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ORIGINAL PAPER

Impact of Computerized Order Entry and Pre-mixed Dialysis Solutions for Continuous Veno-Venous Hemodiafiltration on Selection of Therapy for Acute Renal Failure

Lawand Saadulla · W. Brian Reeves · Brittany Irey · Nasrollah Ghahramani

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Abstract To investigate the impacts of availability of pre-mixed solutions and computerized order entry on nephrologists' choice of the initial mode of renal replacement therapy in acute renal failure. We studied 898 patients with acute renal failure in 3 consecutive eras: era 1 (custom-mixed solution; n=309), era 2 (pre-mixed commercial solution; n=324), and era 3 (post-computerized order entry; n=265). The proportion of patients treated with renal replacement therapy and the time from consult to initiation of continuous renal replacement therapy was similar in the 3 eras. Following introduction of the pre-mixed solution, the proportion of patients treated with continuous renal replacement therapy increased (20% vs. 33%; p<0.05), it was initiated at a lower serum creatinine (353±123 μmol/L vs. 300±80 μmol/L; p< 0.05) and in older patients (53±12 vs. 61±14 years; p< 0.05). There was a progressive increase in the use of continuous veno-venous hemodialysis (18% vs. 79% vs. 100%; p<0.05) and in the total prescribed flow rate (1,382± 546 vs. 2,324±737 vs. 2,900±305 mL/hr 3; p<0.05). There was no significant impact on mortality. The availability of a pre-mixed solution increases the likelihood of initiating continuous renal replacement therapy in acute renal failure, initiating it at a lower creatinine and for older patients, use of continuous veno-venous hemodialysis and higher prescribed continuous renal replacement therapy dose. Computerized order entry implementation is associated with an additional increase in the use of continuous veno-venous hemodialysis, higher total prescribed dialysis dose, and use of CRRT among an increasing number of patients not on mechanical ventilation. The effect of these changes on patient survival is not significant.

Keywords Acute renal failure · Computerized order entry · CRRT · Hemodialysis

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Introduction

The incidence of acute renal failure (ARF) ranges between 10 and 23 per cent of patients in intensive care units and is associated with high mortality rates ranging from 37 to 70 per cent [1–8]. Continuous renal replacement therapy (CRRT) and intermittent hemodialysis (IHD) are the key components of the therapeutic approach for acute renal failure (ARF). Prior to the relatively recent advent of CRRT, IHD and peritoneal dialysis were the only available modes of RRT [9]. The popularity of CRRT has been growing all over the world because of perceived clinical advantages, particularly improved hemodynamic tolerance [10–12]. Early in its inception, the solutions used to replace the ultrafiltrate in CRRT, the replacement solution, were custom-mixed at each site. Dialysate solutions were either custom-mixed on site or were commercially available peritoneal dialysis solution which contained large amounts of glucose and acetate. The requirement for custom mixing of large volumes of CRRT solutions created the potential for medication errors and contamination and was labour-intensive and expensive [13, 14]. This has encouraged the development of pre-mixed commercial solutions for CRRT.

In addition, due to the incompatibility of certain components of the dialysate and replacement solutions, e.g. bicarbonate and calcium, early CRRT protocols involved complicated combinations of several different bags of solutions infused simultaneously. These limitations, i.e. the expense and effort associated with the preparation of CRRT solutions and the perceived complexity of the treatment protocols may have limited the tendency of nephrologists to use CRRT and may have limited the volumes of CRRT solutions prescribed when this treatment was utilized. From the perspective of physician ordering of CRRT, pre-printed order sets or the use of computerized order entry (COE) have been suggested as ways to avoid the ambiguities of handwritten orders, reduce adverse drug reactions and improve patient safety [15–18] and simplify the ordering of CRRT [19, 20].

In our hospital, replacement and dialysis solutions for CRRT were manually mixed prior to September of 2004, at which point use of a commercial pre-mixed solution (PrismaSate; Gambro Renal Products, Lakewood, CO) and a pre-printed order set for CRRT were implemented. In addition, mandatory COE has been in use since May of 2005. We aimed to determine the impact of these changes on the consulting nephrologists' choice of the initial mode of RRT and on the dose of CRRT prescribed for patients with ARF.

