KSN 2021
FULLY VIRTUAL MEETING
September 02 (Thu) - 05 (Sun)

Abstract Submission No. : 9188

How to achieve high convection volumes in post-dilution online hemodiafiltration

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Online haemodiafiltration (OL-HDF) represents the most technologically advanced convective form of blood purification and has a potential to improve outcomes in end-stage renal disease (ESRD) patients. OL-HDF is defined as a combination of diffuse and convective solute transports. It uses a high-flux membrane at an effective ultrafiltration rate with 20% or more of a blood flow rate and an online-generated sterile and non-pyrogenic solution for fluid substitution. Currently, four modalities of OL-HDF differed by replacement fluid infusion sites are used, such as post-dilution HDF, pre-dilution HDF, mixed dilution HDF and mid-dilution HDF. Post-dilution provides the highest solute clearances for the lowest convection volume, and, as a result, it is the most cost effective today. Pre- and mixed-dilutions can be used when the desired convection volume cannot be achieved in post-dilution. Mid-dilution allows substitution fluid to be introduced directly into the dialyzer at a midpoint of the blood pathway, thus combining elements of both post- and pre-dilutions. Previous evidence suggests that if adequate convection volume is achieved, HDF can reduce a risk of all-cause and cardiovascular mortality compared to conventional hemodialysis (HD). Several large observational studies on convective techniques have been published in recent decades. Most of the investigations showed reduction in the mortality risk of patients when treated with HDF. Over the past years, four large RCTs comparing HDF with HD have been published. All studies aimed to address a question whether online HDF is superior to standard HD in terms of effects on relevant clinical endpoints, but designs of the studies were different. None of the four studies gave a definite answer to the question. However, post hoc analysis of the four RCTs showed a significantly lower mortality in patients treated with the highest convection volumes, even after extensive adjustments were made.
Treatment time, blood flow rate and filtration fraction are crucial to convection volume. Blood flow rate is mainly determined by vascular access type and needle size. Controversy exists as to whether patients with a central venous catheter (CVC) are eligible for OL-HDF. Several studies showed that patients with a CVC could also have high blood flow and high convection volume. A previous study showed that >21 L of convection volume was achieved in >84% of patients with AV shunts and in only 33% of patients with a catheter. It appears that an AV fistula or graft is preferred, but a catheter is not a contra indication of the OL-HDF. For an AVF or a graft, achievement of a high extracorporeal blood flow rate is dependent not only on a quality of the access, but also on a size of the needles used for

puncture. However, no particular needle deserves a priority and a large bore needle (15G) is not associated with serious complications. Apart from treatment time and blood flow rate, convection volume is to a large part determined by a fraction of blood ultrafiltered during OL-HDF. There are several HDF machines with automated settings to optimize filtration fraction at the lowest possible rate of machine alarms. With these machines, an FF of 33% is possible in a majority of patients. Kangnam and Chuncheon Sacred Heart Hospital conducted a study whether high-volume HDF with ≥21 L substitution fluid volume is feasible in clinical practice through modification of some key treatment-related determinants. Following a stepwise protocol, blood flow rate (280→300→330 ml/min), needle size (16G to 15 G) and dialysis membrane (from the polysulfone 1.8 m^2 dialyzer to the polysulfone 2.5 m^2 dialyzer) were optimized as much as possible in all participants and, as a result, 29 of 30 patients (96.7%) could achieve ≥21 L substitution fluid volume. This study showed high-volume HDF is feasible by increasing blood flow rate, needle size, and surface area of dialysis membrane.

There is no conclusive evidence supporting superiority of HDF over standard HD. However, lack of definite evidence for mortality reduction should not deter the most innovative and technologically advanced alternative to conventional high-flux HD.