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97/001: TECHNOLOGICAL INNOVATIONS IN CONTINUOUS RENAL REPLACEMENT THERAPY

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We report on the acumen, as a new approach to continuous hemofiltration/ hemodialysis. The device employs a pneumatic blood pump to drive the blood through the filter. This creates less mechanical stress on erythrocytes than conventional roller pumps and avoids particle spallation from the blood tubing. Furthermore, utilization of a pneumatic blood pump with a discontinuous blood flow allows usage of a single lumen access. It has been shown that discontinuous/pulsatile blood flow reduces concentration polarization and delays the permeability decline in hemofilters. The venous air drip chamber is replaced by a hydrophobic, air separating membrane in the venous line. Negative pressure behind this membrane continuously removes any air bubbles which may enter the system. By avoiding the obligatory blood-air contact within the conventional drip chamber, the system is more biocompatible with less activation of the clotting system. Balance of filtrate with replacement fluid is attained by a volumetric balancing chamber. As plasma is filtered, the protein concentration, blood viscosity and oncotic pressure rises towards the end of the filter. This causes hemoconcentration, which in turn increases the resistance of the filter and promotes clotting. Limiting the filtration fraction to 20% may prolong the life time of the filter. The acu·men uses an all-in-one disposable cartridge, which contains a pneumatic blood pump, a hemofilter, a volumetric balancing chamber, two air-separating membranes and the tubings. Treatment is initiated within minutes after inserting the cartridge into the machine (Table 1).

| Table 1. The different features of the new device in comparison to conventional systems |
|-------------------------------|---------------------------------|------------------|------------------------|
| Conventional                  | Acumen                         | Possible         |
| systems                        |                                 | advantages       |
| roller pump                    | pneumatic                       | less hemolysis    |
|                                 | pump                            | and spallation   |
| continuous blood flow          | pulsatile                       | less concentration|
|                                 | blood flow                      | blood flow       |
|                                 | polarisation                    |                  |
| gravimetric balancing         | volumetric                      | improved motion  |
|                                 | balancing                       | tolerance        |
| venous air drip chamber        | air-separating                  | less cloting     |
|                                 | membranes                       | activation       |
In vitro data: 1,000 ml heparinized sheep blood were circulated through the system for 17 h. The pneumatic blood pump delivered precisely various blood flows from 40 to 120 ml/min and the volumetric balancing chamber provided accurately an exchange volume of 1.5 l/h. No clotting was observed. The air separating membrane removed the air during the filling routine and no air alarm occurred during the entire session. After 14 h of balanced hemofiltration without fluid removal, the blood was diluted with 1,000 ml saline, which were removed with an error of 0.5% over the following 3 h.

In vivo data: The safety and efficacy of the device is being evaluated in ongoing clinical trials. We conclude that the advanced technology of the acumen promises safe and improved patient care in ARF.
97/002: NADROPARIN VERSUS DALTEPARIN ANTICOAGULATION IN HIGH VOLUME CONTINUOUS VENOVOUS HEMOFILTRATION: A DOUBLE-BLIND RANDOMIZED CROSS-OVER STUDY

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Introduction: Low molecular weight heparins (LMWHs) are widely used as anticoagulants during renal replacement therapy. Their biological activity is generally quantified by the extent of factor Xa inhibition. However, the correlation between anti-Xa activity and efficacy of anticoagulation is questionable. Therefore, bioequivalence does not implicate equal clinical efficacy. Aim of this study was to compare filter survival times during high volume continuous venovenous hemofiltration (HV-CVVH) in patients with normal values of prothrombin time (PT) and activated partial thromboplastin time (APTT), using bioequivalent doses of nadroparin and dalteparin. Furthermore, we evaluated which other factors influence filter survival time.

Methods: 32 patients were randomized to receive a continuous infusion of either 320 IU dalteparin per hour after a loading dose of 2,000 IU, or a bioequivalent dose of nadroparin. Patients eligible for a second HV-CVVH run after an interval of 12 h, received the other study medication in a cross-over fashion. HV-CVVH was performed with a standard blood flow rate of 200 ml/min, using a cellulose triacetate filter and postdilution. The HV-CVVH run was stopped when a total of 100 liters had been filtrated, or when the hemofilter had clotted. Anti-Xa activity was determined at baseline, after 0.5, 2, 4, 6 and 12 h and at the end of the HV-CVVH run. Thrombocyte count, PT and APTT were determined at baseline, after 6 h and at the end of the run.

Results: 19 patients could be evaluated and 10 were eligible for the cross-over study. Anti-Xa peak activity (anti-Xa max), area under the curve 0–3 h (AUC0–3) and filter survival time were not significantly different between groups (table 1). When analyzing the patients according to the length of filter survival time, no relationship between anti-Xa max, AUC0–3 and filter survival time was found. However, patients with longer filter survival times had a significantly lower initial thrombocyte count (table 2).

Conclusion: Filter survival times did not differ between patients using bioequivalent doses of nadroparin and dalteparin. There was no relation between filter survival time and anti-Xa activity. However, patients with a longer filter survival time had a lower initial thrombocyte count. This suggests that patients with a normal to high initial thrombocyte count might need a different anticoagulation regime to obtain longer filter survival times.
### Table 1

<table>
<thead>
<tr>
<th>Anti-Xa max</th>
<th>AUC^{II-3}</th>
<th>Filter survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>IU/ml</td>
<td>time, h</td>
<td></td>
</tr>
<tr>
<td>Nadroparin</td>
<td>0.45 ± 0.11</td>
<td>1.02 ± 0.3</td>
</tr>
<tr>
<td>Dalteparin</td>
<td>0.45 ± 0.14</td>
<td>1.03 ± 0.4</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>NS</td>
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</table>

### Table 2

<table>
<thead>
<tr>
<th>Filter survival</th>
<th>Anti-Xa max</th>
<th>AUC^{II-3}</th>
<th>Initial thrombocyte count, x10^9/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>IU/ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥12 h</td>
<td>0.49 ± 0.16</td>
<td>1.12 ± 0.48</td>
<td>103.3 ± 65.6</td>
</tr>
<tr>
<td>&lt;12 h</td>
<td>0.56 ± 0.14</td>
<td>1.27 ± 0.44</td>
<td>209.2 ± 155.3</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>NS</td>
<td>p = 0.02</td>
</tr>
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</table>
97/003: LONGEVITY OF DIALYSIS CIRCUIT AND ADEQUACY OF DIALYSIS IN CONTINUOUS RENAL REPLACEMENT THERAPY: HEPARIN VERSUS CITRATE ANTICOAGULATION

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Between December 1995 and October 1996, 48 patients received CRRT at our institution. Anticoagulation was achieved with heparin in 16 patients, with citrate in 26 patients, and with both (sequentially) in 1 patient. Four patients received no anticoagulation.

We compared adequacy of dialysis as measured by urea reduction ratio (URR) in the first 24 h of therapy as well as longevity of dialysis circuit in the heparin and citrate groups. Patients were excluded from study if they: received no anticoagulant (4), had treatments lasting <24 h (3), received both citrate and heparin (1) were dialyzed against dialysate other than 1.5% Dianeal (Baxter) (4) or if inadequate data was available for analysis (3). In 2 of the 3 patients with inadequate data, death occurred before the data could be obtained. The remaining 33 patients were dialyzed with a biocompatible polyacrylonitrile membrane (Multiflow 60, Fabrique) with blood flows ranging from 100 to 200 ml/min. Of these 33 patients, 13 were anticoagulated with heparin and 24 with citrate. Subgroups of patients who were treated for >24 h were also identified and evaluated.

We found that circuit survival was better with citrate anticoagulation in all patients (p = 0.056) and even more significant when patients were treated for >24 h (p = 0.033). We also found URR to be better in patients anticoagulated with citrate (p = 0.056) than those treated with heparin regardless of time on CRRT. These data must be interpreted cautiously as the numbers are small and this represents a report of our experience rather than a randomized study. However, the trend for longer circuit survival and better adequacy of dialysis is intriguing. Despite the increased complexity of managing patients receiving citrate anticoagulation, citrate may be preferable if adequacy is enhanced. This issue certainly warrants further study.
97/004: EFFECT OF HEPARIN, PROSTACYCLIN OR COMBINATION, AND EFFECT OF POLYACRYLONITRILE OR POLYSULPHONE MEMBRANES ON FILTER SURVIVAL IN CRITICALLY ILL PATIENTS ON CONTINUOUS VENO-VENOUS HAEMOFILTRATION

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There are theoretical advantages and disadvantages of different anticoagulant regimens and different membranes on filter life and function in continuous veno-venous haemofiltration in intensive care. However most have not been tested in controlled conditions on sufficient numbers of filters/patients.

This study aimed to assess the effect of three different anticoagulant regimens and two different membranes on filter life, filtration efficiency and laboratory parameters of coagulation and platelet activation. Each patient was crossed over to each of six treatment arms, thus acting as own controls.

126 haemofiltration episodes in 30 critically ill patients were randomised to initially either a PAN (AN69, Hospal) or a PS (Diafilter 30, Amicon) filter then subsequently crossed over. All circuits were randomised to either heparin (1,000 U/h) or prostacyclin (5 mg/kg/min) or heparin (200 U/h) plus prostacyclin (5 mg/kg/h). Blood was sampled immediately pre and post filter at 0 and 4 h to assess coagulation activation-soluble fibrin and thrombin-antithrombin complex (TATC), and platelet activation $\beta$thromboglobulin. Filter efficiency was assessed by the haemopermeability index (HPI) = ultrafiltrate flow/transmembrane pressure. Filter life was measured in hours until circuit clotted. Data was analysed using nonparametric analysis.

The median filter life was 30.7 h on heparin, 16.0 h on prostacyclin and 21.1 h on combined treatment ($p <0.05$), with no difference between Amicon (24.1 h) and Hospal (22.5 h). Bleeding occurred in 9 patients on heparin, 2 on prostacyclin, and 4 on combined treatment. TATC was significantly lower in the heparin treated circuits only ($p <0.05$), however there was no difference in soluble fibrin or $\beta$ thromboglobulin levels between the groups. The HPI was maintained at up to twice the efficiency for up to 80 h in both regimens receiving prostacyclin, compared to those filters receiving only heparin ($p <0.05$).

Heparin at 1,000 U/h significantly prolonged filter life whereas prostacyclin maintained filter efficiency significantly longer.
97/005: CONTINUOUS VENO-VENOUS HEMOFILTRATION (CVVH) USING HEPARIN-COATED OR NON-HEPARIN-COATED MEMBRANES IN CRITICALLY ILL PATIENTS

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Introduction: The coagulation abnormalities (such as thrombopenia or DIC) often observed in critically ill patients might restrict the indications of CVVH used for renal support if platelets are consumed, heparin is needed and frequent membrane changes are required. We analyzed the efficacy and effects on platelet count of heparin-coated and non-heparin-coated CVVH membranes.

Patients and Methods: 33 consecutive CVVH were performed on 14 mechanically ventilated critically ill patients, using a non-heparin-coated membrane (Renaflo II-PSHF 1200, n = 24) or a heparin-coated membrane (Duraflo II-PSHF 1200, n = 9). Patients with platelet transfusion were excluded. Heparin was not administered systemically, but when indicated, in the membrane (Renaflo II), or after the membrane (Duraflo), since lines and bubble traps are not heparin-coated. Age, SAPS, indication, duration and evolution of CVVH, hemofiltration rate, heparin infusion rate were recorded. Platelet count, coagulation times, urea and creatinine were measured before, 0–12 h and 12–48 h after membrane insertion. Statistical analysis: mean ±SE, with 2 way-Anova.

Results: Baseline patients’ characteristics were identical in the 2 groups. HF was indicated for acute renal failure complicating high risk surgery (n = 20), septic shock (n = 9) or ARDS (n = 4). Heparin was not used for 8 HF (Renaflo II, n = 6, Duraflo II, n = 2). When used, heparin was given in the membrane (for the 18 Renaflo II membranes), or after the membrane (for the 7 Duraflo II membranes). Hemofiltration rate, urea, creatinine, and platelet count were similar. With Duraflo II membranes, ATT remained stable, consistent with lower heparin infusion rates, while membrane lifespan tended to be longer (figure). Causes of HF discontinuation (circuit thrombosis, 58%; planned change, 30%; or death, 12%) were similar with the 2 membranes.

Conclusion: For a similar hemofiltration performance, the heparin-coated membrane required less heparin administration, and tended to last longer than the non-heparin-coated membrane.
97/006: ADVANCES IN RENAL REPLACEMENT THERAPY (RRT) FOR ACUTE RENAL FAILURE (ARF) IN DISASTER SETTINGS: THE NEPHRO CRASH CART

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ARF in disaster settings is characterized by a crush syndrome with marked hyperkalemia and a hypercatabolic state. Prompt institution of supportive measures and RRT is crucial in reducing mortality. Intermittent hemodialysis (IHD) has been the most common modality of RRT used because of the widespread availability and experience with the therapy. Prior experience from the Armenian earthquake (NEJM 1989, 320: 1291) showed that while IHD techniques were efficacious they required a continuous supply of electricity, water and bulky heavy equipment which was difficult to transport and was prone to breakdown. Continuous renal replacement therapies (CRRT) have not been used extensively in disaster settings due to concerns of need for constant monitoring, continuous anticoagulation, requirement for sterile dialysate and replacement fluids. Recent advances in CRRT have resulted in a new generation of pumps (e.g. Hospal Prisma and Fresenius Acu*men) which are small, light and easy to use with monitoring to allow automated fluid balance and continuous solute removal. We present a proposal to use CRRT as a primary modality of therapy in disaster settings. The concept is to provide a mobile dialysis unit in a container which is easily transportable (Nephro Crash Cart). The core of the dialysis unit is a water treatment unit which produces pure sterile water from a water source by sequential treatment including reverse osmosis and filtration. Water is mixed on site with dry concentrate to produce 5 liter bags of sterile fluid for replacement or dialysate for CRRT. To provide a urea nitrogen clearance of 30–50 ml/min (achievable by a combination of convection and diffusion) approximately 25–50 l of sterile fluid would be required per day. The unit contains multiple CRRT pump modules, disposables, a point of care instrument for laboratory testing and is equipped with a power generator and battery backup. The requirements for RRT for 40 patients for 1 week are shown below.

