Brief Communication

Development, implementation, and refinement of a comprehensive postcardiac arrest care training course in Japan

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Aim: In Japan, no training course is dedicated to postcardiac arrest care (PCAC), including venoarterial extracorporeal membrane oxygenation (VA-ECMO); thus, faculty members of the Japanese Circulation Society developed an original, comprehensive PCAC training course. This report reviews the development, implementation, and refinement of this PCAC training course.

Methods: We examined the preserved data from the Japanese Circulation Society PCAC training courses between 2014 and 2020. Data related to the learning content and number of the attendees and instructors were collected and summarized.

Results: Sixteen courses were held between August 2014 and February 2020, before the coronavirus disease 2019 (COVID-19) pandemic. A total of 677 health care providers participated: 351 doctors, 225 nurses, 62 perfusionists, five emergency medical professionals, and two pharmacists. Thirty-two attendees’ data were missing. The core learning contents of all the courses included a standardized postcardiac arrest algorithm, targeted temperature management, VA-ECMO cannulation skills, and postcannulation management. Concerning curriculum evolution, extracorporeal cardiopulmonary resuscitation simulation, postarrest neurological examination and monitoring, and ultrasound-guided Seldinger technique training were added in the 4th, 5th, and 13th courses, respectively.

Conclusion: The Japanese Circulation Society PCAC training course has been developed and refined to provide an organized, comprehensive opportunity for health care providers to acquire specific knowledge and skills in PCAC and VA-ECMO.

Key words: Cardiopulmonary resuscitation, postcardiac arrest syndrome, simulation training, targeted temperature management, venoarterial extracorporeal membrane oxygenation

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INTRODUCTION

SINCE 2001, POSTCARDIAC arrest care (PCAC) with targeted temperature management (TTM) has been a vital intervention to increase the possibility of favorable neurological outcomes for patients after cardiac arrest.1,2 In 2008, postcardiac arrest syndrome was recognized and defined as a complicated, multisystem injury requiring a comprehensive bundle of care, including TTM.3 From 2010, the International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations recommended postcardiac arrest intensive care for patients achieving a return of spontaneous circulation (ROSC), with refinements published in 2015 and 2020.4 In the meantime, venoarterial extracorporeal membrane oxygenation (VA-ECMO) was implemented to treat refractory cardiac arrest, called extracorporeal cardiopulmonary resuscitation (E-CPR), and circulatory failure after ROSC.5,6 The SAVE-J study, recognized as a landmark study for E-CPR, demonstrated the efficacy of E-CPR and revealed that E-CPR was frequently implemented in Japan.8,9 Despite the common practice, in Japan, standardized PCAC training modules and dedicated VA-ECMO/E-CPR training courses had not been established as of 2014. The Japanese Circulation Society (JCS) faculty members who were experienced cardiologists dedicated to emergency cardiopulmonary care and CPR education designed appropriate learning content and developed a 1-day PCAC training course. Since 2014, the course has evolved and been refined over six subsequent years. This report aims to review and describe the development, implementation, and refinement of the JCS PCAC training course.

METHODS

WE RETROSPECTIVELY EXAMINED the preserved data of the JCS PCAC training course from 2014 to 2020. Data related to the learning content, specialty, and number of attendees and instructors were collected and summarized.

Ethical consideration

This study was approved by the Institutional Review Board of Tohoku Medical and Pharmaceutical University (approval number 2016-2-029). As data were anonymously extracted, the requirement of participant informed consent for this study was waived.

RESULTS

SIXTEEN JCS PCAC training courses were held in Japan between August 2014 and February 2020. The first course comprised four learning sessions. Intermittently, some content was changed or added over time. E-CPR simulation, neurological examination and monitoring, and ultrasound-guided needle puncture training were added to the 4th, 5th, and 13th courses, respectively. The final course (February 2020) had eight sections in total (Table 1).

