesis tests with a significance level of $p < 0.05$. The reliability analysis was performed using SPSS version 23 (SPSS, Chicago, IL). Reliability (internal consistency) of post-course feedback questionnaire derived from 33 residents was measured with Cronbach's alpha, and $\alpha \geq 0.7$ was acceptable.

3. Results

A total of 33 internal medicine R2s (25 men and 8 women)

consented to participate in this study. There was no difference between the residents' average scores in the written test and in the simulation test (76.0 ± 6.1 vs. 78.8 ± 8.8). However, comparing the scenarios, one can verify that the scores of written tests in the IABP/TPM (65.5 ± 22.0 vs. 81.5 ± 14.1) and abdominal echo (82.4 ± 10.9 vs. 93.0 ± 5.2) scenarios were worse than those of the simulation test, while the scores of written tests in the hypothermia (83.6 ± 18.3 vs. 61.8 ± 16.3) and chief resident leadership (87.3 ± 15.7 vs. 73.3 ± 13.5) scenarios were better than those of the simulation test (Table 3).

In simulation scenario 1 (IABP/TPM), the highest score was 100 and the lowest was 45; the residents' weak point in this scenario was to diagnose the EKG shape of complete AV block and troubleshooting about TPM non-capture. The residents' scores distribution in the IABP/TPM scenario which showed that there were 23 (70%) residents belongs to A group. There were two residents belong to C group and eight residents belongs to D group. In scenario 2 (abdominal echo in ICU treatment), the highest score was 100 and the lowest was 79; the residents' shortcoming in this scenario was the inability to use good communication skills, which included explaining the indication and communicating with the family. The residents' scores distribution in the abdominal echo in ICU scenario which showed that all residents belong to A group. In this study, we found that the R2s obtained better simulation scores for these two scenarios (Table 3, Figure 1).

