Prolonged Dialysis:
24-hr SLED Is It CRRT?

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Henry Ford Hospital, Detroit, Michigan, USA
Presenter Disclosure Information

• **I will** discuss off label (as defined by the FDA) use and/or investigational use of citrate solutions for regional citrate anticoagulation (RCA) during continuous renal replacement therapy (CRRT) in my presentation

• **I have** financial relationships to disclose:

  • Employee of: Henry Ford Health System, Detroit, MI
  
  • Patent: Automated RCA Systems
Learning Objectives

1. Review some limitations of sustained low efficiency dialysis (SLED) for CRRT

2. Explain the principles of safe, near-automated regional citrate anticoagulation (RCA) during 24-hour SLED

3. Evaluate the performance of our novel 24-hour SLED-RCA program in contrast to traditional CRRT
Henry Ford Hospital ICU RRT Options

Select an IPD Dialysis Order

For: Test1, Patient Previous Date: 02/08/2011 10:23:17

(2010 DATA)

Dialysis
- 10 hr SLED with Saline Flush, under contraction
- InPatient Dialysis Order
- 1000/year
- 2500/year

Traditional CRRT
- 10 hr CVVH Pre-Dilution
- 24 hr CVVH Pre-Dilution
- 900/year
- 200/year

Dialysis-RCA
- 4 hr IHD with CITRATE-research only
- 10 hr SLED with CITRATE
- 24 hr SLED with CITRATE
- 10/year
- 100/year
```
**“Traditional shift-SLED is not CRRT”**

<table>
<thead>
<tr>
<th>Duration</th>
<th>8-16 hours&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Downtime lost for ultrafiltration; daily setup</th>
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<tbody>
<tr>
<td>Blood Flow</td>
<td>200-300 ml/min</td>
<td>Mandates large catheter; Access flow alarms occur</td>
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<tr>
<td>Urea Clearance</td>
<td>Limited by QD; 5-12 L/hr</td>
<td>Lowest QD = 100 ml/min; Hourly clearance too high for 24-hr continuous use&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Online Dialysate</td>
<td>Flexible Na, K, Bicarb, Ca</td>
<td>Easy to use BUT: Risk of endotoxin backfiltration</td>
</tr>
<tr>
<td>Drug Dosing</td>
<td>Filter + Protocol Dependent</td>
<td>Huge variations Clinically Important Minimal Literature</td>
</tr>
<tr>
<td>Convection</td>
<td>Minimal in past&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Low flux filters: little middle molecule removal</td>
</tr>
</tbody>
</table>

```
Rationale for 24-hr SLED-RCA
Heparin versus Citrate

Scanning Electron Micrograph
Polysulfone Dialyzer Hollow Fiber

Heparin

Clotted Fiber

Citrate

Clean Fiber

ICU Extracorporeal Support 2010 → Future

Near-automated RCA to prevent clotting + reduce WBC, PLT and complement activation

Ultrafiltration: relative blood volume and central venous $O_2$ saturation monitoring

Biocompatibility: low blood flow; ultrapure dialysate without glucose degradation products

Computerized SLED prescribing and telemetry monitoring

Antibiotic dosing: according to online measured clearance

Columns for endotoxin, cytokine, inflammatory cell and protein-bound toxin removal

FOCUS: EASE OF USE + LOW COST FOR EARLY START CRRT

OUTCOME:
- Improved Survival & Renal Recovery
- Reduced Complications & Cost
New Dialyzer Designs Provide 24-hour SLED with the Middle-Molecule Transport Properties of CVVHDF
Middle-molecule clearance equal or greater in CVVHD than CVVH\(^2\)

1. Adapted from Depner T, Garred L: Solute transport mechanisms in dialysis; in Replacement of Renal Function by Dialysis, 5th edition; p85
24-hour SLED-RCA: Towards Automated RCA
Dialysis with Automated RCA: QB 20-300 ml/min

Integrated Infusion Pumps With Air Detectors

Access Catheter

Optical Hematocrit and O₂ Saturation Sensor

Internal Balancing Chambers

Conductivity Sensors

Display

Computer

Citrate Infusion

Calcium Infusion

Dialyzer

Effluent Analysis

Optical Citrate and Calcium Sensor Array (0.1 mM accuracy)