A total of 677 health care providers participated in 16 courses: 351 (51.9%) doctors, 225 (33.2%) nurses, 62 (10.8%) perfusionists, 5 (<1%) emergency medical professionals, and 2 (<1%) pharmacists. Thirty-two (4.7%) attendees had missing data. A total of 439 instructors participated in the 16 courses (Table 1). The number of attendees from each specialty is shown in Table 1. In the 2nd, 3rd, 4th, 5th, and 9th courses, nurses comprised the highest percentage of attendees. In the last six courses, more than half of the attendees were doctors.

Precourse learning materials

For precourse preparation, the textbook for this course was published in 2014, and attendees studied this ahead.10 Additional precourse e-learning materials, including PDF files and videos for each section, were prepared.

Learning content

The 10 learning content sections are as follows:
1. Quality of CPR: The attendees handled several CPR feedback and commercially available near-infrared spectroscopy devices.
2. Mechanical compression device: Attendees set up and ran the mechanical compression devices on a CPR mannequin.
3. Airway and ventilation management: Attendees performed endotracheal intubation with video laryngoscopes and the waveform capnography monitoring.
4. TTM with specific devices: Attendees learned about the basic operation of specific TTM devices, including surface and intravascular cooling devices (Fig. 1).
5. Circulatory support with VA-ECMO and intra-aortic balloon pumping: Attendees experienced priming of the ECMO circuit and cannulation procedures utilizing a vascular model installed on a simulator (Fig. 1).11
6. PCAC scenario team training (ventricular fibrillation to ROSC): In teams, the attendees performed PCAC using
| Number of the training course | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|-------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
| Place                        | Shizuoka | Osaka | Hokkaido | Miyagi | Tokyo | Ishikawa | Osaka | Osaka | Osaka | Osaka | Osaka | Osaka | Osaka | Osaka | Osaka | Osaka |
| Year                         | 2014 | 2015 | 2015 | 2016 | 2016 | 2017 | 2018 | 2018 | 2018 | 2018 | 2018 | 2019 | 2019 | 2019 | 2019 | 2020 | 2020 |
| Learning contents             | | | | | | | | | | | | | | | | | |
| Quality of CPR                | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Mechanical compression device | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Airway and ventilation        | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| management                    | | | | | | | | | | | | | | | | | |
| TTM with specific devices     | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Circulatory support           | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| with VA-ECMO                  | | | | | | | | | | | | | | | | | |
| PCAS scenario team training   | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Cerebral monitoring           | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| after ROSC                    | | | | | | | | | | | | | | | | | |
| Neurological examination      | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| after ROSC                    | | | | | | | | | | | | | | | | | |
| Ultrasound-guided needle      | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| puncture                      | | | | | | | | | | | | | | | | | |
| E-CPR scenario                | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Number of attendees, N        | 67 | 60 | 33 | 43 | 45 | 41 | 45 | 36 | 48 | 31 | 25 | 27 | 42 | 46 | 42 | 46 |
| Doctors, n                    | 45 | 17 | 12 | 20 | 14 | 22 | 22 | 22 | 12 | 12 | 16 | 19 | 25 | 38 | 29 | 26 |
| Nurses, n                     | 15 | 26 | 16 | 20 | 30 | 15 | 14 | 11 | 18 | 13 | 6  | 6  | 9  | 7  | 8  | 11 |
| Perfusionists, n              | 6  | 6  | 5  | 3  | 1  | 9  | 3  | 6  | 2  | 2  | 1  | 4  | 1  | 1  | 4  | 9  |
| Pharmacists, n                | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Emergency medical technicians, n | 1 | 1  | 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Missing classification, n     | 11 | 11 | 4  | 1  | 1  | 3  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Number of instructors, n      | 25 | 26 | 21 | 38 | 24 | 29 | 33 | 33 | 32 | 32 | 24 | 24 | 24 | 24 | 24 | 25 |

This table presents the learning content in each course and the number of attendees and instructors. CPR, cardiopulmonary resuscitation; E-CPR, extracorporeal cardiopulmonary resuscitation; PCAS, postcardiac arrest syndrome; ROSC, return of spontaneous circulation; TTM, targeted temperature management; VA-ECMO, venoarterial extracorporeal membrane oxygenation.
the simulator and implemented a comprehensive PCAC algorithm with subsequent debriefing.