<table>
<thead>
<tr>
<th>Modality</th>
<th>No. of units</th>
<th>Dry conc. Wt kg</th>
<th>Water l/h</th>
<th>Energy kW</th>
<th>Equip Wt kg</th>
<th>Size m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHD</td>
<td>10</td>
<td>340–830</td>
<td>270</td>
<td>25</td>
<td>1500</td>
<td>13.5</td>
</tr>
<tr>
<td>CRRT</td>
<td>40</td>
<td>140</td>
<td>40–80</td>
<td>6</td>
<td>1200</td>
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</tbody>
</table>

These comparisons suggest that therapeutic equivalence with IHD can be achieved easily and CRRT allows more flexibility in providing RRT. Additionally there is a reduced risk for cross-contamination. The self contained unit provides ease of transportation and is easily adaptable to any environment. We believe that this method needs to be evaluated and may be of particular relevance for military applications.
97/007: SUCCESSFUL CONTROL OF LACTIC ACIDOSIS IN TEN PATIENTS USING ACETATE-BASED DIALYSATE FOR CONTINUOUS RENAL REPLACEMENT THERAPY

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Acetate or lactate are the alkaline anions of many dialysis solutions thus preventing precipitation of calcium and magnesium salts in the presence of bicarbonate. Acetate solutions have a higher final pH (5.8–6.2) than lactate (<5.4); acetate is a more effective bicarbonate source and is metabolized in the case of lactic acidosis. This study sought to determine whether an acetate based dialysate (ABD) solution is useful in controlling lactic acidosis while treating the primary cause.

Ten patients with type I or II lactic acidosis and renal failure were treated with ABD prepared by the hospital pharmacy in the sterile intravenous products room using an auto mix compounding computer routinely used for preparing total parenteral nutrition solutions. The composition of the 3 liter bags of ABD is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl</td>
<td>6.6 g/l</td>
</tr>
<tr>
<td>Na Acetate</td>
<td>3.3 g/l</td>
</tr>
<tr>
<td>MgCl₂</td>
<td>100 mg/l</td>
</tr>
<tr>
<td>CaCl₂</td>
<td>260 mg/l</td>
</tr>
<tr>
<td>Dextrose</td>
<td>2 g/l</td>
</tr>
</tbody>
</table>

KCl or K phos as directed by chemistries.

Four patients on continuous renal replacement therapy using 1.5% Dianeal developed hyponatremia and rising lactic acid levels were changed to ABD while 6 patients were begun on ABD initially. All patients on ABD revealed significant improvement in lactic acidosis (p <0.01), serum bicarbonate (p <0.01) correction of hyponatremia (p <0.01) and hyperglycemia (p <0.05). The cost of 3 liters of ABD was $8.60 compared to $6.40 for 1.5% Dianeal. The cost of 1.5% Dianeal with sodium quadrate and magnesium chloride added negated the cost difference. There was no product instability.

Conclusion: ABD made by our hospital pharmacy provided excellent control of lactic acidosis until the underlying cause could be corrected. Hyponatremia was corrected by the higher sodium content of ABD vs. 1.5% Dianeal. There was no product or hemodynamic instability noted with acetate buffer.
97/008: INTERLEUKINS 6 AND 8, TUMOUR NECROSIS FACTOR ALPHA AND COMPLEMENT D CLEARANCE BY POLYACRYLONITRILE AND POLYSULPHONE MEMBRANES DURING HAEMOFILTRATION IN CRITICALLY ILL PATIENTS

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It is speculated that inflammatory mediators may be activated, released, adsorbed and/or filtered by haemofilters in critically ill patients. It is uncertain whether these influences alter their serum levels significantly.

The study aimed to detect clearance of interleukins 6 (IL-6) or 8 (IL-8), tumour necrosis factor alpha (TNF α) or complement D onto polyacrylonitrile (PAN) and polysulphone (PS) membranes in critically ill patients, and determine a change in serum levels.

120 haemofiltration episodes in 30 critically ill patients were randomised to initially either a PAN (AN69, Hospal) or a PS (Diafilter 30, Amicon) filter then subsequently crossed over. All circuits were anti-coagulated with heparin and/or prostacyclin. Blood was sampled immediately pre and post filter at 1 and 4 h with UF sampled simultaneously. All samples were assayed for IL-6, IL-8, TNF α and complement D. Data was analysed using Wilcoxon signed-rank and Mann-Whitney U tests. There was significant clearance (p <0.05) of IL-6, IL-8, TNF α and complement D, by adsorption, with a significant fall (p <0.05) in plasma TNF α and complement D over time. There was less clearance of mediators by Amicon with minimal fall in TNF α over time and a rise in IL-6, IL-8 and complement D. There is evidence of significant removal of TNF α and complement D by adsorption onto PAN membranes.
97/009: CONTINUOUS RENAL REPLACEMENT THERAPY FOR TREATMENT OF PEDIATRIC METABOLIC DISEASES

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Inborn errors of metabolism are uncommon, but life threatening conditions can present with severe metabolic acidosis with hemodynamic compromise. Currently, the standard of care for the acute metabolic derangements that accompany these diseases is treatment with hemodialysis (HD) until the patient is able to be controlled by pharmacological therapy. It is common in these patients for a single HD treatment to last 8–12 h and for more than one treatment to be required. The use of CRRT with HD can provide effective control of the metabolic derangements seen in these children, allowing for constant clearance of abnormal waste products without the risk of hemodynamic instability associated with recurrent HD. Over the past 5 years, 10 children have undergone therapy for metabolic disease at the C. S. Mott Children’s Hospital of the University of Michigan. Of these 10 children, 9 had diseases resulting in severe hyperammonemia and one had congenital lactic acidosis. Six of these children (mean age 4.5 years, mean weight 17 kg) were initially with HD then transitioned to CRRT for ongoing therapy. The 4 children who did not receive this therapy were all newborn infants less than 3 kg. Those undergoing CRRT required this until stabilization which varied from 2 to 27. Patients on CRRT underwent CVVH with countercurrent bicarbonate containing dialysate at 1–1.5 liters/1.73 m²/h. End point in therapy was either death (1, congenital lactate), resolution of the elevated ammonia (3) or liver transplantation (2). The figures represent a typical course of each.
CRRT is successful for maintenance of stability in hyperammonemia states but not in congenital lactic acidosis. Further CRRT as a successful bridge to liver transplantation should be considered in children with unrelenting hyperammonemia not amenable to routine medical therapy.
97/010: CONTINUOUS ULTRAFILTRATION OR HEMOFILTRATION IN INFANTS AND CHILDREN WITH PERSISTENT LOW CARDIAC OUTPUT AFTER OPEN HEART SURGERY

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Introduction: Postcardiotomy ventricular failure is a potentially reversible clinical condition. Usually inotropes, vasopressors and/or vasodilators are used to increase cardiac output (CO), optimization of preload conditions by continuous ultra-filtration/ hemofiltration (SCU/CHF) may become life saving.

Objective: Presentation of clinical data of infants and children with severe post-operative low cardiac output (LCO) treated by SCU/HF.

Setting: A pediatric ICU in a University Hospital.

Patients: From June 1988 to June 1996 32 infants and children were treated by SCU/CHF after cardiac surgery because of severe LCO.

Methods: Ultra-/hemofiltration was driven either in the arterio-venous or veno-venous mode using hemofilters with a membrane surface area from 0.04 to 0.25 m². A negative fluid balance of 1–3 ml/kg/h was the initial aim of therapy.

Results: Mean duration of continuous ultrafiltration was 53 ± 9.6 h. A continuous negative fluid balance of 1.1 ± 0.27 ml/kg/h resulted in a decrease in body weight from 9.95 ± 1.1 to 9.4 ± 1.3 kg. Fifty nine percent showed a permanent hemodynamic improvement, 13% a transient hemodynamic improvement and 28% showed no hemodynamic improvement to continuous ultra-/hemofiltration and subsequently died (table 1).
Conclusion:

SCU/HF improves the cardiovascular function in about 70% of infants and children with postoperative LCO by optimizing the preload conditions of the failing heart. In addition, it improves acid-base balance and pulmonary gas exchange.
97/011: FLOW CHARACTERISTICS OF A NEW PEDIATRIC CONTINUOUS RENAL REPLACEMENT THERAPY CATHETER FOR ACUTE RENAL FAILURE MANAGEMENT

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Little access is available for children less than 20 kg for CRRT. Recently a new 8 Fr Dual Lumen Mahurkar catheter (manufactured by Quinton Instrument Company, Bothell, Wash.) has been evaluated. This catheter has a dual lumen design with side-by-side configuration. The catheter was evaluated at 3 different lengths (9 cm, 12 cm, and 15 cm). The 9 cm with only straight extensions, the 12 cm and 15 cm with both curved and straight extensions. The evaluation was conducted at four clinical centers. Data was collected on flow rate, arterial and venous pressures and complications occurring during the use of the catheter.

Data from a total of 36 children (20 of which were from the University of Michigan) is presented. Entry criteria for use in patients 17 years of age or younger weighing between 7 and 40 kg.

Catheter performance in over 270 treatments in 36 children from all four centers is as follows: Average blood flow rates were $118 \pm 3.1$ ml/min, range 40–200; venous pressure was $121.1 \pm 6.3$ mm Hg, range 30–250, while arterial pressure was $129.7 \pm 6.3$ mm Hg, range 130–250. No complications occurred with the use of the catheters, however four of the tip cultures tested positive.

Specific data from 20 patients at the University of Michigan (average age $3.7 \pm 0.9$ years, range 1–13, and average weight $18.6 \pm 21$ kg, range 10–38) undergoing 120 treatments (either HD or CRRT) were as follows: Blood flow average $102 \pm 5.5$ ml/min, venous pressure $119 \pm 6.2$ mm Hg, arterial pressure $195 \pm 6.2$ mm Hg. Percentage of recirculation (available from this center only) overall was 3%. Two of the tip cultures tested positive. Separating this center’s flow data by placement site (femoral vs. subclavian/ internal jugular) is as follows: average blood flow was $103 \pm 7.4$ ml/min vs. $102 \pm 9$ ml/min comparing above vs. below the diaphragm. Venous pressure was $118 \pm 8$ vs. $119 \pm 1$ mm Hg while arterial pressure was $219 \pm 8.99$ vs. $174 \pm 4$ mmHg when compared above to below the diaphragm, respectively. Percentage of recirculation was 3% vs. 4% when comparing above to below the diaphragm. No significant difference was seen in flow characteristics based upon the length of the catheter.

Overall catheter performance was acceptable for the needs of the children in this weight range (7–40 kg). No experience is available with use of the catheter in children weighing less than 7 kg or greater than 40 kg.

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97/012: USE OF THE PRISMA CONTINUOUS RENAL REPLACEMENT THERAPY IN NEONATES

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Veno-venous hemofiltration is the preferred support modality for acute renal failure in neonates with sepsis or hemodynamic instability. We report our initial experience with the use of a new commercially available machine that can deliver a variety of pumped CRRT modalities (PRISMA: Hospal-Gambro).

We retrospectively reviewed our neonatal experience from the medical records of the 6 neonates treated with CVVHD since October 1995. Data collected included APACHE 2 and PRISMA scores, admission diagnoses, indications for dialysis, type of vascular access, need for inotropic support, and number of failing organs.

Our CVVHD protocol for neonates is as follows: The PRISMA machine uses a 0.5 m² AN 69 hollow fibre filter. Vascular access is via a 6.5 Fr double lumen Vascath catheter (Vascath Canada Inc. of Mississauga) via a femoral vein. The circuit is primed with blood for children under 15 kg. using red cells with a hematocrit of 0.3–0.35. We used postdilutional sets for these patients, but have recently changed to predilutional sets. We used either 1.5% bicarbonate dialysate prepared by our pharmacy or 1.5% dianeal solution depending on the acid-base status and hemodynamic stability of the child. The minimum dialysate flow rate with the PRISMA is 500 ml/h. Our blood flow rate for this size patient is 50 ml/min. Heparin (5–25 U/kg/h) was used for anticoagulation to maintain ACT’s between 150–180 s. The amount of net hemofiltration is adjusted to achieve the desired hourly fluid balance. The infusions which the child is receiving must be included in the net ultrafiltrate to achieve the desired balance.

Thus far we have treated 6 neonates (range 33–41 weeks) with an average weight of 3.17 kg (range 2.1–4.08 kg) using the PRISMA machine. All were in multiorgan failure, 2 with septic shock. The underlying diagnoses were: birth asphyxia 2, PPHN/polycythemia, omphalitis, gastroschisis 2. All required inotropic support (dopamine and adrenaline). The mean number of failing organs was 3.5. The worst mean Apache 2 and PRISM scores were 40.6 and 33.5 respectively.

