OPTIMAL BLOOD FLOW RATE FOR THE FILTER LIFETIME OF POLYMETHYL METHACRYLATE MEMBRANE FILTER FOR CONTINUOUS RENAL REPLACEMENT THERAPY.

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Introduction

The lifetime of a hemofilter employed in continuous renal replacement therapy (CRRT) is influenced by a multitude factors. These include operational conditions, the anticoagulant used, module structure (hollow fiber diameter, fiber density, length and diameter of housing, *etc*.), as well as membrane material. Clinical results have demonstrated that filter lifetime is longest at a blood flow rate (Q_B) of 250 mL/min to 300 mL/min in Australia [1]. In Japan, however, the Q_B is often selected at approximately 100 mL/min. Additionally, the membranes with adsorption characteristics, such as polymethyl methacrylate (PMMA) membranes, are frequently used to remove inflammatory cytokines. Additionally, nafamostat mesylate, a serine protease inhibitor, is also used as an anticoagulant. Therefore, the optimal Q_B under CRRT conditions in Japan may differ from that in Australia. The objective of the present study was to determine the optimal Q_B for filter lifetime under CRRT conditions in Japan.

Methods

Two filters with different hollow fiber inner diameters, CH-1.0N (membrane area, 1.0 m^2; hollow fiber inner diameter, 200 µm) and CH-1.0W (1.0 m^2; 240 µm), were used in *in vitro* hemofiltration experiments. Q_B was varied from Q_B = 40 to 160 mL/min at 20 mL/min intervals, and the filter lifetime was determined as the time when transmembrane pressure reached 200 mmHg. To reduce the effects of variation in the likelihood of blood coagulation, porcine blood collected from a single animal was divided into two portions. One portion was used at Q_B = 100 mL/min and the other at a different Q_B (40 to 160 mL/min). The lifetime at a given Q_B was subtracted from the lifetime at 100 mL/min measured with the same blood and divided by the lifetime at 100 mL/min to calculate the percentage prolongation of filter lifetime.

The filtration flow rate and replacement fluid infusion rate were set at 10% of Q_B. The anticoagulants used were nafamostat mesylate, administered at an initial dose of 20 mg and a continuous dose of 20 mg/h, and trisodium citrate that was added to the replacement fluid to be a final concentration of 8 mM.

Results

The percentage prolongation of filter lifetime peaked at Q_B = 60 and 80 mL/min for both CH-1.0N and CH-1.0W ($p = 0.0405$, Jonckheere-Terpstra test). CH-1.0W, which has a larger hollow fiber diameter, demonstrated a more pronounced blood flow dependence and a 20-30% increase in the prolongation of filter lifetime. The percentage prolongation of filter lifetime at a Q_B of 40 mL/min exhibited no consistent trends and a considerable degree of variability, ranging -30 to 30%. For larger Q_B (100 -160 mL/min), the percentage prolongation of filter lifetime exhibited a small change and a narrow range of variation, ranging from -10 to 10%.

Discussion

In the present study, the filter lifetime due to membrane clogging was compared when a filtration flow rate was 10% of Q_B. The longest filter lifetime was obtained at Q_B of 60-80 mL/min. The optimal values were clearly observed at lower flow rates than those reported in clinical studies [1,2], where the filter lifetime increased at over 200 mL/min. In the clinical study conducted in Australia [1], the filtration flow rate was 2 L/h (33 mL/min), which means that if Q_B was 200 mL/min, the filtration flow rate was 17% of the Q_B, which is considerably larger than that set in our experiments. In Japan, the filtration flow rate in clinical settings is approximately 10 mL/min. Therefore, it is rational that the optimum Q_B to prolong filter lifetime was also low in Japan. In the future, it would be beneficial to investigate the effect of changing the ratio of filtration flow rate to Q_B on the lifetime.

In conclusion, the optimal Q_B to prolong the filter lifetime was found to be 60-80 mL/min when blood filtration was performed using PMMA membrane filters with a filtration flow rate of 10% of Q_B.

References

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2. Ronco C et al, Crit Care. 19:146, 2015.