In-line filtration retains particles contained in the replacement solution stored in plastic bags infused into the extracorporeal circuit during CRRT.

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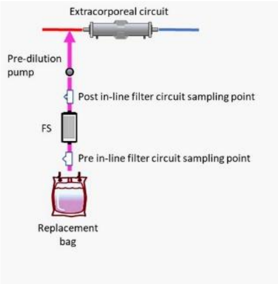
Objective

In continuous renal replacement therapy (CRRT) "membrane fouling" has a direct effect on extracorporeal transmembrane clearance of water and waste solutes. A possible cause of this phenomenon is clogging of the pores of the haemodiafiltration membrane due to the release of particles into the extracorporeal circuit. Dialysate and replacement solutions are strictly required to perform CRRT. These electrolyte solutions, stored within plastic bags often heat-sealed, are infused into the extracorporeal circuit releasing microplastic particles. The aim of the study is to verify the presence of particles in the CRRT solutions, their release into the extracorporeal circuit and to evaluate the qualitative and quantitative effectiveness of in-line filtration for particles retention.

Methods

In vitro experiments simulating CVVH were performed at the ''Laboratory of Extracorporeal Blood Purification Therapy'' of the Department of Health Sciences, Section of Anaesthesiology, Intensive Care and Pain Medicine, University of Florence.
An in-line filter for particles retention was applied to the extracorporeal circuit in the replecament line (pre-filter) between the replacement bag and the replacement peristaltic pump .
CVVH was performed for 5 hours in pre- and post-dilution. The effluent dose was set at 28 mL/kg/h for an ideal 70 kg patient with 30% hematocrit and net ultrafiltration was not applied.
Fluid samples (5 mL) were taken over the 5-hours treatment period. Samples were obtained at the CRRT initiation and interruption, before and after the in-line filter for particles retention.



Results

The samples obtained were analysed using different methods. Qualitative methods: optical microscope, field Emission Scanning Electron Microscope and Energy Dispersive X-Ray Spectroscopy (FESEM-EDX). Quantitative methods: weight of dry residue.

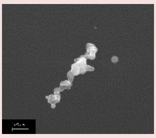
Optical microscope

The optical microscope highlights the presence of particles in the replacement solution, their morphology and average diameter. It was noted that the number of particles detected in solution increased significantly at the end of treatment compared to the beginning of treatment, while decreasing downstream of the filter compared to upstream due to the effect of in-line filtration.

Light microscope images of the replacement solutions at the end of the treatment, pre (a) and post (b) the in-line filter for particles retention.

FESEM-EDX

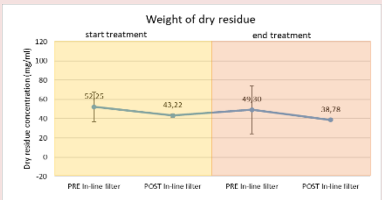
The FESEM-EDX method highlights the presence of micro-sized particles in the solutions and the morphological and chemical difference between salt particles and microplastic particles. The salt precipitates contained in the replacement bags are mainly made up of elements such as sodium, chlorine, calcium and magnesium. The most common microplastic particles, on the other hand, are composed of carbon and oxygen.



Example of micro-sized particles detected within the samples acquired at 100.00KX (a). The spectra detected by EDX show the chemical composition of the particles (C-O). The Si detected represents the wafer substrate (b).

Weight of dry residue

The dry residue method allows a quantitative analysis of the concentration of particles in samples. Using the data of the empty weight and the dry weight of the tubes, in which the collected samples were placed, the dry residue weight of the solution was calculated. It is assumed that the amount of salts contained within each replacement bag, and therefore of each sample, is equal. The obtained results, in terms of mean and standard deviation of the two experimental sets, show that the amount of particles was reduced in samples collected after the in-line filter for particle retention compared to samples obtained before the in-line filter . This highlights, once again, the effectiveness of in-line filtration.



Mean and standard deviation of dry residue concentrations in the two experimental sets pre- and post-filter at CRRT initiation and interruption

Conclusion

As demonstrated in this study, the materials of which the circuits and bags of the CRRT are made can release particles of microplastics. Their morphology and concentration can be assessed using the optical microscope, the FESEM-EDX method and the weight of dry residue method. According to literature studies, some types of microplastic can have harmful effects, have been reported to be endocrine disrupting chemicals. They have also been categorized as carcinogenic, mutagenic or toxic for reproduction. The in-line filtration processes decrease the presence of these particles and it has been shown that it also reduces the incidence of phlebitis and catheter infections.

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