

Acute Dialysis Quality Initiative

Workgroup 4

Membranes

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Introduction

The filter membrane in a CRRT extracorporeal circuit is vitally important for several reasons. Because it has the largest degree of exposure to blood of all circuit components, the membrane is the most important determinant of the circuit's overall biocompatibility. In addition, membrane characteristics determine both the solute removal and water permeability properties of a CRRT filter. The following addresses key clinical issues relating to CRRT membrane performance and biocompatibility.

What are the criteria for choice of membranes used in CRRT?

The parameters used when selecting a filter for CRRT are small solute removal, middle/large solute removal, and biocompatibility. With respect to small solute removal, membrane pore characteristics (pore size distribution and density)¹ and surface area^{2,3} are important membrane-related determinants. However, when conventional flow rates (2 L/hr or less) are used in CRRT, the major determinant of small solute clearance is flow rate²⁻⁶. For middle and larger size molecule removal, hydraulic permeability and adsorption capacity are the major determining factors, in addition to flow rates⁷⁻¹³.

How should biocompatibility be assessed and how much emphasis should be placed on it?

Unlike in chronic hemodialysis, in which leukopenia and complement activation are well-accepted indicators of poor biocompatibility (i.e. bioincompatibility), the markers of inflammation in critically ill patients with ARF are less clearly defined. It is unclear whether or not the biocompatibility data obtained from intermittent HD studies¹⁴⁻¹⁶ are applicable to CRRT, since the data are inconclusive and synthetic membranes are predominantly used in the latter setting. The potential clinical effects of blood-membrane interaction in CRRT on the biology of these inflammatory mediators are poorly defined and require additional study. The specific role of the backtransport of pyrogen-related substances across CRRT membranes also requires further investigation.

Recommendations for clinical practice: Based on the clinical evidence at the present time, recommendations about the use or avoidance of certain membranes in CRRT cannot be made. However,

until proven otherwise, there is consensus that the use of synthetic membranes, especially those of high water permeability, is appropriate. Recommendations for future research: The following remain important objectives: 1. To better characterize back-transport of solute during CRRT (especially when non-sterile and/or pyrogen-containing solution are used). 2. The effect of CRRT on the biology of inflammatory mediators should be explored. Specifically, the kinetics of inflammatory mediators (generation and removal) should be better defined, with special consideration of the effect of adsorption. 3. Better characterize the potential for adverse events related to blood-membrane interactions in specific patient populations and with specific filters. 4. Determine the potential benefits of high permeability filters on middle/large molecule removal in general (and, specifically, their ability to modulate inflammatory mediator levels in critically ill ARF patients).

How should membrane function be assessed and how long should membranes be used for?

At present, there is no widely accepted method to assess filter function in CRRT. The following are proposed as potentially useful indicators of acceptable filter function in the clinical setting: Transmembrane pressures of 120 –150 mm Hg; urea SC > 0.6 (CVVH); urea equilibration ratio > 0.6 (CVVHD and CVVHDF); filtration fraction < 0.20 (CVVH). With respect to duration of filter/circuit use, minimal hemolysis may occur after 50 hrs of use¹⁷. However, filter duration should be primarily governed by manufacturers' recommendations or hospital infection control policy¹⁸. It is unknown whether certain patients would benefit from more frequent filter changes because of saturation of adsorption capacity.

Recommendations for clinical practice: Although not demonstrated conclusively to be of benefit, transmembrane pressure monitoring and measurement of urea sieving coefficient, urea equilibration ratio, and filtration fraction may all be employed to assess filter function. Recommendations for future research: Further studies are needed to assess or monitor membrane filter function (in relation to anticoagulation, therapy mode, filter saturation etc).

Should different types of membranes be used for different modalities e.g. HF vs. HD?

Specific clinical situations may require the use or avoidance of specific types of CRRT filters. Specific filter choice may be highly dependent on the flow rates used. While exact specifications have not been established, high-volume hemofiltration^{19,20} requires a filter of higher water permeability while SLED and EDD may require larger surface area dialyzers to maximize small solute clearances²¹. Based on the specific modality choice, either a hemofilter or hemodialyzer may be appropriate. However, priming volume and anti-coagulation requirements may be influenced by device surface area. Adsorptive removal of inflammatory mediators may require frequent filter changes or a targeted adsorptive approach. Under ideal circumstances (with cost not a major factor), unmodified cellulose membranes should be avoided. In addition, hypersensitivity reactions may occur with certain types of filters.

Summary: Recommendations for clinical practice: Filter choice requires special consideration for proper implementation of certain modalities, such as high-volume HF, SLED, and EDD. Recommendations for

future research: 1. For adsorptive membranes, the optimal frequency of filter changes should be investigated in specific populations. 2. The possibility of using specially modified membranes (heparin-bonded, ligand-modified) and sorbent technologies should be investigated²². 3. Better characterize the potential for adverse events related to blood-membrane interactions in specific patient populations and with specific filters.

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