Methods

The study was conducted at the Penn State Milton S. Hershey Medical Center, a tertiary academic medical centre. The study protocol was approved by the Institutional Review Board. We used billing data to identify all adult patients (age at admission ≥18) who had been seen in consultation by a nephrologist with the diagnosis of ARF between January 2004 and December 2005, and also to identify all of these patients who had been initiated either on IHD or CRRT. At our institution IHD and CRRT are performed exclusively by nephrologists. We identified 898 patients (Table 1), among whom 278 patients (30.1%) were treated with RRT. We categorized the patients into three different groups (eras) based on the time of the initial consultation (Fig. 1). Era 1 (custom-mixed solution) was defined as the time period between January 1, 2004 and August 31, 2004. In this era, 309 patients were seen in consultation for ARF and 85 were treated with RRT. Era 2 (pre-mixed commercial solution) was the period between September 1, 2004 and April 30, 2005. The number of patients with ARF in this era was 324, and 103 of these patients were treated with RRT. Era 3 (post-COE) was the period between May 1, 2005 and December 31, 2005. In this era, of the 265 patients with ARF, 90 received RRT.

Table 1 Clinical and laboratory characteristics of patients on RRT

Total number of patients with ARF	898
Age (years)	65±12[a]
Male (%)	67
Female (%)	33
Setting of ARF (%)	
Medical	57
Surgical	43
Pre-treatment creatinine (μmol/L)	327±44.2[a]
Pre-treatment BUN level (mmol/L)	22.8±11.8[a]
Specific etiologies of ARF (%)	
Sepsis	17%
Hypotension/post-operative	31%
Multifactorial	52%

[a] Mean ± S.D.

The mode of order entry in the three eras for CRRT was as follows. During the first era, orders were hand-written by completing an order sheet indicating the composition of the replacement fluids (to avoid mixture of bicarbonate and calcium in the solution, separate replacement (R) fluids were used. R1: $NaHCO_3$ + additives; R2: $CaCl_2$ + $MgSO_4$ + additives; and an optional R3) and the dialysate (1.5% Dianeal + KCl) (Appendix 1). In the second era, the choices for replacement solution and dialysate were circled from a printed list of available pre-mixed solutions (BK 0/3.5: K= 0, Ca=0.87 mmol/L, Glucose=0; BGK 2/0: K=2 mmol/L, Ca=0, Glucose=6.05 mmol/L; BGK 4/2.5: K=4 mmol/L, Ca=0.62 mmol/L, Glucose=6.05 mmol/L) (Appendix 2). In era 3, electronic CRRT order sets had been developed by a collaborative group consisting of informatics specialists, clinical pharmacists and nephrologists (Appendix 3). Default concentrations of additives and other safety parameters were evaluated and approved by the nephrologists. Recognizing the fact that the three commercially available formulas on the hospital formulary may not meet the needs of certain patients, COE pages for patient-specific tailoring of CRRT fluids with a list of additives and default concentrations were also available. In the third era, the provider selected the "CRRT order set" from the ordering screen. When the CRRT option was selected, the most recent lab values appeared on an adjacent screen. The CRRT therapy type, type of dialyzer and the replacement and dialysis solutions (same solutions as in era 2) were selected from drop-down menus.

The availability and techniques of both forms of renal replacement therapy, as well as the composition of nephrologists practicing in the group, remained similar throughout all three eras of the study. The primary outcome of our study was impact of each era on nephrologists' practice of initiating RRT mode. The secondary outcome

