Blood Purification

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Abstracts

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Contents

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Patient Characteristics

1

Mortality Predictors and Biochemical Profile of South Indian Patients with Rhabdomyolysis in an Intensive Care Setting

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Aim: To identify mortality predictors and to analyze the biochemical profile of patients with rhabdomyolysis in an intensive care setting, for determining prognosis and to anticipate and treat electrolyte abnormalities that arise in this disease process. **Methods:** A cross sectional, single centered study involving 104 patients admitted in the intensive care unit of a tertiary care center in south India from July 2006 to November 2007. Mean age 60.48 yrs (SD16.96 yrs).males 70 patients, females 34 patients. Data was analyzed for age, sex, presenting complaint, etiology, presence or absence of Acute Kidney Injury (AKI), Positivity of urine myoglobin,electrolyte profile, Anion gap (AG), Presence of Multiorgan dysfunction syndrome (MODS), Creatinine Phosphokinase (CPK), requirement for renal replacement therapy (RRT) and the final outcome (Recovered or died). **Results:** Of the 104 patients, males 70 (67.3%), females 34 (32.69%) Altered sensorium was the commonest presentation (55.7%), commonest etiology being sepsis (59%), 68.9% had negative urinary myoglobin and 31.1% had positive urinary myoglobin, 83.6% had AKI, 72.6% required renal replacement therapy. Electrolyte profile, Potassium (55.7% had hyperkalemia, 32.8% had eukalemia, 11.5% had hypokalemia), sodium (57.2% had hypernatremia, 40.1% had normal serum sodium, 2.7% had hyponatremia) calcium (86.7% had normal calcium, 6.6% had hypercalcemia 6.7% had hypocalcaemia), Phosphorus (63.9% had normal phosphorus, 26.3% had hyperphosphatemia, 9.8% had hypophosphatemia), 63.9% had normal serum uric acid and 36.1% had hyperuricemia, mean CPK was 5690.54 U/l. 96.7% patients presented with metabolic acidosis, 83.6% had a raised AG, 59% had MODS. General Mortality was 78.7%. Patients with MODS had 100% mortality. 61.2% of patients who were initiated on renal replacement therapy on the first day survived. Age >67 yrs ($P < 0.05$), Positivity of urine myoglobin ($P < 0.05$), normal serum calcium ($P < 0.001$) and normal serum Phosphorus ($P < 0.001$), CPK > 6000 U/L ($P < 0.05$) were associated with mortality. **Conclusion:** Geriatric patients with a CPK > 6000 U/L have a high risk for mortality. A normal electrolyte profile and a negative urinary myoglobin does not rule out the diagnosis of rhabdomyolysis. Early aggressive management is required as mortality is 100% when the patient goes into the stage of MODS. Early initiation of renal replacement therapy within 24 hrs of admission improves survival.

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Prognostic Value of Platelets Count and Course on the Mortality of Critically Ill Patients in Need of Renal Replacement Therapy for Acute Kidney Injury

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Purpose: To describe and evaluate the effect of platelets count and course in relation to the hospital mortality rate of patients admitted to intensive care unit (ICU) with acute kidney injury (AKI). **Methods:** Between November 2004 and July 2007, all patients admitted to the ICU of three tertiary care hospitals who required RRT for AKI for >4 days were studied. Patients with end-stage renal disease requiring chronic dialysis were excluded. AKI was classified according to RIFLE criteria. Organ failures were evaluated by the SOFA score. Platelets count was obtained at AKI diagnosis, day1, 3 and 5 of RRT. Multivariate logistic regression analysis was used to identify predictors of hospital mortality. **Results:** Two hundred and fifty-one patients (78% medical admissions) with a mean age of 72 ± 16 years were studied. Mean SAPS II was 47 ± 11 points; mechanical ventilation was used in 75% and vasopressors in 69% patients. Continuous RRT was used in 78% patients. Overall ICU and hospital mortality rates were 66% and 69%, respectively. On day 1 of RRT, median platelets count was 162,000 (95,000–257,000)/mm^3 and 26% patients had thrombocytopenia (<100,000/mm^3). In general, the platelets count increased overtime in survivors and decreased in non-survivors. From day 1 to day 5 of RRT, platelets count increased in 18%, remained stable in 13% and decreased in 69% of patients. Mortality rates increased as the platelets count on day 1 decreased, especially in patients with <50,000/mm^3. In addition, mortality also increased as the platelets count decreased from day 1 to day 5 of RRT, mainly in patients with a decrease >30%. Adjusting for age, functional capacity, comorbidities, associated organ failures and the time for the start of RRT, a platelets count <50,000/mm^3 on day 1 of RRT [odds ratio = 8.2 (95% CI, 1.7–41.0)] and decreases in the platelets count from day 1 to day 5 of RRT of 30%–60% [3.7(1.6–8.6)] and of >60% [8.9(2.7–28.8)] were independently associated with increased hospital mortality. **Conclusions:** In patients receiving RRT >4 days in the ICU, a decline in platelet counts provides significant prognostic information.

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The Effects of Hemofiltration on the Outcome of Multiple Organ Failure with Acute Renal Failure in the Very Old Patients

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Background: To analyze the clinical setting and outcome of the multiple organ failure (MOF) with acute renal failure (ARF) in the very old patients managed with continuous veno-venous hemofiltration. **Method:** From January 2005 to September 2007, 35 aged patients of MOF with ARF underwent CVVH in our department. Of the 35 patients studied, 29 were males and 2 females. Their average age was 82.8 yrs (75–92). There was at least 3 organs function failure in all the patients. The cause of ARF included Sepsis shock in 16 (46%), Hemodynamically unstable state mediated by myocardial dysfunction and other different clinical problems in 15 (43%), and acute over chronic renal failure in 4 (11%) patients. 15 (43%) patients need mechanical ventilation. The mean duration of CVVH was 61.5 hrs (30–128 hrs). The mean filtration volume was 2.75 L/hr (2.0–3.5 L/hr). CVVH was performed using PRISMA CRRT machine. Vascular access was used with femoral venous cannula in 5, Internal Jugular cannula in 25, and AVF in 5 patients. Anticoagulation using heparin was achieved in 26 patients. No anticoagulation was used in 11 patients. **Results:** There were no patients died and no major adverse events occurred during the procedure of CVVH. No patients experienced bleeding complications secondary to CVVH. On average of therapy for 3 days, the CVVH led to a markedly better control of serum creatinine (mmol/L: 586.5 ± 247.2 vs 327.4 ± 179.1, $p < 0.05$), blood urea (mmol/L: 33.7 ± 9.5 vs 24.7 ± 9.1, $p < 0.05$), serum bicarbonate (mmol/L: 16.3 ± 5.0 vs 22.7 ± 4.1, $p < 0.05$) and serum potassium (mmol/L: 5.72 ± 1.3 vs 4.31 ± 0.9, $p < 0.05$). 12 patients died in one month after CVVH. The patients variables influencing survival vs mortality were the number of organ failure and mechanical ventilation, while serum creatinine, blood urea, serum bicarbonate, blood pressure, serum potassium, and UF rate did not affect outcome. There was 1/13, 4/12, 5/7, 3/3 patients died with 3, 4, 5, 6 organs failure respectively. 10 died of the 15 patients with mechanical ventilation in 10 days after CVVH. **Conclusions:** (1) Despite the mortality is very high, but no patients died within the procedure of CVVH, it suggests that the CVVH is a safe therapy in the very old patients with MOF under hemodynamical unstable state. (2) CVVH had better effects on control of hypervolemia, uremia, serum potassium and acid-base balance in the old patients. (3) The number of organ failure adversely affects outcome of the aged patients with CRRT. (4) Mechanical ventilation is an adversely predictor of outcome in the old patients with treatment of CVVH.

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Outcome and Prognosis in Critically Ill Children Receiving Continuous Renal Replacement Therapy

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Purpose: Continuous renal replacement therapy (CRRT) has been the first choice for the treatment of acute renal failure in critically ill children not only in Western countries but also in Korea. However, there are very few studies that have analyzed the outcome and prognosis of this modality in Korean children. We performed this study to evaluate the factors associated with the outcome and prognosis of patients treated with CRRT. **Patients and Methods:** We retrospectively reviewed the medical records of 32 children who had received CRRT at Severance hospital from 2003 to 2006. The mean age was 7.5 years (range 4 days–16 years) and the mean body weight was 25.8 kg (range 3.2–63 kg). Bone marrow transplantation and malignancy were the most common cause of death and underlying disease leading to the need of CRRT. **Results:** Eleven (34.4%) of the 32 patients survived. Mean patient weight, age, duration of CRRT, number of organ failure, urine output, estimated glomerular filtration rate (eGFR), C-reactive protein, and blood urea level did not differ significantly between survivors and nonsurvivors. (1) Pediatric risk of mortality (PRISM) III score at CRRT initiation (9.8 ± 5.3 vs. 26.7 ± 7.6, $P < 0.0001$), (2) maximum pressor number (2.1 ± 1.2 vs. 3.0 ± 1.0, $P = 0.038$), and (3) the degree of fluid overload (5.2 ± 6.0 vs. 15.0 ± 8.9, $P = 0.002$) were significantly lower in survivors than in nonsurvivors. Multivariate analysis revealed that fluid overload was the only independent factor reducing survival rate (Odds ratio = 27.0, 95% Confidence interval 3.8–191.7, $P = 0.001$). **Conclusion:** CRRT was successfully applied for the treatment of acute renal failure in a wide range of critically ill children. To improve survival, we suggest an early initiation of CRRT to prevent the systemic condition from worsening and progression of fluid overload in critically ill children with acute renal failure.

5

Clinical Experience with Continuous Renal Replacement Therapy (CRRT) after Liver Transplantation

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Purpose: Acute kidney injury is a common complication in liver transplant recipients (LTR). We analyzed the clinical outcome and prognostic risk factors for renal functional recovery in LTR treated with CRRT. **Methods:** In our center 327 LTR were identified during last 6 years. Out of them, the clinical data from 72 cases of CRRT in 49 LTR were retrospectively analyzed. In all patients, CRRT modality was

CVVHDF [blood flow rate 100 (70–180) ml/min, dialysate flow rate 1,000 (400–1,800) ml/hr, fluid replacement 1,000 (500–1,800) ml/hr, ultrafiltration rate 80 (50–200) ml/hr]. **Results:** Out of 49 LTR, male was 37, mean age was 60 ± 3 years, and living donors were 48. The indications for liver transplantation were viral and alcoholic liver cirrhosis (26), hepatocellular carcinoma (16), and acute hepatic failure (7). In most cases (78%), CRRT began at first post-operative week, and median duration of CRRT was 3 days. The indications for CRRT were uremia (69%), sepsis (18%), acidosis (7%) and volume overload (5%). At the time of beginning CRRT, mean BUN was 99 mg/dl, and serum creatinine (Scr) was 2.6 mg/dl. In all patients, the BUN and Scr levels returned to normal range in 7 days of CRRT. However, ALT and serum bilirubin levels were not affected by CRRT. The reasons for discontinuation of CRRT were recovery of renal function (59%), patient death (27%), converting to intermittent hemodialysis (8%), hypotension (4%), and bleeding (1%). The clinical characteristics of the patients were compared between the patients whose renal functions were completely recovered (31%) and the patients whose renal functions were partially recovered or unchanged (69%). The patients survival rates whose renal functions were completely recovered at 3 months were 100%. According to the multivariate analysis, the prognostic risk factors for renal functional recovery were DM, sepsis, patients requiring ventilator care, high seum bilirubin levels, and high serum alkaline phosphatase levels. **Conclusion:** CRRT is a safe and effective modality for managing uremia, sepsis and volume overload in liver transplant recipients during early post-operative period.

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Continuous Hemofiltration and Multiple Organ Dysfunction Syndrome

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The high effectiveness of hemofiltration for survival and organ dysfunction correction in patients with sepsis and SIRS has been widely reported [Honore, P.M. et al., 2000; Cole, L. et al., 2001; Piccinni P. et al., 2006]. We estimated the effects of continuous hemofiltration (CVVH) on survival in septic shock patients with acute renal failure and acute respiratory distress syndrome in a control retrospective study. The two groups were comparable for gender, age (62.8 ± 4.37 and 48.1 ± 6.05; p = 0.06), basic therapy, baseline APACHE II score (20.6 ± 1.23 and 21.6 ± 2.23; p = 0.71), SOFA score (7.46 ± 0.55 and 7.9 ± 0.79; p = 0.64), acute renal and lung injury markers. The control group (group 1) included 14 patients and the CVVH group (group 2) 11 patients.

CVVHs were performed with the help of a Multifiltrate machine (Fresenius) for 50.9 ± 13.46 h with HF80-100 hemofilter changed daily. Replacement lactate buffer fluid was infused in a post-dilution mode at a rate of 35 ml/kg/h over 24 h, following gradual lowering to 20 ml/kg/h. The control group was retrospectively evaluated during the 'before CVVH' period from ICU protocols and hospital charts. The laboratory and clinical data were evaluated daily and are presented in the table. A significant decrease of creatinine, increase of pO_2/FiO_2 and urine output, as well as SOFA score amelioration were registered in CVVH (group 2). Significant changes were not observed in group 1. The mortality rate on discharge was higher in group 1, 64.3%, versus 45.5% in group 2 ($p < 0.05$). The ICU stay was longer in group 2 (23.5 ± 4.7 vs. 10.2 ± 2.17 days, p = 0.01). Hospital stay was also longer in group 2 (39.4 ± 8.2 vs. 17.8 ± 3.73 days, p = 0.02). We conclude that CVVH ameliorates survival and multiple organ dysfunction in septic patients.

