Acute Plasma Separation with Hemodialysis Equipment

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ABSTRACT

Although plasma separation has been reported to have a relatively small complication rate in large series of healthy outpatients, little attention has been directed to the evaluation of the safety and effectiveness of the therapy in acutely ill, hospitalized patients. The experience of using standard hemodialysis equipment and membrane plasma separators with 281 plasma separation treatments in 49 patients over the last 7 yr is reported and analyzed. The data reveal a 1.4% incidence of hypotension and a 0.4% incidence of hematuria in the 281 treatments—rates similar to those reported in outpatients. In addition, analysis of the diseases and patients treated over the 7 yr reported demonstrates a marked shift from immunological and hematological disorders towards neurological disorders. The data suggest that plasma separation may be easily and safely performed by any institution capable of performing acute hemodialysis.

Key Words: Plasmapheresis, plasma separation, membrane plasma separation, Guillain-Barré syndrome, neurological disease

During the last 10 yr, plasmapheresis therapy has had an increasing role in the therapy of a number of diseases, mainly neurological, whereas at the same time being largely discarded as therapy for other disorders (1–16). Although centrifugal separators have continued as the mainstay of blood bank-oriented separation (17), the introduction of simple membrane separators has the potential of greatly increasing the availability of acute plasma separation therapy (9,17,18).

Although many reports in the past have documented the safety of plasmapheresis, most of these reports did not distinguish between routine, outpatient plasmapheresis and plasma separation provided to acutely, often gravely, ill hospitalized patients (19–21).

We analyze our experience of providing acute plasma separation therapy in a large (480-bed) urban hospital over the last 7 yr. The safety of the procedure, as well as the changing indicators for therapy, is analyzed.

METHODS

Beginning on January 1, 1984, prospective records were maintained for all patients receiving plasma separation therapy. Along with the patient’s name and identification number, other data including diagnosis, number of plasma separation procedures, complications, and outcome were recorded by one of the authors (R.E.G.). Complications included any untoward events occurring during the plasma separation and any untoward events that could be attributed to the plasma separation.

All plasma separation procedures are performed with a standard Gambro AK-10 (Gambro AB, Lund, Sweden) hemodialysis machine and Asahi AP-05H membrane separators (Asahi Medical Co., Tokyo, Japan). A standard double-lumen dialysis catheter is placed in the femoral vein, and the blood is circulated over the plasma separator as shown in Figure 1. Only the blood pump-monitor module of the Gambro AK-10 is required, because no dialysis fluid is needed. A bypass block (Part *K12106002; Gambro AB, Lund, Sweden) is used to defeat the alarm portions of the dialysis fluid monitor, which is not required. The separated plasma is collected by gravity in a graduated cylinder, and the appropriate replacement fluid (fresh frozen plasma or 5% albumin in saline) is returned via a separate pump to the venous drip chamber. The nurse performing the procedure titrates the pump speed on the replacement fluid to equal the volume removed; after initial adjustments, little change is required during the procedure.

The cellulose diacetate membrane is very efficient, permitting removal of our standard 4,000 mL of plasma in approximately 90 min. The manufacturer recommends that the transmembrane pressure be maintained less than 75 mm Hg, and this generally equates with a blood flow of 125 to 150 mL/min.
Heparin is used as an anticoagulant, in the dose recommended by the manufacturer (5,000 U initially and then 1,000 U/h), with determination of activated coagulation time being performed frequently throughout the procedure. Heparin need has been related to patient hematocrit and plasma flow (22).

Replacement fluid is 5% albumin in saline in all patients, save those with thrombotic thrombocytopenic purpura where the replacement fluid is fresh frozen plasma. Earlier experience with plasma separation found that patients experienced occasional mild circumoral tingling or mild burning in the chest area; both were rapidly relieved with i.v. calcium. Therefore, all patients receive one half of an ampule of calcium gluconate after the removal of 2 L of plasma and the second half of the ampule at the end of the procedure. This has prevented any further episodes of these minor side effects.