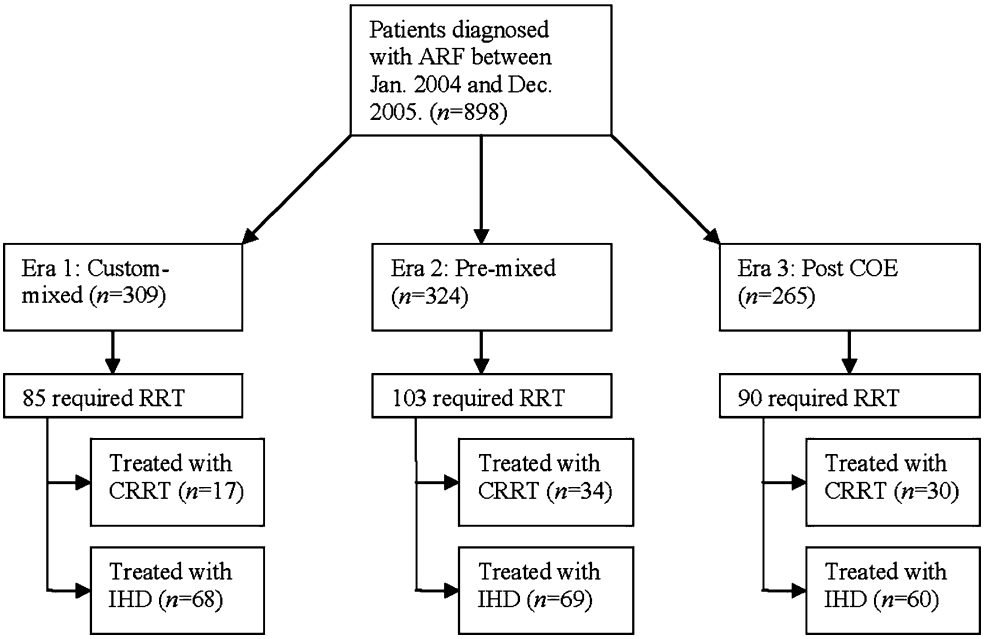

Fig. 1 The number of patients with acute renal failure, the number of patients with acute renal failure treated with continuous or intermittent renal replacement therapy in each of the three consecutive eras

was dialysis dosing in CRRT in the three eras. Statistical analysis was carried out using two-tailed, two-sample *t* test for continuous variables and chi-square test for categorical variables.

Results

The characteristics of CRRT, severity of illness and indications for initiation of CRRT in the three eras are shown in Tables 2 and 3. The proportion of ARF patients treated with RRT remained similar in the three eras. Following introduction of the pre-mixed solution, CRRT was initiated at a lower serum creatinine (era 1: 353±123 μmol/L vs. era 2: 300±80 μmol/L; $p<0.05$), in older patients (era 1:53±12 years vs. era 2: 61±14 years; $p<0.05$) and the proportion of patients treated with RRT who were initiated on CRRT increased significantly (20% vs. 33%; $p<0.05$) (Fig. 2). Also, among patients started on CRRT, there was a progressive increase in the use of CVVHD as the prescribed modality in the three eras (18% vs. 79% vs. 100%; $p<0.05$) (Fig. 3) and in the total prescribed (dialysate + replacement) flow rate (1,382±546 mL/hr in era 1 vs. 2,324±737 mL/hr in era 2 vs. 2,900±305 mL/hr in era 3; $p<0.05$) (Fig. 4). Following implementation of COE, an increasing number of ventilator-independent patients were initiated on CRRT and while there was a decrease in patient mortality (era 2: 82% vs. era 3: 63%), the change was not statistically significant. The mean days from consult to initiation of CRRT, indications for initiation of CRRT, and severity of illness as indicated by the Sequential Organ Failure Assessment (SOFA) score remained similar in the three eras. There were no reported complications or safety issues relative to RRT.

Discussion

The popularity and use of CRRT in the treatment of ARF has increased dramatically over the past 20 years [21]. This increase has been driven by the perception, which has been

Table 2 Characteristics of CRRT in the three eras

	Era 1	Era 2	Era 3
Total number of patients with ARF	309	324	265
Treated with RRT (% of all ARF)	85 (28%)	103 (32%)	90 (34%)
CRRT (% of all RRT)	17 (20%)	34 (33%) †	30 (33%) †
Age at time of CRRT (years)	53±12	61±14†	62±16 †
CVVHD (% of all CRRT)	3 (18%)‡	27 (79%)	30 (100%) ‡
Total flow rate (mL/hr)	1,382±546‡	2,324±737	2,900±305 ‡
Days from consult to CRRT	2.0±1.8	2.0±1.9	2.0±2.4

† $p<0.05$ compared with Era 1

‡ $p<0.05$ compared with Era 2

Table 3 Severity of illness and indication for CRRT in the three eras

	Era 1	Era 2	Era 3
Severity of illness at CRRT initiation:			
Mean serum creatinine (μmol/L)	353±123	300±80†	283±115 †
Mean SOFA[a] Score	13±4	12±4	12±4
Requiring vasopressor support	12 (71%)	27 (79%)	24 (80%)
Requiring mechanical ventilation	15 (88%) ‡	28 (82%) ‡	18 (60%)
Indication for CRRT:			
Hyperkalemia	2 (12%)	6 (18%)	3 (10)%
Acidosis	8 (47%)	15 (44%)	11 (37%)
Volume overload	8 (47%)	15 (44%)	12 (40%)
Azotemia	4 (24%)	8 (24%)	12 (40%)
Mortality of patients on CRRT	13 (77%)	28 (82%)	19 (63%)