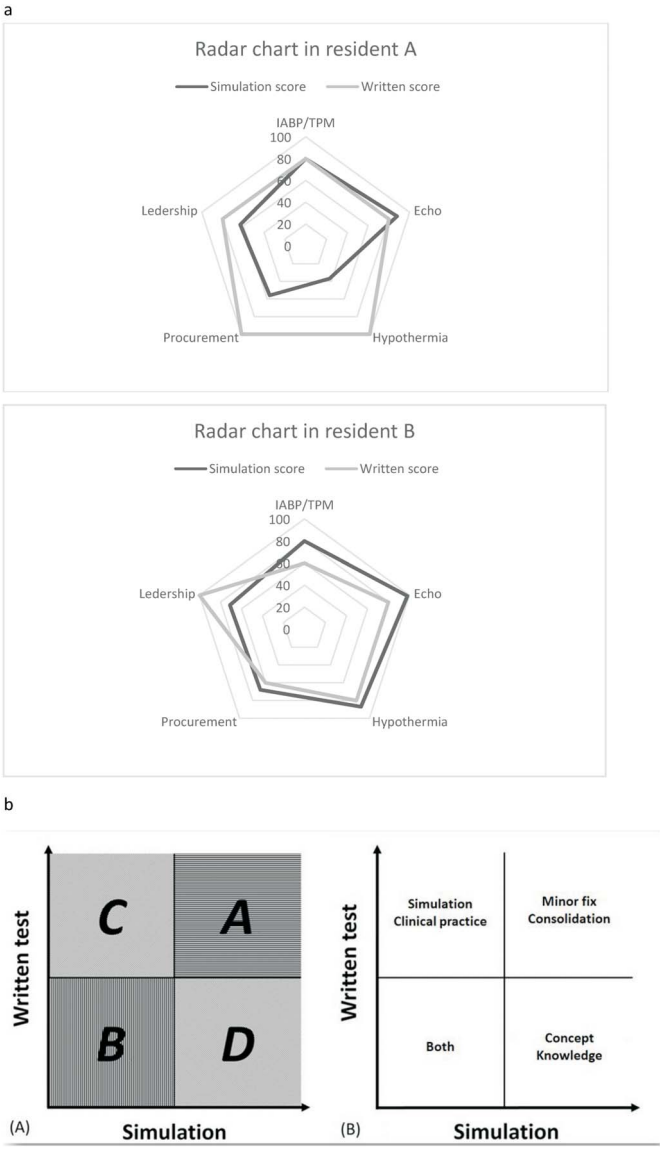

Figure 1. a. The radar charts of residents according to simulation and written scores. b. Match-Mismatch Highlight. (A) Legend: A: match good performance for written test and simulation. B: match bad performance for written test and simulation. C: mismatch performance (high in written test, low in simulation). D: mismatch performance (high in simulation, low in written test). (B) Different future training programs according to their match and mismatch profiles.

In scenario 3 (hypothermia treatment), the highest score was 93 and the lowest was 17; more than one-third (36%) of the R2 failed on this topic – the residents easily neglect heart rate measurement, risk of coronary artery disease, and urine volume during shock condition. The residents' scores distribution in the hypothermia scenario which showed that there were 19 (58%) residents belongs to A group, 12 (36%) residents belong to C group need more simulation and two residents belongs to D group need more reading. In scenario 4 (organ procurement), the highest score was 84 and the lowest score 40; most R2s were unfamiliar with the process of declaring brain death and discussing end-of-life care with family members of patients in the ICU; 15% of the R2s failed in this topic. The residents' scores distribution in the organ procurement scenario which showed that there were 27 (82%) residents belongs to A group, 5 (15%) residents belong to C group and one resident belongs to D group. The simulation scores in these two scenarios were relatively low (Table 3). In scenario 5 (chief resident leadership), the highest score was 96 and the lowest was 42; the residents' weak point in this scenario was to identify the available beds before controlling ICU admissions, the residents' scores distribution in the leadership scenario which showed that there were 28 (85%) residents belongs to A group, 5 (15%) residents belong to C group need more simulation (Table 3).

The scores of educational objective subitems, concerning the ability to utilize the indication, contraindication, complication, and mechanisms for the five scenarios, the best was abdominal echo scenario, and the worst was the hypothermia scenario. The ability to diagnose or practice in the five scenarios was worse in hypothermia and procurement scenarios. About showing the ability of trouble shooting or communication skills, the best was abdominal echo scenario, and the worst was the procurement scenario (Table 4).

The mean degree of satisfaction with the discussion of video

Table 3
Residents' scores in simulation and pre-course tests (n = 33).

Scenarios	Simulation test	Written test
1. IABP/TPM	81.5 ± 14.1	65.5 ± 22.0
2. Echo	93.0 ± 5.2	82.4 ± 10.9
3. Hypothermia	61.8 ± 16.3	83.6 ± 18.3
4. Procurement	66.8 ± 9.1	72.7 ± 15.7
5. Leadership	73.3 ± 13.5	87.3 ± 15.7
Average	76.0 ± 6.1	78.8 ± 8.8

Abbreviations are as in Table 1.

Table 4
Residents' educational objective subitem sores in simulation (n = 33).

Scenarios	Subitem a	Subitem b	Subitem c
1. IABP/TPM	67.2 ± 20.2	80.0 ± 15.2	73.5 ± 22.5
2. Echo	91.7 ± 8.3	96.4 ± 7.8	93.0 ± 9.2
3. Hypothermia	53.6 ± 21.1	55.0 ± 21.3	74.5 ± 25.3
4. Procurement	69.3 ± 9.6	63.0 ± 11.9	68.2 ± 13.6
5. Leadership	67.2 ± 20.2	80.0 ± 15.2	73.5 ± 22.5

Subitem a: Understand the indication, contraindication, complication, and the mechanisms for the scenarios; Subitem b: Evaluate the ability to practice the scenarios; Subitem c: Show the ability of trouble shooting through simulation and artificial models.

learning was (4.85/5) and with the SBE was (4.76/5); the mean score for perceived advantage for the future was (4.52/5). There was significant difference between before-training and after-training post-course feedback questionnaire scores concerning difficulty in caring for MICU patients (4.00 ± 0.56 vs. 3.67 ± 0.74; p = 0.012, Table 5).

