EXTRACORPOREAL BLOOD PURIFICATION TECHNIQUES:
PLASMAPHERESIS AND HEMOPERFUSION

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INTRODUCTION

This chapter will focus on techniques other than dialysis for removal of chemical toxins (endogenous or exogenous), immune toxins, or other naturally occurring biochemical substances considered to produce disease. Plasmapheresis is the process of removal of plasma (by mechanical, immunoprecipitation, cryoprecipitation, or filtration techniques) which contains the substance in question. Hemoperfusion is the passage of blood over sorbent agents for removal of harmful products.

PLASMA EXCHANGE

Introduction

The therapeutic rationale of plasma exchange is removal from the circulation of high molecular weight species which are instrumental in the pathogenesis of a wide variety of disorders. Examples of well characterized and clinical relevant pathologies include:

1. uremic toxins (molecular weight range 60 up to 5,000 or more Daltons) in renal failure;
2. circulating toxins in drug intoxications as well as exogenous and endogenous poisonings;
3. other types of glomerulonephritis;
4. IgA nephropathy;
5. Membranoproliferative glomerulonephritis type II;
6. Lupus nephritis;
7. Polycyheria nodosa and Churg–Strauss disease;
8. Hemolytic uremic syndrome; thrombotic thrombocytopenic purpura;
9. Renal involvement in paraproteinemia;
10. Mixed essential cryoglobulinemia;
11. Plasmapheresis in renal transplantation;
12. Removal of preformed lymphocytotoxic antibodies prior to transplantation;
13. Plasma exchange in renal transplant rejections;

Conclusions - plasma exchange

Hemoperfusion

Principles of hemoperfusion

Sorbents

Solute spectrum adsorbed and the effects of coating adsorbents

Adverse effects of hemoperfusion

Hemoperfusion and uremia

Potential clinical benefits

Hemoperfusion and drug intoxication

Clinical and laboratory studies

Indications for hemoperfusion in intoxication

Hemoperfusion and hepatic encephalopathy

Other uses of hemoperfusion

Schizophrenia and psoriasis

Immunoadsorption

Miscellaneous

Future development

References
3. autoantibodies of the IgG or IgM class (molecular weight 150,000 and 970,000 Daltons respectively) with subsequent binding to antigens in autoimmune disorders (e.g., Goodpasture's syndrome, myasthenia gravis, immune thrombocytopenia);

4. circulating immune complexes (molecular weight about 500,000 up to 3,000,000 Daltons) which cause tissue lesions by deposition;

5. excessive low density lipoprotein concentrations (molecular weight about 2,400,000 Daltons) in type II hyperlipidemia; and

6. paraproteins (intact immunoglobulins as well as free light or heavy chains) with subsequent disturbances, e.g., renal paraprotein deposition, hyperviscosity, polyneuropathy, cutaneous vasculitis and cryoglobulinemia.

Ideally, a blood purification system should remove only the pathogenic molecule and not other substances. It should also have a high removal capacity and its clinical application should be free of side effects. These three criteria have been realized for only a few systems applicable in some distinct clinical entities with well characterized pathogens (e.g., LDL removal systems). This chapter summarizes the technology and clinical application of extracorporeal macro-molecular separation processes.

Methods for unselective plasma exchange

Separation techniques

The simplest way to harvest an adequate volume of plasma from whole blood is to collect a bag of anticoagulated blood, centrifuge it and express off the plasma supernatant (1). Plasma containing the target pathogens may be discarded in which case the cells are resuspended in a saline or protein solution and returned to the patient. When repeated several times this batch process provides effective reduction in the plasma concentration of intravascular toxins (2).

In the late 1960s continuous closed centrifugal apheresis equipment was developed, originally with the aim of collecting blood cells for bone marrow transplant recipients (3) and these could also be used for separating plasma from whole blood. Originally such equipment was quite bulky. Newly developed centrifuges for therapeutic plasmapheresis have become more compact and require smaller extracorporeal priming volumes and a few are capable of performing apheresis with a single venous access. These techniques are utilized almost exclusively in blood banking and hematology.

Clinical on-line plasma separation employing membrane filters became available in 1978 (4). Highly permeable membranes were originally developed to recover a cell free filtrate of ascitic fluid for reinfusion in patients with advanced liver disease. Although not ideally suited for plasmapheresis (5), early studies with these membranes motivated the development of a wide variety of clinical membrane filters fabricated from several different polymers (6). These filters exhibit a wide range of permeabilities (Figure 1) without significant retention of high molecular weight proteins. Furthermore, the design of membrane filters has been improved so that devices with smaller surface areas permit plasma exchanges at low blood flow rates eliminating the need for central venous access (7). A further development in the field of plasmapheresis, available since the mid 1980s, employs the com-