The average duration of CRRT for each neonate was 2.8 days. The average number of filters used for each neonate was 3.7. The average life for each filter overall was 27 h. The main cause of filter failure was catheter problems causing inadequate flow and filter clotting. Venous access problems (poor flow) were encountered in 2 of the children. Only 1 of the 6 babies survived. There were no complications related to the use of the PRISMA machine.

In conclusion, we have found the PRISMA system to be a simple, user friendly method to support critically ill neonates with multiorgan failure.
97/013: OUTCOME OF ACUTE RENAL FAILURE IN CARDIOVASCULAR PATIENTS AFTER TREATMENT WITH CONTINUOUS RENAL REPLACEMENT THERAPY

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7,652 open-heart surgery (OHS) patients were studied during the period 1988–1995 for incidence and outcome of acute renal failure (ARF). 150 patients (112 M, 38 F, mean age 63 ± 10 years) developed ARF which needed intensive care and continuous renal replacement therapy (CRRT) with continuous arteriovenous hemofiltration or continuous arteriovenous hemodialysis (CAVH/CAVHD).

The patients were arranged into three groups: 1st for coronary bypass, 2nd for valve replacement and 3rd for patients operated for coronary bypass and valve re-placement. Arterial BP was maintained at about 87 ± 21 mm Hg using vasopressors. The 24-hour urine output was 1,762 ± 1,628 ml (range 78–5,970) on the first day post operation, and 576 ± 651 ml (range 30–2,100) when CRRT was started. Daily follow-up of serum urea showed a notable decrease in average, but not significant difference between values at the beginning and the end of CRRT was obtained despite a maintained steady-state.

Incidence of ARF in this study was about 2% (n = 150/7,652). Overall survival within ARF patients was 55% (n = 82/150) hence, a mortality of 45% (n = 68/150). Twenty five percent of the deaths (n = 37/150) occurred in group 1, 13% (n = 19/150) and 8% (n = 12/150) in group 2 and 3, respectively. Circulatory failure due to acute peri-operative myocardial infarctions was the major cause of death. Several factors might have influenced this outcome: (i) predisposing risk factors, e.g. hypertension, previous myocardial infarctions, (ii) postoperative multiple organ failure (MOF), (iii) postoperative bleeding and reoperations. However, no complications due to CRRT itself were seen.

We conclude that CRRT can be considered as a reliable artificial renal support for ARF postcardiac surgery as it offers adequate uremic control. This may influence positively the outcome of ARF.
97/014: OUTCOME OF CONTINUOUS RENAL REPLACEMENT THERAPIES IN PATIENTS ADMITTED TO THREE INTENSIVE CARE UNITS

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Continuous arteriovenous (CAVH) and venovenous (CVVH) hemofiltration are purely convection-based blood purification techniques. The rationale of their utilization in critically ill patients with acute renal failure and precipitating comorbidities (myocardial infarction, ARDS, gastrointestinal bleeding, septicemia) is the extreme hemodynamic instability which renders conventional intermittent hemodialysis technically difficult to perform.

The purpose of the study was to determine the outcome in three critical care units with particular interest to clinical characteristics and to the hemofiltration method. We evaluated 78 procedures, out of a population of 140, performed in patients admitted in cardiosurgical intensive care unit (CSIC), intensive care unit (ICU) and cardiovascular intensive care unit (CVIC) from 1988 to 1996 (respectively 51, 17 and 10 cases). 52 were males and 26 females, with a mean age of 65.7 ± 1.1 years. The indications for hemofiltration procedures were: oligo-anuria, metabolic acidosis, hydro-electrolytic imbalances, azotemia.

We performed 47 CAVH and 31 CVVH, so divided: 25 CAVH and 26 CVVH in CSIC; 7 CAVH and 3 CVVH in CVIC; 15 CAVH, 2 CVVH in ICU. The difference between the ages in the CAVH/CVVH group were not significant (CAVH 66.3 ± 1.3 years; CVVH 64.8 ± 1.8 years). The mean ±SE of days of procedure were globally 4.37 ± 0.4 (CAVH 4.16 ± 0.6; CVVH 4.68 ± 0.7).

Global survival rate was 29.49%. Mortality was significantly higher (82.4%) in patients who had undergone cardiac surgery whereas patients in ICU (septic shock, cardiorespiratory failure) had the lower mortality rate (30%). Age, chronic renal failure preceding admission, diuresis and plasma creatinine at onset did not alter the course of the disease. Survival rates did not differ globally in the CVVH group when compared to the CAVH group (CAVH 23.4% vs. CVVH 38.7%, χ² = 2.1, p = 0.15), but in the CSIC patients the CVVH group had higher survival rates (CVVH 30.8%, CAVH 4%; χ²= 6.3, p = 0.012).

Survival was not influenced by the length of the procedure. We have observed lower mortality rates, though not statistically significant, with a shorter latency between the beginning of the procedure and the clinical signs which required hemofiltration. In our population the acute and physiologic chronic health evaluation (APACHE II) was not helpful to evaluate the outcome; we found no improved survival rates in patients with lower APACHE II scores vs. higher scores (dead 18.79 ± 0.49, alive 19.4 ± 1.05).
Regional citrate is becoming the anticoagulant of choice for CRRT due to decreased incidence of bleeding problems, prolonged membrane life, lack of association with thrombocytopenia, and ease of administration. Review of data from the University Medical Center CRRT registry revealed an increase in the total calcium and a reduction in the ionized calcium with regional citrate. Thirty-three consecutive patients on CRRT for greater than 24 h with heparin or citrate anticoagulation and standard dialysate bath (Dianeal 1.5% Baxter) were analyzed for alterations in calcium, ionized calcium and magnesium. Twenty-three patients on citrate anticoagulation experienced no significant changes in mean ionized calcium; 3.59 mg/dl before CRRT, 3.07 mg/dl during CRRT and 4.16 mg/dl following CRRT. Mean total calcium increased from 8.12 mg/dl to 9.84 mg/dl on citrate though not significant (p <0.06). Ten patients on heparin anticoagulation did not experience significant changes in ionized calcium, 3.53 mg/dl before and 4.12 mg/dl after or total calcium, 7.02 mg/dl before and 8.04 mg/dl after.

Of significance, 10 of 23 patients on citrate anticoagulation developed total hypercalcemia during ionized hypocalcemia. None of the patients on heparin anticoagulation developed this same finding. Mean pH increased 0.08 units during citrate anticoagulation with only a 0.03-unit increase with heparin anticoagulation. Serum magnesium concentration did not change significantly in either group. Anticoagulation with regional citrate is associated with a number of factors which alter plasma levels of ionized and total calcium. Metabolism of citrate can lead to metabolic alkalosis which can potentiate protein binding of calcium thus lowering the ionized fraction. Calcium complexed to citrate and protein can lead to spurious elevations in the total calcium. These data emphasize the importance of frequent measurement of ionized calcium during CRRT and the pitfalls of following the total calcium.
97/016: A STUDY OF METABOLIC CONTROL WITH PHYSIOSOL, A BICARBONATE BUFFERED STERILE DIALYSATE, COMPARED TO STANDARD LACTATE BUFFERED SOLUTION, DURING SLOW CONTINUOUS VENO-VENOUS HEMODIALYSIS

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Purpose: To determine whether Physiosol, a bicarbonate-buffered dialysate used for CVVHD provides superior metabolic control in critically ill patients with acute renal failure.

Background: Bicarbonate dialysate has become the standard of care for intermittent hemodialysis in chronic renal failure. Acetate which was associated with vascular instability and hypoxemia was replaced once the technical difficulties associated with bicarbonate and calcium were resolved. In acute renal failure in the intensive care unit, the use of bicarbonate dialysate has been cumbersome with the majority of centres utilizing lactate buffered solutions. Acute renal failure in the intensive care unit is accompanied by metabolic derangements and high overall patient mortality. The number of physiologic derangements on presentation to the ICU with acute renal failure is proportional to patient outcome. Organ replacement therapies, such as continuous veno-venous hemodialysis (CVVHD), should correct and not create these derangements. It is unclear whether the low pH of peritoneal dialysis solution (pH 5.4) or sodium lactate used as buffer will worsen existing lactic acidosis due to tissue hypoxia and/or liver dysfunction. A bicarbonate buffer for CVVHD could provide a more physiologic dialysate.

Design: Randomized cross-over design. Patients received 48 continuous hours of lactate buffered (Dianeal, 40 mmol/l lactate, 1.5% glucose, Baxter Inc, Toronto, Canada) or bicarbonate-based dialysate (Physiosol, 35 mmol/l bicarbonate, 0% glucose, Vaughan, Canada) on CVVHD in random order. CVVHD was carried out using a Prisma Dialysis machine (Hospal Inc.) and an AN69 filter (Hospal Inc.) in all patients. Patients were treated with hemodialysis and not hemofiltration and the ultrafiltration adjusted as necessary for each patient. The sample size of 24 was calculated to detect a difference in bicarbonate level of 12.8% ±3 mmol) with an alpha of 0.25 two tailed and beta = 0.1.

Eligible Patients: All patients with acute renal failure requiring hemodialysis who were felt to be suitable candidates for continuous veno-venous hemodialysis in the intensive care unit were eligible.

Results: At the present time 3 patients have completed the protocol. The average age was 70, all were male and the cause of renal failure was ATN due to trauma in one, alcoholism and sepsis in one and pancreatitis and sepsis in the third patient. Results for patients expressed in mmol/l ± standard deviation) are mean over 48 h.
Conclusion: While bicarbonate dialysate does not appear to confer an advantage in metabolic control over lactate buffered dialysate for CVVHD, in these few patients there was a trend to reduced lactate levels.
97/017: EFFICACY OF CONTINUOUS HEMODIAFILTRATION IN THE TREATMENT OF PATIENTS WITH SEVERE ACUTE PANCREATITIS

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Severe acute pancreatitis (SAP) remains to be a challenge to the modern medical practice despite recent advances in critical care. On the other hand it has been claimed that activated cascade of humoral mediator including cytokine and neutrophil elastase plays a major role in the pathophysiology of SAP. Furthermore, clinical data from our laboratory as well as from others clearly indicate that continuous hemodiafiltration (CHDF) can effectively and continuously remove various humoral mediators from blood stream of a patient. Therefore we applied CHDF in the treatment of the patient with SAP aiming at the removal of causative humoral mediators.

Fourteen patients with SAP diagnosed according to the criteria of Ministry of Health and Welfare of Japan were entered to the study. All the patients were male and ranging from 29 to 73 years in age. All of them developed single or multiple organ failures such as respiratory and renal failure. Their average Ranson's score was 4.1 ±1.2 (mean ±SD). CHDF was performed using a PMMA (polymethylmethacrylate) hemofilter and nafamostat mesilate as anticoagulant. The standard blood flow, filtration rate and dialysate flow was 60 ml/min, 300 ml/h and 500 ml/h, respectively. Conventional therapy such as intravenous hyperalimentation and intravenous pro-tease inhibitor administration was also applied.

Twelve patients survived resulting in the survival rate of 85.7%. Five patients received open peritoneal drainage when they became septic. Mean duration of CHDF treatment was 12.9 ±11.2 days. There was no complication of CHDF such as bleeding tendency. The changes in the blood levels of TNF, interleukin 6 and interleukin 8 indicate that those cytokines were removed effectively with CHDF. CHDF also effectively improved the respiratory index through the removal of causative humoral mediators of the increased permeability of alveolar membrane and resultant pulmonary interstitial edema. CHDF was also very beneficial in the maintenance of water and electrolyte homeostasis. Thus we conclude that CHDF is an inevitable therapeutic tool in the treatment of the patient with SAP.
97/018: OUTCOMES ASSOCIATED WITH THE PRISMA CONTINUOUS VENOVENOUS RENAL REPLACEMENT THERAPY SYSTEM

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While pumped continuous renal replacement therapy (CRRT) in the ICU setting is recently increasing in popularity, there is still no proof that outcomes are improved. This paper describes our experience using Prisma (Hospal-Gambro) to deliver continuous veno-venous hemodialysis (CWHD), at the Toronto Hospital (TTH), a large academic tertiary care teaching hospital. Technical data are reported in a separate abstract.

We retrospectively reviewed the medical records of 73 consecutive patients treated with CVVHD from implementation of this program on March 14, 1995 to July 14, 1996. Data collected from these patients included APACHE II scores; number of failing organs; presence of sepsis; type of vascular access; need for inotropic support, ventilation, or total parenteral nutrition (TPN); and various dialysis parameters. APACHE II scores were either recorded on entry to the ICU or reconstructed from the patient's medical records retrospectively. Three patients were treated on CWHD at two different time periods during their stay at the ICU; in the subsequent analysis they will be considered as two separate treatments respectively (i.e. 76 treatments). Fifty-two male and twenty-one female patients have been treated thus far. Their mean age was 56.3 years (range 24–84). Vascular access was achieved via femoral vein in 59 patients, 9 required subclavian venous access while 8 utilized internal jugular venous access (3 patients required two different kinds of vascular access). The mean APACHE II Score was 25.0 (range 6–55). The mean number of failing organs was 2.4 (range 1–4). Sepsis was present in 39 patients. On commencement of CWHD, 52 patients required inotropic support (dopamine, epinephrine, or norepinephrine), 57 required ventilator support, and 6 required TPN. During CWHD therapy, 6 additional patients required inotropes, 3 were ventilated and 8 began TPN.