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Prescribed Versus Delivered Hemodialysis Treatment in the Acute Setting

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The dose of hemodialysis (HD) treatment in acute setting is often not delivered as prescribed. Discrepancy between prescribed and delivered dose influence the adequacy (URR ≥ 65%) of HD and ultafiltration (UF). The aim of the study was to evaluate prescribed versus delivered HD treatment and to determine factors responsible for inadequate (URR < 65%) HD treatment. Two hundred and seventy

Table for abstract 6

	Parameters	Control group 1 (n = 14)	Probability to the 1st day	CVVH (n = 11)	Probability to the 1st day	Probability between groups 1 & 2
1	Urine output on 1st day	846.4 ± 133.2		1122.7 ± 178.8		0.22
	Urine output on 3rd day	1818.5 ± 261.7	0.002	3039.1 ± 560.7	0.004	0.05
	Urine output on 7th day	1178 ± 246.3	0.22	2550 ± 266.8	0.0002	0.001
2	SOFA 1st day	7.46 ± 0.55		7.9 ± 0.79		0.64
	SOFA 3rd day	7.75 ± 0.98	0.79	6.36 ± 0.86	0.2	0.3
	SOFA 7th day	7.7 ± 1.43	0.87	4.9 ± 0.99	0.03	0.13
3	Creatinine on 1st day	172.5 ± 29.7		147.1 ± 19.9		0.51
	Creatinine on 3rd day	167.7 ± 25.3	0.9	95.7 ± 7.16	0.025	0.02
	Creatinine on 7th day	141.4 ± 28.37	0.47	94.1 ± 13.2	0.045	0.15
4	pO_2/FiO_2 1st day	240.6 ± 12.96		219.6 ± 20.6		0.4
	pO_2/FiO_2 3rd day	221.6 ± 23.5	0.47	309 ± 37.4	0.05	0.07
	pO_2/FiO_2 7th day	249.8 ± 25.2	0.74	358.7 ± 30.95	0.001	0.015

Variable	URR ≥ 65% (n = 189)	URR < 65% (n = 88)	P value
Age (Yrs)	51.3 ± 16.3	58.8 ± 15.3	<0.001
Weight (Kg)	68.1 ± 17.9	99.4 ± 34.0	<0.001
URR (%)	74.4 ± 7.2	56.1 ± 7.0	<0.001
Duration of HD Prescribed (Hrs)	3.7 ± 0.3	3.7 ± 0.3	0.23
Duration of HD Delivered (Hrs)	3.7 ± 0.3	3.6 ± 0.4	0.08
Blood flow rate Prescribed (ML/min)	367.9 ± 41.1	358.8 ± 44.4	0.04
Blood flow rate Delivered (ML/min)	351.2 ± 46.0	337.1 ± 49.1	0.02
UF Prescribed (L)	2.3 ± 0.9	2.5 ± 0.9	0.19
UF Delivered (L)	2.01 ± 1.0	2.15 ± 1.0	0.31

seven treatments in 66 patients (47 males and 19 females with a mean age of 53.6 ± 16 years) hospitalized to the tertiary care center from March to August 2007 were evaluated. One hundred and twenty four (45%) treatments were done using AV fistula or graft and 152 (55%) were done with catheters. One hundred and eighty (68%) had URR ≥ 65% and 88 (32%) had URR < 65%. Data are summarized in the table (Mean ± SD). The use of heparin, type of access (AVF/catheter), type of dialyzers, AM/PM shifts, weekend HD treatments and, pre and post treatment mean arterial blood pressure were similar between the two groups. In both groups, the delivered blood flow rate, net UF and heparin dose were significantly lower than prescribed. No significant difference was observed between the prescribed and delivered HD duration in the group with URR less than 65%. Albumin was used in 26 of the 277 HD treatments. The treatment sessions using albumin achieved significantly lower net UF (1.45 versus 2.12 L, $p < 0.01$) although the prescribed UF (2.33 versus 2.35 L) was similar for both groups. Inadequate HD treatments in the group with URR <65% may be related to both lower prescribed and delivered blood flow rates, and higher body weight.

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Clinical Effects of High Volume Hemofiltration on Acute Kidney Injury in Post-Cardiotomy Patients

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Objective: To evaluate the efficiency of high volume hemofiltration (HVHF) in the treatment of acute kidney injury (AKI) in post-cardiotomy patients, and investigate the impact of therapy on different stage of AKI. **Methods:** HVHF was performed in 25 patients with AKI after cardiotomy, including 16 males and 9 females, with average age of 56.4 ± 16.80 (15 ~ 80) years. Except 6 of the patients quitted in early stage of HVHF for economics, the remaining 19 patients were divided into three groups: group I (AKI I stage, n = 6) received HVHF when serum creatinine (Scr) increase to ≥0.3 mg/dl (≥26.4 μmol/l) or ≥150–200% (1.5- to 2-fold) from baseline, or urine output <0.5 ml/kg/h for >6 hrs; group II (AKI II stage, n = 6), HVHF was started when Scr increase to >200−300% (2- to 3-fold) from baseline, or urine output <0.5 ml/kg/h for >12 hrs; group III (AKI III, n = 7) had HVHF when Scr increase to >300% (>3-fold) from baseline (for serum creatinine of ≥4.0 mg/dl (≥354 μmo/l) with an acute increase of at least 0.5 mg/dl (44 μmol/l), or urine output <0.3 ml/kg/h for >24 hrs or anuria for 12 hrs. HVHF was performed with AV600 hemofilter (polysulfone, 1.6 m^2) and the substitute fluid rate at 4000 ml/h by a pre-dilution route, blood flow rate was 200 ~ 250 ml/min. Low molecular weight heparin and/or citrate were used for anticoagulation. Clinical conditions including mean arterial pressure (MAP), heart rate (HR), and temperature (T) were monitored every 30 min, and blood gas analysis, serum biochemistry test were detected before and every 24 hrs after the initiation of HVHF. APACHE II scores were evaluated every 12 hrs during HVH. **Results:** HVHF was well tolerated in all patients with the hospital mortality of 57.9%. The mortality of group I was lower than group III (50% vs 71.4%) while the patients in group I were more severe: the cardiopulmonary bypass (CPB) time (244.2 ± 170.46 vs 154.3 ± 73.58) and x-clamp time (93.2 ± 43.21 vs 82 ± 59.59) were both longer than group III, and there were more patients accepted IABP (66.7% vs 28.6%). After 12 hrs' HVHF treatment, the high fever of patients was improved obviously ($P < 0.05$), while heart rate and MAP was maintained in normal range. After 24 hrs' therapy, the Scr and blood urea were both decreased ($P < 0.05$), and all survival patients had renal function recovered. After HVHF we also found APACHE II scores improved significantly after 60 h ($P < 0.05$). **Conclusions:** HVHF is technically possible in AKI patients after cardiac surgery, which was an important treatment to post-cardiac patients with AKI and MODS. We also found that early and aggressive use of HVHF performed in AKI I stage was associated with better survival rate in AKI patients after cardiac operations.

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A Retrospective Study of Continuous Blood Purification in the Treatment of 1692 Critical Patients

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Objective: To retrospective analysis the effective of continuous blood purification (CBP) in the treatment of 1692 critical patients and the influencing factors of prognosis. **Methodology:** From Jan, 1998 to Mar, 2007, a total of 1692 critical patients were treated with CBP in Jingling Hospital clinical information was collected: General conditions: sex, age and original disease, clinical status prior to CBP indications of CBP, APACHE II score, SAPS II score, number of organ dysfunction, complication, and the percentage of patients with vasoactive agent and mechanical ventilation, technique and method of CBP modality, dosage, and vascular access of CBP, category of

anticoagulant and membrane of hemofilter used in CBP Outcome of patients: the individual predicted risk of death was calculated form the SAPS II scores of each patient. **Results:** (1) Among the 1692 patients, 1088 were males and 604 females with an average of 46.85±19.58 (3.5 ~ 94, median 46) years old. 1107 cases (65.43%) were admitted for medical reasons and 585 (34.57%) for surgical reasons. (2) The three main indication of CBP were: azotemia (60.46%), oliguria/anuria (39.07%)and refractory organ edema (especially lung)/nutritional support in patients with or at risk of pulmonary edema/ARDS (16.13%). (3) Continuous high-volume hemofiltration (HVHF) (66.55%) and continuous veno-venous hemofiltration (CVVH) (27.30%) were the main modality of CBP. A double-lumen catheter was used in most of the patients through internal jugular vein (64.72%) and femoral vein (30.91%). Polysulfone (78.72%) and polyacrylonitrile (15.77%) were the most common used membranes. 57.21% of the patient was anticoagulated with low molecular weight heparin (LMWH) combined with citrate acid, and 23.40% with LMWH only. (4) Except for 94 cases (5.56%) quitted for economic reasons, 800 cases (47.28%) were cured and 458 (27.07%) were improved, the total effective cure and improve rate was 74.35%, 340 cased died, the mortality was 20.09%, which was lower than the predicted in-hospital mortality of 29.53%. (5) The M/F ratio was much higher in the non-survivals, with an average of 55.78 ± 21.14 years old vs 44.80 ± 18.75 in the survivals ($p < 0.001$). The clinical condition of non-survivals were more severe before CBP: with higher APACHE II scores and SAPS II scores, more patients complicated with hypotension/shock, bleeding and infection/sepsis, more patients treated with vasoactive agents and mechanical ventilation, and more organ function were injured. **Conclusion:** The outcome of critical ill patients was significantly improved by CBP, the mortality was decreased.

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Acute Renal Failure in Neuro ICU

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Introduction: Acute renal failure is not uncommon in Neuro ICCU. Apart from other common risk factors (e.g. Sepsis, Hypotension and Drugs) these patients frequently have other risk factors which make them further susceptible for developing Renal failure like Seizures induced rhabdomyolysis, High Intracranial pressure, frequent administration of Hypertonic fluid, prolong ventilator dependency, labile body Temperature, multiple lines and severe malnutrition. Pattern of ARF and It's etiology in NICU setup has not been an area of active research. This study is done to identify the pattern and prognosis of ARF in NICU setting. **Objectives:** To determine the prevalence of ARF in Neuro Intensive care unit (NICU), to characterize ARF etiology and to determine the impact of ARF on patient outcomes. **Study Design:** It is a prospective observational study of NICU patients. Patients who either were treated with renal replacement therapy (RRT) or fulfilled at least 1 of the predefined criteria for ARF were included in last 11 months (from January 2007 to November 2007). **Main Outcome Measures:** Occurrence of ARF, Factors contributing to etiology, Need for renal support, Mortality and Morbidity. **Results:** Out of 527 patients admitted during the study period in NICU total 86 patients had ARF during their ICU stay. 38 patients were treated with RRT. Approximately 39% of patients had preadmission renal dysfunction. The most common contributing factors for ARF are HYPERTONIC FLUID/ MEDICINE, RHABDOMYOLYSIS and HOSPITAL acquired INFECTION particularly PNEUMONIA. Independent risk factors for hospital mortality included use of VASOPRESSORS and MECHANICAL VENTILATION. Overall hospital mortality was 62.83%. Dialysis dependence at hospital discharge was 12.8% for survivors. **Conclusion:** Occurrence of ARF has unique etiology in Neuro ICU and responsible for immediate and long term mortality and morbidity. Judicious use of Hypertonic saline, early recognition of Rhabdomyolysis and prevention of cross infection can reduce the prevalence and severity of ARF in Neuro ICU set up.

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Postoperative Acute Kidney Injury Is an Important Determinant of Long Term Survival of Surgical Patients

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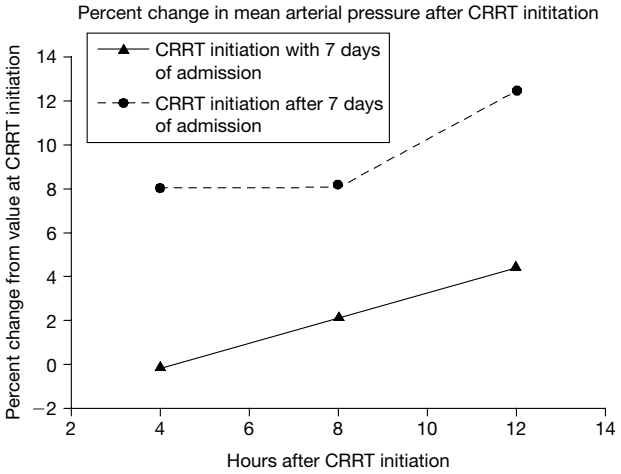
Acute kidney injury (AKI) is a common occurrence in surgical intensive care units (SICU). Long-term survival of patients with AKI who survive to leave the hospital is poorly studied. Our study reports the epidemiology and long-term outcome of surgical intensive care patients who developed post-operative AKI according to RIFLE criteria and survived to be discharged from the hospital. The administrative ICU database of Shands Hospital at the University of Florida was searched for all surgical patients discharged alive between 1992 and 2002. Medical records of patients were reviewed and AKI was determined using RIFLE classification. Patients were stratified according to the maximum RIFLE class (class R, class I or class F) reached during their hospital stay, based on glomerular filtration rate criteria, using changes in serum creatinine concentrations. Patients with end-stage renal disease (CKD 5) were analyzed separately. 10,678 patients had complete creatinine data. AKI was identified in 3,308 (31%) of patients who were discharged alive, while 7,076 (66%) patients had no episode of AKI. 156 CKD 5 patients who were hemodialysis-dependent prior to hospital admission were identified at the time of discharge. Patients with AKI were older (62.6 ± 14 vs. 55.6 ± 16, respectively, $p < 0.001$) compared to patients who did not develop AKI; both groups were similar in regard to gender and ethnicity distribution. CKD 5 patients were more likely to be African-American (33% vs. 8%, respectively). Length of ICU and hospital stay was significantly longer among AKI patients (5 vs. 2 days and 16 vs. 9 days, respectively, $p < 0.001$). There was a significant difference in the AKI prevalence among the four major groups of surgery (General, Vascular, Cardiothoracic, and Neurosurgery). Five and ten year survival was significantly worse for patients with AKI (62% and 43% vs. 78% and 64%, respectively) (fig. 1). Cox regression analysis confirmed AKI to be an independent predictor of long-term mortality when adjusted for patients' age, multiple co-morbidities on

Fig. 1.



admission, postoperative sepsis and acute respiratory failure (RR 1.55, $p < 0.001$). We have demonstrated for the first time that postoperative AKI is not only an important complication in the immediate postoperative course, but also carries significant implications for long-term mortality.