† $p<0.05$ compared with Era 1

‡ $p<0.05$ compared with Era 3

[a] SOFA: Sequential Organ Failure Assessment

challenged recently, that CRRT is superior to IHD for the treatment of ARF. A number of factors may influence the selection of CRRT as a treatment modality by the nephrologist, such as limited availability of CRRT devices, unfamiliarity of nephrologists, cost, pharmacy and nursing time required to prepare and administer CRRT, continuous need for anticoagulation, and concerns about patient immobilization [22]. The sequential implementation of use of pre-mixed CRRT solutions and a pre-printed order set for CRRT, followed in 8 months by mandatory computerized order entry with an electronic order set for CRRT, provided a unique opportunity to analyze the potential effects of these interventions on the choice of RRT treatment by nephrologists over a 24-month period.

The first major finding from our study was that the use of a commercial CRRT solution along with a pre-printed order set was associated with the increased likelihood of initiating CRRT in patients with ARF. These changes also led to the initiation of CRRT at an earlier phase of renal failure and among older patients. Since the pre-printed order set and the commercial solutions were implemented simultaneously, the independent effect of each of these changes on practice is difficult to discern. However, we postulate that the explanation for the increase in use of CRRT relates to simplification of the administration and ordering of CRRT for both the nephrologists and the nursing staff.

CRRT requires large volumes of sterile, non-pyrogenic solutions. CRRT solutions have traditionally been compounded manually in the pharmacy or at the bedside. At our institution, the task of preparing CRRT solutions was assigned to the primary nurse caring for the patient. The

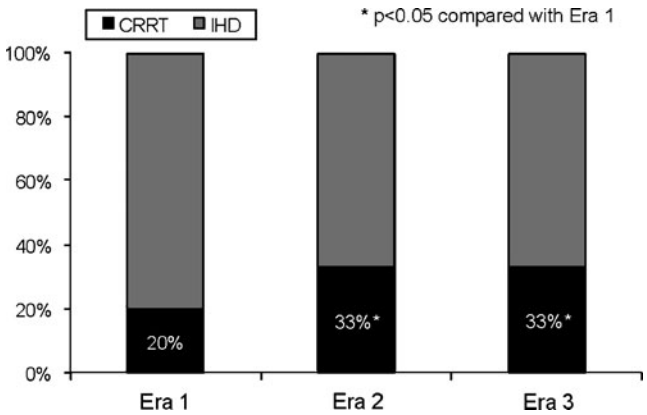

Fig. 2 Utilization of modalities of renal replacement therapy in the three eras. The gray portion of the bars indicate the proportion of patients in each era requiring renal replacement therapy who were treated with intermittent hemodialysis (IHD). The black portions indicate proportion of patients in each era who were treated with continuous renal replacement therapy (CRRT)

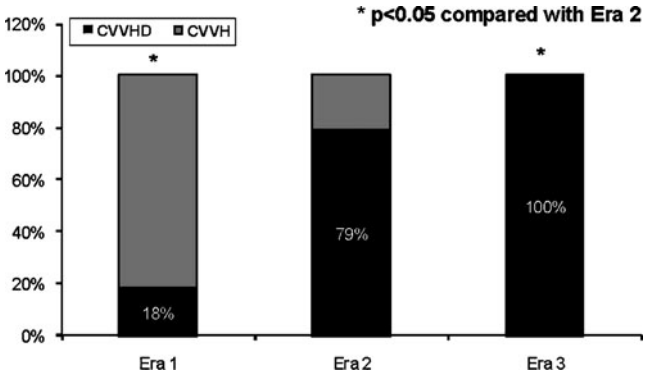

Fig. 3 Relative use of continuous veno-venous hemodialysis (CVVHD) for patients on continuous renal replacement therapy (CRRT) in the three eras. The gray portions of the bars indicate the proportion of patients in each era receiving continuous veno-venous hemofiltration (CVVH) and the black portions indicate the proportion of patients in each era receiving CVVHD

