Discovering tandem plasma exchange and haemodialysis: a single-centre, 18-month experience

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Abstract
Performing ‘tandem’ treatments, which combine the two procedures of haemodialysis (HD) and plasma exchange (PE), has been an exciting endeavour for our unit, effectively supporting patient care whilst minimising the length of time for treatment delivery. Naturally this cannot be considered without the thorough assessment of the patient’s condition, potential risks related to anticoagulation, and effective symptom management related to both HD and PE. Due diligence is required during the set-up of both machines, and adjustments will be discussed in relation to both prescriptions, the nursing management of complications and treatment challenges. It is hoped by sharing our experiences over the last 18 months and examining the various case studies, that other units will feel more comfortable with this concept and the level of experience and evidence will continue to grow.

Keywords
Tandem, plasma exchange, plasmapheresis, haemodialysis

Introduction
Plasma exchange (PE) treatments are a common therapy in our unit due to the need to support various acute conditions associated with kidney disease and renal transplantation. Due to high patient numbers and current resources we utilise both centrifugal therapeutic plasma exchange (cTPE) and membranous therapeutic plasma exchange (mTPE) therapies. cTPE utilises a specifically designed machine, which spins the blood, allowing the cells to be separated by gravity (due to the different densities of red blood cells, platelets and plasma). This allows plasma and associated antibodies to be removed, and then replaced with ‘clean’ fresh frozen plasma (FFP) or human albumin (40 g/L). mTPE utilises a highly permeable plasma filter (similar to a dialyser), which facilitates the removal of the plasma (Kiprov, et al., 2015) using a dialysis machine (with the dialysate flow turned off), supporting the flow of plasma from the circuit. Likewise, plasma replacement is required with FFP and/or albumin.

Haemodialysis (HD) may additionally be prescribed for patients with acute kidney injury or chronic kidney disease (CKD), whose electrolyte and fluid status is not optimal. Tandem treatments referred to by some as tandem PE and haemodialysis (TPH) (Paglialonga, et al., 2012) is the combination of both treatments, allowing cTPE and HD to run concurrently, therefore removing plasma and associated antibodies in cTPE, whilst replacing the removed plasma with fresh frozen plasma, albumin or a combination of these are prescribed by the consultant and removing fluid and solutes in HD. Dependent on the patient’s clinical state they may require HD for a period of two to five hours, and cTPE may take between two and four hours. Traditionally, both treatments are required consecutively, requiring the patient to have a treatment time of six to nine hours. Therefore by combining treatments, this reduces the time spent within the dialysis unit by at least 2.5hr per treatment (Pagliaongal, et al., 2012). Several planning and treatments considerations will be discussed in determining which patients are suitable candidates for a combined therapy.

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Clinical considerations

Patients are recommended for tandem by the consultant, clinical nurse consultant or the clinical nurse responsible for the shift, considering the patient’s risk factors and previous treatment history. Traditionally, the HD circuit is anticoagulated with heparin and depending on the patient risk, body size, vascular access, haematocrit, bleeding tendency and clinical state, routine heparin dosing, minimal heparin, or heparin-free treatments are prescribed.

Heparin provides systemic anticoagulant that inhibits the formation of thrombin from prothrombin; however, it is metabolised slowly over one to two hours in patients with renal failure (Cervelli). cTPE is performed using a centrifugal machine, which requires a constant rate of citrate (anticoagulant citrate dextrose solution) to maintain patency. Citrate binds with ionised calcium-inhibiting platelet aggregation, with an immediate but temporary action; however, its metabolism rate varies between patients (Kiprov, et al., 2015). Therefore, these two anticoagulant factors need to be considered in a combined treatment and adjustments made accordingly.

Clinical evidence

There is little published data relating to HD and cTPE within Pubmed, Medline and CINAHL; however, comparisons have been noted throughout this article where able. The Canadian team of Farah, Leven, Kiall, Vickars and Werb (2012) with 18 years’ experience in this procedure and the Terumo BCT clinical team (distributor of machine and extension line), provided the reference point for our clinical procedure. This has formed the basis for the procedure and clinical care within our unit, and has been reviewed at departmental meetings with no significant changes in practice undertaken. Of those published articles many focus on case studies, and various methods of treatment (cTPE or mTPE), set-up considerations and complications, and our recent experience endeavours to build on this knowledge.