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The Use of Radiocontrast Nephropathy Prophylaxis in Critically-Ill Patients

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Introduction: Radiocontrast nephropathy (RCN) is an important cause of acute kidney injury (AKI) in patients admitted to the intensive care unit (ICU). To date, intravascular volume expansion, sodium bicarbonate infusion, and N-Acetylcysteine (NAC) administration have been shown to reduce the incidence of RCN. Despite the benefit of these preventative strategies, the utilization rate for these prophylactic therapies in patients with AKI within the ICU is not known. **Methods:** We conducted a retrospective clinical and administrative database review to identify all patients admitted to the surgical or cardiac ICU at Shands Hospital (Gainesville, Fla.) between 01/01/05 and 12/31/05 that developed AKI during their ICU course. In this project, we used the Acute Dialysis Quality Initiative conference RIFLE criteria definition of AKI as a rise in serum creatinine concentration greater than 50% above baseline. Patients who received hemodialysis within 3 days of admission or were diagnosed with CKD on admission were excluded from this review. The subgroup of patients included in this study that received radiocontrast agents with or without prophylaxis with either sodium bicarbonate or NAC were then identified. **Results:** After review of the clinical and administrative databases, 2,436 patients were identified that matched inclusion and exclusion criteria (table 1). Of these patients, 533 (21.8%) developed AKI while in the ICU and 132 (4.7%) received radiocontrast agents after developing AKI. These

	n	%
Total number of patients admitted to the Surgical or Cardiac ICU	2,770	
Total number of patients included in review	2,436	87.9
Total number of patients excluded from review	334	12.1
Total number of patients with AKI in the ICU	533	21.8
Total number of patients with AKI in the ICU who received radiocontrast agents	132	4.7
Number of radiocontrast administrations to who received radiocontrast agents	212	
Total number of prophylaxis administrations patients in the ICU with AKI	7	3.3
NAC prophylaxis	6	2.8
Sodium bicarbonate prophylaxis	1	0.5

132 patients underwent 212 radiocontrast administrations, of which RCN prophylaxis was provided for 7 radiocontrast administrations (3.3%). There were 6 administrations of NAC and 1 administration of sodium bicarbonate. **Discussion:** This project demonstrates that patients who developed AKI while in the Surgical or Cardiothoracic ICU were routinely administered RCN prophylaxis at very low rates (3.3%). The possible reasons for the low rate of prophylaxis administration in this study include poor physician recognition of AKI, poor physician knowledge of RCN prophylaxis or incomplete data collection. Further study of this data may elucidate the cause of low prophylaxis rates. The use of routine guidelines by physicians in the ICU to identify and provide prophylaxis to patients with AKI may improve the apparent low utilization of RCN prophylaxis.

Emerging Concepts

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Timing of Renal Replacement Therapy and Clinical Outcomes in Critically Ill Patients with Severe Acute Kidney Injury

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Purpose: To evaluate the relationship between timing of renal replacement therapy (RRT) in severe acute kidney injury (AKI) and clinical outcomes. **Methods:** Prospective multicentre observational

study from 54 ICUs in 23 countries enrolling 1238 patients. **Results:** Timing of RRT was stratified into 'early' and 'late' by median urea and creatinine at the time RRT was started. Timing was also categorized temporally from ICU admission into early (<2 days), delayed (2–5 days) and late (>5 days). RRT timing by serum showed no significant difference in crude (63.4% for urea ≤ 24.2 mmol/L vs. 61.4% for urea >24 .2 mmol/L; odds ratio [OR] 0.92, 95% CI, 0.73–1.15, p = 0.48) or covariate-adjusted mortality (OR 1.25, 95% CI, 0.91–1.70, p = 0.16). When stratified by creatinine, late RRT was associated with lower crude (53.4% for creatinine >mol/L; OR 0.46, 95% CI μmol/L vs. 71.4% for creatinine ≤309 μ309 0.36–0.58, p < 0.0001) and covariate-adjusted mortality (OR 0.51, 95% CI 0.37–0.69, p < 0.001). However, for timing relative to ICU admission, late RRT was associated with greater crude (72.8% vs. 62.3% vs. 59%, p < 0.001) and covariate-adjusted mortality (OR 1.95, 95% CI, 1.30–2.92, p = 0.001). Overall, late RRT was associated with a longer duration of RRT and stay in hospital and greater dialysis dependence. **Conclusion:** Timing of RRT, a potentially modifiable factor, might exert an important influence on patient survival. Moreover, late RRT was associated with a longer duration of RRT, longer hospital stay and higher dialysis dependence.

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High-Flow Isovolemic Continuous Hemodialysis Improves 28-Day Mortality in Patients with Septic Shock

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Objective: To evaluate the effectiveness of high-flow isovolemic continuous hemodialysis (HFCHD) in patients with septic shock, we compared the actual mortality and the predicted mortality based on Acute Physiology And Chronic Health Evaluation II (APACHE II). We also compared physiological parameters between HFCHD responder and non-responder group to identify the index of effectiveness. **Methods:** Eighteen patients with intractable cardiovascular failure complicating septic shock, who had failed to respond to conventional therapy between January 1998 and September 2006, were included in this study. HFCHD, followed by conventional continuous hemodialysis (CHD) were carried out for these 18 patients. HFCHD consisted of a 24-hr period during which 53 L of dialysate (3.0 L/hr for 0–5 hr; 2.0 L/hr for 6–24 hr). Subsequent conventional CHD (1.0 L/hr) continued for at least 3 days. Vascular access was obtained with 12 Fr triple lumen catheters and blood flow was set at 120 ml/min. The ACH-10 machine (Asahi Kasei Medical Co., Ltd., Tokyo, Japan) was used for HFCHD and conventional CHD with 0.6-m^2 polyacylonitrile filter (PANFL-06S, Asahi Kasei Medical). We measured changes in mean blood pressure (MBP), heart rate (HR), central venous pressure (CVP), noradrenalin (NA) requirements, arterial pH (pH), and body temperature (BT). The patients whose NA requirements dosage were reduced over 50% during HFCHD from 0-hr (T0) to 12 hr (T12) were considered hemodynamic responders group, and the others were considered hemodynamic non-responders group. **Results:** Predicted 28-day mortality for the 18 patients based on APACHE II was 67%, and the actual observed mortality of 39% was significantly less than predicted (p = 0.023). Thirteen patients were included in hemodynamic responders group. NA requirement dosage at T0 were not different between responders (0.172 ± 0.059 μg/kg/min) and non-responders (0.189 ± 0.098 μg/kg/min). At T12, NA requirement dosage in responders group were significantly reduced (0.028 ± 0.035 μg/kg/min) but not in non-responders group (0.195 ± 0.073 μg/kg/min). Initial dose of dialysate was not different between responders (54.3 ± 19.3 ml/kg/hr) and non-responders (53.5 ± 15.7 ml/kg/hr). MBP was increased both group at T0 to T12, but there was no significant difference in both group. There were no statistically significant differences in HR, CVP, pH and BT between two groups. APACHE II scores were not different between two groups (responders; 29.1 ± 6.9, non-responders; 31.6 ± 4.6). **Conclusions:** HFCHD improves hemodynamic states in most of septic shock patients, resulting in increased 28-day survival rate compared with predicted mortality. We could not found the index in physiological parameters in regard to HFCHD effectiveness. It is possible that unmeasured small molecular vaso-dilatory solutes were removed during HFCHD. Other modalities to non-responders to HFCHD have to be developed.

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Effects of High-Volume or High Flow Continuous Renal Replacement Therapy and PMX-DHP for Patients with Septic Shock

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Background: Continuous renal replacement therapy (CRRT) for septic shock can be achieved by several interventions including hemodialysis, hemofiltration, and hemodiafiltration. Especially, high-volume or high-flow CRRT (H-CRRT) has been shown to improve hemodynamic status and 28-day mortality in patients with septic shock. Furthermore, recent reports demonstrated that direct hemoperfusion with polymyxin-immobilized fiber (PMX-DHP) is also effective for the treatment of septic shock, although the high cost of this column has to be considered with regard to clinical use. Thus, the optimal selection of CRRT in the treatment of septic shock remains to be unclear. In the present study, we examined the clinical course of septic shock patients who underwent CRRT in our institute. **Methods:** The clinical profile of 54 septic shock patients who were treated with CRRT between January 1994 and September 2002 in our institute was analyzed retrospectively. Acute physiology and chronic health evaluation II (APACHE-II) score, hemodynamic status, 28-day mortality and standardized mortality ratio (SMR) were evaluated for each treatment modality. **Results:** 20 patients were treated with H-CRRT (>40 ml/hr/kg), and 14 patients with PMX-DHP plus conventional CRRT (C-CRRT; <40 ml/hr/kg). The remaining 20 patients were used treated with C-CRRT alone. The prediction mortality of H-CRRT, C-CRRT and PMX-DHP with C-CRRT is 71.9 ± 21.0, 56.1 ± 23.3 and 54.1 ± 21.0, suggesting that the disease severity of patients treated with H-CRRT seemed to be worse than others. The 28-day mortality in patients treated with PMX-DHP plus C-CRRT was lower (14.3%, P < 0.01) than that of patients with C-CRRT alone (65.0%). The

28-day mortality in patients with H-CHD was 40.0%, which indicates the effectiveness of this treatment considering the severe disease activity in this group. In 30 of 54 patients, surgical interventions such as operation or drainage for infectious sites were performed. In these patients, the effectiveness of H-CHD as well as PMX-DHP was found to be more prominent. **Conclusion:** The present study confirms the efficacy of PMX-DHP and H-CHD for the treatment of septic shock. Of note, the effectiveness seems to be different with or without the surgical interventions for infectious sites. Further studies are required for the appropriate selection of CRRT to reduce mortality in patients with septic shock and to save their therapeutic cost.

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Clinical Study of PMX-DHP for Pediatric Sepsis Patients

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There are some reports concerning with PMX-DHP for adult sepsis patients. PMX-DHP is immobilized Polymyxin-B fibers Direct Hemo Perfusion. PMX-DHP can remove Endotoxin selectively. But there are few reports about PMX-DHP pediatric sepsis patients. We studied PMX-DHP for pediatric sepsis patients. **Method:** Survival rate was an endpoit. There are 32 pediatric sepsis patients who were performed PMX-DHP (PMX+) or were not performed (PMX−) from 1997 to 2005. All of them were performed CRRT (CHF or CHDF). We excluded patients who had were performed ECMO, because we cannot calculate D-PELOD (PELOD). PMX+ was 12 cases. PMX− was 13 cases. We analyzed effect of PMX-DHP on survival rate and blood purification. We used Fisher X2 test. **Results:** PMX− patients mean age was 3 year and 7 month old. Mean body weight is 10.7 kg. Average PELOD is 33.5 points in PMX− patients. About blood purification, there were 12 cases of CHF and one cases of CHDF). PMX+ patients mean age was 3 year and 1 month old. Mean body weight is 15.1 kg. Average PELOD is 28.4 points in PMX+ patients. About blood purification, there were 2 cases of CHF and two cases of CHDF. Survival rate of PMX+(66.7%) is significantly higher than PMX−(15.4%) ($p < 0.05$). **Conclusion:** Our study shows that PMX-DHP can significantly achieve much better survival for pediatric sepsis patients.

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Colistimethate Sodium Clearance during in vitro Continuous Hemodialysis

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Introduction: Colistimethate sodium commonly referred to as colistin or polymyxin E is a polypeptide antibiotic that is part of the polymyxin family and is indicated for use in the treatment of gram-negative infections. Reports of multi-drug resistant strains of gram negative bacteria are increasing in critically ill patients and colistimethate sodium is being used with added frequency as salvage therapy for these patients. Colistimethate sodium's clearance during continuous hemodialysis is unknown and needs to be determined for clinician's to appropriately dose this antimicrobial agent. **Purpose:** To determine the extraction coefficient and transmembrane clearance of colistimethate sodium during In vitro continuous hemodialysis. **Methods:** Colistimethate sodium's transmembrane clearance was assessed with a validated single-pass bovine blood in vitro continuous hemodialysis model. The model was prepared with a polysulfone hemodialyzer (HF 1200, Minntech) at a blood flow rate (Qb) of 200 mL/min and dialysate flow rates (Qd) of 1, 2, and 4 L/hr (16.7, 33.3, and 66.7 mL/min). Blood and effluent samples were obtained at each Qd from the arterial and effluent ports of the extracorporeal circuit. The experiment was repeated six times with new disposable components for each experiment. Blood and effluent samples were determined by a HPLC-MS method and the assay was linear over the concentration examined ($r^2 > 0.99$). Extraction coefficient (EC) and transmembrane clearance for colistimethate sodium was calculated and the results were analyzed using a student's t-test and ANOVA. **Summary of Results:** The results show a linear decrease in the EC of colistimethate sodium over the sampling period with a significant difference between the EC for the Qd of 1 L/hr and 4 L/hr ($P = 0.02$). The transmembrane clearance at a Qd of 16.7 mL/min (1 L/hr) of 13.3 ± 3.9 mL/min was approximately 80% of Qd, which indicates a substantial removal of colistimethate sodium by continuous hemodialysis. **Conclusion:** Colistimethate sodium is removed by continuous hemodialysis. These in vitro findings suggest that dosage adjustments of colistimethate sodium during continuous hemodialysis will be required. A clinical trial is needed to confirm these results.

