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BRIEF COMMUNICATION

Positive emotions for promoting quality improvement of extracorporeal membrane oxygenation therapy for COVID-19: In situ interprofessional simulation

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Abstract

Aim: The requirement during the COVID-19 pandemic to provide extracorporeal membrane oxygenation (ECMO) treatment regardless of experience caused high levels of anxiety among healthcare professionals. The aim of the present study was to evaluate the effectiveness of an in situ interprofessional simulation training conducted to improve readiness and preparedness for ECMO management of patients with COVID-19 at a non-high-volume ECMO centre.

Methods: Three emergency physicians, three clinical engineers and two nurses attended the 3-h simulation held at Hirosaki University Hospital in December 2021, during the COVID-19 pandemic. The training comprised a 30-min briefing, a 1-h ECMO circuit change session, a 1-h in-hospital transfer simulation for CT and a 30-min debriefing. Before and after the training, participants completed an online survey of their emotions, based on the Japanese version of the Medical Emotion Scale (J-MES). Related-samples Wilcoxon signed rank test was used to assess potential changes in emotional responses before and after the simulation, and $p<0.05$ was considered to indicate significance.

Results: Participants' positive deactivating emotions increased from a median of 3.3 (range, 2.0–4.5) before the simulation to 4.0 (range, 2.5–5.0) after the simulation ($p=0.02$), which indicates favourable performance according to the control value theory of educational psychology. There was no statistically significant change in other emotional categories.

Conclusion: Participants' positive deactivating emotions increased significantly following an in situ ECMO simulation training, which indicates the efficacy of the training for improving the quality of ECMO management in patients with COVID-19.

KEYWORDS
ECMO, emotions, in situ simulation, interprofessional

INTRODUCTION

Collaboration between emergency physicians, nurses and perfusionists is essential for optimising extracorporeal membrane oxygenation (ECMO) treatment in the critical care setting, particularly in the context of severe respiratory failure such as that associated with COVID-19.[1] Their expertise in critical care is essential for the stabilization and management of patients with severe COVID-19. Interdisciplinary teamwork, characterised by effective communication and a shared commitment to patient care, enhances the overall success of ECMO treatment and highlights the integral role that teamwork plays in achieving optimal patient outcomes in the challenging context of ECMO treatment.[2]

Interprofessional team-based in situ simulation in medical education takes into account the complex and collaborative nature of healthcare, particularly in the context of managing critical patients in non-high-volume ECMO centres.[3] This proactive strategy promotes experiential learning and interdisciplinary teamwork by engaging practitioners in realistic scenarios in authentic clinical settings.[4] Involving physicians, nurses and perfusionists within the team addresses the interdisciplinary nature of patient care and aims to bridge educational gaps. The primary rationale is to promote collaboration and improve patient outcomes through a synergistic healthcare team,[5] and the emphasis on teamwork and communication enables professionals to prepare for the challenges associated with managing critically ill COVID-19 patients in non-high-volume ECMO centres.

Recent studies have recognised the emotions of health professional trainees as important indicators of outcome in medical education.[6–8] Research into perceived stress has shown that negative emotions, including anxiety and fear, can lead to poor clinical performance.[9] Even in a simulation training environment, perceived negative emotions in medical trainees could contribute to increased cognitive load and impaired performance.[10]

The control value theory of achievement emotions by Pekrun is commonly used as a robust theoretical framework in medical education research.[6] According to this theory, individuals' emotions can influence performance through mediation by cognition, motivation and achievement behaviour.[11] Health professionals and trainees experiencing positive emotions are reported to be more likely to adopt flexible actions in challenging situations and effectively generalize the simulation experiences to real-world settings in the future.[12] In addition, the control value theory postulates that emotions are one of the important predictors for trainees' future performance and indicates that trainees' emotions can be utilized as a 'surrogate outcome' that predicts the trainees' performance in the real-word settings. It is, therefore, essential that simulation training is designed to promote positive, rather than negative emotions in trainees in order to optimise performance and achieve an even better impact on patient safety in real practice. Furthermore, measuring emotions of the trainees participating in the simulation training is also important to evaluate the effectiveness of the in situ training sessions.

The current educational initiative aimed to develop in situ interprofessional ECMO simulation training for treatment of patients with COVID-19 during the pandemic, with the aim of improving the quality of ECMO management and in-hospital transport in these patients. As all professionals in our emergency department were stressed during the pandemic, to achieve our training goals we focused on facilitating positive mood and emotions in the interprofessional team during the simulation. Thus, the present preliminary study attempted to evaluate the effectiveness of in situ interprofessional ECMO simulation training for improving ECMO treatment in patients with COVID-19.

MATERIALS AND METHODS

Study design

We conducted an educational in situ interprofessional ECMO simulation course at Hirosaki University Hospital in December 2021, during the COVID-19 pandemic.