7. Cerebral monitoring after ROSC: Attendees learned the importance of preventing secondary brain injury and nonconvulsive status epilepticus along with that of continuous electroencephalogram monitoring.

8. Neurological examination after ROSC: Attendees learned about several neurological assessment scores on a standardized patient.

9. Ultrasound-guided needle puncture: Attendees experienced ultrasound-guided needle puncture and guidewire insertion (the Seldinger technique) using a gel-pad training model to prepare for ECMO cannulation.

10. Full-scale E-CPR simulation: In teams, attendees were required to treat patients with persistent ventricular fibrillation using the VA-ECMO, with subsequent debriefing (Fig. 1, Table 2).

DISCUSSION

PCAC WITH TTM and VA-ECMO for circulatory failure or E-CPR requires a complex, multidisciplinary approach; health care providers responsible for these procedures should obtain specific knowledge and skills related to their roles. However, standardized educational opportunities for PCAC had not been developed before 2014 in Japan.

The advantage of the JCS PCAC training course is that it provides an intensive, dedicated, and hands-on opportunity to learn updated, comprehensive PCAC using the TTM algorithm and the logistics of VA-ECMO/E-CPR management using currently available medical devices. Furthermore, the learning content was refined to address post-ROSC neurological evaluation and monitoring. Finally, ultrasound-guided ECMO cannulation training was added to optimize safety cannulation skills.

Fig. 1. Photographs of actual sessions from the seminar: TTM with specific device (left above), VA-ECMO cannulation (left below), E-CPR simulation (right). E-CPR, extracorporeal cardiopulmonary resuscitation; TTM, targeted temperature management; VA-ECMO, venoarterial extracorporeal membrane oxygenation.
Table 2. E-CPR simulation scenario

| Time                        | Simulator rhythm                                      | Team action CPR/Defibrillation/Drugs                                                                 | Quality assessment of CPR                                                                 | ECMO                                                                 | Ultrasound/Chest radiography/CT                                                                 |
|-----------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Before ECMO, 5 –10 min      | Shock-resistant VF                                     | • Manual CPR by EMTs                                                                                | • CPR feedback device                                                                   | • Vascular sheath insertion into the femoral artery and vein         | • Ultrasound: no tamponade, no flap in the aorta                                           |
|                             |                                                       | • Additional defibrillations                                                                         | • NIRS monitoring                                                                      | • Ultrasound-guided venipuncture                                    | • Ultrasound-guided guidewire placement                                                      |
|                             |                                                       | • Amiodarone administration                                                                         | • EtCO₂ monitoring                                                                      | • Confirmation of cannulae placement by portable chest radiography  |                                                                                              |
|                             |                                                       | • Endotracheal intubation                                                                             |                                                                                          | • Brain and body CT if needed                                       |                                                                                              |
|                             |                                                       | • Transition to mechanical CPR                                                                        |                                                                                          | • Ultrasound: detailed examination to assess native heart condition and function |
| ECMO cannulation and initiation, 15–20 min | Shock-resistant VF                                     | • More epinephrine, if needed                                                                       | • Targeted values                                                                        | • ECMO priming                                                      |                                                                                              |
|                             |                                                       | • More defibrillations, if needed                                                                    | • NIRS >50                                                                              | • Cannulation with ultrasound and/or fluoroscopy                    |                                                                                              |
|                             |                                                       | • Heparin administration                                                                              | • EtCO₂ > 20                                                                             | • Arterial 15–18 Fr                                                |                                                                                              |
|                             |                                                       | • Insertion of right, radial arterial catheter, if possible                                          |                                                                                          | • Venous 19–24 Fr                                                  |                                                                                              |
|                             |                                                       | • Termination of CPR                                                                                 |                                                                                          | • Initiation of ECMO                                               |                                                                                              |
|                             |                                                       | • Defibrillation after ECMO initiation (failed)                                                      |                                                                                          | • Pump flow: 2.5–4.0 L/min                                        |                                                                                              |
| Post-ECMO management, 10 min | VF amplitude gets bigger, converts to organized rhythm after PCI and defibrillation                  | • Core temperature monitoring and initiation of cooling                                             | • EtCO₂ ≥50 on ECMO                                                       | • Heat exchanger for TTM                                         |                                                                                              |
|                             |                                                       | • Sedative/Analgesia/Muscle relaxant                                                                 |                                                                                          |                                                                      |                                                                                              |