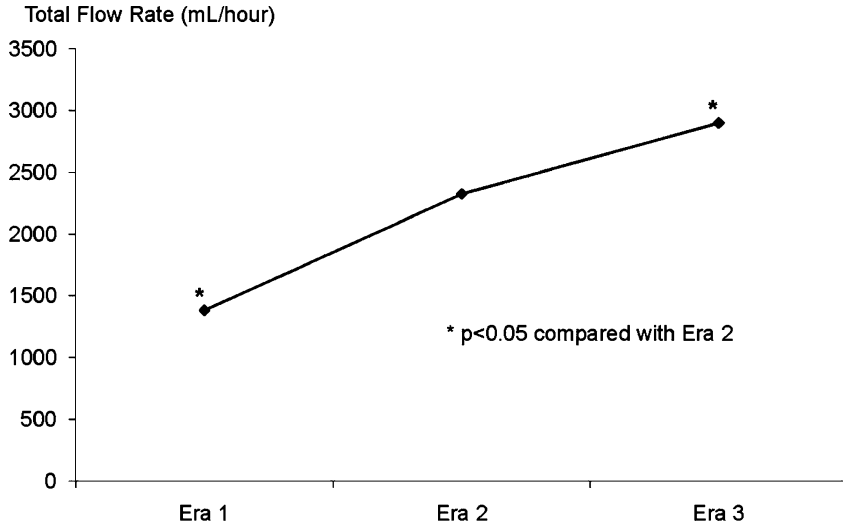

Fig. 4 Total (dialysate + replacement) prescribed flow rate in the three eras

time required preparing these solutions coupled with the complexity of multi-bag CRRT protocols and the other needs of these critically ill patients presented a great challenge and was a great source of dissatisfaction for the ICU nursing staff. As a result, nephrologists may have been hesitant to prescribe CRRT; waiting until later in the course of renal failure to initiate it, or attempting IHD as the initial modality. With the introduction of pre-mixed CRRT solutions, nurses were much more accepting of CRRT and physicians had a more standardized selection of solutions from which to choose. In addition to the strain on pharmacies or nurses, variability of the constituents in the custom-made solutions has been implicated as a potential source for mixing errors and multiple manipulations to each bag can potentially lead to the risk of contamination. The Institute of Safe Medication Practices (ISMP) has designated dialysis solutions as high-alert medications and encourages development of standard concentrations and base solutions, including the use of commercially available pre-mixed solutions [14]. Pre-mixed commercial CRRT solutions allow the provider to select these solutions when the composition and concentration of additives are appropriate for the individual patient and are anticipated to reduce the risks of mixing errors and contamination [13].

A second finding in this study was that the use of commercial CRRT solutions and pre-printed order sets increased the use of CVVHD over CVVH. The use of CVVHD was further increased following implementation of COE. We believe that is largely due to the increased familiarity and comfort of the physicians with use of the commercial solutions rather than the order sets. Pre-printed or computerized order sets in themselves do not facilitate ordering of CVVHD rather than CVVH. In fact, the orders for CVVHD are more complex than for CVVH due to the requirement for the composition and flow rates of the dialysate. Rather, the premixed solutions offer significant advantages over the peritoneal dialysis solutions or custom-mixed solutions which were used in earlier CVVHD protocols. Peritoneal dialysis solutions required the addition of potassium, had very high glucose concentrations which often precipitated hyperglycaemia in the patients and had high acetate concentrations which could present problems in patients with poor liver function [23]. Likewise, custom-mixed dialysis solutions presented the same problems for nurses and pharmacy as the custom-mixed replacement solutions. As a result, CVVH was often selected as the mode for CRRT before the advent of pre-mixed solutions.

A third finding was that the total dose of CRRT prescribed was significantly enhanced by the use of pre-mixed CRRT solutions. This relates chiefly to the increased use of CVVHD and its attendant diffusive clearance. The total dose increased further following implementation of COE. This increase is likely to have resulted from the programming of a high flow rate (1,500 ml/hr) as the default selection in the computerized order set. Time-dependent changes in practice patterns could also account for some of the increase in CRRT dose. For example, the study by Ronco [6] which demonstrated improved survival in patients treated with high doses of CRRT may have influenced practices among the nephrologists. The impact of high CRRT dose on outcomes, however, remains controversial [24, 25].

In summary, we determined that the implementation of commercial pre-mixed CRRT solutions and pre-printed order sets dramatically increased both the utilization and prescribed dose of CRRT. The effect of this change in practice on patient survival was not significant.