To Drain

1. SCD Device
2. Polymyxin B Column
3. Plasma adsorption

1. SCD Device
2. Polymyxin B Column
3. Plasma adsorption

Online Effluent
Citrate- and Calcium Sensor

Principles of the Henry Ford Hospital 24-hour SLED-RCA Protocol
24-hour SLED with RCA System

- Citrate Anticoagulation
- Patient Access Catheter
- Optical Hematocrit and $O_2$ Saturation Sensor
- Flow Rate Monitor
- Calcium 0.5-Liter bag
- Flow Rate Citrate
- Hematocrit Monitor
- Dialysis Machine
Uniform 24-hour SLED-RCA Prescription

1. SLED Prescription with high-flux filter
   - QB = 60 ml/min
   - QD = 400 ml/min (Ca-free)
   - QCit = 150 ml/h (ACD-A) (fixed)
   - QCa = 30-50 ml/h (from table)
   - QNetUF = 0-500 ml/h
   - 24-hour (continuous)

2. Other Features w iHD mode 9h 59min
   - Online measured delivered dose of dialysis
   - Continuous online display of the hematocrit and central venous O$_2$ saturation
“Truly Regional” Citrate Anticoagulation

- Citrate Infusion
- Calcium Infusion
- ~ 98% Removal of Calcium and Citrate!
- Dialyzer
- Ca-free Dialysate
- Drain Circuit

Start RCA
- iCa ≈ 1.2 mM
- Cit: < 0.3 mM

End RCA
- iCa < 0.2 mM
- Cit: < 0.3 mM

Citrate Infusion

Calcium

iCa < 0.2 mM
- Cit: 7-10 mM

iCa ≈ 1.2 mM
- Cit: < 0.3 mM
# Commercial Citrate Solutions

<table>
<thead>
<tr>
<th>ACD-A Solution</th>
<th>4%-TSC Solution</th>
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<tbody>
<tr>
<td>Na⁺ 225 mM</td>
<td>Na⁺ 408 mM</td>
</tr>
<tr>
<td>Citrate⁻ 75 mM</td>
<td>Citrate⁻ 136 mM</td>
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<tr>
<td>Citric acid 38 mM</td>
<td>Citric acid 0 mM</td>
</tr>
<tr>
<td>Dextrose 124 mM</td>
<td>Dextrose 0 mM</td>
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</tbody>
</table>

**ACD-A — Acid**
- Used most often
- Provides acidic circuit pH
- Plasma $\Delta$Na⁺ $\approx$ +3 mEq
- Plasma $\Delta$HCO₃⁻ $\approx$ -4 mEq

**4%-TSC — Basic**
- Used rarely, briefly
- Acidemic patients (pH <7.1 or $\text{HCO}_3^-$ <14)
- Plasma $\Delta$Na⁺ $\approx$ +9 mEq
- Plasma $\Delta$HCO₃⁻ $\approx$ 0 mEq

**Qcit (ml/h) = 2 x QB (ml/min) for 4%-TSC**

**Qcit (ml/h) = 2.5 x QB (ml/min) for ACD-A**

(Ex: $Q_B$ 100 ml/min $\rightarrow$ $Q_{cit}$ 200 ml/h if 4%-TSC is used)
# Online-Generated Dialysate

<table>
<thead>
<tr>
<th>Ion</th>
<th>Concentration (Range)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>140 (130-150)</td>
<td>mM</td>
</tr>
<tr>
<td>K⁺</td>
<td>1, 2, 3 or 4</td>
<td>mM</td>
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<tr>
<td>HCO₃⁻</td>
<td>32 (20-40)</td>
<td>mM</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>0.5</td>
<td>mM</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>102</td>
<td>mM</td>
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<tr>
<td>Phosphate</td>
<td>1.0</td>
<td>mM</td>
</tr>
<tr>
<td>Acetate</td>
<td>4</td>
<td>mM</td>
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<tr>
<td>Dextrose</td>
<td>5.5</td>
<td>mM</td>
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</tbody>
</table>

- Flexible control of sodium, potassium and bicarbonate
- May contain phosphate; IV supplementation not required
### 136 mM Calcium Solution

- **Ca$$^{2+}$$** infusion restores Ca$$^{2+}$$ mass balance
- **Na$$^{+}$$** mass balance is restored by the dialysis fluid
- Dextrose mass balance set by dialysis fluid dextrose
- At QB of 60 ml/min, QCa = 30–50 ml/hour