Debriefing and wrapping up (20 min)

This table presents the details of the e-CPR simulation scenario for instructors.

CPR, cardiopulmonary resuscitation; CT, computed tomography; ECMO, extracorporeal membrane oxygenation; E-CPR, extracorporeal cardiopulmonary resuscitation; EMTs, emergency medical technicians; EtCO₂, end-tidal carbon dioxide; NIRS, near-infrared spectroscopy; PCI, percutaneous coronary intervention; TTM, targeted temperature management; VF, ventricular fibrillation.
In a real E-CPR situation, ECMO cannulation during chest compressions is a highly technical procedure associated with a risk of serious complications. Therefore, ECMO cannulation training and E-CPR simulation are required for E-CPR practitioners. The increasing number of doctors in recent courses might be attributable to changes in the training content, including the focus on ECMO cannulation.

There were some course-associated disadvantages. First, the duration spent at each learning station was relatively short for attendees to appropriately experience the learning objective. Second, the frequency of this course remains inadequate for the number of dedicated health care providers.

Despite these disadvantages, improvements in knowledge, skill, and attitude have the potential to bring high-quality PCAC and VA-ECMO/E-CPR management into diverse working environments and save lives. Unfortunately, this course has been suspended since March 2020 owing to the coronavirus disease 2019 (COVID-19) pandemic. Faculty members are now planning to resume in-person training even during the COVID-19 pandemic.

Limitations

This study had several limitations. This course did not incorporate a post-test assessment; therefore, we could not evaluate the true acquisition of knowledge and skills. Participation in this course did not guarantee actual performance improvement in clinical settings. Further, regardless of the sophistication of the simulation, it cannot match the real-life stress and chaos of actual resuscitation. However, although these limitations exist, the learning content is specific and helpful to disseminate standard PCAC and VA-ECMO/E-CPR. To validate the true effect of this training, the long-term training effect on attendees’ performance and improvements in PCAC quality at their institutions should be evaluated.

CONCLUSIONS

The JCS PCAC training course was developed in 2014, and it was implemented and refined over the next 6 years. It was offered 16 times during this period. This course provided health care providers with the opportunity to acquire specific knowledge and skills for PCAC with TTM and VA-ECMO/E-CPR.

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DISCLOSURE

A PPORVAL OF THE Research Protocol with approval No. 2016-2-029 and committee Name: This study was approved by the Institutional Review Board of Tohoku Medical and Pharmaceutical University.

Informed Consent: N/A.

Registry and the Registration No. of the study/Trial: N/A.

Animal Studies: N/A.

Conflict of Interest: Dr Endo reports lecture honoraria from Senko Medical Instrument, Terumo Corporation, and Laerdal Medical Japan. Dr Kikuchi reports honorarium for manuscript writing from Nihon Kohden. Dr Kasaoka reports lecture honorarium from Nihon Kohden. Dr Kuroda reports honorarium for manuscript writing from International Medical Intelligence Corporation and honorarium for educational events from Asahi Kasei ZOLL Medical Corporation. Dr Nagayama reports lecture honoraria from Takeda Pharmaceutical Company and Eisai Corporation.

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