RESULTS

During the 7 yr of the study, a total of 281 plasma separation treatments was administered to 49 patients. No serious complications were noted with the procedure; mild hypotension occurred during four treatments in three patients, and there was one episode of transient hematuria (Table 1). The incidence of complications is similar or less than that in other series reported in outpatients (19–21). Femoral catheters are placed and removed immediately after each procedure; with intermittent femoral cannulation, we saw neither evidence of the local bleeding nor the systemic infection previously reported (23) but subsequently not found in an additional large study (24). Only three patients had placement of permanent dialysis shunts (all of these patients required prolonged therapy with plasma exchange). No complications (hives or anaphylaxis) were seen in the patients receiving fresh frozen plasma.

Although the separated plasma frequently has a reddish hue, secondary to some hemolysis, measurements of serum K+, platelets, and hemoglobin have shown no change from baseline (unpublished observation), which suggests only slight hemolysis at the membrane with rapid clearing of potassium. Our measurements of membrane permeability (Figure 2) show excellent permeability to a wide range of compounds with almost 100% permeability to electrolytes. Permeability was determined by measuring the constituents in simultaneous samples of plasma and ultrafiltrate and expressing the concentration ratio as a percentage.

Since 1984, we have noted a distinct change in the pattern of diseases referred for plasma separation and the number of treatments rendered by disease (Figure 3). Although initially most patients (and most treatments) were for nonneurological problems, over the last several years, the balance has swung so that nearly all patients are referred for, and most treatments given are for, neurological diseases—generally myasthenia gravis and Guillain-Barré syndrome.

DISCUSSION

Despite the severity of illness in our patients (all were hospitalized and many were in an intensive care unit setting with respiratory compromise), the hypotensive side effects of plasma separation are no greater when performed by experienced hemodialysis nurses and a nephrologist with standard hemodialysis equipment than when performed in outpa-
Figure 2. Membrane permeability, defined as

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(patient's \ plasma \ concentration \times 100\%)
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of a number of constituents. From reference 9; reproduced by permission of ISAO Press; copyright by ISAO Press. Ig, immunoglobulin.

Figure 3. Number of plasma separation treatments (n) rendered for specific disease entities, by year, at the Pennsylvania Hospital. TTP, thrombotic thrombocytopenic purpura; SLE, systemic lupus erythematosus.

patients (19–21). Thus, our complication rate (Table 1) of 1.8% in 281 treatments (8.1% of 49 patients) is similar to the complication per treatment rate of 2.7 to 12% reported in several large series (19–21). The exact cause of the one incident of hematuria was never elucidated. Urological studies were not revealing, and it was believed that the bleeding may have been secondary to the heparin anticoagulation.

We attribute our low complication rate to the effective team of hemodialysis nurses and nephrologists experienced in treating critically ill patients exposed to fluid shifts and electrolyte change. In intensive care unit patients, this treatment team may be ideally suited for performing plasmapheresis therapy. The ease with which the membrane separator is adapted to a standard hemodialysis machine obviates any unfamiliarity with equipment and markedly increases the learning curve. Finally, no capital outlay is needed, only the purchase of the disposable membrane separator.

Membrane plasma separation has been shown to be qualitatively and quantitatively equivalent to centrifugal procedures in the removal of plasma constituents with the notable exception that there is less of a decrease in platelet count (11%) with membrane separation versus centrifugation (53%)—an important factor in the treatment of thrombocytopenic states (17). In addition, patients have been reported to prefer membrane separation to centrifugation (17).

The variety of diseases to which plasma exchange can be applied is vast, but there are, in our experience and that of others (25), a finite number of diseases for which patients are referred. Of interest is the changing spectrum of diseases for which plasma separation is requested at our institution. Although in the early years of this study, systemic lupus erythematosus, especially lupus nephritis, was a frequent indication for plasma separation, the lack of response found in a large multicenter study has essentially eliminated this indication for plasmapheresis (15,16). Conversely, studies supporting the therapeutic efficacy of plasma separation in both myasthenia gravis (1,5) and Guillain-Barré syndrome (14) are responsible for the increased number of neurological patients referred for this procedure. Although our experience may not be universal, the trend in our institution is certainly consistent.

Thus, although the spectrum of diseases has changed toward neurological diseases, plasma separation is still applied to a number of extremely sick, hospitalized patients. Our experience demonstrates that membrane plasma separation with standard hemodialysis equipment can be readily and safely performed in an acute hemodialysis unit.

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