Clinical efficacy of extracorporeal membrane oxygenation in cardiogenic shock patients: a multi-center study

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Cardiogenic shock (CS) is a life-threatening condition in intensive care unit, which leads to death of many critically ill patients. Although survival of CS patients seems to have improved, it continues to carry a poor prognosis, and mortality rates range from 60% to 80%.[1]

Extracorporeal membrane oxygenation (ECMO) on CS has been developed as a more advanced alternative short-term mechanical support device,[2] which can provide partial or full circulatory support.[3] ECMO placement has been applied to support the patient as a bridge to recovery, destination, surgery, or heart transplant therapy. Observational studies have indicated beneficial effects in patients with CS in heart failure and cardiac arrest.[4] Despite the broad use of ECMO in experienced centers, randomized trials evaluating veno-arterial-ECMO in CS are still lacking and data from larger studies are limited. Most studies are retrospective series or registry studies. Thus, conducting a multi-center study to investigate the clinical efficacy of ECMO is important.

The design is a multi-center cross-sectional study with the aim to assess the clinical therapeutic efficacy of ECMO and investigate the influence on key parameters. All the CS patients who received ECMO from six hospitals in China from January 2013 to January 2015 were selected (n = 27) as ECMO group, and the control group of 27 CS patients were randomly selected from all the patients who also developed CS in the same period and received conventional therapy. However, due to the fact that five patients in control group abandoned the treatment after initiating treatment, those patients were excluded in the final analysis (n = 22 in the control group). The study was conducted in accordance with the ethical guidelines of the 1975 Declaration of Helsinki. The study was also approved by the Ethics Committee of the Second Affiliated Hospital of Harbin Medical University (No. 2013-Research-06) and all subjects signed written informed consent.

In ECMO group, all the patients received standard ECMO treatment. The patients in control group received conventional treatment including inotropes, diuresis, coronary artery dilation, heart preload, and afterload improvement. Meanwhile, intra-aortic balloon pump counterpulsation, blood purification, or mechanical ventilation was also applied when necessary in both groups.

All statistical analyses were performed using Statistical Analysis System (SAS) (version 9.1.3, SAS Institute Inc., Cary, NC, USA). Spearman rank correlation coefficient was used to analyze the correlation of Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) score with survival and survival time. Logistic regression analysis was used to analyze the influence of treatment, age, gender, and APACHE II score on survival time. The dynamic changes of variables were analyzed by running repeated measures analysis of variance (ANOVA). A P < 0.05 was considered as statistically significant.

The results showed that the baseline data were not statistically different between the two groups. However, acute physiology and chronic health evaluation II (APACHE II) score in ECMO group was higher than that of control group (Z = 3.64, P = 0.0008), suggesting that the ECMO patients were more severe than the control patients. The mortality rate was 17/27 (62.96%) in ECMO group and 18/22 (81.82%) in control group. However, the mortality rates and survival time were not statistically different between two groups. In addition, APACHE II score in the non-survivors in ECMO group was higher than non-survivors in control group (t = 3.03, P = 0.0064). In 35 non-survivors, Spearman rank correlation analysis showed that APACHE II score was negatively correlated with survival and survival time. Logistic regression analysis showed that APACHE II score was an independent factor affecting survival time. The mortality rate was 17/27 (62.96%) in ECMO group and 18/22 (81.82%) in control group. However, the mortality rates and survival time were not statistically different between two groups. In addition, APACHE II score in the non-survivors in ECMO group was higher than non-survivors in control group (t = 3.03, P = 0.0064).

Qing-Qing Dai and Yan Liu contributed equally to this work.

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The improvement on MAP, PaO2/FiO2, and CVP demonstrated a significant difference between ECMO group and control group. Figure 1E showed that the patient was most probably not going to survive if the factors were not improved within the 1st day, patients could be estimated based on those factors. In other words, if the factors were not improved within the 1st day, the reason might be that there was already severe kidney dysfunction so it was hard to restore the kidney function even when the perfusion was improved [Figure 1A–D].

Repeated measures ANOVA showed that the dynamic changes of mean arterial pressure (MAP), central venous pressure (CVP) and PaO2/FiO2 and creatinine were significantly different between ECMO group and control group. The improvement on MAP, PaO2/FiO2, and CVP demonstrated that ECMO was more effective than the conventional treatment. The baseline of creatinine in ECMO group was higher than that of control group (P<0.05). However, the ECMO did not show significant improvement on creatinine. The reason might be that there was already severe kidney dysfunction so it was hard to restore the kidney function even when the perfusion was improved [Figure 1E–H].

Heart rate (HR), MAP, central venous oxygen saturation (ScvO2), and hemoglobin (Hb) were significantly different between non-survivors and survivors in ECMO group. Hb level can be easily affected by transfusion history. Thus, we did not focus on Hb in the discussion. The generalized linear model for repeated measurement analysis of HR, MAP, and ScvO2 have certain guiding significance to assess the clinical efficacy and evaluate the prognosis after ECMO application.

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**Conflicts of interest**

None.

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