Evaluation of capability for drug diffusion in the hard-shell venous reservoir
–Evaluation by time constant and drug concentration ratio–

Yuka Hatanaka（Department of Medical Engineering Faculty of Health Science, Aino University）, Shimpei Kohri, Honoka Mochigaki, Yusaku Kochi, Shirato Niina, Akira Hatanaka

Abstract

There are no clear methodologies regarding the flow rate and route of administration of drugs into a hard-shell venous reservoir during extracorporeal circulation, making it important to understand the characteristics of drug diffusion in the hard-shell venous reservoir that is used. An assessment of drug diffusion is difficult because there is no established method for evaluating these characteristics and evaluations can only be performed based on the operator's existing knowledge, experience, expertise, or familiarity with injecting drugs into the hard-shell venous reservoir being used. Therefore, in this experiment, we developed an analytical model to assess changes in the concentration of drug solution flowing out of four types of hard-shell venous reservoirs, conducted basic experiments by changing the liquid levels, and investigated a method for evaluating the performance of hard-shell venous reservoirs in terms of diffusion of the drug solution. The results of the basic experiments showed that there was little difference in drug diffusion performance between the four types of hard-shell venous reservoirs used in the experiments. In addition, when the fluid level was 500 mL or less, evaluation of the performance of drug diffusion could be conducted using the time constant based on the analytical model, but when the fluid level was 1000 mL or more, the rise-time was better than the time constant. In future research, based on this experimental method, we would like to evaluate the drug diffusion performance of hard-shell venous reservoirs by changing the following: (1) flow rate in the circuit, (2) the location of drug administration, and (3) the flow rate of injected drugs.

Key words: hard-shell venous reservoir, drug diffusion, venous reservoir level, time constant, rise time

Examination of cardiopulmonary bypass related risk factor to cause acute kidney injury after congenital heart disease surgery

Takehiro Gotoh（Department of Clinical Engineering, Mie University Hospital）, Seiji Tani, Yusuke Sugitani, Yuki Ikezawa, Masashi Yamazaki, Takashi Sasoh, Masahiro Yukimitsu, Masako Yamada, Kentaro Umezu, Motoshi Takao

Abstract

Acute kidney injury（AKI）is a common complication of prolonged cardiopulmonary bypass（CPB）performed during cardiac surgery. There are several known risk factors associated with AKI perioperatively. However, there is little knowledge about CPB and its complications in children with congenital heart disease（CHD）undergoing cardiac surgery. This study aims to identify and analyze the risk factors associated with perioperative AKI due to CPB performed in patients with CHD.

The study includes 217 patients with CHD who underwent surgery and CPD at Mie University Hospital. The participants had a bodyweight of 20kg or less；they were classified into two groups：the non-AKI group consisting of 150 cases, and the AKI group containing 67 cases. The risk factors were identified and analyzed.

The body surface area（BSA）of each patient（OR 0.461, 95%C.I. 0.317-0.732；p＝0.008）, time duration of CPB（OR 1.546, 95%C.I. 1.108-3.527；p＝0.021）, the maximum level of PF-Hb（OR 2.142, 95%C.I. 1.276-3.998；p＝0.011）, and the minimum DO2 value（OR 0.659, 95%C.I. 0.518-0.802；p＝0.032）were detected as independent risk factors for the perioperative AKI.

These may be associated with perioperative AKI in patients of congenital heart surgery that undergo CPB during cardiovascular surgery.

CPB is often performed during cardiovascular surgery in patients with congenital heart disease in the first few days or months of their life. These infants have very small BSA and CPB performed for a long time can easily damage their blood cells and elevate their PF-Hb. Despite various preventive measures, often AKI still occurs. Hence, further research should be conducted to understand the characteristics of CPB and its complications in pediatric patients undergoing cardiovascular surgery.

Key words: acute kidney injury-cardiopulmonary bypass, plasma free-hemoglobin, cardiopulmonary bypass time, oxygen delivery, goal directed perfusion

Evaluation of the appropriate cool-seal system settings in EVAHEART® blood pump shutdown-restart events

Yuma Tanaka（Department of Clinical Engineering, Osaka University Hospital）, Yuki Nakamura, Yusuke Minematsu, Shigetaka Kusumoto, Kiyoshi Yoshida, Masaki Takashina

Abstract

Methods to improve the EVAHEART® blood pump stop-restart event include increasing the filter outlet pressure（FPout）of the cool-seal unit（CSU）, increasing the pressure in the CSU reservoir（pressurized supplementary fluid）, and installing a pressure-boosting clip. The effects of these methods on the sliding surface pressure were investigated to determine the appropriate setting method.

A simulated pump cable and a manometer were connected to the CSU, and the sliding surface pressure was measured when changing the FPout and CSspeed while installing the pressurized supplementary fluid liquid and the pressure-boosting clip（metal and plastic clips）. We also measured the change in the sliding surface pressure with the decrease in the cool-seal liquid when installing the pressurized supplementary fluid liquid and the metal clip. Consequently, the sliding surface pressure increased linearly with the decrease in CSspeed in the pressurized supplemental fluid and metal clips. For the plastic clip, the sliding surface pressure increased exponentially with each tightening of the clip ratchet. The sliding surface pressure decreased with the decrease in cool-seal liquid in the pressurized supplementary fluid liquid, but remained constant in the metal clip case. These results indicate that it is helpful to set the target value of CSspeed by increasing the FPout and pressurized rehydration and adjusting the CSspeed using the metal clip.

Key words: cool-seal unit（CSU）, sliding surface pressure, E-30, pressure-boosting clip, cool-seal speed（CS speed）