Case Report

Therapeutic Hypothermia with Extracorporeal Membrane Oxygenation (ECMO) and Surface Cooling in Post-Cardiac Arrest Patients: 4 Case Reports

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Background: *Therapeutic hypothermia has been recently approved to show benefits for neurological outcomes in patients after cardiac arrest. Application of both ECMO and surface cooling for treatment of therapeutic hypothermia has not yet been reported in the literature. We reported four cases that experienced in-hospital cardiac arrest during ECMO application treated with therapeutic hypothermia under surface cooling at Thammasat University Hospital.*
Case Reports: *Four cases of in-hospital cardiac arrest during ECMO application were treated with therapeutic hypothermia under surface cooling with similar machine. The characteristics of each patient were described. The core temperature control during treatment was reported with temperature curves. A Glasgow coma score was used as index for neurological outcome*
Conclusion: *Application of surface cooling together with extracorporeal membrane oxygenation (ECMO) is safe and feasible. Both devices facilitate treatment with therapeutic hypothermia in patients with post-cardiac arrest.*

Keywords: *Therapeutic hypothermia, Cardiac arrest, Extracorporeal membrane oxygenation, Surface cooling*

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Therapeutic hypothermia has been approved to be benefit for better neurological outcomes in patients after cardiac arrest[1]. There are also reported cases of therapeutic hypothermia after cardiac arrest in Thailand[2,3]. Endovascular and surface cooling techniques are accepted to be used for treating with therapeutic hypothermia[4]. Surface cooling with ArcticSun™ is the most preferable method in post-cardiac arrest patients at Thammasat University Hospital[2]. Extracorporeal membrane oxygenation (ECMO) has included a heat exchanger device which is able to maintain constantly the body temperature control in patients indicated by acute severe cardiopulmonary failure[5]. This advantage of ECMO was shown as an internal temperature control option[6-10]. Application of both ECMO and surface cooling with ArcticSun™ for treatment of therapeutic hypothermia has not yet been reported in the literature. We reported four cases, which had in-hospital cardiac arrest during ECMO application treated with therapeutic hypothermia under surface cooling with ArcticSun™ at Thammasat University Hospital.

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Case 1

A 65-year-old Thai man with a history of 2-week progressive dyspnea was admitted to Thammasat Hospital for further management. The patient had underlying diabetes, hypertension, hyperlipidemia and chronic kidney disease. He was on aspirin 81 mg/day, atorvastatin 20 mg/day, furosemide 80 mg/day and multiple insulin injections. On admission, he was diagnosed of congestive heart failure. His echocardiogram revealed ejection fraction (EF) of 33% with akinesia at posterior wall. The coronary angiography was done and exhibited 80% stenosis of left anterior descending artery (LAD) including 100% stenosis of left circumflex artery (LCx) and 40% stenosis of right coronary artery (RCA). The CABG was recommended for this patient. After surgery, he had been stable until sudden cardiac arrest occurred on postoperative day 5 due to sudden ventricular fibrillation. The cardiopulmonary resuscitation (CPR) was done for 10 cycles before a return of spontaneous circulation (ROSC). His Glasgow coma scale (GCS) was E1VTM1 which represented comatose. The patient was on ECMO for cardiovascular and respiratory support with veno-arterial vascular access. Therapeutic hypothermia was started via surface cooling technique with ArcticSun™ and the ECMO following Thammasat Hospital post-cardiac arrest therapeutic hypothermia protocol-which cools the core body temperature to 33°C at first 24 hours and then rewarming within 48 hours at a rate of 0.1°C/hour until normal body temperature. The core temperature was monitored via esophageal probe of ArcticSun™. The temperature of ECMO machine was set up at 33°C at hypothermic phase and stepped up every 1°C until 37°C during rewarming phase. The core temperature of the patient was showed in Fig. 1. Several inotropic agents were used throughout the therapeutic hypothermia process. After regaining normal body temperature, vital signs were stable and GCS was E2VTM4. Unfortunately, on the postoperative day 8, the patient developed severe renal failure and passed away despite receiving continuous renal replacement therapy (CRRT).

Case 2

A 58-year-old Thai man with a history of myocardial infarction (MI) due to left main coronary disease was admitted to the Thammasat Hospital for elective CABG. He had no chest pain or palpitation. His medications were aspirin 81 mg/day, clopidogrel 75 mg/day, enalapril 5 mg/day, isosorbidedinitrate 40 mg/day, metoprolol 50 mg/day and simvastatin 20 mg/day. A day after admission, he had a severe chest pain with sudden cardiac arrest while he was going to the bathroom. The CPR was done immediately to resume the ROSC with the Glasgow coma scale of E2VTM4. The cardiovascular and thoracic (CVT) surgeon team approached for evaluation and the patient was inserted the ECMO at the bedside for cardiopulmonary support. He then was sent to the operating room for emergent CABG. Saphenous veins were used for bypass graft at LAD and LCx. Therapeutic hypothermia was started via surface cooling technique with ArcticSun™ and the ECMO. The protocol and the setting of ArcticSun and ECMO were as same as showed in case 1. The core temperature of the patient was showed in Fig. 2. GCS was E4VTM5 after 72 hours of rewarming. The patient was stable for ten days. Unfortunately, cardiac decompensation then occurred leading to subsequent cardiac arrest. Although CPR succeeded, the patient finally passed away despite receiving several inotropic agents including dopamine, epinephrine and lidocaine.