Mean Results – Colistimethate Sodium n = 6	Qb 200 Qd 1 L/hr	Qb 200 Qd 2 L/hr	Qb 200 Qd 4 L/hr
Extraction Coefficient (EC)	0.80 ± 0.23	0.66 ± 0.34	0.47 ± 0.18
Transmembrane Clearance (mL/min)	13.3 ± 3.9	21.9 ± 11.4	31.3 ± 12.1

Technique Characteristics

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Management of Hypernatremia Present at Initiation of CRRT

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Background: Acute renal failure in an ICU setting is sometimes accompanied by hypernatremia. If CRRT is initiated, a rapid decrease in serum sodium can occur, possibly causing cerebral edema. Case report: We report the case of a 45 year old man with cardiogenic shock and oliguric acute renal failure after cardiac surgery for a congenital

heart defect, followed by requirements for pressors, an intra-aortic balloon pump, mechanical ventilation and extracorporeal membrane oxygenation. The patient developed hypernatremia due to sodium bicarbonate administration for acidosis. Prior to the initiation of CRRT on postoperative day 2, he had been hypernatremic for 2 days with a peak serum sodium concentration of 163 meq/L. The sodium was 155 when CRRT was started. The regimen was CVVH using commercially-available replacement fluid with a sodium concentration of 140 at 4 L/hr (50% prefilter, 50% postfilter) with citrate anticoagulation (ACD Formula A at 250 ml/hr) and a blood flow rate of 200 ml/min. We added 3% saline (sodium = 513 meq/L) at 41 ml/hr via a separate IV to slow the rate of serum sodium correction. This rate provided an average sodium concentration in the administered fluid of 147 after correcting for the sodium in the citrate solution (224 meq/L), other intravenous fluids (76 ml/hr with a mean sodium of 31) and the filtration of 561 ml/hr of prefilter replacement fluid. One day after CRRT was initiated, the patient's serum sodium was 147. The 3% saline was decreased to 20 ml/hr and later stopped. The patient's serum sodium reached 140 two days after CRRT was initiated. A CT of the head, obtained for other reasons 6 days after CRRT initiation, did not show evidence of cerebral edema. The patient failed to recover hemodynamically and died on postoperative day 13. **Conclusion:** Hypernatremia during initiation of CRRT can be successfully managed using 3% saline to prevent too-rapid serum sodium correction.

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Electrolyte Control and Supplementation in Continuous Venovenous Hemodialysis (CVVHD) Patients Receiving a Standardized Dialysate

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Background: Standardized dialysate use in CVVHD has been suggested to reduce medical errors, but evaluations of the utility of standardized dialysates have not been conducted. Excessive customization of dialysate or electrolyte supplementation to meet patient needs may defeat the purpose of standardizing dialysate. **Purpose:** To assess the utility of a standardized dialysate in critically ill patients receiving CVVHD and quantification of electrolyte supplementation and dialysate modification in these patients. **Methods:** A retrospective chart review of 62 adults receiving CVVHD for >48 hours was performed. Data collected included length of CVVHD treatment and serial electrolyte concentrations. The amount of intravenous/oral electrolyte supplementation of magnesium, potassium, and phosphate per day was recorded. The standard dialysate contained: 135 mEq/L sodium, 110 mEq/L chloride, 25 mEq/L bicarbonate, and 1.5 mEq/L magnesium sulfate. Upon request 0.75 mMol/L of sodium phosphate and/or 2–4 mEq/L of potassium chloride could be added. The amount of phosphate and/or potassium added to the dialysate per day was documented. **Results:** The average age of the 26 females and 36 males was 57.5 ± 11.9 years. Mean ± SD CVVHD duration was 6.9 ± 3.5 days, range 2–18 days. Typical CVVHD orders were blood flow 200 mL/min, dialysate flow 2 L/hr, and an ultrafiltrate production rate of 400 mL/hr. By day three, CVVHD normalized serum electrolyte levels in all subjects. Electrolyte serum concentrations on day three were: potassium 3.9 ± 0.4 mEq/L, magnesium 1.9 ± 0.2 mg/dL, and phosphorus 3.2 ± 0.9 mg/dL. Most subjects eventually required electrolyte supplementation. Intravenous or oral supplementation of magnesium was required at least once during CVVHD treatment in 53/62 (85.4%) subjects. Similarly, 52/62 (83.9%) subjects required potassium and 10/62 (16.1%) required phosphate. Potassium was added in 60/62 (96.8%) subjects' dialysate and phosphate was added in 31/62 (50%) of the subjects' dialysate at least once during the course of CVVHD. **Conclusion:** This standardized CVVHD dialysate solution was not adequate for normalizing and maintaining patients' serum electrolyte values without either electrolyte supplementation or dialysate modification. In order to reduce medication errors, changes should be made to standard dialysate formulas to reduce the need for dialysate modifications as well as oral or intravenous electrolyte supplementation.

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Ertapenem Transmembrane Clearance During Modeled Continuous Hemofiltration

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Introduction: Ertapenem (Invanz®, Merck) transmembrane clearance (CLt) by continuous hemofiltration is unknown. Reported ertapenem protein binding values in healthy adults are high (85–95%) suggesting that CLt might be low. However, ertapenem has a small volume of distribution (0.1 L/kg), consequently substantial CLt may occur. **Purpose:** To determine ertapenem CLt during continuous hemofiltration using a validated in-vitro bovine blood-based model. **Methods:** Ertapenem CLt during continuous hemofiltration was assessed with AN69 (M100, Hospal) and polysulfone (F160NR, Fresenius) hemofilters at ultrafiltrate flow rates (Quf) of 1, 2, 3 and 6 L/h. Blood flow rates were adjusted between 200–400 mL/min to

	Ertapenem SC	Ertapenem SC	Ertapenem CLt (mL/min)	Ertapenem CLt (mL/min)
Hemofilter	Polysulfone (n = 5)	AN69 (n = 5)	Polysulfone (n = 5)	AN69 (n = 5)
Quf	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1 L/hr (16.6 mL/min)	1.16 ± 0.14	1.02 ± 0.04	19.3 ± 2.3	17.0 ± 0.71
2 L/hr (33.3 mL/min)	1.18 ± 0.07	1.06 ± 0.09	39.3 ± 2.4	35.3 ± 2.9
3 L/hr (50 mL/min)	1.07 ± 0.27	1.00 ± 0.10	53.7 ± 13.3	49.9 ± 4.8
6 L/hr (100 mL/min)	1.18 ± 0.30	1.03 ± 0.15	118.5 ± 30.1	103.5 ± 15.5

maintain an appropriate filtration fraction. Formed ultrafiltrate was circulated back into the system to preserve a constant blood volume and solute concentration. Blood and ultrafiltrate samples were collected at each flow rate and assayed for urea (the control solute) and ertapenem. The experiment was repeated 5 times with each hemofilter type, using a new hemofilter every time. Ertapenem and urea sieving coefficient (SC) and CLt were then calculated. Student's t-test was used to analyze data between hemofilter types and ANOVA was used to analyze data within the same hemofilter type. **Results:** Urea SC was approximately 1, regardless of Quf and hemofilter type. There was no significant difference in ertapenem CLt between hemofilter types at all Quf studied (table). **Conclusion:** The SC and CLt of ertapenem approximated those of urea, indicating that ertapenem CLt during continuous hemofiltration may be higher than predicted from protein binding data derived from healthy adults. These in-vitro findings need to be confirmed in patients. If in-vivo studies corroborate our findings, ertapenem dosage adjustments during continuous hemofiltration may be required.

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Ertapenem Transmembrane Clearance During Modeled Continuous Hemodialysis

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Introduction: Ertapenem (Invanz®, Merck) transmembrane clearance (CLt) by continuous hemodialysis is unknown. Reported ertapenem protein binding values in healthy adults are high (85–95%) suggesting that CLt might be low. However, ertapenem has a small volume of distribution (0.1 L/kg), consequently substantial CLt may occur. **Purpose:** To determine ertapenem CLt during continuous hemodialysis using a validated in-vitro bovine blood-based model. **Methods:** Ertapenem CLt during continuous hemodialysis was assessed with AN69 (M100, Hospal) and polysulfone (F160NR, Fresenius) dialyzers at four different dialysate flow rates (Qd): 1, 2, 3 and 6 L/h. Blood flow rates were adjusted between 200–400 mL/min to maintain appropriate transmembrane pressure. Blood and dialysate samples were collected at each flow rate and assayed for urea (the control solute) and ertapenem. The experiment was repeated 5 times with each dialyzer type, using a new dialyzer every time. Ertapenem and urea saturation coefficient (SA) and CLt were then calculated. Student's t-test was used to analyze data between dialyzer types and ANOVA was used to analyze data within the same dialyzer type. **Results:** Urea SA was approximately 1, regardless of dialyzer type. Ertapenem SA and CLt were significantly different between dialyzer types only at Qd 6 L/h (p-value < 0.001; t-test). As Qd increased, SA significantly decreased with the AN69 dialyzer (p-value < 0.001; ANOVA), but with the polysulfone dialyzer, SA was unaffected by Qd. **Conclusion:** Observed ertapenem SA and CLt were higher than would be predicted from known ertapenem protein binding data derived from healthy adults. These in-vitro findings need to be confirmed with in-vivo studies. If in-vivo studies corroborate our findings, ertapenem dosage adjustments for continuous hemodialysis may be required.

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Feasibility, Cost-Effectiveness and Staff Satisfaction of Continuous Hemofiltration Using Regional Citrate Anticoagulation and On-line Prepared Replacement Solution for Critically Ill Patients in the Intensive Care Unit

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Purpose: With regard to the renal support for patients in the intensive care unit (ICU) with acute renal failure (ARF), continuous renal replacement therapy (CRRT) in form of hemofiltration (HF) is a commonly used modality. Use of heparin as anticoagulant is contraindicated in patients with bleeding tendency. Handling of the five-litre commercially prepared replacement fluid entails significant nursing workload. We herein describe a method to overcome the above issues by using regional citrate anticoagulation and on-line prepared sterile replacement solution. **Methods:** Consecutive patients admitted to our ICU from November 2005 to April 2006 who were indicated for renal support were included, with exclusion of patients with liver problem. CRRT was delivered in form of three successive ten-hour sessions of HF, totaling 30 hours. The dialysis machine would undergo a two-hour disinfection and decalcification every thirty hours, following

Table for abstract 21

Dialyzer	Ertapenem SA	Ertapenem SA	Ertapenem CLt (mL/min)	Ertapenem CLt (mL/min)
	Polysulfone (n = 5)	AN69 (n = 5)	Polysulfone (n = 5)	AN69 (n = 5)
Qd	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1 L/hr (16.6 mL/min)	0.79 ± 0.05	0.87 ± 0.12	13.2 ± 0.8	14.5 ± 2.0
2 L/hr (33.3 mL/min)	0.80 ± 0.07	0.79 ± 0.07	26.6 ± 2.3	26.4 ± 2.4
3 L/hr (50 mL)	0.79 ± 0.07	0.66 ± 0.02	39.6 ± 3.6	32.8 ± 1.2
6 L/hr (100 mL/min)	0.70 ± 0.06	0.45 ± 0.02	70.5 ± 6.4	44.8 ± 2.3

which HF would be continued if indicated. HF was performed using AK200 Ultra S (Gambro, Lund, Sweden) with an APS 650 dialyser (1.3 m^2, Asahi Medical, Tokyo, Japan). Blood flow rate was maintained at 120–150 ml/min. Anticoagulant Citrate Dextrose Formula A (ACDA) (3% solution; trisodium citrate, 2.2% and citric acid 0.8%; 112.9 mmol of citrate/L; Baxter) was infused pre-filter at 240 ml/hr (i.e. citrate 27.1 mmol/hr), with KCl added if necessary. Sterile replacement solution was produced on-line after two U8000 filters and one U2000 filter, mixing with the BiCart cartridge and Gambro concentrate D204, infused post-filter at 1.8 L/hr. Ultrafiltration was maintained at 2 L/hr or more, adjusted to the desired fluid balance. 10% calcium chloride was infused via a separate central venous catheter to maintain the ionized calcium level at 1.0–1.2 mmol/L. A questionnaire survey was conducted to evaluate nursing satisfaction and cost comparison with conventional method was made. **Results:** Twenty (10 males) critically ill patients with median APACHE II score 31.5, (range 17–48) and median age 73 (range 36–86) were included. Fifteen patients had ARF and five had pre-existing end-stage renal disease. Among those with ARF, using the RIFLE criteria, one patient was classified as 'at risk', seven patients 'injury' and seven patients ' failure'. Filter clotting did not occur during the three 10-hour sessions. No significant bleeding event was recorded. During the course of HF, pH, urea, creatinine levels progressively improved. One alkalemic (pH $>$ 7.55) episode was encountered, with no patient morbidity resulted. Three patients had total calcium- ionized calcium ratio $>$ 2.5 but no patient developed symptomatic hypocalcemia. The questionnaire survey showed that majority of nursing staff preferred this system of citrate- HF to conventional CRRT because of its simple logistics and less workload involved in handling the replacement fluid. Comparative cost estimation showed that the daily cost of on-line HF was only one-fifth of conventional CRRT (absolute daily cost reduction US$ 77.3). **Conclusion:** On-line hemofiltration with regional citrate anticoagulation was feasible, simple, cost-effective and well accepted by nursing staff. Further prospective comparative studies should be carried out to evaluate its longer-term benefits.