Appendix 1

PHYSICIANS ORDER SHEET

INSTRUCTIONS 1. IN CASE OF NARCOTICS-ADD NARCOTIC LICENSE NUMBER TO SIGNATURE, ALSO INDICATE DURATION OF ORDER, DOSE AND INTERVAL.
2. STOPPING OF AN ORDER-WRITE AS A NEW ORDER.

DATE/TIME	PRESCRIBED TREATMENT, MEDICATION AND DIET NOTED	DATE, TIME, INITIAL

☐ CVVH ☐ CVVHD PHYSICIAN ORDERS
To be filled out by NEPHROLOGIST ONLY

1. Daily weights and vital signs at least every hour during procedure.
2. Maintain C.R.R.T. Flow Sheet every hour.
3. Blood Flow Rate _____cc per minute (150-180 cc/min)
4. Replacement fluid Flow Rate _____ L/hr. (1-3 L/hr)
5. Dialysis Flow rate (for CVVHD) _____ L/hr
6. Ultrafiltrate Goal ("Net Off") _____cc per hour
7. Heparin _____ U bolus, _____ U/hr infusion.
8. Replacement Fluids
   R 1: _____ + ____ mEq $NaHCO_3$/L + _____
   R 2: _____ + ____ cc 10% $CaCl_2$ /L + ____cc 50% $MgSO_4$/ L +
   _____
   R 3 (optional): _____
9. Dialysis solution (for CVVHD): 1.5% Dianeal + _____ mEq KCl/L
10. Labs: Stop replacement fluids infusing into the system for 2-3 minutes prior to drawing blood samples (Except when drawing clotting times, do not stop the Heparin drip).
    b. Electrolytes, Ionized Calcium, Magnesium, Phosphorous, at: 5AM/1PM/9PM
    b. BUN, Creatinine, INR, PTT, QAM
11. Notify Nephrologist if:
    a. Sodium less than _____ or greater than _____.
    b. Potassium less than _____ or greater than _____.
    c. Bicarbonate less than _____ or greater than _____.
    d. Ionized Calcium less than _____ or greater than _____.
    e. Magnesium less than _____ or greater than _____.
12. Potassium Replacement Protocol (use only if initialed by Physician _____)
    a. $K^+ \geq 4.1$ but < 4.5: give 10 mEq KCl in 50 cc Sterile H_2O over 30 MIN
    b. $K^+ \geq 3.8$ but < 4.1: give 20 mEq KCl in 50 cc Sterile H_2O over 30 MIN
    c. $K^+ \geq 3.5$ but < 3.8: give 30 mEq KCl in 100 cc Sterile H_2O over 60 MIN
    d. $K^+ \geq 3.0$ but < 3.5: give 40 mEq KCl in 100 cc Sterile H_2O over 120 MIN
    Recheck K+ level 1 Hour After Infusion Completed.
13. Calcium Replacement Protocol (Use only if initialed by Physician _____)
    a. ICa^{2+} (ionized calcium) ≥ 1.13 but ≤ 1.32: continue current "R-2" CaCl2
    b. $ICa2^+ \geq 1.00$ but < 1.13: increase the amount of 10% $CaCl_2$ in "R-2" by 2 cc/L
    c. $ICa^{2+} \geq 0.90$ but < 1.0: increase the amount of 10% $CaCl_2$ in "R-2" by 4 cc/L
    d. $ICa^{2+} > 1.32$ but ≤ 1.45: decrease the amount of 10% $CaCl_2$ in "R-2" by 2 cc/L
    e. $ICa^{2+} > 1.45$ but ≤ 1.55: decrease the amount of 10% $CaCl_2$ in "R-2" by 4 cc/L
14. Magnesium Replacement Protocol (Use only if initialed by Physician _____)
    a. $Mg^{2+} \geq 1.6$ but ≤ 2.2: continue current Mg^{2+} in replacement fluid
    b. $Mg^{2+} \geq 1.3$ but < 1.6: increase the 50% $MgSO_4$ by ½ ml/L.
    c. $Mg^{2+} \geq 1.0$ but < 1.3: increase the 50% $MgSO_4$ by 1 ml/L
    d. $Mg^{2+} > 2.2$ but ≤ 2.6: decrease the amount of 50% $MgSO_4$ by ½ ml/L
    e. $Mg^{2+} > 2.6$ but ≤ 3.0: decrease the amount of 50% $MgSO_4$ by 1 ml/L

_____
Nephrologist's signature

Appendix 2

PENNSTATE
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College of Medicine

PHYSICIAN ORDER SHEET - PRISMA SYSTEM
CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT)

INSTRUCTIONS: 1. IN CASE OF NARCOTICS-ADD NARCOTIC LICENSE NUMBER TO SIGNATURE, ALSO INDICATE DURATION OF ORDER, DOSE AND INTERVAL.
2. STOPPING OF AN ORDER-WRITE AS A NEW ORDER.