Case 3

A 40-year-old Thai woman was scheduled for an elective thoracolumbar internal fixation due to degenerative disc disease. She had a history of hyperlipidemia, which was treated by diet and lifestyle modification. The pre-operative evaluations were within normal limits consistent with her good cardiac function from her last echocardiographic result. The surgery went well but later she developed acute dyspnea and sudden deoxygenation at the recovering room. Her vital signs were unstable and the electrocardiogram (ECG) revealed pulseless electrical activity (PEA). The CPR was done immediately for 1 minute then ROSC occurred. The echocardiogram was done showing moderate tricuspid regurgitation with systolic D-shaped septum of right ventricle. The computed tomographic angiogram (CTA) of the chest was done and found blood clots at right pulmonary artery leading to a diagnosis of massive pulmonary embolism (PE). The CVT surgeons set operation for emergent pulmonary thromboembolectomy with ECMO to support the cardiopulmonary circulation. Her GCS was E1VTM1. Therapeutic hypothermia was immediately started via surface cooling technique with ArcticSun™ and the ECMO. The protocol and the setting of ArcticSun and ECMO were as same as showed in case 1. The core temperature of the patient was showed in Fig. 3. The GSC was E1VTM2 after 72 hours of rewarming. Her

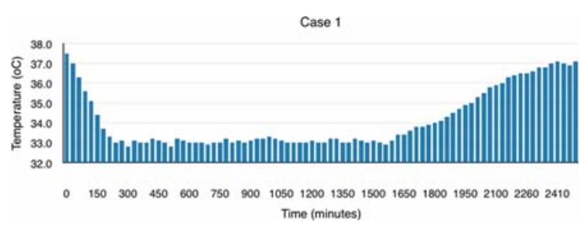

Fig. 1 The temperature bar chart of case 1.

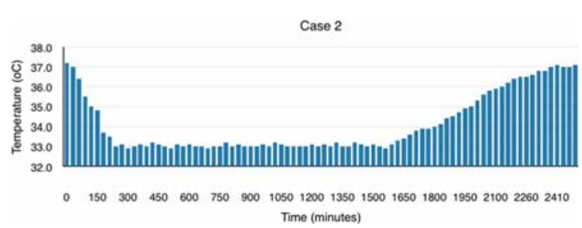

Fig. 2 The temperature bar chart of case 2.

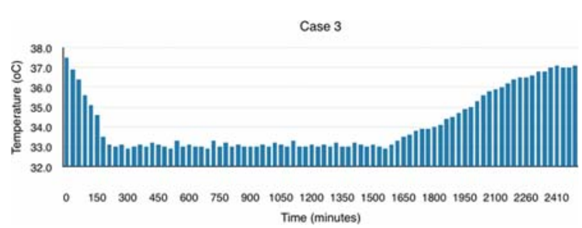

Fig. 3 The temperature bar chart of case 3.

vital signs were maintained with high dose of several inotropic and vasopressor agents including epinephrine, norepinephrine and dopamine. Unfortunately, the patient then passed away over the next few days with renal complication and severe coagulopathy due to profound shock.

Case 4

A 37-year-old Thai man with a 3-year history of mitral valve repairs from a private hospital presented to the hospital with progressive dyspnea on exertion for 1 year. He was diagnosed of congestive heart failure. His medications were warfarin 17.5 mg/week, furosemide 500 mg/day, amiodarone 100 mg/day, digoxin 0.25 mg/day, spironolactone 50 mg/day and penicillin V 800,000 units/day. The recent echocardiogram revealed impaired LV systolic function with EF of 30-40% with global wall hypokinesia, severe aortic stenosis and regurgitation with pulmonary hypertension. The CVT surgeons planned to set an operation for aortic valve replacement. While admitting in the hospital, the patient had a sudden cardiac arrest with ventricular fibrillation. The CPR was done for 10 minutes then ROSC occurred with a sinus rhythm and the GCS of E1VTM1. The coronary artery angiogram revealed normal coronary arteries. Therapeutic hypothermia was immediately started via surface cooling technique with ArcticSun™ and the ECMO. The protocol and the setting of ArcticSun and ECMO were the same as showed in case 1. The core temperature of the patient was showed in Fig. 4. The GCS was E1VTM2 after rewarming. The patient developed severe acute kidney injury which needed CRRT and then passed away.