Whilst some units have extensive experience in immunoabsorption and HD, a specialised treatment performed as tandem for ABO-incompatible (ABOi) transplantation (Maggioni, et al., 2015), we have erred on the side of performing separate treatments until we gain further experience. Additionally, due to the pre-planned nature of life - related ABO blood group incompatible (ABOi) renal transplantation, we have also found that few patients required regular HD, with most only requiring one treatment if any. Therefore, the need to undertake tandem in this population currently is limited. We have also only embarked upon tandem therapies in combination with cTPE and not mTPE for various logistical and prescription-related considerations; therefore all references to PE throughout this article will be noted as cTPE.

Disease manifestations and prognosis

The main reasons for PE treatment include: removal of circulating antibodies for antineutrophilic cytoplasmic antibody vasculitis; antiglomerular basement membrane disease, acute antibody-mediated renal transplant rejection; monoclonal proteins; removal of circulating immune complexes, alloantibody or toxic factors and conditions such as thrombotic thrombocytopenia and haemolytic uraemic syndrome (Kiprov, et al., 2015).

Although some authors note renal recovery rates such comparisons are beyond the scope and focus of this paper, as some patients were dialysis-dependent prior to treatment initiation. Likewise, other papers have reviewed data related to adequacy results for HD, but as this combination treatment is considered a short-term strategy, that is, lasting three to four weeks, and with the hopeful withdrawal for the need for dialysis in cases of acute kidney injury, we have not focussed on adequacy as a clinical concern. Anecdotally there have not been any concerns about dialysis adequacy in patients on tandem therapy.

Due to disease variability and challenges in predicting patient responses to treatment, several sessions of individualised treatment (that is, HD alone and cTPE alone) were attended prior to commencing on tandem. This allowed the nurses the opportunity to predict if complications were related to fluid shifts (related to HD); citrate sensitivity (related to cTPE) or replacement fluid sensitivity (related to cTPE). For patients who have been on long-term HD, that required sessions of PE such as those experiencing rejection post-renal transplant, then several cTPE alone sessions were attended prior to commencing on tandem. This allowed the opportunity to identify any complications related to cTPE, as any pre-existent challenges with HD had already been identified.

Equipment set-up considerations

Space is at a premium in a high dependency dialysis unit; however, the machine set-up was attended in numerous areas of this unit, to ensure more acute medical guidance if required. For each treatment one nurse was allocated care for both machines for safety and learning opportunities. The cTPE and HD machine are set up separately as per the usual routine, with the HD machine often closest to the patient due to the arterial line length (Figure 1); however, it must be remembered that the extension line for the cTPE is attached at the venous section of the HD blood lines.

Anecdotally, some units provide this treatment in parallel via a “Y-connector”; that is, the blood is removed from the patient and diverted separately into the HD and the PE machines simultaneously. However, references recommend a sequential
treatment processing the blood through the HD machine then the cTPE machine (Filler, et al., 2014). For our current procedure the blood circulates through the dialysis machine and prior to return to the patient (at the venous limb) a portion (approximately 25%) of the blood flow is diverted to the PE machine, with the remaining percentage returning to the patient (Figure 2). The ease at which we are attending the current treatment, utilising the extension line, ensures the blood pump speed (Qb) through the HD machine remains within prescription guidelines; and based on the Canadian technique with 18 years’ experience with cTPE (Farah, et al., 2012) has made us reluctant to consider alternatives at this point.

The extension ‘combo’ line, which is 50 cm long with two access ports 12 cm apart (Farah, et al., 2012), is attached to the venous line during set-up to ensure ease of connection and safe priming. The open ports of the ‘combo’ extension line are capped off with negative pressure displacement connectors to allow for ease of connection/disconnection during the treatment. Patient data is entered into the machine and the set-up is checked by a second nurse for quality and safety purposes.