Thirty patients survived to be discharged from the ICU (34.2%); of these 11 were later discharged home, 8 died on the ward, while 11 were transferred to another institution. Forty-seven patients died in the ICU. Survival to discharge was therefore only 28.9%. Stratified by APACHE II score, survival to discharge was 27.7% for 18 patients <19, 30.6% for 36 patients 19–29, and 27.3% for 22 patients >29.

In conclusion, a CVVHD program using the Prisma system has treated 73 patients. Overall survival remains relatively poor. Whether benefits will extend to reducing morbidity and mortality in this high-risk group (or in certain subgroups), awaits future prospective, comparative studies.
97/019: IMPLEMENTATION OF A CONTINUOUS RENAL REPLACEMENT PROGRAM: THE INTENSIVE CARE UNIT EXPERIENCE

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Continuous Renal Replacement Therapy (CRRT) has recently increased in popularity as a treatment of choice among critically ill patients who present with renal failure. In terms of patient outcomes, the introduction of this therapy, has proven advantageous for hemodynamically unstable patients in the Intensive Care Unit (ICU), as it is now a viable medical treatment option, when standard dialysis therapies are contraindicated or not available.

Because patient care in the ICU often focuses on a broader aspect of care, the introduction of any specialized procedure represents a significant challenge for all involved. The recent implementation of a CRRT program in our ICU, has represented a considerable achievement for our community hospital, a medical facility which lacks a dialysis unit for back up support.

Prior to the implementation of the Prisma Continuous Fluid Management System, standards of care were developed around these types of patients, as well as medical directives, policies and procedures, and new documentation flow sheets. A comprehensive education program and detailed learning package were also developed in order to assist staff in the care of these types of patients. A certification program was also implemented in order to ensure staff competency, patient continuity, and standardization of care.

This oral presentation will discuss the development and implementation of a successful CRRT program recently introduced into our ICU. An emphasis on implementation, program design, and educational strategies will be discussed, as well as successes and obstacles encountered along the way.
97/020: CONTINUOUS VENO-VENO HEMOFILTRATION IN PEDIATRIC PATIENTS

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Once a patient has been identified as a Continuous Renal Replacement Therapy candidate, the technical aspects of initiation of therapy will determine the success of this intervention. At Children’s Hospital, Seattle, Wash., 55 pediatric patients have undergone Continuous Veno-Veno Hemofiltration (CVVH) therapy over the past 5 years. The patients ranged in age from 1 day to 21 years (mean 4.4 years) and weighed 1–60 kg (mean 17.1 kg).

Adequate access in the infant less than 5–7 kg may require insertion of two single lumen catheters, Fr. 3–5. In infants and children greater than 5–7 kg an adequately large double lumen catheter (Fr. 6.5–12) will prove successful in the majority of patients.

In our institution the BM 11™ (Baxter) pump for CVVH is utilized. Pump speeds vary depending on patient and access size ranging from 30 to 300 ml/min. The pump speed may be limited by catheter characteristics. The Hotline Blood Warmer (SIMS Level 1, Inc.) is used in line to maintain temperature stability. This is particularly important in small patients.

Priming solution is selected with consideration for patient size and stability. A 1:1 dilution of packed red blood cells and 5% albumin is indicated if circuit size >= 10% of the total blood volume or for severe anemia or hemodynamic instability. In larger or more stable patients, normal saline or 5% albumin may be used. Anticoagulation with heparin is used to maintain an activated clotting time (ACT) of 180–200 s. Patients with underlying coagulopathy or hemorrhage risk may be treated without heparin with careful attention to ACT and circuit function. Anticoagulation is achieved with a heparin bolus of 25 U/kg followed by continuous infusion of 10 U/kg/h. Dilutional fluids are run pre-filter at a starting rate of 10 ml/kg/h. This rate can be adjusted upward for improved clearance of non-protein bound solutes. The choice of dilutional fluid depends on the indication for therapy. Ringers Lactate is often acceptable. For the patient with metabolic acidosis additional bicarbonate can be given in the dilutional fluid. If calcium containing dilutional fluids are being used, bicarbonate can be given as a drip post-filter or via alternate intravenous (IV) access to avoid calcium carbonate precipitation. The current practice of high dilutional fluid rates has shown excellent clearance without the need for countercurrent dialysate (CVVH/D) in the majority of patients.

Net ultrafiltration rate is determined by the desired volume status of the patient. The rate of ultrafiltrate is controlled by an IV pump, and may exceed the ability of a single IV pump requiring two or more pumps in series.

The CVVH circuit will remove medications that are not protein bound. Those medications will require level monitoring and dose adjustment upward to achieve therapeutic levels.

Monitoring of electrolytes, ionized calcium, glucose, magnesium, and phosphorus is required prior to initiation of treatment and at least every 6 h to assess replacement needs for solute losses. Hematocrit and platelet count are monitored every 12–24 h. Platelet count may decline due to membrane adherence and destruction within the circuit.
These 55 patients treated with CVVH received 192 patient days of therapy (mean 5.1 days/patient, ranging from 1 to 24 days per patient). Complications potentially attributable to the therapy included 1 patient with hyperglycemia (with CVVH/D), 5 patients with thrombocytopenia, 1 with aortic thrombus, 1 with portal vein thrombosis, and 1 with hemorrhage. 50% of these patients survived and were able to discontinue CVVH. The remainder succumbed to the primary disease and its complications. Our experience demonstrates the utility of CVVH in the pediatric population. This procedure can be performed successfully in even the smallest infant with few serious complications.
97/021: INFLUENCE OF HIGH VOLUME HAEMOFILTRATION ON THE HEMODYNAMIC COURSE AND OUTCOME OF PATIENTS WITH REFRACTORY SEPTIC SHOCK. RETROSPECTIVE STUDY OF 15 CONSECUTIVE CASES

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ICU Ottignies, Belgium

Background and Objectives: High volume haemofiltration may have beneficial effects on the course of septic shock but there is little documentation of its effects on humans. Accordingly, we retrospectively studied the clinical features and haemodynamic course of 15 patients with septic shock treated with high volume haemofiltration.

Clinical Status on Admission: Fifteen consecutive cases of refractory septic shock were retrospectively studied. They were admitted between January 1995 and July 1996. All the patients were mechanically ventilated. The mean arterial pressure measured was less than 52 mm Hg. Mean arterial pH was less than 7.13. Mean lactate (in mmol/l) was 8.6 (nl value <1). The cardiac index on admission was less than 1.8 l/min/m² despite high doses of adrenaline >35 mg/min) and also noradrenaline >10 mg/min). Mean Apache II score was 31 and the expected mortality was 79%.

Setting: ICU of tertiary hospital.

Haemofiltration Technique: All these patients were put on 'high volume' haemofiltration. The haemofiltration technique consisted in an exchange of 35 l in 4 h period of time with achieving a neutral balance. We used a ‘Gambro’ machine with polysulphone membranes (1.6 m² of surface - capillary filters) and we used bicarbonate in the exchange fluid. We used a post-dilution technique.

Results and Statistics: (1) Influence on the haemodynamic course: All the data were analysed using nonparametric statistical methods. Seven patients (responder group) improved dramatically during the procedure as show by the following table. Responder Non- Time p value
### Table 1

<table>
<thead>
<tr>
<th>Time after onset of procedure</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>T0</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Responder group n=7</th>
<th>Non-responder group n=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.13</td>
<td>7.11</td>
</tr>
<tr>
<td>Mean arterial pressure</td>
<td>51.6 mm Hg</td>
<td>46.6 mm Hg</td>
</tr>
<tr>
<td>Cardiac index</td>
<td>1.76 l/min/m²</td>
<td>1.85 l/min/m²</td>
</tr>
<tr>
<td>Inotropic support</td>
<td>A = 36.6 µg/min</td>
<td>A = 38.2 µg/min</td>
</tr>
<tr>
<td>NA</td>
<td>10.6 µg/min</td>
<td>13.3 µg/min</td>
</tr>
<tr>
<td>T4</td>
<td>&gt;7.3</td>
<td>&lt;7.15</td>
</tr>
<tr>
<td>T4</td>
<td>&lt;0.01*</td>
<td></td>
</tr>
</tbody>
</table>

**SVO₂**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Increase</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>&gt;50%</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>T2</td>
<td>&lt;0.01*</td>
<td></td>
</tr>
</tbody>
</table>

A = adrenaline, NA = noradrenaline. T0 = start, T2 = after 2 h, T4 = after 4 h. SVO₂ = global venous saturation. Only 6 patients survived and were discharged from the hospital. One `responder` died two weeks after from multiple organ failure. *significant were comparing with the other group.
The observed mortality was only 60% (statistically different from the predicted mortality). Both groups were similar in terms of APACHE II scoring and expected mortality, but were significantly different regarding the time of intervention.

**Conclusion:** Our retrospective study suggests a beneficial effect of high volume haemofiltration on the haemodynamic course of patients with septic shock. Response to the therapy is variable and appears to be dependent on the time of intervention. Early intervention is associated with significantly higher likelihood of improvement.
97/022: CONTINUOUS HEMODIAFILTRATION CAN REMOVE HUMORAL MEDIATORS FROM BLOOD STREAM OF PATIENTS WITH SYSTEMIC INFLAMMATORY RESPONSE SYNDROME AND MULTIPLE ORGAN FAILURE

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There has been controversy concerning the removal of humoral mediators from the blood stream of patients with continuous renal replacement therapy. Therefore the present study was undertaken to investigate whether continuous hemodialfiltration (CHDF) can remove the humoral mediators from the blood stream of the patient with systemic inflammatory response syndrome (SIRS) and multiple organ failure (MOF).

CHDF was performed using a PMMA hemofilter with a membrane area of 1.0 m². Nafamostat mesilate, a synthetic protease inhibitor, was used as anticoagulant. The standard blood flow, filtrate flow and dialysate flow was 60 ml/min, 300 ml/h and 500 ml/h, respectively. The levels of cytokines such as TNF, interleukin-6 (IL-6), interleukin-8 (IL-8), C3a, lipid peroxide and granulocyte elastase in the blood at inlet and outlet of hemofilter as well as in the mixture of filtrate and dialysate were measured. The changes in the blood level of those humoral mediators following 3 days of CHDF treatment was evaluated. Clearances of those humoral mediators were also calculated.

The clearance of TNF, IL-6, IL-8, C3a and lipid peroxide significantly and positively correlated with the blood level of those humoral mediators. However there was no significant correlation between blood level and clearance with granulocyte elastase. The blood levels of TNF, IL-6 and IL-8 decreased significantly among the patients with high blood level of those cytokines before the CHDF treatment. On the other hand the blood level of those cytokines did not change significantly when its blood level was not elevated before the initiation of CHDF treatment.

Those results indicate that CHDF can effectively remove cytokines from the blood stream of a patient and that the removal of cytokines is not only through the convection and diffusion but also through the adsorption of the cytokines to the hemofilter membrane. Therefore it could be suggested that CHDF can play an important role as a cytokine modulator in the treatment of the critically ill with hypercytokinemia.
97/023: IMPROVED SURVIVAL WITH CONTINUOUS VENO-VENOUS HEMOFILTRATION IN NONOLIGURIC BURNED SEPTIC PATIENTS

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Continuous veno-venous hemofiltration (CVVH) is a safe and effective method for renal replacement therapy in critically ill patients. We have used CVVH in nonoliguric burned septic patients with ARDS to evaluate its role in preventing MSOF.

Methods: All patients met Bone’s criteria for sepsis, and had an urinary output <1 ml/kg/h. Patients were selected for CVVH based on availability of the apparatus and of trained personnel. The selected patients presented a burn area between 50 and 70% of the body surface area, and a burn degree of II and III. CVVH was continued until the PaO₂/FIO₂ ratio was 250 or higher. CVVH was performed with a polyamide hemofilter (Gambro FH 66D), via two high flow 8F femoral catheters. All untreated patients meeting the same criteria during the study were used as controls. SAS was used for statistical analysis.

Results: Over the study period 11 patients met the inclusion. 4 patients were treated with CVVH and 7 were not (controls). Although both groups were similar, the PaO₂/FIO₂ ratio was lower in the CVVH group, and this value showed a marginal improvement with CVVH. The survival rate was significantly higher in the CVVH group (3 of 4 patients in CVVH group compared to 1 of 7 in control group).

Conclusions: This nonrandomized cohort study shows a significant higher hospital survival rate when CVVH was added to the conventional treatment of nonoliguric burned septic patients. The predicted mortality rate of septic burned patients with a large burn area and respiratory failure is near 70% (Wong MK, Ngim CK, Burns 1995). This high mortality rate was seen in conventional therapy group, while survival was higher in CVVH group. We speculate that this improvement is probably the result of either better fluid balance control or the clearance of toxic mediators.
<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>CVVH</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 7)</td>
<td>(n = 4)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>58.2 (17.9)</td>
<td>53.9 (18.9)</td>
<td>0.57</td>
</tr>
<tr>
<td>% males</td>
<td>56</td>
<td>75</td>
<td>0.68</td>
</tr>
<tr>
<td>APACHE</td>
<td>11.8 (5.8)</td>
<td>16.1 (3.8)</td>
<td>0.45</td>
</tr>
<tr>
<td>TISS</td>
<td>32.6 (8.0)</td>
<td>35.96 (5.2)</td>
<td>0.14</td>
</tr>
<tr>
<td>(\text{PaO}_2/\text{FiO}_2)</td>
<td>150 (60)</td>
<td>110 (40)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Survival</td>
<td>46.1%</td>
<td>77.0%</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Daily fluid balance, l/d</td>
<td>+16.4 (6.2)</td>
<td>-4.8 (2.7)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
97/024: PLASMAPHERESIS IN SEPTIC PATIENTS PERFORMED BY A NEW CONTINUOUS HEMOFILTRATION MACHINE

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**Introduction:** To the best of our knowledge not a great deal is known about the effects of plasmapheresis on septic patients. Owing to the development of new equipment which automatically balances continuous veno-venous hemodiafiltration, this equipment may also make the use of plasmapheresis easier. The aim of the study was to investigate if, for the first time, one of these new continuous hemofiltration machines can also be used for automatically balanced plasmapheresis (Prisma™, Hospal Inc. France) and whether there are any effects on the patient’s hemodynamic status or inflammatory process.