Ordering Physician: **Date/Time:**

Procedure: SCUF CVVH CVVHD CVVHDF **Filter:** M 60 M100 HF 1000

Fluids:
Target Net hourly Fluid removal: _____ mL/hour
Maintain CRRT flow sheet hourly: _____
Weigh patient daily: _____

Flow Rates:
Blood flow rate: _____ mL/minute
Replacement flow rate: _____ mL/hour
Dialysate flow rate: _____ mL/hour

Circle appropriate solution **Replacement fluid** **BKO/3.5** Sodium: 140 mEq/L Calcium 3.5 mEq/L Magnesium 1.0 mEq/L Potassium 0 mEq/L Chloride 109.5mEq/L Lactate 3.0 mEq/L Bicarbonate 32 mEq/L Glucose 0 mg/dL	Circle appropriate solution **Replacement fluid** **BGK2/0** Sodium: 140 mEq/L Calcium 0 mEq/L Magnesium 1.0 mEq Potassium 2.0 mEq/L Chloride 108 mEq/L Lactate 3.0 mEq/L Bicarbonate 32mEq/L Glucose 110 mg/dL	Circle appropriate solution **Replacement fluid** **BGK4/2.5** Sodium: 140 mEq/L Calcium 2.5 mEq/L Magnesium 1.5 mEq Potassium 4.0mEq/L Chloride 113 mEq/L Lactate 3.0 mEq/L Bicarbonate 32mEq/L Glucose 110 mg/dL	**Additional Electrolytes** to be added to selected Replacement bag: Calcium chloride _____mEq/L Potassium chloride _____ mEq/L Magnesium sulfate _____ mEq/L Sodium bicarbonate _____ mEq/L Glucose _____ mg/dL **Other Replacement solution**:
Circle appropriate solution **Dialysate Solution** **BKO/3.5** Sodium: 140 mEq/L Calcium 3.5 mEq/L Magnesium 1.0 mEq/L Potassium 0 mEq/L Chloride 109.5mEq/L Lactate 3.0 mEq/L Bicarbonate 32 mEq/L Glucose 0 mg/dL	Circle appropriate solution **Dialysate Solution:** **BGK2/0** Sodium: 140 mEq/L Calcium 0 mEq/L Magnesium 1.0 mEq Potassium 2.0 mEq/L Chloride 108 mEq/L Lactate 3.0 mEq/L Bicarbonate 32mEq/L Glucose 110 mg/dL	Circle appropriate solution **Dialysate Solution:** **BGK4/2.5** Sodium: 140 mEq/L Calcium 2.5 mEq/L Magnesium 1.5 mEq Potassium 4.0mEq/L Chloride 113 mEq/L Lactate 3.0 mEq/L Bicarbonate 32mEq/L Glucose 110 mg/dL	**Additional Electrolytes** to be added to selected Dialysate bag: Calcium chloride _____mEq/L Potassium chloride _____ mEq/L Magnesium sulfate _____ mEq/L Sodium bicarbonate _____ mEq/L Glucose _____ mg/dL **Other Dialysate solution:**

Anticoagulation: YES or NO Heparin Concentration: 1000 units/mL _____
Continuous Heparin Infusion: _____ units/ hour via PRISMA Heparin pump
Monitor per Heparin protocol: _____

Laboratory Tests:
_____ every _____ hour/s.
_____ every _____ hour/s.
_____ every _____ hour/s.