Participants

The simulation team members included three physicians (a trauma surgeon, an emergency medicine attending physician and an emergency medicine and critical care fellow), three clinical engineers and two nurses. The median clinical experience of the physicians and clinical engineers was 16 and 5 years, and the clinical experience of the two nurses were 20 and 15 years. Each of the team members had equal opportunities to provide acute and intensive care to critical patients in the ICU of the emergency department, but the number of patients requiring venovenous ECMO was limited to only a few per year before the COVID-19 pandemic. Participants completed an online survey before and after the training using their own smartphones. As only four patients with COVID-19 had received ECMO management in our emergency centre prior to this simulation, we sought to identify solvable challenges for improving the quality of ECMO care in these patients and to build positive mood among the participants during the sessions.

Educational contents

The objectives of the course were to identify the challenges for our team in implementing a new ECMO circuit device and to safely perform the circuit exchange technique in ICU and in-hospital transport with the new devices in patients being transported to CT examinations. The 3-h simulation consisted of a 30-min briefing, a 1-h ECMO circuit change, in-hospital transfer for CT and a 30-min debriefing

1. Briefing
   The facilitator reviewed the objectives of the session and the assumptions of simulation training to assure leaners' safety and to foster positive mood.
2. ECMO circuit change (Figure 1)
   The interprofessional team performed in situ simulation of ECMO circuit change using a mannequin that is mechanically ventilated in the emergency intensive care unit. The scenario case was a 50-year-old male patient with severe COVID-19 ARDS treated with VV-ECMO with adjunctive mechanical ventilation using a lung-protective

FIGURE 1 Interprofessional in situ extracorporeal membrane oxygenation (ECMO) simulation.

strategy, and the circuit change was required on day 10 of ECMO treatment. The team changed the circuit from the conventional MERA Exceline CPB Circuit HP2 ECMO Circuit SOLAS (Senko Medical Instrument Mfg. Co., Ltd., Tokyo, Japan) to the newly implemented Cardiohelp HLS SET Advanced-LT (Maquet, Inc. Wayne, NJ, USA). The patient mannequin was connected to the real mechanical ventilator, and chest movement of the mannequin was observable. The simulated vital signs of the scenario were displayed on the patient monitor in the ICU. Two physicians (a trauma surgeon and an emergency medicine and critical care fellow) mainly performed the circuit change procedure, and the other nurses supported their procedures. An emergency medicine attending physician monitored the respiratory and circulatory status of the patient mannequin (File S1).

3. In-hospital transfer for CT scan
   The team transferred the mannequin with ECMO to the CT scan room located one floor downstairs, using the elevator. They returned the mannequin to the ICU after completing the CT scan. This in-hospital transfer simulation aimed to identify the emerging challenges in using the newly implemented ECMO device.
4. Debriefing
   The team debriefed their emotions and experiences during the in situ simulation and discussed area for quality improvements. To encourage the team members to feel relaxed, the debriefing was carried out with the team members and the facilitator seated on chairs.

Data collection

The pre-simulation survey included questions regarding participants' profession and the pre-emotion part of the Japanese version of the Medical Emotion Scale (J-MES).[13] The post-simulation survey included the post-emotion part of the J-MES: perceptions towards simulation authenticity, difficulty, effectiveness for quality improvement and self-efficacy for similar simulation training and real ECMO practice in the future. The J-MES consists of 20 items containing adjectives describing discrete emotions and uses a five-point Likert scale (File S2). The items are grouped into four subscales according to valence (positive/negative) and arousal (activating/deactivating) of the emotions: (a) positively activating (e.g. happiness, hope); (b) positively deactivating (e.g. relaxed, relieved); (c) negatively activating (e.g. anger, shame); or (d) negatively deactivating (e.g. sadness, boredom). The perceptions and self-efficacy rates were assessed using a Likert scale from 0 (no agreement or confidence) to 100 (complete agreement or confidence) with 11-point intervals measuring confidence.[14]

Statistical analysis

Related-samples Wilcoxon signed rank test was used to assess potential changes in emotional responses before and after the simulation. This non-parametric test was chosen due to the small sample size and the ordinal nature of the data. The test enables examination of paired observations within the same participants across two conditions, providing a robust assessment of potential differences in medians. All statistical analyses were conducted using SPSS version 22, and $p < 0.05$ was considered to indicate statistical significance. Data are reported as medians with associated ranges to account for the non-normally distributed nature of the emotional response data.

Ethics

The Ethics Committee of the Graduate School of Medicine, Hirosaki University, approved this study (ethics approval number 2021-227). The protocol conforms to the provisions of the Declaration of Helsinki (as revised in Fortaleza, Brazil, October 2013). Written informed consent was obtained from the participants prior to participation in the study.

RESULTS

The descriptive statistics are listed in Table 1. The results of the related-samples Wilcoxon signed rank test for a sample

TABLE 1 Descriptive statistics.

Variable	Mean (SD)
Authenticity of the simulation session (0–100)	66.6 (20.2)
Difficulty of the simulation scenario (0–100)	54.6 (22.2)
Applicability of the simulation for quality improvement (0–100)	89.1 (18.4)
Self-efficacy for future simulation training (0–100)	70.5 (8.1)
Self-efficacy for real ECMO practice (0–100)	69.1 (8.7)

TABLE 2 Descriptive statistics of emotions across time.