Pre-medication use to prevent sensitivity reactions is commonplace in many adult and paediatric units (Filler, et al., 2014) and is prescribed and administered as routine for all patients having fresh frozen plasma (FFP) as replacement fluid, in cTPE/mTPE. The pre-medication consists of oral paracetamol, intravenous (IV) hydrocortisone, and IV promethazine, except when on high-dose methylprednisolone (then hydrocortisone is omitted). Similarly Dechmann-Sultemeyer, Linkeschova, Lenzen, Kuril, Grabensee and Voiculescu (2009) utilise an antihistamine and steroid to prevent allergic reactions. Likewise Perez-Saez, Toledo, Ojeda, Crespo, Soriano, Alvarez de Lara, Martin-Malo, and Alijama (2011) utilised similar pre-medication, with the addition of oral calcium supplementation, which could be individually considered by the consultant for more at-risk patients. After the pre-medication, we wait 30 minutes prior to commencing HD and cTPE to ensure the medication has been absorbed and is therefore less likely to be removed by the cTPE treatment.

Procedure commencement

Three-way taps are connected at the patient arterial access site (to allow for blood sampling if required or alternatively the arterial line of the HD circuit can be utilised) and on the venous patient access site (to allow for the administration of IV calcium, if required). In this situation, any IV supplementation cannot be connected to the venous limb of the HD circuit, as it will potentially be withdrawn into the cTPE circuit and not given directly to the patient.

The HD treatment is commenced initially at a blood pump speed (Qb) of 200 ml/min for five minutes to ensure machine pressures are correct, access is viable and blood pressure (BP) is stable, then cTPE is connected. One Spanish unit waits 30 minutes prior to connecting the patient, although clarification is not given regarding the rationale; however, this may be due to

![Figure 1: PE and HD machine set-up](image1)

![Figure 2: HD venous return line with attached extension (combo) line for PE connections](image2)
the delay required for the pre-medication to take effect (Perez-Saez, et al., 2011).

The ports on the ‘combo’ line are swabbed with alcohol as per hospital infection control guidelines and then the cTPE set-up is connected via the ‘combo’ extension line, ensuring the connections are correct (venous closest to the patient) to minimise risk of recirculation. The cTPE treatment is commenced at an inlet speed of 50 ml/min for the first 15 minutes then increased to 60 ml/min if the patient is stable. This ongoing rate is standard practice across many units as guided by the manufacturer’s clinical team with Puppe and Kingdon (2014), increasing up to inlet rate to 65 ml/min (where platelet losses are minimised [to <1%]). Inlet rates are linked with the calculated rate of citrate administration; therefore, increasing the speed (increased inlet rate) will increase the citrate rate exposing the patient to increased risk of hypocalcaemia. As a result, we have retained the rate at the recommended 60 ml/min. For ongoing treatments, if the patient remains stable cTPE is commenced at 60 ml/ min, continuing this rate for the entire run. Qb for HD should be set as previously prescribed by the renal consultant, ranging between 200 and 300 ml/min, dependent on patients’ tolerability and vascular access.

Anticoagulation

Of particular interest was the acute conditions of the patients and the potential for bleeding related to disease processes or possible procedures being undertaken, hence the requirement to change anticoagulation regimes. Whilst medical guidance was provided in terms of withholding or reducing heparin doses in HD, the citrate anticoagulant rates during cTPE are often automated or adjusted by nursing staff independently. Whilst some nurses may have had experience with regional anticoagulation, it is not commonly practised within the HD unit due to the risk of hypocalcaemia if infusion rates are not closely monitored and lack of experience compounds this risk. However, the cTPE machine utilises Anticoagulant Citrate (AC) as the only anticoagulant option and hence nurses are trained in the use of, standard prescriptions and risks as part of their competency process. The machine also has safety limits built in and colour-coding alerts as part of safety mechanisms in regard to citrate administration.