Concerning the reliability and validity of the post-course feedback questionnaire, we had the feedback questionnaire after the workshop of 33 residents, and the internal reliability of these questions had good agreement (Cronbach's alpha = 0.748). The initial draft of the questionnaire was created by experts from clinically relevant professional fields, and then reviewed by the Teaching Plan Panel of the Clinical Skills Center for test format and content. The experts in the relevant fields collectively reviewed all the test format and content in a committee meeting (Supplement 2).

4. Discussion

In this program, a simulation-based education workshop including five key scenarios integrated with an interactive learning class enabled to decrease the difficulty to care for MICU patients. This workshop enabled the assessment of the initial ICU core abilities of internal residents from R2 to R3, which may become the preliminary reference material for ICU teaching faculty.

The traditional lecture class, which comprised reading and teaching sessions, did not allow adequate identification of individual performance. In contrast, interactive learning class and SBE allowed teachers to focus on students' individual difficulties and to develop their application, analytical, and creative abilities. In our workshop, these five simulation scenarios were paramount. IABP simulation training has been reported as an effective tool to enhance the acquisition of knowledge and technical skills of cardiology trainees.[15] Tejos et al. highly recommended the simulated training program in abdominal paracentesis as an educational strategy as it can accelerate the acquisition of clinical skills in a safe learning environment.[16] Therapeutic hypothermia was an independent prognostic factor for the three-month cerebral function outcome.[17] Simulation-based communication training for the designated requester role in family donation conversations increased the clinicians' knowledge and confidence to raise the topic of donation.[18] Burden et al. stated that simulation education with deliberate practice can help develop leadership and resource management skills of senior residents.[19] In this study, the pre-course written test aimed to assess residents' knowledge and "know how." Likewise, each individual demonstrated his/her "show how" ability which represent the ability of skill and attitude during the SBE. The teachers can help residents to correct their shortcoming according to these two scores.

For example, the residents' scores distribution in the procurement scenarios which showed that there were 27 (82%) residents belongs to A group, that's mean they have basic knowledge, skill and attitude in this field. There were five residents belong to C group that's mean they need more simulation training, and only one resident belong to D group, he needs more reading in teaching material.

After the training, each resident received his/her own five-scenario assessment including radar chart scores (Figure 1a); these not only served as future goals but also enabled teachers to develop personalized future training plans for students to complete before practicing in the medical intensive care unit. In general assessment for these residents (Figure 1b), group A residents showed good performance both in the simulations and the written test, which indicates that they probably only required minor revisions and consolidations. Residents in Group C, who had high scores on written test but low simulation outcomes, needed more practice in simulation-based education and clinical practice. On the other hand, residents in Group D knew what to do but did not know the reason. Thus, Group D residents need greater focus on concepts and knowledge. In group B, since residents did not do well both in the written test and simulations, future training programs should focus on both aspects.

Regarding the results of the post-course feedback questionnaire and panel discussion, the residents' comments, and reflections on the interactive learning class and SBE included the following. 1) It is helpful to review the teaching materials provided before the interactive learning class. 2) Hypothermia treatment included many procedure details that required simulation training. 3) In the organ procurement scenario, self-introduction, built relationships, and listening are extremely challenging; the residents acknowledged that they had acquired listening and communication skills, and decision confidence. 4) It takes more time (three minutes) to read the candidate's information at each station. Despite its contributions, our study had some limitations. First, it was a pilot test because of the small sample size of third-year residents (R3). Second, we do not have data to evaluate the correlation between the score of simulation and written test and the reading time spent before the discussion of video learning class.

5. Conclusion

This residents' advanced ICU simulation training integrating video learning and SBE could improve their learning outcomes and promote patient safety. This innovative training program offers residents' individual scores, which may be the reference for ICU tea-

Table 5
Post-course satisfactory questionnaire (n = 33).