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Factors Contributing to the Suboptimal Delivery of the Prescribed Dose in Continuous Renal Replacement Therapy

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Introduction: The treatment time lost usually is due to elective procedures (routine filter change, surgical procedures) and nursing procedures (changing of CRRT fluid bags and delays in adressing alarms). Access dysfunction and filter clotting account for the remainder of time lost. **Objectives:** We performed a prospective observational study, focus in the nursing procedures, to quantify the differences between the dialysis dose prescribed and delivered, and also trying to found if exist differences between the machines used in our ICU. **Material and Methods:** The delivered dyalisis dose was calculated using the hourly effluent rate, patient's weight, and duration of CRRT for each 24 hour period. Thirteen ICU patients receiving CVVHF CRRT were observed for a total of 620 treatment hours (25.8 days). Prisma and Multifiltrate CRRT machines with AN69 filters in pre and pos-filter replacement fluid, femoral catheters and prefilter heparin as anticoagulation were used. We did the statistical analysis with ANOVA and t student test. **Results:** 13 patients, mean age 63.3 years, SAPS II 60.3, NEMS 35.9, weight 71.7 Kg (116–45). The mean dyalysis dose prescribed was 41.7 ml/kg/h. The mean total fluid bags changes were 45.6 and the median lost dose/hour were 9.2 ml/h. In the linear logist regression (r-8.76; IC95%) we found a direct correlation between the delivered dose and the exchange fluid bags. Comparing the two machines, we only found significant differences in the exchanges fluid bags (p 0.014) but without influencing in the dose prescribed by treatment. **Conclusions:** So we didn't found significant losses in the total dialysis dose treatment, but the variable that seems to influence the prescribed and delivered dose differences in 24 hours was the fluid bags exchanges, independently of the used machine.

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Effect of Dilution Mode and Blood Flow Rate on Small Solute Clearance in Continuous Venovenous Hemofiltration (CVVH)

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The landmark CVVH dose study (Ronco et al, Lancet 2000) was performed in the post-dilution mode, which is not used commonly in most of the world. As such, the extrapolation of data from the Ronco study to other modalities may be difficult. The purpose of this laboratory study is to compare small solute (urea: U; creatinine: C) clearances achieved in three different CVVH modes: post-dilution (POST); standard (pre-filter) pre-dilution (PRE); and pre-dilution with replacement fluid (RF) infusion prior to the blood pump (PBP). Isovolemic CVVH was performed with the Prismaflex system and a set containing a 1.4 m^2 filter (Gambro). In this system, prescribed blood flow rate (QB) is maintained despite a pre-blood pump infusion

Table 1 for abstract 24

	Urea			Creatinine		
	POST	PRE	PBP	POST	PRE	PBP
Condition #1	34.0 ± 2.0	27.0 ± 0.8	25.3 ± 1.9	34.0 ± 1.0	27.8 ± 1.0	26.0 ± 0.5
Condition #2	54.0 ± 1.2	35.1 ± 0.7	36.4 ± 0.7	55.0 ± 0.7	35.5 ± 0.3	35.7 ± 1.4
Condition #3	71.0 ± 2.0	52.1 ± 1.7	49.5 ± 5.6	71.0 ± 1.0	51.6 ± 0.6	52.8 ± 3.6
P value	6.5E-09	1.1E-06	4.3E-04	3.7E-09	4.5E-08	1.9E-05

by automatic blood pump speed compensation. For each mode above (corresponding to doses of 22, 35, and 47 mL/kg/hr for an 85 kg patient), QB (mL/min)/RF rate (L/hr) under conditions #1, #2, and #3 were 190/2.0, 290/3.0, and 380/4.0, respectively. QB in each condition was dictated by a POST maximum filtration fraction (FF) of 25% (table 1). Although clearances in POST were significantly higher than in PRE and PBP, clearances in the latter two modes were not different. Clearances of U and C were not different in any condition/ mode. These data confirm POST provides the highest small solute clearances, as long as FF is acceptably low. For pre-dilution, PBP is equivalent to traditional PRE and may provide clinical advantages in certain situations.

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Discrepancy Between Prescribed and Delivered Dose of Continuous Veno-venous Hemodiafiltration in Pediatric and Adult Patients

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While much emphasis had been placed on determining the optimal prescribed dose of continuous renal replacement therapy (CRRT), it has yet to be shown that the prescribed dose is actually delivered. In order to determine whether the clearance prescribed during CRRT is achieved, we performed a prospective study comparing the prescribed clearance (corrected for time off therapy, body surface area and ultrafiltration) to the achieved clearance in both adult and pediatric patients receiving continuous veno-venous hemodiafiltration (CVVHDF) therapy. A total of 108 daily creatinine clearance (CrCl) measurements were made over an average of 6.5 ± 1.6 and 4.7 ± 2.3 consecutive days of CVVHDF therapy in 7 adult and 12 pediatric patients, respectively. The delivered clearance was only 69% and 74% of the prescribed clearance in the pediatric and adult populations, respectively (see table). The prescribed dose was significantly lower in the adult compared to the pediatric patients ($P < 0.005$). The principal cause of temporary cessation of therapy was filter clotting, accounting for 66% and 49% of total time off CVVHDF in pediatric and adults respectively. These results demonstrate that in both populations, despite accounting for time off therapy, the delivered daily CrCl was significantly less than prescribed. The reasons for this relatively poor delivered dose have yet to be identified but may be due to inaccuracies in the current methods used in calculating the prescribed dose or poorer than expected CVVHDF filter performance. Thus, in order to achieve targeted clearance during CVVHDF therapy, relatively higher CrCl needs to be prescribed.

	Age (y)	Prescribed CrCl (L/day/ 1.73 m^2)	Delivered CrCl (L/day/ 1.73 m^2)	% Delivered of prescribed dose
Pediatrics	9.6 ± 7	51,264 ± 17,962	34,968 ± 12,998	69 ± 16*
Adults	60.9 ± 11	41,552 ± 12,415	29,360 ± 7,427	74 ± 15†

*,† Delivered vs. Prescribed dose; $P < 0.001$.

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Single-Pass Albumin Dialysis (SPAD) in Liver Failure in South East Asia (SEA)

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Objective: The role of liver replacement therapy in liver failure is to temporarily support the patients until the native liver recovers or to serve as a bridge to liver transplantation. Although MARS® and Prometheus® are demonstrated to be effective, both are expensive. SPAD is a more affordable technique but needs more clinical efficacy data. This is the first study from SEA to utilize SPAD in patients with liver failure. **Materials and Methods:** Eighteen patients with acute liver failure or acute on top chronic liver failure underwent SPAD with continuous renal replacement therapy machine (CRRT) for 6 hours at King Chulalongkorn Memorial hospital. A 20% albumin solution was mixed with standard conventional dialysate to yield a dialysate with concentration of 2–4% albumin. The Sure-flux 150E® which was low-flux dialyzer, was used in the protocol. Serum total and direct bilirubin levels were measured before and 2 hours after treatment. To evaluate the efficacy of the whole treatment regimen, the treatment phase percent removal rate (RRt) was calculated. **Results:** Patient characteristics are shown in table 1. The severity scores (APACHE, MELD) were very high (22.9 ± 7.2, 33.7 ± 6.6, respectively). Despite the high severity scores, four patients (22.2%) were still alive after day 15 of treatment and one was successfully received cadaveric liver transplantation. In patients with moderate severity, APACHE score equal or less than 25, the patient survival on day 15 of treatment increased upto 44.4%. The SPAD could significantly reduce total bilirubin and direct bilirubin levels (40.7 ± 12.4 to 35.2 ± 8.3 mg/dl, $p < 0.01$ and 29.2 ± 8.0: 25.3 ± 6.5 mg/dl, $p < 0.005$, respectively). The treatment phase percent removal rate (RRt) of total bilirubin and direct bilirubin were 10.5% and 10.1%, respectively. The cost of treatment by SPAD was cheaper than MARS® about 3–5 times despite the fact that the efficacy of treatment were comparable between both modalities. **Conclusion:** SPAD with CRRT is feasible and effective in treatment of patients with liver failure. This technique may be a useful alternative therapy in centers that do not have access to MARS® and Prometheus® therapies.

Table 1

Gender (Female:Male)	3:15
Mean age (years ± SD)	46 ± 9.7
Number of SPAD treatments	3.6 ± 2.4
APACHE score (mean ± SD)	22.9 ± 7.2
MELD score (mean ± SD)	33.7 ± 6.6
Child-Pugh score (A:B:C)	0:2:16
Total bilirubin (pre-SPAD:post-SPAD, mg/dl)	40.7 ± 12.4:35.2 ± 8.3
Direct bilirubin (pre-SPAD:post-SPAD, mg/dl)	29.2 ± 8.0:25.3 ± 6.5
RRt total bilirubin (%)	10.5
RRt direct bilirubin (%)	10.1

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Regional Citrate Anticoagulation in CRRT Using Commercial Solutions: Comparison with Systemic Heparinization and Saline Flushes

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Purpose: The optimal means of anticoagulation is one of the important issues for continuous renal replacement therapy (CRRT) to be appropriately carried out. Although regional citrate anticoagulation has been reported to be an alternative to systemic heparinization, it is not widely used because of impractical protocols. We tested the feasibility of using commercial preparations of citrate anticoagulation and replacement solution in CRRT. **Methods:** Clinical data from 35 patients requiring CRRT were retrospectively analyzed, 11 treated with citrate, 9 with heparin, and 15 with saline flushes. All patients were treated using the PRISMA quadruple pump system (GAMBRO) using an AN69 hollow fiber biocompatible membrane with a surface area 0.6 m^2. Regional citrate anticoagulation was done with Anticoagulant Citrate Dextrose in formula A (ACD-A, Baxter) containing dextrose 2.45 g/dL, sodium citrate 2.2 g/dL, citric acid 730 mg/dL. The ACD-A solution was started at a rate of 225 mL/h and titrated as needed so as to keep post-filter ionized calcium levels at 0.25–0.35 mmol/L. The hemofiltration replacement fluid was Hemosol BO (GAMBRO) containing sodium 144 mmol/L, bicarbonate 35 mmol/L, calcium 1.75 mmol/L, magnesium 0.5 mmol/L, and lactate 3 mmol/L. **Results:** Severity of illness estimated by APACHE II score was significantly ($P < 0.01$) higher in citrate group (29.8 ± 2.6) than in those with heparin (21.7 ± 4.5), and saline flushes (26.2 ± 5.2). Overall hemofilter life span with citrate (52.9 ± 21.9 h; 17 to 72 h) was significantly ($P < 0.001$) greater than heparin (10.8 ± 5.6 h; 5 to 19 h) and saline flushes (15.4 ± 12.3 h; 4 to 48 h). Kaplan-Meier curves for cumulative survival of hemofilter revealed that citrate anticoagulation was superior to heparinization and saline flushes. No hemorrhagic complications occurred in the patients with citrate anticoagulation during the procedure of CRRT. Serum calcium and electrolytes and arterial blood gas analyses measured at 48 hrs of citrate anticoagulation-based CRRT showed no overt hypocalcemia, metabolic alkalosis, and hypernatremia. **Conclusion:** Regional citrate anticoagulation using commercial preparations of citrate anticoagulation and replacement solution may be applicable to CRRT with both efficacy and safety.

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Daytime Intermittent Venovenous-Hemofiltration (IVVH) for Treatment of Refractory Edema with or without Acute Renal Failure

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Background: The management of the edematous patient is a problem frequently encountered by the clinician. Whether the cause is congestive heart failure, cirrhosis of the liver, the nephrotic syndrome, or severe degrees of renal insufficiency, patients can present with fluid retention which is refractory to standard treatment. We performed venovenous hemofiltration for eight hours in the daytime in dialysis unit and repeated intermittently at 1 or 2 days interval for treatment of refractory edema. **Methods:** From Dec. 1992 through Apr. 2006, we retrospectively reviewed the efficacy and usefulness of IVVH in 158 patients with refractory edema. **Results:** The mean age of the patients was 48.9 years, 85 patients were male and underlying disorders which required IVVH were diabetes in 76 patients (48%). The mean duration of treatment was 12.4 ± 7.3 hrs. Total UFR was 23.0 ± 13.6 L and mean UFR/hr was 1.9 ± 0.6 L. Edema was successfully controlled with only one time treatment of IVVH in 67 (42.4%), two in 58(36.7%), three in 23 (14.5%), four in 8(5.1%), and five in 2(1.3%). Changes in blood chemistry and hemodynamics before and after IVVH were not significantly different. Body weight and abdominal girth decreased significantly after IVVH ($p < 0.000$). There were 17(5.7%) episodes of transient hypotension and no major complications occurred during the study period. **Conclusions:** Daytime IVVH is a substitutive technique well tolerated by patients with a severe fluid overload and refractory to diuretic therapy. IVVH was safely performed during daytime by the general or dialysis nurses without any potential problems of the extracorporeal circulation and interruption of patient's sleep at night.