When both anticoagulants are utilised in tandem treatment then modifications are required, traditionally with the citrate prescription. The settings on the centrifugal machine refer to an inlet: AC (anticoagulant citrate) ratio, a combination of a portion of blood (inlet) with a variable rate of AC. Traditionally the inlet: AC ratio setting can range between 1:10 and 1:14, dependent on the patients’ platelet count. The rate of AC remains constant at 1, but the inlet rate (amount of blood that can be increased or decreased to dilute or concentrate the rate of anticoagulant); however, there is a paucity of evidence to guide practice when variable amounts of heparin are utilised in combination with AC, as in tandem procedures. Comparisons with other units is challenging, with the prescribed Inlet: AC ratios ranging between 1:20 and 1:25 (Filler, et al., 2014), down to a more concentrated mix of 1:25 (standard) or 1:45 (if hypocalcaemic) (Farah, et al., 2012).

If too little anticoagulant is administered the cTPE circuit will clot, and if too much there is increased risk of citrate toxicity. However, anecdotal experience from our Australian colleagues has suggested for patients on ‘standard’ heparin such as 1000 International Units initial then maintenance, then a starting point of 1:18 for the inlet: AC ratio is recommended due to concerns with clotting (that is, the inlet rate of blood will be set at 18, as the citrate component of 1 is never altered). On a positive note, due to the nature of the centrifugal circuit, the majority of citrate is removed to the waste bag rather than being infused into the patient. Therefore, we drafted the guidelines to commence our practice (Table 1). At times, medical consultation was required to increase heparin dosage due to concerns with clotting, high platelet counts and high haemoglobin results, and each treatment should be reviewed and individualised, based on current clinical concerns.

Puppe and Kingdon (2014) calculated that they used a total AC rate of 0.8 mL/min/L for the total blood volume, which corresponds to between 0.0047 and 0.0068 mmol citrate/ kg/min (the AC: inlet ratio was not stated), noting that at such rates citrate reactions are rare as the estimated drop in ionised calcium would not be >10–15%. As most of the AC in cTPE is removed into the waste bag, it is uncommon for any of the patients in our unit to run at rates this high; however, we are always mindful of citrate reactions and incidence is likely higher than that stated. In our units patients receive less than 100 ml citrate (on average) per treatment, which is in line with the three clinical cases noted by Puppe and Kingdon (2014). Therefore, during cTPE hypocalcaemic risk due to citrate administration is highly variable due to the range of clinical conditions and serum calcium levels. In our unit, IV calcium supplementation is prescribed on an individual basis if symptoms become evident (Kiprov, et al., 2015) rather than as a routine.

Treatment considerations

Whilst there were variations between treatments in the literature, the main themes were in regard to HD blood flow rates and anticoagulation regimens. Blood flow rates (Qb) in our unit are conservatively set between 200 and 300 ml/min compared to wide variations within the literature from 150 to 200 ml/min (Dechmann-Sultemeyer, et al., 2009) up to 350 ml/ min (Farah, et al., 2012). The chosen Qb in our centre was able
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Table 1: Inlet: AC (anticoagulant citrate) ratio adjustments

<table>
<thead>
<tr>
<th>Inlet: AC ratio setting/range</th>
<th>Anticoagulant considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 (to 25)</td>
<td>Tandem with usual heparin dose (individually assessed)</td>
</tr>
<tr>
<td>16</td>
<td>Minimal heparin, i.e 1000 IU bolus and 500 IU maintenance</td>
</tr>
<tr>
<td></td>
<td>For heparin-free treatment or plasma exchange alone — refer to platelet count</td>
</tr>
<tr>
<td>14</td>
<td>&lt;150 (reduced platelet count)</td>
</tr>
<tr>
<td>12 (standard setting)</td>
<td>150–400 (normal platelet count)</td>
</tr>
<tr>
<td>10</td>
<td>&gt;400 (high platelet count)</td>
</tr>
</tbody>
</table>

* International Units (IU).

to be achieved without exposing the patient to increased risk of complications or machine concerns related to higher pump speeds. Qb have not been included in the treatment details (Table 3) as these were not seen to have been impacted upon in combining the therapies, whereas cTPE inlet rates were 60 ml/min, as the standard setting recommended and evident within the literature.

**HD prescription**

Traditional HD hours were undertaken as prescribed by the registrar or consultant with patient specifics taken into consideration. As is common practice in our unit, all patients were dialysed with a high-flux dialyser matched for surface area, patient size and ultrafiltration and solute removal requirements.