Discussion

Therapeutic hypothermia for cardiac arrest after cardiopulmonary resuscitation with ROSC is proved to be beneficial in improving neurological outcomes[1]. Recent evidences suggest that the prediction of neurological outcome depends on several prognostic variables including motor responses, brain stem reflexes, somatosensory evoked potentials, serum NSE levels, and early myoclonus[11]. In addition, the Glasgow coma score is also acceptable for monitoring of neurological changes in hypothermic patients[12]. Two out of four cases have significant improvement of GCS after treatment with therapeutic hypothermia. Other two cases have just minimal neurologic improvement. However, all four cases passed away early due to conditions other than hypoxic-ischemic encephalopathy. Therefore, we are not able to report either exactly bad or good neurological outcomes.

The rapid induction to targeted temperature, proper smooth temperature control during maintenance and gradual rewarming back to normal temperature are the keys of success in treatment with therapeutic hypothermia[13,14]. ECMO which has a heat exchanger device can provide a cardiopulmonary support together with the body temperature control[5]. There were evidences thatcore body temperature can be controlled well via the ECMO[6-10]. Surface cooling method should easily be applied to patients who have already treated via ECMO. Our cases show feasibility and safety of ECMO application during therapeutic hypothermia with ArcticSun™. Moreover, ECMO also promotes treatment with therapeutic hypothermia. The core temperature of all four cases are very well control under ECMO and surface method of targeted temperature management with ArcticSun™.

In conclusion, application of surface cooling with ArcticSun™ together with extracorporeal membrane oxygenation (ECMO) is safe and feasible. Both devices facilitate treatment with therapeutic hypothermiain patients with post-cardiac arrest.

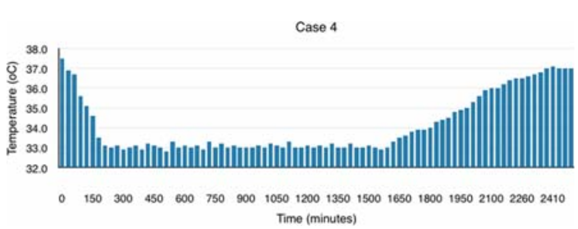

Fig. 4 The temperature bar chart of case 4.

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Potential conflicts of interest

None.

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การลดอุณหภูมิร่างกายโดยการใช้ extracorporeal membrane oxygenation (ECMO) และ surface cooling ในการรักษาผู้ป่วยหลังจากเกิดภาวะหัวใจหยุดเต้น: 4 กรณีศึกษา

อรรคพล พินิจจินดาทรัพย์, บุลวัชร์ หอมวิเศษ, สมบัติ มุ่งทวีพงษา

ภูมิหลัง: *การลดอุณหภูมิเพื่อการรักษาถูกยอมรับเมื่อไม่นานมานี้ว่ามีประโยชน์ต่อผลลัพธ์ทางระบบประสาท ภายหลังจากภาวะหัวใจหยุดเต้นเฉียบพลัน วิธีการลดอุณหภูมิเพื่อการรักษาด้วยเครื่อง ECMO และวิธี surface cooling ยังไม่มีรายงานมาก่อน ผู้นิพนธ์จึงรายงานกรณีศึกษา 4 กรณีที่ใช้เครื่อง ECMO อยู่ร่วมกับมีภาวะหัวใจหยุดเต้นภายในโรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติได้ทำการลดอุณหภูมิเพื่อการรักษาด้วยวิธี surface cooling*

รายงานผู้ป่วย: *4 กรณีศึกษาที่ใช้เครื่อง ECMO อยู่ร่วมกับมีภาวะหัวใจหยุดเต้นภายในโรงพยาบาล ได้รับการลดอุณหภูมิเพื่อการรักษาโดยวิธี surface cooling ร่วมด้วยรายละเอียดของแต่ละกรณีศึกษาถูกบรรยายการควบคุมอุณหภูมิ ระหว่างการรักษาถูกนำเสนอด้วยแผนภูมิแท่ง Glasgow coma score ถูกใช้เป็นดัชนีชี้วัดผลลัพธ์ทางระบบประสาท*

สรุป: *การลดอุณหภูมิเพื่อการรักษาโดยวิธี surface cooling ร่วมกับการใช้เครื่อง ECMO นั้นปลอดภัยและสามารถทำได้การใช้ทั้ง 2 อย่างร่วมกันช่วยในเรื่องการรักษาโดยการลดอุณหภูมิเพื่อการรักษาในผู้ป่วยที่มีภาวะหัวใจหยุดเต้น*