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Effect of Dilution Mode and Flow Conditions on Middle Molecule (MM) Clearance in Continuous Venovenous Hemofiltration (CVVH)

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The clinical outcome benefits provided by high-dose CVVH may be related to high MM clearances. However, actual solute clearances were not measured in the landmark dose study (Ronco et al, Lancet 2000) and a careful assessment of the treatment factors influencing MM clearance in CVVH has not been performed. The purpose of this study is to compare MM (vancomycin, MW 1350; inulin, MW 5200) clearances as a function of both dilution mode and flow conditions. The dilution modes were: post-dilution (POST); standard (pre-filter) pre-dilution (PRE); and pre-dilution with replacement fluid (RF) infusion prior to the blood pump (PBP). Isovolemic CVVH was performed with the Prismaflex system and a set containing a 1.4 m^2 filter (Gambro). For each mode above, QB (mL/min)/RF rate (L/hr) under conditions #1, #2, and #3 were 190/2.0, 290/3.0, and 380/4.0, respectively. Within each dilution mode, increasing RF rate was associated with a significant increase in MM clearances. However, as opposed to small solute clearances, for which POST is superior to PRE and PBP under all three conditions (see Huang et al; this meeting), dilution mode did not a have a significant impact on MM clearances. The mechanisms explaining the differing effects of the two dilution modes on small solute vs MM clearances remain to be defined. However, if MM clearance accounts largely for the effect of CVVH dose on clinical outcome, pre-dilution modes may be most desirable.

Table for abstract 29

	Vancomycin			Inulin		
	POST	PRE	PBP	POST	PRE	PBP
Condition #1	30.6 ± 4.6	25.2 ± 1.2	23.7 ± 0.5	26.8 ± 2.3	26.0 ± 4.7	24.5 ± 0.9
Condition #2	36.7 ± 3.8	31.9 ± 0.6	33.7 ± 1.5	34.7 ± 5.6	33.6 ± 3.1	36.4 ± 0.9
Condition #3	43.8 ± 3.6	46.3 ± 0.9	46.7 ± 0.6	48.5 ± 4.1	44.4 ± 6.5	47.2 ± 1.8
P value	0.02	5.4E-07	2.3E-07	0.0014	0.014	2.1E-06

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Citrate when Compared to Heparin as Catheter Locking Solution in Hemodialysis Patients Does Not Prolong PT/PTT/INR

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In hemodialysis (HD) patients with a catheter as vascular access, heparin or citrate is usually used as a locking solution to maintain catheter patency. Due to poor peripheral veins in HD patients, PT/PTT/INR is usually drawn from the catheter as part of pre procedural labs and adjusting dose of coumadin. The objective of the study was to determine the affect on PTT/PT/INR in HD patients with catheter locked with heparin or citrate. This project was undertaken at our tertiary care hospital from July 2007 to Nov 2007 in the acute HD unit. 66 samples of PT/PTT/INR at 0, 30, 60 min in HD patients with a catheter were obtained from 24 patients. 29 similar samples were obtained from 8 HD patients with AVF/AVG. None of the patients were getting coumadin, systemic heparin or argatroban. After discarding 5 ml of blood from each port, PT/PTT/INR was drawn at 0 min from arterial blood line. Subsequent samples were collected at 30 and 60 min prior to initiating heparin for extracorporeal circulation. At the end of dialysis treatment, the catheter was filled with citrate 2.9% (ACD-A) or heparin 5000 U/ml to match the volume of the catheter. Data are summarized in the table below (Mean ± SD). Data suggests that PT/PTT/INR were prolonged at 0 min but not at 30 or 60 min in HD patients with the catheter locked with heparin. In contrast, data suggest that PT/PTT/INR were not prolonged when drawn from the catheter locked with citrate. Similarly PT/PTT/INR were not prolonged at 0, 30 or 60 min in patients with the AVF/AVG. Blood flow rate prescribed (BFR-P) and delivered (BFR-D) between heparin (BFR-P 310.57 ± 62.51, BFR-D 307.69 ± 64.71) and citrate (BFR-P 330.43 ± 39.13, BFR-D 325.00 ± 41.96) were similar. During first 60 min when heparin was not administered, clotting of circuit happened only on one occasion. Catheter patency was similar between catheter locked with heparin or citrate. In conclusion, PT/PTT/INR were not prolonged when drawn from catheter locked with citrate as compared to heparin in HD patients.

Variable	Heparin (N = 30)	Citrate (N = 36)	P value
PT0	44.07 ± 47.61	12.98 ± 1.66	<0.0005
PTT0	127.75 ±100.75	30.01 ± 4.08	<0.0005
INR0	3.93 ± 4.05	1.18 ± 0.20	<0.0005
PT30	13.17 ± 1.35	12.86 ± 1.61	0.40
PTT30	36.50 ± 12.39	29.54 ± 4.06	<0.01
INR30	1.21 ± 0.15	1.16 ± 0.20	0.37
PT60	12.98 ± 1.2	12.89 ± 1.60	0.81
PTT60	36.63 ± 16.00	29.52 ± 4.48	<0.01
INR60	1.18 ± 0.15	1.17 ± 0.19	0.79

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Evaluation of Zosyn (Piperacillin/ Tazobactam) in Patients Receiving Continuous Renal Replacement Therapy (CRRT)

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Background: Continuous renal replacement therapy (CRRT) is commonly used in intensive care units. One of the challenges with the use of CRRT in acutely ill patients is proper antibiotic dosing. Adequate antimicrobial dosing is critical for treatment and preventing resistance. Dosing of Piperacillin/Tazobactam(Pip/Taz) in high volume CRRT has not been adequately studied to determine dosing frequency as a function of ultrafiltration (UF) clearance. We sought to determine the clearance and optimal dosing of Pip/Taz in patients requiring CRRT at different rates of Ultrafiltration (UF). **Methods:** 15 anuric patients on continuous venovenous hemofiltration(CVVH) were randomly assigned to one of three UF goals A) 25, B)35 or 45 ml/kg/hr. All patients had been on CRRT and Pip/Taz for at least 24 hours prior to study initiation. Patient demographics and cause of Renal Failure were collected. Patients were on the NxStage (Lawerence, MA) system 1 with prepackaged cartridge polysulfone filter. Replacement fluids were run pre-filter. Patients were receiving Pip/Taz 3.375 Grams every 6 hours. To evaluate drug clearance, serum

Table. Piperacillin/ Tazobactam Clearance as a function of Ultrafiltrate Goal

UF Goal rate (ml/kg/hr)	Piperacillin clearance (μg/min)	Tazobacatam clearance (μg/min)	Percentage of patients at risk of antibiotic under-exposure (%)
25	31 ± 13	19 ± 8.1	0
35	58.1 ± 41	28.8 ± 30	60
45	84.3 ± 66	55.6 ± 57	60

levels were checked prior to study dosing, 15 minutes after infusion, at 3 hours, and a final trough level prior to next dose. Also, ultra-filtrate levels were checked 15 minutes after infusion and at the final trough. Samples were analyzed by high pressure liquid chromatography (HPLC) to determine drug concentration. Antibiotic clearance was then calculated. The minimum inhibitory concentration breakpoint (MIC-B) of Pip/Taz was used as the reference standard for adequate antibiotic levels in severely septic patients. Those patients who had less than 70% percent of the dosing interval over the MIC breakpoint were considered at risk for potential under dosing of Pip/Taz during CRRT. **Results:** 11 males and 4 females with an average age of 54.4 yrs and body surface area (BSA) of 2.03 were studied. The average peak Pip level was 213.9 ± 60.7, 191.6 ± 138.4, 186.7 ± 74.8 in Groups A, B, and C. The Average mid point Pip and trough levels for the three groups were 131.1 ± 52.7, 102.7 ± 69.4, 91.1 ± 25.8 and 93.5 ± 25.4, 76.6 ± 54.2, 65.4 ± 23.9, respectively. The average sieving coefficient of the three groups was 0.62 ± 0.25 and remained consistent throughout the study period. The average rate of clearance did vary linearly with increasing rate of UF and was 31 ± 13, 58.1 ± 41, 84.3 ± 66 for Pip in groups A, B and C, respectively. Similarly, tazobactam (Taz) clearance increased with increasing dose of dialysis. Taz clearance was 19 ± 8.1, 28.8 ± 30 and 55.6 ± 57 for groups A, B and C, respectively. The percentage of patients with less than 70% percent of Pip/Taz dosing interval above the MIC-B increased with increasing UF goal were 0%, 60%, and 60% in groups A, B and C, respectively. **Conclusion:** Higher rates of UF in CRRT are associated with increased level of Pip/Taz clearance. In dosing of 35 and 45 ml/kg/hr dosing a significant percentage of patients may have sub-therapeutic levels for prolonged periods putting them at risk of therapeutic failure. Higher UF dosing may require higher Pip/Taz dosing in severe sepsis.

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Relationship between Operating Conditions and Filter Performance in High-Dose Continuous Venovenous Hemofiltration (CVVH)

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The relationship between transmembrane pressure (TMP) and filter performance is unknown in high-dose CVVH. The purpose of this experimental study is to measure the temporal profile of middle molecule (vancomycin: V; inulin: I) sieving coefficient (SC) and TMP during isovolemic CVVH performed in 3 different modes with the Prismaflex system (Gambro): post-dilution (POST); standard (pre-filter) pre-dilution (PRE); and pre-dilution with replacement fluid (RF) infusion prior to the blood pump (PBP). Blood/replacement flow rates (mL/min)/(L/hr) for conditions #1, #2 and #3 were 190/2.0, 290/3.0, and 380/4.0, respectively (table 1). Although TMP did not change significantly, SC decreased for both V and I (data shown only for I) as a function of time, with the largest change in POST (Table shows SC values for I; TMP is mean over 240 min). In conclusion, TMP is not an adequate indicator of filter performance in CVVH.

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Comparison of no Versus Heparin Anticoagulation during CRRT

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Introduction: Systemic heparinisation during CRRT is associated with well known disadvantages especially in those with deranged coagulation profile. We carried out this study to analyse efficacy of no-anticoagulation (frequent saline flushings) compared with heparin anticoagulation in CRRT. **Methodology:** From January 2004 to November 2007, 65 critically ill patients with ARF underwent CRRT. CVVHDF was performed using Diapact Braun CRRT machine and diacap hgh flux dialyser. Vascular access used were – Femoral in 42, Internal Jugular in 10, AVF in 04 and Subclavian 09 patients. 1.7% P.D. fluid was used as dialysate. 0.9% NS with addition of 10% Ca Gluconate, Magnesium Sulphate, Soda bicarbonate and Potassium Chloride added sequentially in separate units were used for replacement, carefully monitoring their levels. Anticoagulation of extracorporeal circuit was achieved with unfractionated heparin (250–500 units alternate hour) in 35 patients targeting aPTT of 55–65 seconds.No anticoagulation was used in 30 patients with baseline aPTT >65 seconds and extracorporeal circuit was maintained with saline flushes at 30 min interval. **Results:** Of the 65 patients studied, 42 were males and 23 females (1.82:1). The average age was 58.24 yrs. The co-morbidities included – Type II DM in 38(58%) Hypertension – 27 (41.5%), Coronary artery disease – 21 (32%) and Chronic kidney disease in 14 (21.5%) patients. Cause of ARF included Sepsis in 35(54%), Hemodynamically mediated in 21(32%)

Table 1 for abstract 32

Mode	Condition	TMP (mm Hg)	SC (T = 0 min)	SC (T = 120 min)	SC (T = 240 min)	P value
POST	#1	116	0.93 ± 0.02	0.78 ± 0.02	0.47 ± 0.01	3.5E-11
	#2	137	0.91 ± 0.00	0.68 ± 0.05	0.38 ± 0.03	6.5E-09
	#3	156	0.93 ± 0.02	0.67 ± 0.05	0.32 ± 0.06	2.0E-09
PRE	#1	74	0.87 ± 0.03	0.78 ± 0.01	0.73 ± 0.04	2.4E-04
	#2	85	0.92 ± 0.01	0.80 ± 0.03	0.70 ± 0.07	9.8E-04
	#3	96	0.86 ± 0.01	0.73 ± 0.06	0.69 ± 0.01	1.4E-04
PBP	#1	66	0.86 ± 0.04	0.78 ± 0.04	0.77 ± 0.01	1.2E-05
	#2	84	0.89 ± 0.01	0.77 ± 0.05	0.77 ± 0.02	4.1E-04
	#3	101	0.91 ± 0.01	0.75 ± 0.08	0.71 ± 0.01	8.7E-04

and acute over Chronic renal failure in 09(14%) patients. The mean pre-dialysis systolic and diastolic BP was 102.92 and 60.22 mm Hg respectively. 43(66%) patients were ventilated. The mean duration of CRRT was 47.81 ± 22.4 hrs. Average filter life in patients receiving heparin anticoagulation was 26 ± 6.4 hrs. while that in patients received only saline flushings was 24.5 ± 6.36 hrs.(p not significant) .Patients receiving heparin had 16 bleeding episodes (0.45/patient). While only 4 bleeding episodes occurred in non heparin group (0.13/patient, $p < 0.05$). The overall mortality was 75% in heparin group and 72% in the no heparin group. **Conclusions:** Frequent saline flushings is an effctive mode of maintainance of extracorporeal circuit in CRRT. With significantly decreased bleeding episodes.