Miscellaneous Orders:
Use Prismaflo (fluid warmer) and set at _____ Celsius
Heparin flush to double lumen catheter: 5000 units / port or 10,000 units/port (CIRCLE ONE)

CRRT = Continuous Renal Replacement Therapy
SCUF= Slow continuous ultrafiltration
CVVH = Continuous veno venous hemofiltration
CVVHD = Continuous veno venous hemodialysis
CVVHDF= Continuous veno venous hemodiafiltration
BK0/3.5 = Bicarbonate/ Calcium
BGK/2.0 =Bicarbonate/Potassium/Glucose
BGK4/2.5 = Bicarbonate/Potassium/Glucose/Calcium

Physician Signature:
_____ Pager # _____
Signature
_____ _____ AM
Date Time PM

AUTHORIZATION IS HEREBY GIVEN TO DISPENSE A CHEMICALLY IDENTICAL DRUG. (AS RECOMMENDED BY THE PHARMACY COMMITTEE).
UNLESS THE REQUEST FOR NON-FORMULARY DRUG FORM IS COMPLETED AND SUBMITTED FOR THE INFORMATION OF THE PHARMACY COMMITTEE.

MR 1.79 7/04 Page 1 of 1 **PHYSICIAN ORDER SHEET - PRISMA SYSTEM**
CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT)

Appendix 3

Careset: Continuous Renal Replacement Theraphy

Component	Order Details
CRRT orders are to be placed and modified by Nephrologists Only.	
Patient Care	
For M60 filter type, choose flow rate 10-180 mL/min For M100 filter type, choose flow rate 10-400 mL/min	
☑ CRRT Orders	T;N, CVVHDF-Cont V-V Hemodiafiltration, Filter Type M100
☑ Prismaflo Blood Warmer Orders	
☑ Weight	2/27/2010 04:00, q24h
☐ Call Nephrologist	2/26/2010 07:14, Na+ Level < 130, Na+ Level > 145, Ca++ < 1.05, Ca++ > 1.45, PO4 < 2, HCO3 < 18, K+ > 5, K+ < 3.5
Medication	
☐ heparin 20,000 unit + Diluent for drips 20 mL	20 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, 0 unit/hr
NOTE: Flush for double lumen ports	
☐ heparin	5,000 unit, injection, IV, After dialysis, PRN, 2 doses/times, One to each lumen of double lumen catheter.
☐ sodium citrate (Tricitrasol)	mL, intracath red lumen, After dialysis, PRN, See Order Comments, fill RED Catheter
☐ sodium citrate (Tricitrasol)	mL, intracath blue lumen, After dialysis, PRN, See Order Comments, fill BLUE catheter
Laboratory	
☐ Electrolyte Levels (Lytes)	Stat, Clinician to Collect, starting at T;N, q12h
☐ Renal Profile	Stat, Clinician to Collect, starting at T;N, q12h
☐ Calcium, Ionized	Stat, Clinician to Collect, starting at T;N, q12h
☐ Magnesium Level (Mg Level)	Stat, Clinician to Collect, starting at T;N, q12h
☐ Phosphorus Level	Stat, Clinician to Collect, starting at T;N, q12h
☐ Hematocrit (Hct)	Stat, Clinician to Collect, starting at T;N, q12h
☐ Partial Thromboplastin Time (PTT)	Stat, Clinician to Collect, starting at T;N, q12h
Prismaflex Solutions	
Note to Orderer: After completion of choosing solutions and the rest of the orderset, click OK. BEFORE signing orders, add any required additives by double clicking the order. Tab to additive line and search for	
CRRT Replacement Solutions-PRE-Filter	
☐ CRRT Base BGK 2/0 - Replacement Pre-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BGK 4/2.5 - Replacement Pre-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BK 0/3.5 - Replacement Pre-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
CRRT Replacement Solutions -POST-Filter	
☐ CRRT Base BGK 2/0 - Replacement Post-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BGK 4/2.5 - Replacement Post-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BK 0/3.5 - Replacement Post-Filter 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
CRRT Pre-Blood Pump Solutions	
Component	Order Details
☐ CRRT Base BGK 2/0 - Pre-Blood Pump 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BGK 4/2.5 - Pre-Blood Pump 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BGK 0/3.5 - Pre-Blood Pump 5000 mL	5,000 mL, IV, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
CRRT Dialysate Solutions	
☐ CRRT Base BGK 2/0 - Dialysate 5000 mL	5,000 mL, per dialysate, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BGK 4/2.5 - Dialysate 5000 mL	5,000 mL, per dialysate, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000
☐ CRRT Base BK 0/3.5 - Dialysate 5000 mL	5,000 mL, per dialysate, Routine, 2/26/2010 07:14, 30 day, Hard Stop, mL/HR, HR, 5000

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