Changes in dialysate components were considered, based on patients’ biochemistry results; however, as AC is required for all cTPE procedures and hence there is always the potential risk of calcium toxicity and hypocalcaemia, increased calcium dialysate (1.5 or 1.75 mEq/L) has been prescribed prophylactically in order to minimise this occurrence. Farah, et al. (2012) noted the need to review bicarbonate levels due to the increased risk of alkalosis associated with citrate administration with Filler, Clark and Huang (2014) reducing

Table 3: Summary data of all patients comparing parameters

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Number of sessions</th>
<th>Tandem</th>
<th>HD hours</th>
<th>HD ultrafiltration goal (L)</th>
<th>Heparin rates (IU* as bolus/maintenance IU per hr)</th>
<th>Dialysate Calcium (mmol/L)</th>
<th>Inlet: AC ratio (1:1)</th>
<th>Supplementation</th>
<th>IV* Ca requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>1 session @ 4hrs then 7 sessions @ 5hrs</td>
<td>1.4–2.2</td>
<td>Standard (1000/1000)</td>
<td>2 treatments @1.5, 6 treatments @ 1.75</td>
<td>18 for 8 sessions</td>
<td>3 out of 8 treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>–</td>
<td>1.5</td>
<td>–</td>
<td>1.5 for all treatments</td>
<td>–</td>
<td>Nil required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1 session @ 3hrs; 1 session @ 4hrs</td>
<td>0.7</td>
<td>1000/500</td>
<td>1.75 for all treatments</td>
<td>16 for 1 session; 12 for 1 session</td>
<td>2 out of 2 treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>2 sessions @ 2hrs; 1 session @ 3hrs; 3 sessions at 4hrs</td>
<td>0–3.0</td>
<td>Nil or 1000/700 or 1000/900</td>
<td>1.75 for all treatments</td>
<td>16 for 1 session; 11 for 1 session (due to clotted HD circuit)</td>
<td>Nil required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>3 sessions @ 4hrs</td>
<td>0.3–1.5</td>
<td>Nil or 1000/500</td>
<td>1.75 for all treatments</td>
<td>12 for 3 sessions</td>
<td>2 out of 3 treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>4</td>
<td>2.0</td>
<td>1000/500</td>
<td>1.75 for all treatments</td>
<td>18 for 2 sessions; 16 for 2 sessions</td>
<td>3 out of 4 treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>4</td>
<td>1.3–2.0</td>
<td>Minimal (500/500)</td>
<td>1.5 for 3 session and 1.75 for 1 session</td>
<td>18 for 2 sessions; 16 for 2 sessions</td>
<td>1 out of 4 treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>4</td>
<td>–</td>
<td>–</td>
<td>1.75</td>
<td>18</td>
<td>Nil required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>4</td>
<td>–</td>
<td>–</td>
<td>1.75</td>
<td>18</td>
<td>Nil required</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* International Units (IU), intravenous (IV), – nil data available.
dialysate settings to 25 mEq/L. No changes have been required in our unit, with no symptoms or biochemical data indicating risk and hence bicarbonate settings remain at 35 mEq/L. Dialysate potassium concentrations are prescribed by the consultant, with no hypokalaemia evident from citrate administration. As part of routine biochemistry, serum magnesium is reviewed (at times supplemented in some cTPE patients); IV magnesium supplementation was required for one patient and another received oral supplementation which they had been receiving whilst on HD.

**PE prescription**

Farah, et al. (2012) prescribe a PE volume (PEV) of 1–1.5 times the patient’s plasma volume (PV) for the first three treatments then reducing this to 1 times PV for subsequent treatments. Our unit individually assesses patients’ needs, with the majority of patients receiving 1–1.5 times the PV as routine, and on the rare occasion with more aggressive diseases treated with up to 2 times PEV as per consultant request. The medical team actively monitors patient progress and the effectiveness of the treatments.