**Methods:** Ten septic patients with multiple organ dysfunction syndrome, including acute renal failure following surgery, were included in this institutionally approved study having obtained the informed consent of the relatives. The maximum amount was 4.81 of plasma replacement (1,500 ml/h initially). During plasmapheresis patients were intravenously heparinized with 250–500 IE/h, depending on the activated clotting time (160–180 s). Blood flow was kept constant with 80 ml/min, the removal rate was at a maximum of 100 ml/h according to the clinical requirement. If required, the removal rate or substitute was reduced to keep the transmembranous pressure (TMP) below 150 mm Hg. The filter’s (Gambro, PF 2000) TMP was measured, the patient’s hemodynamic parameters registered and blood samples were taken to determine the inflammatory parameters before and after treatment.

**Statistics:** Wilcoxon matched pairs signed rank sum test.

**Results:** The median age was 54 years (48–67). In 5 patients only 1 filter was required to replace the full amount of plasma. In the other 5 patients (causes 3 TMP increases due to clotted filter, 1 due to technical alarm of the machine, 1 catheter related) a maximum of 2 filters was used. In these cases a median of 2.11 (1.8–4.8 l) of plasma was replaced. The TMP’s increase was described using the formula y [mm Hg] = b ´ m x [minutes] (b = [6.3; 275], median 34.3 and m = [0.95; 1.04], median 1.01).
Conclusion:

From a technical point of view this automatically balanced continuous veno-venous hemofiltration machine is suitable for plasmapheresis. In as little as 30% of our patients the clotted filter had to be exchanged to reach the full amount of plasma replacement. To evaluate additional effects on septic patients concerning the inflammatory process further studies are required.
97/P01: TECHNICAL EXPERIENCE WITH THE PRISMA CONTINUOUS VENOVENOUS RENAL REPLACEMENT THERAPY SYSTEM

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University of Toronto, Toronto, Canada

Pumped continuous renal replacement therapy (CRRT) in the ICU setting has gained increasing acceptance over the past decade. Recently, a commercial manufacturer developed a sophisticated machine dedicated to the delivery of various pumped modalities in the critical care unit (Prisma, Hospal-Gambro), which we introduced in March 1995. This paper describes our experience using Prisma to deliver continuous venovenous hemodialysis (CVVHD), at the Toronto Hospital (TTH), a large academic tertiary care teaching hospital. Outcomes are reported in a separate abstract.

We retrospectively reviewed the medical records of 73 consecutive patients treated with CVVHD from implementation of this program on March 14, 1995 to July 14, 1996. Three patients were treated on CVVHD at two different time periods during their stay at the ICU; in the subsequent analysis they will be considered as two separate treatments respectively (i.e. 76 treatments).

Our current CVVHD protocol is as follows. The Prisma machine uses a 0.5 m² AN 69 hollow fibre filter which was changed every 48 h initially but more recently every 72 h. Standard dialysate is Hemosol. Standard anticoagulation regimen consists of heparin infused at a rate of 500 U/h, dialysate flow rate is 1 l/h, blood flow rate is 100 ml/h. The amount of net ultrafiltration is sufficient to achieve an appropriate fluid balance and there is no infusion of physiological replacement fluid.

Fifty-two male and twenty-one female patients have been treated thus far. Their mean age was 56.3 years (range 24–84). Total time spent by patients on CVVHD was 7,993 h, with a mean time of 109.5 h; treatment length ranged from less than 1 day to 28 days. Mean filter life was 30.4 h. Of the 263 filters used, 139 were changed for protocol reasons (53%), while the rest were changed early due to clotting or other problems.

Nineteen patients were on CVVHD for less than 24 h and are not included in the clearance data reported below. The mean values for plasma urea, serum creatinine, and serum potassium on commencement of CVVHD were 30.7 mmol/l, 419 mmol/l, and 4.5 mmol/l, respectively. Mean urea levels dropped to 24.7 mmol/l by the third day of treatment and to 20.2 mmol/l by the fifth day. Mean creatinine levels dropped to 318 µmol/l and 282 µmol/l over the same time period. Mean potassium levels were maintained in the normal range throughout. Mean actual (delivered) ultrafiltration rate was 106 ml/h (range 0–500).

In conclusion, a CVVHD program using the Prisma system has been successfully implemented at TTH. Technically, we are delivering good dialysis and ultra-filtration, with reasonable filter life. CVVHD is effective in so far as it allows provision of renal replacement therapy to these unstable patients.
97/P02: A PROSPECTIVE RANDOMISED CONTROLLED STUDY COMPARING TWO HAEMOFILTER MEMBRANE SURFACE AREAS WITH CIRCUIT LIFE IN ULTRAFILTRATE CONTROLLED CONTINUOUS VENO-VENOUS HAEMOFILTRATION

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**Introduction:** Hemofilters are available in a variety of surface areas. In pump controlled hemofiltration, the onset of negative pressure in the ultrafiltrate line is prolonged in larger filters. This delayed onset of negative pressure is possibly due to a slower rate of membrane fouling and capillary clotting. This may result in a clinically important increase in filter life. Hypothesis: In pump controlled ultrafiltrate CVVHD, circuit life, number of hours before clotting and failure, is longer in large surface area filters. Accordingly we compared two Hollow Fibre hemofilters of differing surface areas (Hospal AN69 Filtral.tm, 0.75m² , versus Hospal AN96 Filtral.tm,1.30 m²).


**Results:** Number of circuits: 130 (65 each group). Mean circuit life: Filtral 8: 16 h ±12.2 SD), and Filtral 12: 15.75 h ±14.3 SD). t test p = 0.972. No correlations existed between circuit life and INR, APTT, Hb or platelet count. 21% of circuit failures were due to venous chamber clotting and occurred with equal frequency in both groups.

**Conclusion:** A hemofilter surface area of 1.30 m² does not offer any circuit life advantage over a hemofilter with a surface area of 0.75 m² in ultrafiltrate controlled CVVH. Clotting of CVVH circuits remains a clinical problem and is significantly affected by factors other than membrane surface area, APTT, INR, platelet count and haemoglobin i.e. mechanical factors related to blood flow and access.
97/P03: A PROSPECTIVE ANALYSIS OF CIRCUIT LIFE IN CONTINUOUS VENO-VENOUS HAEMOFILTRATION WITH HEPARIN ANTICOAGULATION USING THROMBOELASTROGRAPHY (TEG)

I. Baldwin, R. Bellomo, N. Bridge
Austin and Repatriation Medical Centre, Heidelberg, Australia

Introduction: The measurement of clotting parameters (INR, APTT, platelets) in CVVH with anticoagulation is common practice. In our experience there appears to be little correlation between these measured parameters and circuit life. Accordingly, we used TEG measured parameters to identify markers by which to titrate anticoagulation therapy and predict circuit life. The TEG is a measure of blood coagulability. We correlated the TEG in 20 consecutive CVVH circuits to patient INR, APTT, platelet count and circuit life.


A correlation existed between heparin dose and circuit life but none existed between APTT and circuit life. A correlation also existed between 30 min clot lysis time and circuit life.

Conclusions: The TEG offers some clinical advantage in detecting a marker demonstrating suitable heparin anticoagulation levels and predicting extracorporeal circuit life. Measurement and maintenance of APTT at specific levels does little to predict or determine the extracorporeal circuit life.
97/P04: THE TEACHING POSTER FOR ICU NURSES ON CONTINUOUS VENO-VENOUS HEMODIALYSIS: A REVIEW AND A RESOURCE

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Program Summary: A dialysis department responsible for continuous renal re-placement therapies (CVVH or CVVHD) only provides on-call staff support during weekends and evenings after 22.30. Critical care nurses provide routine monitoring and troubleshooting of the patients and equipment during these times. The dialysis department designed and implemented a successful education campaign that positively impacted the critical care nurses skills, knowledge, and attitudes; and assured their competence when caring for patients undergoing CRRT.

Program Goal: Safe and effective provision of CRRT during times and shifts when critical care nursing staff are responsible for patient and equipment monitoring and troubleshooting, as well as routine and emergent shutdown of the equipment.

Problem: We identified knowledge and skill deficits among the critical care nurses responsible for the routine and emergency shutdown procedures for this ‘home-grown’, unfamiliar equipment setup. Our clinicians easily outlined program content. However, this is a worst-case scenario for intervention design: rare, equipment intensive procedures for which errors have lethal consequences. We also identified attitudinal barriers to performance. These critical care nurses felt that monitoring CRRT was not their job and their lack of expertise in this complicated setup put their patients at risk and made them legally vulnerable.

Intervention: We compared the effectiveness and costs of various formats and arrived at an intervention that kept costs at minimum and assured competence; a full color, illustrated job guide (in poster form) showing the procedures in numbered steps and diagramming the appearance and function of each component of this complicated setup. We used the job guide in several ways: (1) As a teaching aid for providing just-in-time training; (2) as a self study poster for the critical care staff to review the rationale and procedures for CRRT; (3) as an algorithmic aid to the routine and emergent shutdown of the equipment due to clotting, leakage, or patient emergencies, and (4) as a visual ‘map’ and a shared vocabulary to aid telephone communication between the on-call Dialysis Nurse and the critical care staff.

Evaluation: We assessed nurses’ performance in a simulation, and found that the job guide was a highly successful intervention. After an initial orientation, they were able to use the job guide to perform the routine and emergent shutdown procedures with no additional assistance. An important side benefit was the immediate improvement in attitude among nurses after using the job guide. They expressed excitement and interest in CRRT and stated that, with this new aid, they were looking forward to caring for patients with CRRT.
97/P05: CONTINUOUS ARTERIO-VENOUS HEMOFILTRATION (CAVH) USING HEPARIN-COATED AND NON-HEPARIN-COATED MEMBRANES IN CRITICALLY ILL PATIENTS: EFFECTS ON PLATELET COUNT

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Abstract

Introduction: Critically-ill patients frequently present SIRS for various reasons (trauma, ischemia-reperfusion injury, infection...), which induces coagulation abnormalities in thrombopenia or DIC... For these reasons, hemofiltration (HF) indications might be restricted if platelets are consumed, heparin is needed or frequent membrane change is required.

Patients and Methods: 37 consecutive CAVH were performed on 22 mechanically ventilated critically ill patients, using a non-heparin-coated membrane (Hemospal-AN69, n = 24) or a heparin-coated membrane (Duraflo II-PSHF 1200, n = 13). Patients with platelet transfusion were excluded. When indicated, anticoagulation was administered systemically (Duraflo II) or in the circuit (Hemospal). Age, SAPS, indication, duration and evolution of CAVH, depletion rate, heparin in-fusion rate were recorded. Platelet count, coagulation times, urea and creatinine were measured before, 0–12 h and 12–48 h after membrane insertion. Statistical analysis: mean ±SE, with 2-way Anova.

Results: Baseline patients’ characteristics were identical in the 2 groups. HF was indicated for volemic control (n = 7), acute renal failure complicating high risk surgery (n = 9), septic shock (n = 10) or ARDS (n = 11). Heparin was not used for 4 HF (Hospal n = 1, Duraflo II n = 3). Heparin was given systemically (for the 10 Duraflo II membranes), or in the membrane (for the 23 Hospal membranes). Depletion rate, urea, creatinine, duration of HF and heparin infusion rates were similar. Compared to Hospal membranes, platelet count was stable over time for Duraflo II membranes (figure). Causes of HF discontinuation were circuit thrombosis (50%), planned change (28%) or death (23%).
Conclusion: Platelet count and ATT remained stable with the Duraflo II membrane. This impact on coagulation remains unclear and requires randomized trials.
97/P06: PHARMACOKINETICS OF CEFPIROME DURING CONTINUOUS VENOVENOUS HEMOFILTRATION

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¹Department of Internal Medicine I, Division of Infectious Diseases; ²Internal Medicine II, Intensive Care Unit, University of Vienna, Austria

Introduction: Cefpirome is a new cephalosporin of the ‘fourth generation’ eliminated primarily by the kidneys. The substance offers a broad activity against gram-positive and gram-negative bacteria. Thus, it is particularly useful in the empirical therapy of intensive care patients (patients). However, no pharmacokinetic data exist on cefpirome in patients with continuous venovenous hemofiltration (CVVH). The present study was conducted to establish dosage recommendations in patients with CVVH.

Methods: Nine patients with anuric acute renal failure were included in the study. All patients received 2 h cefpirome t.i.d. As dialyzer a polysulfone membrane (Diafilter-30, Amicon, Ireland) was used. Cefpirome serum concentrations and filtrate aliquots were determined by high-performance liquid chromatography.