Targeted Interventions

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High Flow Continuous Veno-Venous Hemodialysis Protocol in Hyperammonemic Encephalopathy

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Back Ground: Hyperammonemic encephalopathy (HAE) is a medical emergency, which leads to irreversible neuronal damage unless treated urgently. Removal of serum ammonia can be achieved through dialysis, which can be enhanced by increased blood and dialysis flow rates in a flow dependent manner. Although hemodialysis is most effective, it is difficult to practice in hemodynamically unstable patients. The aim of present study is to assess the efficacy and safety of high flow continuous veno-venous hemodialysis (CVVHD) in HAE, in hemodynamically unstable patients. **Methods:** Prospective study from 2001 to 2007. Evaluation included – history, clinical examination, biochemical, hematological, microbiological investigations and imaging. Indication for CVVHD was encephalopathy with serum ammonia level >4 times the normal after excluding the other causes. Hemodynamic instability is defined as requirement of ionotropes to maintain systolic blood pressure of 90 mm Hg. Serum ammonia was estimated 12th hourly. The criteria of response to treatment was complete recovery from encephalopathy with normalization/ near normalization of serum ammonia. **Results:** Number of patients 21and thirteen were males. Average age was 43.2 years (Range 17–68). Etiology of HAE – Complicated malaria (n-5), leptospirosis (n-3), anti tuberculosis treatment (n-3), valproate toxicity (n-1), urinary diversion with ureteosigmoidostomy (UD) (n-2), pyonephrosis due to urea splitting bacteria (n-1), massive empyema due to urea splitting anaerobes (n-2), myxedema coma (n-1), multiple myeloma (n-1), cytoreductive therapy for leukemia (n-1), urea cycle disorder (UCD) (n-1). Presenting features were – confusion (71.4%) irritability (66.6%), somnolence (66.6%), lethargy (61.9%), disorientation (61.9%), asterixis (57%), decline in cognitive abilities (42.85%), ataxia (28.57%) and coma (19%). All the patients of complicated malaria, patients on ATT and 2 patients of leptospirosis had evidence of liver damage. Poor muscle mass present in 61.9%. Average duration of symptoms before admission was 2.61 days (Range 1–5). Average serum ammonia concentration was 152.14 μmol/lit (Range 132–231). CVVHD was initiated with in 24 hours after admission in 12 (57.15%) patients and after 24 hours in 9 (42.85%). The blood and Dialysate flow rates set were at 200 ml/mt and 6 lit/hr respectively. Average duration of CVVHD was 63.8 hrs (48–120). Nineteen patients (90.47%) achieved the criteria of response to the treatment. Specific treatment of the underlying cause was started simultaneously or at the earliest after stabilization. Overall mortality was 38.1%, due multi organ failure. No complications were related to the procedure and patients were hemodynamocally stable through out the procedure. **Conclusions:** Early CVVHD is an effective and safe bridging procedure in HAE and complements the definitive treatment. Our modified CVVHD protocol showed that rapid and sustained reduction of serum ammonia can be achieved with relatively high blood and dialysate flow rates even in hemodynamically unstable patients. Poor muscle mass is a predisposing factor for development of HAE. Negative prognostic factors are-Advanced age (Survived 38.84 years; Died 51.5 years), shorter duration of symptoms before admission (Survived 3.15 days; Died 1.62 days) associated liver damage and delayed initiation (24 hrs after admission – in 30.8% of the survived and in 62.5% of the expired) of CVVHD.

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Preventing Intradialytic Hypotension in Acute Kidney Injury Patients Submitted to Slow Low Efficiency Dialysis (SLED)

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Introduction: Hypotension is the main complication during hemodialysis. The aim of this study is to evaluate the effects of dialysate temperature (DT) reduction with Na and ultrafiltration (UF) profiling on hemodynamics and dialysis dose at the first dialysis session in ICU AKI patients (pt) submitted to SLED. **Methods:** SLED was performed for 6–8 hours, dialysate flow 300 ml/min, blood flow 150 ml/min, polysulfone dialyzer 1.8 m^2. Pts were divided in: group A (GA) DT 37°C, fixed Na dialysate (138 mEq/L) and UF rate; group B (GB) DT 35.5°C, variable Na dialysate (150–138 mEq/L) and UF rate (linear reduction of UF rate, beginning with 30% over the mean UF rate). Hemodynamics was evaluated by mean arterial pressure (MAP), rise in vasoactive drugs (VD) dose and changes in relative blood volume (RBV, Crit Line, Hema Metrics, USA). Dialysis dose was evaluated by spKt/V, dpKt/V and URR. **Results:** 37 pts, 18 in GA and 19 in GB, with no difference between groups regarding gender or age (GA 58 ± 13 vs GB 56 ± 16 y) were evaluated. Dialysis time was similar between groups (GA 5.4 ± 2.6 vs GB 6.7 ± 1.3 h) but the median UF was higher in GB (GA 0.8 vs GB 1.7 l; $P < 0.05$). Post dialysis MAP was lower (GA 73 ± 26 vs GB 98 ± 18 mmHg; $P < 0.01$), hypotension episodes (GA 67% vs GB 27%; $P < 0.01$) and rise in VD dose (GA 55% vs GB 27%; $P < 0.05$) were more frequent in GA. Changes in RBV were more pronounced in GB (GA –5.7% vs GB –7.9%). Post dialysis Na (GA 144 ± 5 vs GB

144 ± 4 mEq/L) and post dialysis pts temperature (GA 37.1 ± 1.3 vs GB 36.5 ± 0.8°C) were similar in the two groups. Dialysis dose was not different between groups: spKt/V – GA 1.07 ± 0.19 vs 1.09 ± 0.26; dpKt/V – GA 0.93 ± 0.29 vs GB 0.96 ± 0.24; URR-GA 54 ± 15% vs GB 59 ± 15%. **Conclusions:** ICU AKI pts treated by SLED with reduction in DT coupled with Na and UF profiling showed better hemodynamic stability when compared to standard SLED. These data suggest that SLED with modulation of dialysate temperature, Na and UF profiling is a safer dialysis method for ICU AKI pts, preventing IH.

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Volume Related Weight Gain and Mortality in Continuous Renal Replacement Therapy

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Acute renal failure in setting of critical illness is associated with very high mortality. This fact has not changed significantly despite rapid advances in the practice of critical care nephrology, including the increasing availability of continuous renal replacement therapy (CRRT). We have previously reported on a mortality factors in our single center registry of patients on CRRT, however data on volume status had not been available at the time of that analysis. We report here on the association between volume related weight gain during pre-renal consult ICU course and mortality. **Methods:** A registry of all patients initiated on CRRT at a single institution was assembled over an 18 month period and a subsequent cross-sectional analysis of selected variables was conducted for associations with mortality. Predictors evaluated were age, gender, diagnosis of sepsis, Apache II score, oliguria, absolute weight gain, greater than 10% of body weight gain and greater than 20% body weight gain. The principle outcome was mortality at 30 days. Chi square analysis was used for bivariate analysis of association between variable and mortality. Independent T-test was used to assess the association of continuous variables with mortality. Multivariate logistic analysis was used to look at more complex associations. **Results:** Eighty-one individuals met inclusion criteria. Overall mortality for the study was 50.2%. Mean Apache II score was 27.5 (±6.9). Oliguria was common, but not universal (65.4%). Mean weight gain was 8.3 kg (±9.6 kg). Mean percent weight gain was 10.24% (±13.54). The odds ratio (OR) for mortality was increased in those with oliguria, 3.21 (1.23–8.45) and weight gain more than 10% of body weight, OR = 2.62 (1.07–6.44). The mortality rate for the 13 patients who gained more than 20% of their body weight was 76.9% versus those with less weight gain 45% ($p = 0.04$) with an OR of 3.98 (1.01–15.75) for mortality. Both oliguria and weight gain more than 10% maintained their statistically significant association with mortality in multivariate models that included sepsis and or Apache II score.

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Amberchrom Class Resin Adsorption Protects Tubular Epithelial Cells from Apoptosis and Loss of Functional Integrity Induced by Septic Plasma

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Sepsis is the major cause of acute kidney injury (AKI) in critically ill patients. The pathogenetic mechanisms of sepsis-associated AKI are complex and seem to be related not only to tissue hypoperfusion, but also to a direct pro-apoptotic effect induced by circulating mediators on kidney resident cells. On this basis, adsorption-based extracorporeal therapies have been proposed to decrease plasma levels of inflammatory substances. Experimental and clinical trials showed that adsorption was able to restore immunomodulation and to exert beneficial effects on hemodynamic stability. Amberchrom class of poly (styrene/benzene) resins have been previously shown to bind high amounts of pro- and anti-inflammatory cytokines potentially involved in AKI. The aim of this study was to evaluate whether plasma derived from septic patients induced loss of functional integrity and apoptosis of tubular cells and the possible protective effect derived from unselective removal of soluble factors by Amberchrom class resin adsorption. For this purpose, we enrolled in the study 8 critically ill patients with sepsis-related AKI in accordance to the ADQI-RIFLE criteria. Plasma was adsorbed by Amberchrom class resin for 120 minutes at 37°C in condition of slight agitation. We found that Amberchrom resin adsorption induced a significant decrease of plasma TNF-alpha, IL-1beta, IL-8, IL-10, Fas-Ligand and CD40-Ligand. After resin adsorption, septic plasma lost their pro-apoptotic effect on tubular cells with the decrease of caspase-3, 8 and 9 activities and the down-regulation of Fas signalling pathway. In addition a significant decrease of adhesion of inflammatory cells on tubular cells was observed in presence of resin-treated plasma. This anti-inflammatory property was associated to the down-regulation of the adhesion receptor ICAM-1 and of the costimulatory molecule CD40 on tubular cell surface. Before the onset of apoptosis, a wide range of sub-lethal alterations have been described in tubular cells exposed to inflammatory cytokines. We observed that septic plasmas altered tubular trans-epithelial electrical resistance, a marker of cell polarity essential to maintain distinct fluid-filled compartments with precise electrolyte concentrations. Septic-plasma induced loss of polarity associated with the down-regulation of the tight junction molecule ZO-1 and of the endocytic receptor megalin. Megalin is a key molecule for tubular re-absorption of filtered proteins and its dysfunction may lead to low-molecular weight proteinuria that is frequently observed in septic patients. Our results demonstrated that in presence of resin-adsorbed plasma, tubular cells maintain polarity, ZO-1/ megalin expression and the ability to internalize albumin. Furthermore, when cultured on extracellular matrixes, tubular cells preserved a normal morphogenesis that was dramatically abrogated in presence of untreated septic plasma. In conclusion, the results of this study showed that resin adsorption reduced the injurious effects exerted by plasma of critically ill septic patients on cultured tubular cells, thus contributing to inhibition of apoptosis and preservation of viability, polarity and correct tubular remodelling. These effects may be

ascribed to the removal of inflammatory mediators involved in tissue injury, suggesting a putative protective effect of this plasma adsorption technique in AKI prevention and treatment.

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Hypoglycemia: Resolution by Continuous Renal Replacement Therapy

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A 52 year old African American male presented to the emergency room(ER), with loss of consciousness and hypoglycemia. Past medical history of non-insulin dependent diabetes mellitus.on glipizide 5 mg daily, a baseline creatinine of 3.5; hypertension and history of multiple renal masses, secondary to Von Hippel Lindau disease. Patient had recently, 32 days earlier, had a cryotherapy treatment for bilateral renal masses. Patient was found unresponsive, with finger stick glucose (FSG) of 20. He received D50 and repeat FSG was 258. On arrival in the ER, his FSG was 105 and he had a witnessed tonic-clonic seizure, with dilated right pupil of 6 mm. A rapid sequence intubation was initiated, using succinylcholine 120 mg, versed 5 mg and 50 gm mannitol, for suspected herniation. Vital signs on admission were temp 38.6°C, BP of 214/115, RR 33, P 112 sodium 124, potassium 6.2, chloride 90, bicarbonate 17, BUN 156, creatinine 13, glucose 136, ABG.7.27/37/283. White count 25.9, hemoglobin 5.7, platelets 313, lactate 0.7, INR 1, CSF with WBC 6, segmented neutrophils 5, protein 77, lymphocytes 76, and glucose 48. Patient was admitted to the medical intensive unit (MICU) loaded and maintained on dilantin, given acyclovir, vancomycin, flagyl and cefepime. He was septic with severe persistent hypoglycemia, in the setting of renal failure. He received 3 sets of D50 infusion, then D10W at 200 ml/hr without resolution of hypoglycemia. Nephrology was consulted for management of acute renal failure (ARF). He was accessed to have ARF secondary to combined effects from sepsis and renal hypoperfusion, with RIFLE criteria stage F. He was started on hemofiltration with continous venovenous hemofiltration (CVVHDF), using a bicarbonate based substitution fluid—dialysate was Accusol 2.5 L bag, and replacement fluid of ½NS with 75 meq/L of sodium bicarbonate, Y-connected with 30 ml/L of calcium gluconate in 0.9% sodium chloride, both infused at a rate of 2000 ml/hr and a blood flow rate of 150 ml/min. Nephrology was informed of the refractory hypoglycemia. We switched the replacement fluid from distilled water to D5W with 150 meq/L of sodium bicarbonate, Y connected with 30 ml/L of calcium gluconate in 0.9% sodium chloride, at a rate of 2000 ml/hr, with complete resolution of the refractory hypoglycemia. The etiology, of this refractory hypoglycemia, was multifactorial consisting of severe sepsis; predisposing diabetic history and, most of all, due to sulfonylurea. Sulfonylurea exacerbates hypoglycemia, in the setting of hepatic or renal failure. One of the mechanism by which it produces prolonged hypoglycemia is by inhibiting gluconeogenesis. CVVHDF has a beneficial effect, in the setting of sepsis, due to increased clearance of inflammatory molecules such as tumor necrosis factor-α and interleukins. It also contributed to increased removal of circulating sulfonylurea molecules, and provided a means of continuous glucose infusion, in the setting of refractory hypoglycemia. We suggest that CVVHDF should be used in treatment of severe refractory hypoglycemia.