**Nursing management — prevention of complications**

Nurses need to be aware of clinical symptoms of hypocalcaemia in addition to other complications related to HD and cTPE. Nursing management was able to mitigate these complications by monitoring patients’ blood pressure, pulse and temperature to observe for changes in observations every 30 minutes to hourly, thereby assessing response to ultrafiltration rate and identifying potential reactions to citrate/ fluid replacement. This is in line with Dechmann-Sultemeyer, et al. (2009) reviewing the severity of disease and noting clinical observations at the same intervals. They also extended this monitoring to undertake electrocardiogram monitoring for the first two treatments; however, this was considered unnecessary in our unit as concerns with clinical hypocalcaemia should be noted early by clinical assessment and urgent pathology testing before or during treatment and before extreme clinical implications become evident. Perez-Saez, et al. (2011) noted that clinical observations were undertaken hourly, which is more feasible for stable patients. Bhowmik, Kumar Jain, Aslam Mash, Saha, Gupta, and Kumar Agarwal, et al. (2001) note that vital observations were constantly monitored, with hypotension the most common complication.

Part of the patient assessment includes discussion and identification of hypocalcaemia symptoms as outlined in Table 2. A warm-touch or “Bear hugger” patient warming device assists with citrate metabolism as recommended by the manufacturer’s clinical team.

<table>
<thead>
<tr>
<th>Table 2: Possible clinical symptoms during tandem procedure</th>
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<tbody>
<tr>
<td>Symptomatic hypocalcaemia due to citrate use</td>
</tr>
<tr>
<td>Neuromuscular:</td>
</tr>
<tr>
<td>• Parasthesia (perioral, peripheral)</td>
</tr>
<tr>
<td>• Chills, shivering</td>
</tr>
<tr>
<td>• Chest wall vibrations</td>
</tr>
<tr>
<td>• Twitching, muscle cramps, tremors</td>
</tr>
<tr>
<td>• Spasm (laryngeal, abdominal muscles), tetany</td>
</tr>
<tr>
<td>Neurological:</td>
</tr>
<tr>
<td>• Anxiety, confusion, and irritability, which can progress to seizures</td>
</tr>
<tr>
<td>• Prolonged myocardial muscle depolarisation time, leading to:</td>
</tr>
<tr>
<td>• ECG changes (prolonged QT interval, arrhythmias)</td>
</tr>
<tr>
<td>• Myocardial depression (decreased cardiac output, hypotension)</td>
</tr>
<tr>
<td>Symptomatic hypotension due to fluid removal, hypocalcaemia or anaphylaxis</td>
</tr>
<tr>
<td>Symptomatic hypothermia to cool replacement fluid utilised for PE</td>
</tr>
<tr>
<td>Bleeding due to various anticoagulants used</td>
</tr>
<tr>
<td>Anaphylaxis including fever, rigors, urticaria, wheezing, hypotension</td>
</tr>
<tr>
<td>Potential infection risk due to immunosuppressed status</td>
</tr>
</tbody>
</table>

Anecdotally, due to haemoconcentration of the blood circuit (due to HD fluid removal) one interstate unit noticed raised blood levels in the cTPE circuit requiring adjustments to the haematocrit (Hct) level of the PE machine. We have not identified this concern with any of our treatments, despite varying ultrafiltration goals and rates for HD.

**Blood tests**

Electrolytes and full blood count are taken at the commencement of the treatment to assess the risk of hypocalcaemia and ensure correct settings for the cTPE machine (primarily haematocrit which is used in the total blood volume calculation). Mid-run bloods for ionised calcium are also performed to review progress and prompt supplementation if required. As treatments progress and the patient stabilises this may be omitted. Liaison with the medical staff guides care at this point. Dechmann-Sultemeyer, et al. (2009) felt that the treatment requires electrolyte testing every hour; however, this was considered excessive in our current patient population with dialysate electrolyte constituents supporting potential deficiencies and excessive pathology testing adversely affecting those patients with lower haemoglobin levels. However, if clinical concerns arise urgent pathology testing is possible.

**Patient data**

To date a total of nine patients have been treated with tandem treatments; our average is 3–4 treatments then patients are able to transfer to cTPE or HD alone, depending on clinical condition and treatment requirements. The literature states that
most patients need between 3 and 31 treatments on average (Perez-Saez, et al., 2011). The specifics of the treatments undertaken are presented in Table 3.