Results: Peak serum concentrations after the first 2 g cefpirome were 14.9 ±3.1 mg/ml in arterial and 12.4 ±3.0 mg/ml in venous samples. Arterial and venous trough levels after 8 h were 3.3 ±1.3 mg/ml and 1.8 ±0.6 mg/ml, respectively. A mean of 75.2 ±7.8% of the cefpirome dose was removed between the arterial and venous port of the dialyzer. Mean pre and post administration concentrations during CVVH (observation period 57 h) were 4.74 mg/ml and 9.2 mg/ml, respectively. No serious side effects of cefpirome were observed (figure).
Conclusion: Cefpirome used in the conventional dosage of 2 g t.i.d. results in serum levels that are above the MIC for most of the key target pathogens for between 40 and 100% of the time. However, peak levels are considerably lower in patients treated with CVVH than those reached in healthy volunteers. Further studies to establish dosage guidelines for patients on hemofiltration are necessary.
97/P07: TROUBLESHOOTING A SIMPLE VOLUMETRIC CIRCUIT FOR VENO-VENOUS DIALYSIS

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St. James’ University Hospital NHS Trust, Leeds, UK

The attempt to produce volumetric circuits in the early nineties for continuous veno-venous dialysis/filtration for acute renal failure employing infusion pumps was unsatisfactory. This led to our producing equipment comprising dual pumps with a single drive (i.e. linked mechanically by a timing belt) which balances the flow of dialysate to and from the dialyser for the performance of continuous venovenous haemodialysis. Ultrafiltration is achieved by an infusion pump connected via a compliance chamber [1].

There was concern always over the accuracy and stability of the balance components during treatment. Since 1992 we have completed 1,633 treatments, with problems due to a positive balancing error in 2 cases. This was recognised from oedema, oxygen desaturation and fluid charts, since weigh beds were not in use. Positive balance was corrected without morbidity or mortality. We have not recognised negative balance errors, but these may have been obscured in the severely ill.

Checks revealed that although the pump heads can only turn at the same speed, the pump providing fluid to the dialyser was passing a greater volume than that removing the fluid from the dialyser. At worst this occurred at a rate up to 2 ml/min. The discrepant fluid was forced into the patient through the High flux hollow fibre dialyser, since there was no pre-filter pressure device to alert nursing staff. The duration of treatment was not found to be relevant. It was discovered that changes in the production method of the line sets were responsible.

The solution to the problem was twofold: (1) The two plastic pump chambers of the line set are now made to closer tolerance, from a single length of evenly-stretched tubing. (2) A procedure for daily checking of the balance of the system is in place. A simple bypass of the dialyser allows any pump asymmetry to be detected quickly, and with great sensitivity, without disrupting treatment to the patient. The result is an ability to identify any balance error in the system at an early stage and allow correction to meet acceptable fluid balance limits. These safeguards, which have been operating successfully for the past four years, allow the safe volumetric management of a wide range of acute renal and hepatic conditions in the Intensive Care Unit.

97/P08: A NEW CATHETER FOR CONTINUOUS ARTERIAL-VENOUS HEMOFILTRATION

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**Purpose:** To develop and test a new catheter for arterial and venous access during continuous arterial-venous hemofiltration (CAVH) that would extend the life of a filter, by allowing for high flow and measurement of arterial and venous pressure at the site of catheter insertion.

**Methods:** A bi-lumen catheter was developed. The catheter is 10 cm long. It consists of two separate lumens, the larger being 8.5 gauge, the other being 20 gauge. The smaller lumen tracks down the inside of the 8.5 gauge lumen exiting laterally at the distal end of the catheter. Both the arterial and venous vascular femoral access was obtained the smaller lumen was attached to pressure monitor. The arterial and venous pressure were titrated to maintain a delta greater than 50 mm Hg across the filter. A Biospal filter was used for CAVH. Patients were systemically anticoagulated. Length of time to filter failure was recorded.

**Results:** 82 catheters were used in 41 patients over a 4-year period. 32 patients received CAVH for >48 h. The average time for CAVH was 6 days. The average time until filter failure was 4.8 ±1.3 days. Prior to the use of the new bi-lumen catheter the average filter failure occurred at 3 days. Average ultra-filtration volume was 380 ±104 cm³/h. Only two filters failed within a 48-hour period. The most common reason for filter failure was clot formation in the filter tubing at the venous access sideport.

**Conclusions:** There is very little specific literature as to the length of time to filter failure. Our data demonstrates at our institution we are able to extend the life of our CAVH filters by approximately 2 days. Realizing that there are many influence as to the time of filter failure we feel that this new bi-lumen catheter offers the advantages of a large lumen, short length, stiffness, and the ability to continuously measure hemodynamic pressures at the distal tip of the catheter and maintain the delta across the filter. The use of the bi-lumen catheter also removed the need for a separate arterial and central venous catheters while doing CAVH.
97/P09: BENEFICIAL USE OF HIGH VOLUME HAEMOFILTRATION IN A CASE OF REFRACTORY ‘TOXIC STREP SYNDROME’

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Background: Devastating toxic shock syndrome due to streptococci in young healthy patients are still very concerning in our daily practice. The mortality rate is about 30% despite all the therapeutic procedures that have been developed in the last decade. Several descriptions of favorable outcome using plasmapheresis, intravenous immunoglobulin therapy have been described before. Amongst these, haemofiltration and especially high volume haemofiltration could be used as a therapeutic rescue. We describe a case of a toxic shock syndrome who was dramatically improved after this procedure.

Case Report: A 48-year-old woman developed abdominal pain, fever and alteration in mental status. She was found to be unarousable and was admitted from the accident and emergency department to intensive care with septic shock. Mean arterial pressure was 40 mm Hg, cardiac index 0.9 l/min/m² on admission, arterial pH was 6.9 and blood lactate was at 9 mmol/l. The Apache-II score was 33 with a predicted mortality of 81%. Pulmonary gas exchange was extremely poor with a PaO₂/FiO₂ ratio of 45 and we could see signs of lung injury on the chest x-ray compatible with a setting of ARDS (adult respiratory distress syndrome). Laboratory investigations revealed severe disseminated intravascular coagulation and signs of hepatic failure. Blood cultures (three sets) grew group A streptococci. The strain was highly susceptible to penicillin. Despite being treated with respiratory support (FiO₂ of 100%), inotropes (dopamine at 8 mg/kg/min, adrenaline at 68 mg/min and noradrenaline at 20 mg/min) and antibiotics (penicillin 20 10⁶ U/day and amikacin (15 mg/kg/day), she deteriorated over time and had three consecutive cardiac arrests. She was successfully treated. A ‘rescue’ therapy with ‘high volume haemofiltration’ was initiated. This procedure consisted in an exchange of 35 liters in a 4-hour period of time with achieving a neutral balance. A ‘Gambro machine’ was used with a polysulphone membrane (1.6 m² of surface, capillary filter). Bicarbonate was used in the exchange fluid.

After a 4-hour period the clinical status of the patient improved dramatically (see graphs 1 and 2). The mean arterial pressure rose up to 65 mm Hg, the blood lactate fell down to 2 mmol/l and the pH was corrected (7.37). The SVO₂ (global venous saturation) increased up to 72%. The cardiac index rose up to 5.4 l/min/m² and the inotropic support was substantially reduced as follows: noradrenaline was stopped,
adrenaline was reduced down to 6 mg/min and dopamine was still on 8 mg/kg/min. The PaO$_2$/FiO$_2$ ratio improved up to 110. The patient was then put on classical hemodiafiltration (PRISMA with an exchange of 1 l/h and 1 liter of dialysis with a polyacrylonitrile filter (AN69, Hospal, capillary surface 1 m$^2$). Two days later the patient was weaned of inotropes, still on ventilatory support but with a FiO 2 of 30% and passing some urine (1.1 l/24 h) with furosemide infusion (40 mg/h). Unfortunately, after 7 days of support, the patient developed a nosocomial pneumonia (Pseudomonas aeruginosa) and subsequently died.

**Conclusion:** Haemofiltration and especially 'high volume haemofiltration' could be used as rescue in refractory 'toxic shock syndrome'. Obviously, we need more cases to confirm this observation. The mechanism remains unclear. M-protein and exotoxin A which play a crucial role in the setting are probably too large to be eliminated by haemofiltration. Nevertheless, these two superantigens are able to initiate the cytokine cascade and produce high amounts of cytokines which could potentially be eliminated by haemofiltration.
97/P10: LUNG DENSITY FOR ASSESSMENT OF DRY WEIGHT IN HEMODIALYSIS PATIENTS – COMPUTED TOMOGRAPHIC DENSITOMETRY TECHNIQUE

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Computed tomographic measurement of lung density is based on in vivo tomographic imaging of electron density with an accuracy of ±3%. Lung density is a blended value, determined by relative proportions of gas, blood, extravascular fluid per volume unit of pulmonary tissue; fluctuations in any of these variables can have profound effect on density measurements.

This technique has been applied before to measure changes in lung water with hemodialysis. Therefore, the aim of this study was to find out whether lung density properly reflects the hydration status in hemodialysis patients in comparison to other standard methods.

**Methods:** In 14 hemodialysis patients, with an ultrafiltration ranging from 0.3 to 4.5 liters per session, measurements were undertaken for lung density by computed tomography (CT), the diameter of the inferior vena cava after quiet expiration (IVCe) and quiet inspiration (IVCi) by ultrasonography, in addition to the hematocrit and biochemical markers (cGMP and ANP). These measurements were performed both before and 3.5–4 h after termination of dialysis. From the CT numbers (difference in X-ray attenuation between water and air, measured in Hounsfield units (HU), and by using a special computer program, quantitative estimates of lung density was obtained within the pixels of CT numbers ranging between -1000 and -100 HU, and compared to normal data from 20 normal controls.

**Results:** The range of lung density in normal controls was -800 to -750 HU. In hemodialysis patients, lung density was significantly higher than normal before dialysis -678 ±96 HU, p <0.01) and significantly decreased after dialysis -706 ±92 HU, p <0.05) implying more air introduced into the lung. Density was normalized in 5 patients. A significant correlation was present between lung density and IVCe both before and after dialysis (r = 0.8, p <0.01 for both). The change in density was significantly correlated to amount of ultrafiltration (r = 0.67, p <0.01) and percent change in blood volume (r = 0.63, p <0.05), indicating that lung density is greatly affected by the intravascular volume change. cGMP and ANF appeared to be valuable in order to detect changes rather than absolute measurements of the hydration state.

**Conclusion:** Normalisation of lung water (including intra- and extravascular) could be a good concept to achieve a proper dry weight in hemodialysis patients. This could be achieved through measuring the lung density by computed tomography.
97/P11: THERAPEUTIC PLASMA EXCHANGE CONCURRENT WITH CONTINUOUS RENAL REPLACEMENT THERAPY

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The need for both Continuous Renal Replacement Therapy (CRRT) and Therapeutic Plasma Exchange (TPE) may occur concurrently in critically ill patients. Usually, CRRT must be stopped and then restarted after each TPE is completed. The ability of CRRT to maintain or lower waste products will decrease because of time off therapy. We performed CRRT and TPE in tandem four times in three patients. The same dual lumen, central venous access was used for both procedures.

A Cobe spectre (spectre) apheresis machine was primed with normal saline, albumin or blood and infused as indicated by the patient’s hemodynamic status. A Cobe Hospal BSM-22 (Hospal) pump was used with an F40 (Fresenius) filter for CRRT. CRRT blood flow averaged 150 ml/min and TPE blood flow was 50 ml/min. Existing coagulopathy precluded the need for heparin and only 2–3 ml/min of citrate was given with TPE. To connect the Spectre and Hospal blood circuits, a three-way stop-cock was placed on each port of the central venous catheter. The Hospal blood lines were connected directly to each end of the three way stopcocks, while the Spectre blood lines were connected to each side port of the three way stopcocks intermittently. When TPE was completed, each side port was flushed and capped. Hypotension, thrombosis or excessive bleeding did not occur.

We conclude that TPE can be safely done in tandem with CRRT using the Spectre and Hospal pumps. Waste product removal is not interrupted and nursing labor and supply costs are decreased.
97/P12: OXALATE CLEARANCE IN CONTINUOUS VENO-VENOUS HEMOFILTRATION

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In normal subjects oxalate is almost entirely removed by the kidney and hyperoxalemia occurs in end stage renal disease (ESRD). Oxalate generation is not increased in these patients and oxalate removal by hemodialysis (HD) or peritoneal dialysis (PD) is equal to oxalate production. However, in primary hyperoxaluria the rate of oxalate production far exceeds the rate at which it can be removed and the patients develop systemic oxalosis.

We examined oxalate clearance in two patients with primary hyperoxaluria and ESRD using Continuous Veno-Venous Hemofiltration (CVVH). In patient 1, a 69.3 kg male, we used Diafilter ™40 hemofilter with a blood flow rate (BFR) of 150 ml/min. The filtrate oxalate concentration was determined from a 24-hour collection and plasma oxalate was measured during this same period. Oxalate clearance with hemodialysis was also determined for comparison. Hemodialysis was performed using a COBE Centrysystem ™400 HG with BFR of 250 ml/min. In patient 2, a 6.5 kg male, CVVH was performed using a Diafilter ™20 hemofilter with a BFR of 40 ml/min. The filtrate was collected for three consecutive 24-hour periods and oxalate concentration was determined. Plasma oxalate levels were measured during each of these periods and the clearance was calculated. The clearance data in the table represents an average of the three measurements. Oxalate clearance was then determined with peritoneal dialysis using 1.5% dextrose dialysate and inflow volumes of 35 ml/kg, and a dwell time of 30 min. Oxalate concentration was determined from the collected dialysate and the patient’s plasma during the treatment period. The clearance data from both patients is summarized below.