	Before training	After training	p-value
Satisfaction degree with discussion of video learning class[&]		4.85 ± 0.30	
Satisfaction degree with simulation[&]		4.76 ± 0.44	
Scenario 1		4.82 ± 0.31	
Scenario 2		4.81 ± 0.30	
Scenario 3		4.82 ± 0.31	
Scenario 4		4.79 ± 0.32	
Scenario 5		4.78 ± 0.34	
Difficulty to care MICU patients	4.00 ± 0.56	3.67 ± 0.74	0.012
Perceived advantage in future[$]		4.52 ± 0.51	

The rubrics and questionnaire were based on the Likert scale for the level of satisfaction: [&] very satisfied (5); satisfied (4); unsure (3); dissatisfied (2); very dissatisfied (1).

Scenarios: (1) intra-aortic balloon pump; (2) abdominal echo in ICU treatment; (3) hypothermia treatment; (4) organ procurement; (5) chief resident's leadership.

[$] Level of agreement: strongly agree (5); agree (4); neither agree or disagree (3); disagree (2); strongly disagree (1).

ching faculty to teach residents in accordance with their aptitude.

Ethics approval and consent to participate

This study was approved by the Mackay Memorial Hospital Institutional Review Board, Taipei, Taiwan.

Competing interests

All authors declare no conflict of interest.

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Supplement

Supplement 1 – MMH R2–3 ICU SBE Post-Course Feedback Questionnaire

General data

Name:_____ Sex:_____ Age:_____

1. ( ) What is your satisfaction degree with this discussion of video learning class?
very satisfied (5); satisfied (4); unsure (3); dissatisfied (2); very dissatisfied (1)

2. ( ) In general, what is your satisfaction degree with this simulation class?
very satisfied (5); satisfied (4); unsure (3); dissatisfied (2); very dissatisfied (1)

3. ( ) What is your satisfaction degree concerning below five different simulation scenarios training?
very satisfied (5); satisfied (4); unsure (3); dissatisfied (2); very dissatisfied (1)

Scenarios	Educational strategies	Score
1. IABP/TPM	Practice trouble shooting through simulation and artificial models	
2. Echo	Practice ultrasound machine skills by simulation and do an aseptic hands-on procedure, using good communication skills.	
3. Hypothermia	Practice hypothermia treatment trouble shooting by using simulation and artificial models.	
4. Procurement	Practice a scenario with a standardized patient (SP) and have one consultative psychologist to give immediate feedback.	
5. Leadership	Practice basic ICU care skills and negotiate with another department doctor to train the communication skills by simulation.	

4. ( ) **Before** this workshop, what do you feel about the difficulty to care for MICU patients.
Level of difficulty: extremely difficult (5); very difficult (4); difficult (3); fair (2); not difficult (1)

5. ( ) **After** this workshop, what do you feel about the difficulty to care for MICU patients.
Level of difficulty: extremely difficult (5); very difficult (4); difficult (3); fair (2); not difficult (1)

6. ( ) Do you feel that this workshop could let you perceive advantage in future?
Level of agreement: strongly agree (5); agree (4); neither agree nor disagree (3); disagree (2); strongly disagree (1)

Supplement 2
The reliability of the post-course satisfactory questionnaire

Q	Themes	Item-total correlation	Cronbach's Alpha if Item deleted
1.	What is your satisfaction degree with this discussion of video learning class?	0.724	0.697
2.	In general, what is your satisfaction degree with this simulation class?	0.761	0.693
3.	What is your satisfaction degree concerning below five different simulation scenarios training? 1. IABP/TPM	0.774	0.691
4.	What is your satisfaction degree concerning below five different simulation scenarios training? 2. Echo	0.786	0.687
5.	What is your satisfaction degree concerning below five different simulation scenarios training? 3. Hypothermia	0.497	0.719
6.	What is your satisfaction degree concerning below five different simulation scenarios training? 4. Procurement	0.551	0.706
7.	What is your satisfaction degree concerning below five different simulation scenarios training? 5. Leadership	0.068	0.782
8.	Before this workshop, what do you feel about the difficulty to care for MICU patients?	0.610	0.710
9.	After this workshop, what do you feel about the difficulty to care for MICU patients?	0.024	0.831
10.	Do you feel that this workshop could let you perceive advantage in future?	0.361	0.739

The reliability coefficients of the Cronbach's Alpha = 0.748; Q: question.