Variable	Before simulation median (range)	After simulation median (range)	*p*-value	Effect size
Positive activating emotions	3.4 (2.3–4.6)	3.5 (2.4–4.9)	0.75	0.12
Positive deactivating emotions	3.3 (2.0–4.5)	4.0 (2.5–5.0)	0.02	0.82
Negative activating emotions	1.8 (1.0–2.3)	1.5 (1.0–2.2)	0.40	0.30
Negative deactivating emotions	1.3 (1.0–2.0)	1.4 (1.0–2.0)	0.56	0.20

Note: Notes regarding effect size: <0.3; small effect, 0.3–0.5; moderate effect, >0.5; large effect.

size of $n=8$ are presented in Table 2. The medians and ranges of positive activating emotions showed a non-significant increase from 3.4 (range: 2.3–4.6) before the simulation to 3.5 (range: 2.4–4.9) after the simulation ($p=0.75$). Conversely, positive deactivating emotions exhibited a statistically significant change, with a median rise from 3.3 (range: 2.0–4.5) to 4.0 (range: 2.5–5.0) after the simulation ($p=0.02$). There were no statistically significant alterations in negative activating emotions, with the median decreasing from 1.8 (range: 1.0–2.3) to 1.5 (range: 1.0–2.2) after the simulation ($p=0.40$). Similarly, negative deactivating emotions displayed a non-significant increase from 1.3 (range: 1.0–2.0) to 1.4 (range: 1.0–2.0) after the simulation ($p=0.56$). The findings suggest that, for this sample size, the simulation had a discernible impact on positive deactivating emotions but did not elicit statistically significant changes in other emotional categories.

DISCUSSION

This study evaluated the effectiveness of the quality improvement initiative of in situ ECMO simulation by assessing medical professionals' emotions and perceptions of applicability of the training for quality improvement of ECMO treatment. The results demonstrated that participants' positive emotions increased during the in situ simulation training, and participants reported that the training was effective in improving ECMO management in a non-high-volume ECMO centre.

During the pandemic, even emergency physicians and intensivists with no experience in ECMO management were required to provide ECMO treatment. Accordingly, these healthcare professionals experienced high levels of anxiety while practicing in intensive care units, resulting in a high prevalence of burnout during the pandemic.[15] The present in situ simulation was conducted to improve readiness and preparedness for ECMO management in our non-high-volume ECMO centre. The program also emphasized the promotion of positive mood during the training, as the professionals had been in a highly stressful environment during the COVID-19 pandemic.

Our participants reported high applicability of the simulation training for quality improvement. In addition, positive deactivating emotions increased significantly after the simulation. This finding is consistent with educational psychology theory. According to the control value theory,[11] which has been applied in many medical education research studies, achievement emotions are defined as 'emotions that are directly related to performance activities or performance outcomes' and focus in the present study to various tasks undertaken in clinical settings such as solving clinical problems, simulation performance and performing critical care procedures. This theory also postulates that positive outcomes serve to indicate an individual's favourable performance.

The effectiveness of simulation training has been studied using various variables based on educational frameworks such as the Kirkpatrick criteria.[16] The Kirkpatrick model consists of stages one to four: (1) trainees' reactions to their learning experiences, (2) learning outcomes such as increased knowledge and skills, (3) changes in attitudes towards their training and (4) improvements in the quality of care received by their patients'.[17] Evaluating trainees' emotions is common in health professions education research, using Kirkpatrick's level 1 as an example, because emotions are physiological and affective responses to individuals' experiences. Based on the definition of performance emotions, the present measures based on performance emotions could be considered as Kirkpatrick level 2. Furthermore, the participants' attitudes towards practice (e.g., Kirkpatrick 3) are expected to improve based on their perception of potential quality improvement in ECMO treatment. Therefore, in situ ECMO simulation with an interprofessional team may improve the quality of ECMO treatment for COVID-19 patients at a non-high-volume centre.

Limitations

Several limitations are noted in this study. First, there is a risk of type II error due to the small sample size in our study. However, we evaluated the sufficient effect size for at least positive deactivation emotions, in which statistical significance was shown. Second, as only a single session was used for the simulation, the generalisability of our findings is uncertain. Third, we did not evaluate patient outcomes following the simulation as few patients had been treated at our centre. Further longitudinal studies with larger samples and multiple sessions are needed to address these limitations.

CONCLUSION

In situ ECMO simulation effectively promoted participants' positive emotions during the training session and improved their confidence in quality improvement for ECMO management in a non-high-volume ECMO centre.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest for this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

Approval of the research protocol: All methods were carried out in accordance with Japanese Ethical Guidelines for Medical and Biological Research Involving Human Subjects, and this study was reviewed and approved by the Ethics Committee of the Hirosaki University Graduate School of Medicine. The English-language editing of this manuscript was conducted primarily using Chat GTP 3.0 and DeepL Write.

Informed Consent: Written consent was obtained from the participants.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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