In patient 1, oxalate clearance was higher using hemodialysis. In fact, the number of milliliters of oxalate cleared in 3 h of hemodialysis was nearly same as that cleared in 24 h of CVVH (19,688 ml with HD vs. 19,175 ml with CVVH). However, the clearance with CVVH in this patient was better than that reported in
the literature for oxalate clearance with peritoneal dialysis. In patient 2, a 6 kg infant in whom hemodialysis would be technically difficult, we found CVVH clearance of oxalate was better than that measured with peritoneal dialysis. The difference in CVVH clearance between patient 1 and 2 may partially be explained by the difference in hemofilters and blood flow rate.

We conclude that hemodialysis is the renal replacement modality of choice in primary hyperoxaluria. However, oxalate clearance with CVVH is superior to the clearance seen in PD. Therefore, in the small infant where hemodialysis is technically difficult, CVVH could be used to decrease oxalate burden for a defined period such as before transplant. Oxalate clearance would be optimized by using a high replacement fluid rate as the clearance is proportional to the amount of filtrate removed.
97/P13: PROSPECTIVE STUDY OF RENAL REPLACEMENT THERAPY FOR ACUTE RENAL FAILURE IN 21 HOSPITALS IN STATE OF VICTORIA, AUSTRALIA

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Renal replacement therapy (RRT) for acute renal failure (ARF) is managed differently between, and within, countries and has changed substantially in the last 10 years. There is, however, little data available on the changes in incidence, causes and comorbidities of ARF, or on the management of RRT and associated morbidity and mortality. This prospective study was undertaken to establish such data for the 21 hospitals throughout the Australian state of Victoria (population 4 million) that provide RRT for ARF.

Information was collected prospectively on demographic data, diagnoses and severity of illness of all patients requiring RRT for ARF in the 21 hospitals. The cause of ARF, incidence of sepsis, requirement for mechanical ventilation and inotropes, urine output and serum creatinine was recorded prior to commencement of RRT. The mode of RRT, type of filter, vascular catheter type and site, method of anticoagulation, complications of RRT, specialist and nurses responsible for managing the RRT, the time to renal recovery, and the intensive care and hospital mortality were also recorded.

Interim analysis of data reveals that the patients had a mean age of 60 ± 12.6, mean admission APACHE II score of 29.9 ± 7.0, mean admission SAPS of 64.1 CAVH 19.7 and equal gender distribution. On commencement of RRT 68% had sepsis, 84% required mechanical ventilation and 74% were on inotropes. The median duration of RRT was 3.5 days (range 1–20), with 73% receiving CVVHF, 21% CVVHDF and 5% intermittent VVHDF. The risk of death predicted by the admission SAPS score was 75.4%, the hospital mortality was 58%.

The majority of patients requiring RRT for ARF continue to have a high severity of illness associated with multiple organ failure, sepsis and low survival. In Victoria these patients are predominantly managed with continuous RRT with a lower than predicted mortality.
97/P14: DIALYSIS AND MALNUTRITION – ARE ADEQUATE HAEMODIALYSIS AND ERYTHROPOIETIN SUFFICIENT? A RANDOM SAMPLE SURVEY

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Between September 1, 1995 and January 31, 1996, 102 patients (about 0.25% of all the haemodialysis patients in Germany), who had been sent temporarily by their dialysis centres in all parts of Germany to our rehabilitation centre for rehabilitation treatment of dialysis-connected side effects, underwent urea kinetic examination under random selection.

Without any intention of criticism, we were interested in the following questions on hemodialysis therapy: (1) Is the nutrition status sufficient? (2) Are in case of malnutrition adequate dialysis and erythropoietin treatment enough for the wanted optimum? Patients who had been in the chronic haemodialysis programme for less than six months, cancer patients and/or having had major surgery were excluded. From the protein catabolic rate (PCR) determined by urea kinetic modeling (UKM) they were subdivided into three groups with the following dialysis results at start of treatment:

<table>
<thead>
<tr>
<th></th>
<th>Under-dialysis</th>
<th>Adequate</th>
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<tbody>
<tr>
<td>Risk of malnutrition</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Normal nutrition</td>
<td>25</td>
<td>51</td>
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<tr>
<td>Opulent nutrition</td>
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20 out of 102 patients (19.6%) showed symptoms of malnutrition. It was only the urea kinetic calculation which drew our attention to these facts.

On the basis of a questionnaire, the causes appeared to be (in the sequence of their being mentioned):

- Too little change: 18 of 20
- Insufficient information: 15 of 20
- Little possibility of practical implementation: 15 of 20
- Too complicated instructions: 6 of 20

With 13 of those suffering malnutrition, the haematocrit was more than 30%. Thirteen patients were administered erythropoietin, eleven of them in combination with iron intravenously.
Within the normal rehabilitation period of four weeks in only 4 out of the 20 persons with malnutrition was the nutrition status improved by corresponding intervention. The haematocrit was then over 30% for all of them, which indicates that the erythropoietin given can be seen as having been sufficient.

Erythropoietin as a beneficial medicament obviously conceals some effects of malnutrition. However, it is not necessarily a stimulant to appetite. The sufficiently long period of the dialysis session with nourishment adequately adapted to dialysis, in combination with haematocritic values of above 30% are good prerequisites for the capability of the dialysis patients for rehabilitation.

Transfer of practically oriented experience is probably another underestimated factor in Germany. Treatment of malnutrition under dialysis takes a long time, prevention of malnutrition as long as the dialysis.
97/P15: AMINO ACID CLEARANCE FROM PARENTERAL NUTRITION ON CONTINUOUS RENAL REPLACEMENT THERAPY IN PEDIATRIC PATIENTS

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Two forms of continuous renal replacement therapy (CRRT) in pediatric critically ill patients are commonly used. They are continuous veno-venous hemofiltration (CVVH) with countercurrent dialysate or CVVH with pre-dilutional FRF. To date the modality chosen appears based on the physician's preference.

Pediatric critically ill patients with acute renal failure (ARF) are commonly supported with parenteral nutrition. We retrospectively reviewed the amino acid (AA) clearance in three patients on CRRT when the form had been changed from Countercurrent dialysate to pre-dilutional FRF. We compared these two forms to identify if one significantly cleared more amino acids.

Three patients (weight 10 kg, 15 kg, 50 kg) receiving TPN with a protein component of 1.5 g/kg/day of 10% Aminosyn in ARF were evaluated for AA clearance. Blood flow (Q_B = 120 ml/min) and ultrafiltration rate (Q_F = 1.3, 4 m^2/h) were kept constant on both systems. Amino acid clearance on CVVH(D) was determined as:

\[ Q_{bid} \times \frac{C_{Bi} - C_{Bo}}{C_{Bi}} = Q_F \frac{C_{Bo}}{C_{Bi}} \]  

CVVH with FRF being convective clearance primarily, and determined as:

\[ Q_F \frac{C_{Bo}}{C_{Bi}} \]  

We found in all patients total amino acid loss to be twice as great on CVVH(D) system (mean CVVHD clearance = 0.15 g/day and CVVH with FRF = 0.07 g/day), but total AA clearance through either system of CRRT to be less than 0.5 g/day, significantly lower than what has previously been seen in adult studies. Also, a consistent finding in all three patients was an elevated Lysine that was not appreciably affected throughout the CRRT therapy.

In the initial three patients although AA clearance is greater on the CVVHD, neither form had AA loss which would constitute a significant wastage of parenteral protein. Based on this observation and our current practice of usage of CVVH(D) for specific AA clearance in children with inborn errors of metabolism resulting in hyperammonemia, we are prospectively looking at individual and total AA losses as well as total nitrogen balance between these modalities in pediatric patients.
97/P16: CONTINUOUS VENOVENOUS HEMODIALYSIS IN ACUTE RENAL FAILURE ASSOCIATED WITH MULTIPLE ORGAN FAILURE

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The mortality of patients with multiple organ systems failure (MOSF) remains high despite advances in general supportive care and is even greater in those patients requiring renal supportive therapy.

We report on our experience in 13 patients affected by MOSF and acute renal failure (ARF) early treated by continuous venovenous hemodialysis (CVVHD). This study was carried in the ‘Aurelia Hospital Transplant Foundation’ intensive unit care (ICU) (January 1, 1996–September 30, 1996). 13 selected patients (4 females and 9 males; mean age 55.3 years, range 28–70 years) for MOSF and ARF underwent CVVHD for various etiologies (major surgery complications 3 cases, acute myocardial infarction 5, septic shock 2, acute mushroom poisoning 2, septic shock 1). All had a high need for mechanical ventilation. CVVHD was immediately started when sCr was >4 mg/dl and urine flow <60 ml/h, despite forced diuresis. 6/13 patients died after 9.2 days, the remaining 7 were discharged from ICU within 17 days (range 8–30) and received CVVHD treatment for 11 days (range 4–18). Our results are in agreement with other reports.

It is not yet clear whether continuous blood purification techniques improve outcome in ARF on the ICU. Further studies are needed to assess long-term effects of continuous blood purification techniques on morbidity and mortality. However, improved hemodynamic stability and superior metabolic control seem to justify this CVVHD use.
97/P17: CONTINUOUS HEMODIAFILTRATION IN CRITICALLY ILL ANURIC INFANTS AND CHILDREN

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Objective: The purpose of this article is to describe the experience with continuous arteriovenous and venovenous hemodiafiltration in critically ill pediatric patients.

Design: Descriptive account of a case series.

Setting: A pediatric ICU in a University Hospital.

Patients: From June 1985 to June 1994, 84 critically oliguric or anuric infants and children underwent continuous arteriovenous or venovenous renal support. Thirteen of them were treated with continuous hemodiafiltration. Their mean age was 8.6 ± 3.7 months, their mean body weight 6.4 ± 1.3 kg.

Measurement and Main Results: In seven children hemodiafiltration was driven in the arteriovenous mode and in 6 in the veno-venous mode. For pump-driven hemofiltration a roller pump with pressure alarms, an air trap, an air bubble detector, and small blood lines were used. During continuous hemodiafiltration the bicarbonate based dialysate solution was administered in a countercurrent fashion to blood flow at a rate of 3–5 ml/min. Mean duration of renal support was 192 ± 48.6 h, ranging from 48 to 720 h. During arteriovenous and venovenous hemodiafiltration the mean blood flow rates were 21.5 ± 7.2 and 31.8 ± 9.2 ml/min, respectively, and the mean ultrafiltration rates were 6.1 ± 1.6 and 9.6 ± 1.9 ml/min/m², respectively. The hemofilter running time during arteriovenous and venovenous treatment was 42.8 ± 11.4 and 48.5 ± 8.5 h, respectively. During continuous hemodiafiltration urea clearances increased by 180% (polysulfone filter) and 300% (polyacrylonitrile filter), respectively. Clinical tolerance to continuous hemodiafiltration was excellent.

Conclusion: Continuous arteriovenous hemodiafiltration substantially increases urea clearances in small infants while maintaining the simplicity and safety of the continuous arteriovenous hemofiltration system. Continuous venovenous hemodiafiltration is a more complex procedure, but produces the highest urea clearance rates. It is indicated in emergency conditions such as severe metabolic disturbances due to tumor lysis syndrome or severe metabolic crisis due to an inborn error of metabolism.
97/P18: THE OUTCOME OF PATIENTS WITH CONTINUOUS RENAL REPLACEMENT THERAPIES

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Purpose: Continuous high-flux hemodialysis (CHD) and variables seem to be established as renal replacement therapies for critically ill patients. These techniques are expected to be indicated for severer cases with respect to removal of unknown solutes. We will discuss the outcomes and usefulness of these therapies mainly for patients with multiple organ failure.

Subjects and Method: 130 patients who have been treated with continuous hemofiltration (CHF) or CHD from March 1986 to September 1996 are the subjects of this study. We will discuss clinical courses, interactions between each organ disturbance, and the outcomes of this group using our institute’s organ failure scoring system.

Results: CRRT was performed on 130 patients. 50 of these patients survived, making the survival rate 38.4%. The survival rate of the patients with failure of 3 organs or more was significantly low at the initiation of the therapy. The prognosis of patients with respiratory or hepatic failure complications at the beginning was poor. The survival rate also fell significantly when the score deteriorated on the 4th day.

Conclusion: The prognoses of the patients treated with CRRT were determined by the number and the kind of organs involved. Efforts should be made to improve involved organs in the early stage of the clinical course.
97/P19: REALITIES OF CONTINUOUS VENOVENOUS HEMOFILTRATION: A NURSING PERSPECTIVE

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Continuous Venovenous Hemofiltration (CVVH) has been the choice of Continuous Renal Replacement Therapy (CRRT) in our ICU since September 1995, replacing the previous therapy of continuous arteriovenous hemofiltration (CAVH). The purpose of this discussion is to present some of the practical nursing issues related to our implementation of this therapy. Implementation consisted of three phases: training, implementation, and a quality assurance audit as part of a continuous quality improvement program (CQI). The formal educational program consisted of modules which included four hours of theory, four hours of clinical training and an evaluation phase. The theory module was developed after a review of current literature including the physiology of the renal system, pathophysiology of acute renal failure and biotechnical considerations. Clinical training included biotechnical review of the CRRT device, use of CRRT in a simulation lab setting, and close supervision at the bedside. Certification for nursing advanced competency in CRRT consisted of successful completion of the theory and practical modules and a score of 80% on a comprehensive written exam. Examples of the training modules and examination are provided.