Future Trends

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Nafamostat Mesilate Is the Safe and Economical Choice Anticoagulant for Continuous Renal Replacement Therapy

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Continuous renal replacement therapy has become as an essential therapeutic modality in many intensive care units. However, the bleeding complications caused by anticoagulants, heparin or low molecular weight heparin have been the most serious complications of long-term continuous renal replacement therapy. Moreover, high cost of the treatment has blocked patients from continuous management. Nafamostat mesylate, a synthetic protease inhibitor, has potent inhibitory activity in coagulation system and reported to be a safe anticoagulant for hemodialysis patients with high bleeding tendency. This study was undertaken to investigate the safety and economical efficiency of nafamostat mesylate for continuous renal replacement therapy. Between June 2006 and November 2007, 35 patients were treated with continuous renal replacement therapy. Among them, heparin was used in 20 patients, and nafamostat mesylate was administered in 15 patients as the anticoagulants. Prothrombin time and activated partial thromboplastin time were monitored for the anticoagulation. In heparin administered group, 8 of 20 patients (40%) died during the treatment; in nafamostat mesylate administered group, 7 of 15 patients (46%) died during the treatment, but the difference were not statistically significant. Cerebral hemorrhage and GI bleeding were not the direct cause of mortality, and there were no evidence of continuous renal replacement therapy being the cause of hemorrhage. The number of filters used for each treatment day was 1.46 for the heparin group and 0.93 for the nafamostat mesylate group ($p < 0.01$). Even though the nafamostat mesylate is an expensive anticoagulant, still using nafamostat mesylate as the anticoagulant during renal replacement therapy is a safe and cost effective choice because of the reduced number of dialysate filters used. Therefore, nafamostat mesylate could be a safe and cost-effective replacement of the heparin in anticoagulation during continuous renal replacement therapy.

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Using Evidence-Based Research to Guide Nursing Practices

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In the current healthcare environment, evidence-based decision making is guiding more and more clinical practice. The best available evidence needs to be assessed and applied to our practice. The explosion of information available through the internet, as well as, new technological advances are allowing us to determine readily if new approaches are more effective. This critical phase of clinical decision making leads to determining if they should be incorporated into our current nursing practice. EBP (evidence-based practice) is an important value at our hospital and our hospital has made a commitment to develop and reward evidence-based decision making by our expert level nurses. One of the major goals of our nursing leadership has been to integrate EBP into our nursing structure. CRRT is a high-risk clinical issue that is evolving daily. The most current and reliable evidence available should be incorporated into nursing practice. The clinical issue of heparin verses citrate has been a dilemma our unit faces in caring for our critically ill pediatric patients. This question was the focus of our evidenced-based review. To answer our focused question, nursing leadership has incorporated EBP links in our hospital home page to facilitate access to available information. The links included evidence practice guidelines – NCG, research summaries – EB Nursing and EB Medicine, research synthesis – Cochrane and PUBMED, primary research – CINAHL and Medline, and regulations/Law – Board of Nurse Examiners and texas Medical Board. From these links we were able to look for systemic reviews, RCT's, prospective observational studies,at expert opinions and unpublished observations from 2000–2007. Thes links allowed for us to appraise the evidence in search of an answer to our question. The evidence is the examined to determine which evidence answered our focused question. The EBP data collected will be used to develop a Nursing Clinical Quideline for citrate CRRT for our unit and to facilitate collaboration between our nephrologists, dialysis nurses, and the critical care team.

CRRT Research

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The DOse REsponse Multicenter International Collaborative Initiative (DO-RE-MI) in Intensive Care Units (ICU)

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Background: Current practices for renal replacement therapy (RRT) in ICU remain poorly defined. The observational DO-RE-MI survey addresses the issue of how the different modes of RRT are currently chosen and performed. The primary end-point of DO-RE-MI will be delivered dose vs in-ICU, 28-day, hospital mortality, and the secondary end-point, the hemodynamic response to RRT. The protocol has been published (Crit Care June 14, 2005). The Survey has been listed CRG110600093 in the Cochrane Renal Group. Here, we report the first preliminary descriptive analysis after 1 year recruitment. **Methods:** Data from 724 patients in need of RRT (M/F, mean age 62.1 +, 15.9) from 25 centers in 5 countries (Spain, Italy, Germany, Portugal, France) were entered in electronic case report forms (CRFs) available via the acutevison.net website. On admission, 68% patients had Crs >1.2 mg%, 47% came from Surgery, 29% from Emergency, and 15% from Internal Medicine. On admission, mean SOFA and SAPS 2 were 10 and 49, respectively. The first criteria to initiate RRT was the RIFLE in 33% (Failure: 62%, Injury: 19%, Risk: 10%), the second the high urea/creatinine, and the third imunomodulation. A total of 4981 cumulative CRFs were reported: CVVHDF, 38%; CVVH, 19%; IHD,19%; HVHF, 18%; CVVHD, 4%; CPFA/CVVHD, 1%. In 15% of cases, the patient was shifted to another modality. Mean blood flow rates (ml/min) in the different modalities were: 148 (CVVHDF), 206 (CVVH), 221 (IHD), 240 (HVHF), 169 (CVVHD). Downtime ranged from 8 to 28% of the total treatment time. Clotting of the circuit accounted for more than 60% of interruptions while a clinical reason was the case in 13%. **Conclusions:** Despite a large variability on the criteria of choice of RRT, the most used remains CVVHDF (38%). Clotting and clinical reasons were the commonest causes for RRT downtime. In CRRT, a large variability in the delivered dose is observed in the majority of patients and often in the same patient from one day to another. Preliminary analysis suggests that in a large number of cases the delivered dose is far from the 'adequate' 35 ml/hr/kg.

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Outcome of Severe Acute Renal Failure – A Veteran Affairs Study

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Background: Outcome of acute renal failure (ARF) and use of continuous renal replacement therapy (CRRT) have shown a consistently high mortality. We reviewed outcome of severe acute renal failure (ARF) and the use of CRRT at our center. **Objectives:** 1. To evaluate the short-term patient survival (ICU discharge). 2. To evaluate long-term patient survival (3–6 months post ICU discharge). 3. To evaluate dialysis free survival. 4. To evaluate risk factors associated with overall survival and the continued need for intermittent dialysis. Material and Methods: We identified adults (>18 years) needing CRRT, treated in the critical care units of VAMC from Dec 1st 2004 till Oct 15th 2007. Patients were characterized as having severe acute renal failure if they had ARF and needed CRRT. Patients were divided into survivors of ICU and non- Survivors. Short-term outcome is defined as dead or alive at ICU/hospital discharge. Groups were sub-analyzed depending on their urine output, GFR (by MDRD), age, days needing CRRT, continued need for IHD. The race was not analyzed further as 35 of 36 patients were Caucasian. Comparison of patient characteristics

between survivors and non-survivors was done by chi-square for non-continuous variables and t-test for categorical and continuous variables, respectively. **Results:** A total of 36 patients received CRRT during the time of the study. Over all in-hospital mortality among patients was 50% (#18). Among survivors, 22% of them needed IHD (intermittent hemodialysis) on discharge from ICU and 11% continued to need HD at last follow-up (6 m – 1 yr). ICU survivors were younger (mean age of 69 vs. 74) than those who died, 72% had oliguria (urine out put 200 cc/day) vs. 44%. Baseline GFR (63 ml/min vs. 62.83 ml/min) and GFR at start of CRRT (16.44 vs. 16.83 ml/min) were comparable. Among ICU survivors 50% (#9) were dialysis dependent on ICU discharge and 22% at last follow-up. Among non- survived patients 38% died on CVVH. Who died on CVVH were younger (71 vs. 75 years) = NS, more oliguric (43% vs. 28%), baseline GFR was lower (62.4 vs. l3.1 ml/min) and had higher GFR (19 vs. 15 ml/min) at start of CRRT. **Conclusion:** Patients with ARF needing CRRT continues to have mortality. A significant percentage of patients in our study remained dialysis dependant on last follow-up.

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Citrate Anticoagulation in Patients on CVVHDF with High Lactatemia and Amine Support: Long Term Follow-Up of Acid-Base and Electrolyte Changes

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Introduction: Trisodium citrate anticoagulation is a useful alternative to heparin for renal replacement therapy (RRT) in critically ill patients with increased bleeding risk. The buffer citrate is converted into bicarbonate in the liver, kidney and skeletal muscle, tissues usually poorly perfused in critically ill patients treated with vasopressor/ inotropes. **Aim of the Study:** In this study we reported the preliminary data of acid-base and electrolyte changes during the first consecutive 10 days of continuous RRT in a group of patients treated with regional citrate anticoagulation. **Patients and Methods:** From January 2001 to December 2006, 161 critically ill patients were treated with RRT in Intensive Care Units of our hospital (1652 days of dialysis). Because of ongoing bleeding or of a high risk of hemorrhagic complications, 36/161 patients (19 burned and 17 polytrauma/post surgery; age 56.7 ± 18.2 years, mean ± SD) received a hemodiafiltration (HDF) in total predilution with citrate containing bags. Patients underwent to a total of 381 days of dialysis at low blood flow (100–120 ml/min), corresponding to 224 dialysis sessions: 83 SLE-HDF and 141 CVVHDF, duration 8.5 ± 1.8 and 37.2 ± 18.2 hours, respectively. Noradrenaline support was 0.34 ± 0.31 μg/Kg/min; 16/36 survived. **Results:** In patients treated with CVVHDF no significant clinical modifications were observed during the first 10 days of treatment (oneway ANOVA), in particular on hemodynamic and perfusion parameters (basal values: MAP 80.3 ± 13.8 mmHg, serum lactate 3.25 ± 2.59 mmol/L), on coagulation indexes (basal values: prothrombin time 65.9 ± 13.3%, PTT 36.8 ± 6.2 sec, fibrinogen 390.7 ± 278.7 mg/dl, antithrombin III 57.9 ± 24.2%, thrombocytes 189,888 ± 170,706 1/mm^3), on serum sodium concentration (basal value 139.6 mEq/L), on Catot/ Ca2+ ratio (1.98 ± 0.17) and on systemic pH (7.379 ± 0.06). Calculated citrate load to the patient (basal: 12.51 ± 3.71 mmol/hour) and calcium administered amount (2.92 ± 0.74 mmol/hour) did not change. On the contrary, from the third day on we observed significant modifications of serum bicarbonate (22.42 ± 3.92 mEq/L vs 29.90 ± 6.00, basal and 3rd day values respectively, $p < 0.05$, ANOVA + Newman Keuls test). **Conclusions:** These data suggest that in patients with shock and acute renal failure, noradrenaline support and high serum lactate, citrate anticoagulation during CVVHDF at low blood flow did not cause any significant metabolic or electrolytic variations, even in a long term follow-up.

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Absence of Etanercept Clearance in Modeled Continuous Hemofiltration

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Introduction: Etanercept is a TNF-α antagonist used in multiple clinical situations involving inflammation. Preliminary trials have demonstrated mortality benefits in stem cell transplant patients with idiopathic pneumonia syndrome (IPS), and a large pediatric, multicenter trial is underway to assess the use of etanercept for IPS. Separately, others have reported clinical improvement in IPS using continuous hemofiltration (CH). It is likely that the combination of etanercept and CH will be used for IPS in some patients, but no data regarding etanercept clearance during CH have been published. **Purpose:** To evaluate the transmembrane of etanercept using an in vitro model of CH. **Methods:** Etanercept clearance was assessed in our validated in vitro CH model using 1 L of citrate anticoagulated, bovine blood and a B. Braun Diapact machine. Etanercept was added to achieve a final serum concentration of ~2–3 mg/L. Urea was added as a control solute (750 mg/L). Experiments were run using five new AN69 (M100, Gambro) hemofilters. The ultrafiltrate rate was 3L/hr and blood flow rate was 200 mL/min. Blood samples were collected at 0, 5, 20, 60, & 240 min from the pre-and post filter lines and UF samples from the post-filter UF port. BUN assays were performed with a Cobas Integra 400 autoanalyzer. Etanercept was assayed using TNFRII ELISA (lowest detection limit 15 pg/L, CV% <10%). Transmembrane clearance was assessed using sieving coefficient techniques. Adsorptive removal rate was calculated using A-V mass balance methods. A linear mixed model was used to compare concentrations, clearance/SC across time using Bonferroni as posthoc analysis at $p < 0.05$. **Results:** The (mean ± SD) SC for BUN was 1.04 ± 0.01 and remained constant at all time points. Ultrafiltrate etanercept concentrations were below the detection limit in all samples, consequently all SCs were <0.02 (lowest detection limit /lowest reported arterial concentration) and transmembrane clearance was negligible. A pronounced etanercept adsorptive clearance was not observed. Adsorptive removal rate was not significantly different across the measured time points ($P > 0.05$).

Conclusion: Etanercept is not appreciably cleared by transmembrane or adsorptive means in CH using the AN69 hemofilter.

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