The causes of renal failure and requirement for PE for the nine patients included: pulmonary vasculitis (1); systemic lupus erythematosus (1); Wegener’s granulomatosis (2); antibody mediated rejection (4); Anti-Glomerular Basement Membrane (cTPE) & IgA (HD) and pre-planned for live, related renal transplant (paired exchange) (1). Of those patients treated, five patients were already on dialysis, with three of those having permanent vascular access and six having HD central venous catheters.

**Significance of Table 3**

In total, nine patients were treated between June and August 2015, receiving a total of 31 treatments. The HD ultrafiltration goal was reviewed to analyse if this had an impact on haemoconcentration of the blood circuit and if associated problem-solving was required. This did not appear to have an impact of the cTPE procedure. In this group of patients, anticoagulation rates were reviewed in line with the patient’s clinical condition and were changed in relation to rates of heparin and AC. Previously these would have been considered in isolation to the particular treatment and anticoagulant requirements. AC rates were adjusted more frequently due to the short-acting nature of AC. The dialysate calcium was instigated at a higher rate where possible and changed after review of recent serum calcium levels. IV calcium supplementation for symptomatic hypocalcaemia was required in 35% of cases.

**Complications**

Farah, et al. (2012) experienced no major treatment-related events, with 10% complicated by minor events (n=621 sessions). Similarly Perez-Saez, et al. (2011) experienced no major events, with minor adverse events in 10.45% of cases, with 0.69% related to extracorporeal clotting, hypotension (3.83% less than HD population) and paraesthesia related to hypocalcaemia in only 0.69% (n=287 sessions). Our data is difficult to compare due to small treatment numbers (n=31); however, evident complications may include those listed in Table 2.

Treatment challenges did include the following:

1. One patient experienced one period of hypotension, requiring both treatments to be paused temporarily.

2. One patient experienced several minor hypotension episodes related to her medical instability and later transferred to separate treatments. Complications did not appear to be directly related to the treatment per se.

3. At least three patients required heparin-free HD post renal biopsy; therefore normal to reduced citrate doses were used for cTPE. Of those patients: 1 patient had platelets initially 1,000 x 10^9/ L (normal between 140 and 400 x 10^9/ L) and ongoing changes with inlet: AC ratio were required; another patient clotted the HD circuit within 40 minutes requiring re-commencement of HD circuit with minimal heparin and cTPE was temporarily suspended then recommenced; another patient exhibited a low haemoglobin requiring cessation of heparin mid-run and a low magnesium requiring supplementation.

**Disconnection procedure**

Ideally the cTPE treatment will finish first, the blood is returned and the lines disconnected from the negative displacement connections on the ‘combo’ extension line. HD is able to continue during this time. For ease of practice, the machine is kept in place to limit disruption to the patient. After the HD treatment time is complete the patients’ blood will be returned as per routine procedure. For those patients that are completing cTPE and HD at similar times the cTPE system is always returned first to minimise alarms and concerns with the cTPE circuit and its reliance on haematocrit readings. At times this has required the HD run to be extended for five to 10 minutes with minimal ultrafiltration. No complications with the disconnection procedure have arisen during our experience.

**Recommendations**

- Our recent experiences of combined HD and cTPE have enabled us to define recommendations within our unit, whilst keeping in mind each treatment needs to be planned and evaluated with regard to patient individual risk in acutely changing situations.

- To ensure patient safety monitoring of clinical observations and possible complications during treatment is essential.

- Nursing staff need to clearly understand the changes required to the anticoagulation prescription and to discuss with experienced colleagues further recommendations required for ongoing treatments.

- Clearly communicating patients’ progress during treatments has increased confidence across the nursing service as staff learn from others.

**Conclusion**

When commencing a new procedure it is vital to share experiences and build a current and local evidence base
Discovering tandem plasma exchange and haemodialysis: a single-centre, 18-month experience

reflecting safe and detailed clinical practice. By sharing our strategies we hope to build this knowledge base supporting clinicians to develop and refine policies and provide timely, patient-focused care. The tandem procedure provides evident benefits to patient care in its ability to combine two treatments and reduce the time patients spend at the hospital. By sharing our experiences we hope others will embark on this endeavour.

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Conflict of interest
None.

References