Implementation of CRRT required an established program to proactively and reactively manage potential problems. Potential problems identified and managed proactively included biomedical engineering coverage, equipment storage and inventory of appropriate supplies. Redress of these problems occurred through a comprehensive CQI program. Problems identified and managed reactively included appropriate anticoagulation, care of lines, and maintenance of the filter. 106 out of 1,169 patients admitted to our ICU over a one-year period developed acute renal failure. 70 patients were managed with intermittent hemodialysis and 36 with CRRT. Complications occurred in 8.3% of patients with CVVH. In the previous year CRRT by CAVH had resulted in a complication rate of 13.5%. Details on the frequency of problems and complications are provided.

A major concern identified during the comprehensive Quality Assurance audit identified variations in CRRT and therapy documentation of care. Design and implementation of Clinical Practice Standards focusing on advanced competency, monitoring and line care were developed and implemented. Examples of monitoring sheets and practice standards are provided including the interface with our clinical information systems.

Successful initiation of new biotechnology in the critical care environment can be successfully managed through a multidisciplinary collaborative approach focusing on education, standards and QA audit of clinical practice.
97/P20: UTILIZATIONS OF CONTINUOUS VERSUS INTERMITTENT RENAL REPLACEMENT MODALITIES IN ACUTE RENAL FAILURE: RESULTS OF A SURVEY

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Continuous renal replacement therapies (CRRT) have been available as a treatment option for ARF since 1977. However, little information has been published about how often CRRT are performed in comparison to intermittent hemodialysis (IHD). We conducted a questionnaire at an international intensive care meeting. 285 European doctors completed the questionnaire (Greece 51, Italy 39, Britain 33, Netherlands 34, Spain 20, Belgium 20, Portugal 18, France 18, Finland 18, Germany 17, Sweden 10, Norway 5, Austria 5, Switzerland 4, Denmark 3). 41% were anaesthesiologists, 21% internists, 14% intensivists, 11% nephrologists, 7% surgeons and 6% ICU nurses. 45% of the doctors worked at large university hospitals, 25% at middle-sized teaching hospitals and 30% at small community hospitals.

Fifty-four percent of patients with ARF are treated with continuous renal replacement therapies and 46% with intermittent hemodialysis. Among the patients treated with CRRT, continuous arterio-venous hemofiltration is performed in 16%, continuous veno-venous hemofiltration in 56%, continuous arterio-venous hemodiafiltration in 2%, continuous veno-venous hemodialysis in 9%, continuous arterio-venous hemodiafiltration in 2% and continuous veno-venous hemodiafiltration in 15%. Only 18% of the doctors don’t perform CRRT. 49% of these doctors came from small community hospitals. On the other side, 17% answered that they employ only CRRT. 50% of these doctors worked at small hospitals, lacking a nephrology department which could provide IHD.

We conclude that: 1. Continuous renal replacement therapies are widely used in Europe. 2. Continuous hemofiltration is preferred over continuous hemodialysis (72% vs. 11%). 3. The veno-venous modalities, which offer increased urea clearance with more complex technology, dominate over the arterio-venous modalities (80% vs. 20%).
97/P21: A COLLABORATIVE APPROACH TO THE TREATMENT OF ACUTE RENAL FAILURE IN AN INTENSIVE CARE SETTING

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Our goal was to manage and treat the critically ill patient in acute renal failure with continuous veno-venous hemodiafiltration (CVVHDF) using the Prisma machine. This required collaboration between the nephrology and critical care (CCTC) teams. Our objective was to train the critical care staff to initiate, monitor, troubleshoot, and discontinue CVVHDF using the Prisma machine under the direction of the nephrologists.

In the initial phase, a core group of both hemodialysis and CCTC staff were trained to use the Prisma. While the dialysis nurses had to learn a new skill at the same time as the CCTC staff, they used their knowledge of the extracorporeal blood circuit to assist the CCTC staff gain expertise in this field. The education and mentoring of staff was a challenge.

We will describe the process used for the transfer of knowledge and skill which will help other units who are planning similar projects.
97/P22: CONTINUOUS VENOVENOUS HEMOFILTRATION/HEMODIALYSIS AND PLASMA EXCHANGE IN NEWBORNS


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Twelve newborn infants, 6 boys and 6 girls, aged 37.7 ± 28.9 days (2–100), BW 4,035 ± 1,078 g (2,700–6,510) were treated by continuous venovenous hemofiltration/hemodialysis (CVVH/CVVHD) and 3 of them also with plasma exchange (PE) because of acute renal failure (ARF) and/or multiple organ failure (MOF). ARF/MOF occurred after abdominal surgery (6), septicemia (3), fulminant hepatitis (1), hemolytic uremic syndrome (1) and hyperammonemia (1). 11 patients were oliguric, all of them were mechanically ventilated. PE monitor (Plasmat 791, Bellco) was used to perform either CVVH/CVVHD or PE. Amicon hemofilters (minifilter, 10, 20 and 30) were used for CVVH and Gambro PF 1000 plasmafilter for PE. Dual lumen pediatric catheters (Medcomp, 5 and 7 F) were either surgically or percutaneously inserted into femoral, jugular or subclavian vein. Heparin and prostacyclin were anticoagulants. Hemofiltration solution (CVVH) and FFP (PE) were replacement solutions. Extracorporeal circuit was primed with whole blood before the procedure. Pre- and postdilutional hemofiltration was performed. Running time of CVVH/CVVHD was 6.5 ± 5.2 days (1–22). Pulmonary edema (during PE) and hematotherax (after catheter insertion) were complications related to the procedures. 5/12 newborns survived and 7/12 died.

Conclusions: CVVH/CVVHD was the only possible way of treatment which gave the opportunity to survive to 42% of infants.
97/P23: TREATMENT OF ACUTE LIVER FAILURE WITH PLASMA EXCHANGE, HEMODIALYSIS AND HYPERBARIC OXYGENATION IN A 3-YEAR-OLD CHILD

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A 3 years and 4 months old girl (BW 16 kg) with acute hepatic failure and coma was treated with plasma exchange (PE), hemodialysis (HD) and hyperbaric oxygenation (HBO). Totally 13 PEs, 13 HDs and 9 HBOs were performed during 1 month of treatment. Initial 4 PEs were followed by HD and other 8 PEs were carried out simultaneously with HD. There was no renal failure, HD was instituted to improve ammonia and bilirubin elimination. 20% human albumin (370 ml) was used as dialysate in one HD session, to improve bilirubin elimination.

3 volumes of plasma (2000 ml) were exchanged per PE and replaced with fresh frozen plasma (FFP). Plasmapheresis monitor Bellco BL 791 and plasmafilters Gambro PF1000 and PF2000 were used. Heparin was anticoagulant. Dual lumen pediatric HD catheter (7F) percutaneously placed into femoral vein was vascular access. Fresenius 2008 C HD monitor and Filtral 10 dialyser were used for HD. Simultaneous PE and HD was instituted to prevent tetanic (hypocalcemic) cramps observed in 2 previous PEs due to citrate in FFP. Extracorporeal circuit was primed with mixture of concentrated red cells, human albumin and saline solution and was discarded at the end of the procedure. Average blood flow in PE and/or HD circuits was 80 ml/min. During HBO the girl has breathed 100% oxygen for 90 min at a pressure of 2.5 atmospheres. During the treatment the patient was physically and mentally in good clinical condition, but she was dependent on blood purification procedures. So she was sent to a liver transplant center and successfully transplanted. Etiology of liver failure is still unknown.

Conclusions: Hepatic coma was reversed and normal mental state achieved using PE and HD. Hepatic function did not further deteriorate during treatment. ‘Albumin’ HD did not significantly improve bilirubin elimination. Simultaneously performed PE and HD prevented citrate toxicity. HBO treatment was tolerated well and without complications.
97/P24: A NEPHROLOGY NURSING ASSESSMENT TOOL FOR CONTINUOUS RENAL REPLACEMENT THERAPY

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The competent use of continuous renal replacement therapy (CRRT) requires assessing system performance, the impact the therapy has on the patient’s overall condition, and how effectively the goals of therapy are being met. Specific assessment areas related to these issues are filter performance, blood flows, clearances, and clinical patient parameters.

The nephrology nursing team at UCSD Medical Center developed a Continuous Renal Replacement Therapy Assessment Tool to meet these requirements. The tool has seven assessment categories: patient information, hemodynamic status, hemodynamic medications, overall system assessment, vascular access, ultrafiltration/clearances, anticoagulation, and hemofilter data, plus an area for recording nursing notes. A nephrology nursing assessment is performed on initiation, then twice daily. Form the gathered data the nephrology nurse can determine filter performance by calculating the sieving coefficient, assess whole blood and dialyzer clearances, and calculate mean blood flow rate/minute on non-pumped systems.

Identified advantages to the use of the Nephrology Nursing Assessment Tool are that it provides an organized and specific method for assessing system performance and the efficacy of therapy, and acts as a means for performing a system ‘cross check’ to the critical care nurse in assuring safe delivery of care. The information from the Assessment Tools has also been integrated into the Quality Improvement process, and developed into a database for research purposes.
97/P25: EFFECTS OF THE CONTINUOUS VENOVOUS HAEMOFILTRATION, IN THE HAEMODYNAMIC PROFILE OF SHOCK SEPTIC PATIENTS

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Introduction: In spite of the new therapeutic strategies, septic shock still has a high mortality. There are multiple factors, and we may consider that the main objectives are the recover of the cardiovascular function and the haemodynamic stability.

The venovenous haemofiltration (CVVH), a technique used in septic patients with renal failure, is now proposed in septic shock without renal failure. We studied the haemodynamic effects of the CVVH in septic shock patients, that have not responded to high doses of catecholamines.

Material and Methods: We made continuous venovenous haemofiltration in 8 patients with septic shock, after trying to control the situation with fluid replacement and high doses of catecholamines. We use the blood pump MB10, a Gambro polyamide filter FH77 to attain an ultrafiltration higher than 2,000 ml/h. We monitorized all the patients with a thermodilution catheter, and we evaluated the haemodynamics and the O2 profile before the beginning of the CVVH, 12–24 h and 24–48 h after.

Results: The data are reported as mean and standard deviation. We made 224 evaluations of the haemodynamic and O2 profile on the 8 patients included in this study.

Conclusion: The CVVH improve the haemodynamic function in septic shock patients, confirmed by the rise of the PAM, IC and of the LVSWI. The haemodynamic stability, after 12–24 h of haemofiltration allowed a reduction in the catecholamine doses, and the withdrawal from shock criteria. We think that CVVH may be one valid alternative to control and treat the haemodynamic anomalies in patients with septic shock.
97/P26: HAEMOFILTRATION IN A COMPLEX TREATMENT OF ACUTE LIVER INSUFFICIENCY CAUSED BY HEPATITIS B

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It is known that haemofiltration (HF) is the most perspective method of the correction of polyorganic failure syndrome (SPF), which is a result of endotoxicosis. Serious viral hepatitis B causes acute liver insufficiency, and it is advisable to regard it as a SPF because two or even more systems of the organism are affected in the symptom complex of this disease. HF as a rule is used in the course of treatment of acute kidney failure, but we used it in the course of treatment of serious liver insufficiency which was complicated by the strongly marked cholestasis.

The continuous arterial-venous haemofiltration through haemofilters ‘Amicon’, ‘Multiflow-60’, ‘Crystal’, ‘Hemospal’, which are supplied with the membrane ‘AN-69’, was used in the course of treatment of 4 patients whose middle level of bilirubinemia was 1,377.2 ± 445.6 mmol/l which straight fraction made up 775.25 ± 211.9 mmol/l (the maximum rate of norm is 22 mmol/l). The level of aminotransferase was either high and made up initially 71.25 ± 36.4 a.u. AST (maximum rate of norm is 30) and 52.25 ± 4.2 a.u. AST (maximum rate of norm is 40). The period of continuous HF lasted from 3 to 14 days and the volume of substituted liquid made up from 45 to 225 liters. There were used the solutions ‘HF-21, ‘HF-23’, ‘Fresenius’ for the substitution. They were warmed up beforehand and the post-dilution variant was used in every case.

The condition of patients in general progressively improved as the HF concomitant with the general therapy of the viral hepatitis B and by the 10th day of treatment the level of bilirubinemia decreased to 178.6 ± 67.4 mmol/l and the level of aminotransferase ALT 22.0 ± 6.5 a.u. and AST 34.0 CAVH 2.1 a.u. correspondingly decreased. Similar to this the level of circulating immunocomplexes decreased from 226 ± 31.4 g/l to 160.1 ± 24.2 g/l (norm = 52 ± 2 g/l). The quantity of agranulocytes did not change considerably and, in spite of the strong glucocorticoid therapy (about 2 g/day), by the 10th day of treatment the quantity of lymphocytes made up 23.25 ± 0.4% and the quantity of monocytes made up 7.25 ± 1.1%.

All the patients recovered and were discharged from the hospital. Thus the use of HF in the complex treatment of ALI of the viral hepatitis B is a sufficiently strong and effective method of detoxification and it enables the rapid management of endotoxicosis complicating polyorganic failure.