<table>
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<tr>
<th>Ion</th>
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<td>Ca$$^{2+}$$</td>
<td>136</td>
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<tr>
<td>Mg$$^{2+}$$</td>
<td>20</td>
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<tr>
<td>Na$$^{+}$$</td>
<td>120</td>
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<tr>
<td>Cl$$^{-}$$</td>
<td>432</td>
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</table>
Albumin Defines Plasma Total Calcium Goal

More Albumin $\Rightarrow$ More Bound Ca $\Rightarrow$ More Ca Needed
Hematocrit Defines Circuit Plasma Flow

More red cells $\Rightarrow$ Less plasma $\Rightarrow$ Less Ca Needed
Optical Hematocrit Monitor

Online Optical Hemoglobin

Sup. Vena Cava O₂ Saturation

HCT 18.5
HGB 6.3
BV 13.8
SAT 76
TIME 15 59
# Ca-Infusion Rate for 24-h SLED (ml/hr)

Ca/Mg solution (10 gm CaCl2 + 2 gm MgCl2 in 0.5 L 0.9% saline)

<table>
<thead>
<tr>
<th>Hgb g/dL</th>
<th>ALB g/dL</th>
<th>6-6.9</th>
<th>7-7.9</th>
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<th>9-9.9</th>
<th>10-10.9</th>
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<td>46</td>
<td>44</td>
<td>42</td>
<td>40</td>
<td>38</td>
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</tbody>
</table>

![Starting Value](#)  ![New Value](#)
Simple, Predictive Ca-Infusion Dosing

• The blood flow rate is fixed
• Hematocrit sensor determines plasma flow rate
• The systemic albumin level is known
• The Ca-infusion rate is easily calculated
Safe SLED-RCA Operation

1. Obtain Patient Labs
2. Start RCA
3. Body Ca^{2+} Fluxes: Less Impact with large Kt/V
4. SLED only normalizes labs
5. Check Ca^{2+}, Na^{+}, HCO_{3}^{-} (ABG)
6. Stable Patient Chemistry

Citrate metabolism irrelevant
24-hour SLED-RCA Program
Clinical Performance
Dialyzer after 43 hours

Dialyzer New
Low blood flow (60ml/min) allows the use of smaller access catheters.
Flexible Dialysate $\text{Na}^+$/HCO$_3^-$ Selection

Dialysate Composition

- **Base Na+**: 138 mEq/l
- **Bicarbonate**: 36 mEq/l
- **TCD**: 13.7 mS/cm
- **K+**: 4.0 mEq/l
- **Ca++**: 0.0 mEq/l
- **Mg++**: 1.0 mEq/l
- **Ac.**: 3.0 mEq/l
- **Dex.**: 99 mg/dl

Conductivity Limits:
- **Alarm Position**: 13.9 mS/cm
- **Alarm Width**: 12.9 mS/cm

SVS Profile: None
Systemic Ionized Calcium

Individual patients during 24-h SLED-RCA

Ionized Ca (mM)

Days of Therapy

Patient #

N = 269

13.5 Days of Citrate Anticoagulation
Severe Liver Failure Patient
Treated with 24-hour SLED-RCA

INR 3-4 on FFP
Lactate 15-20 mM
Total Bilirubin 29 mg/dL

\[ f(x) = -0.00683x + 2.29 \quad R^2 = 0.303 \]

\[ f(x) = 0.00124x + 2.06 \quad R^2 = 0.293 \]

\[ f(x) = 0.00334x + 0.905 \quad R^2 = 0.344 \]

Ca Ratio
Total / Ionized

Ca (mM)

Total Ca
Ionized Ca

Time (hours)
Calcium infusion rate
Individual patients during 24-h SLED-RCA

Days of Therapy

Ca/Mg Infusion Rate (ml/hr)

N = 1638
Online Dialyzer Clearance

QB = 60 ml/min:
Kecn = 45 to 55 ml/min
(≈effective urea clearance)

Gotch, FA; Panlilio, FM; Buyaki, RA; Wang, EX; Folden TI; Levin, NW. Mechanisms determining the ratio of conductivity clearance to urea clearance. Kidney International (2004) 66, SS3–SS24
Online Ionic Dialysance Kinetic Modeling

Gotch, FA; Panlilio, FM; Buyaki, RA; Wang, EX; Folden TI; Levin, NW. Mechanisms determining the ratio of conductivity clearance to urea clearance. Kidney International (2004) 66, SS3–SS24

24 hrs $K_t/V = 1.2$

(at 15 hrs)
Online Ionic Dialysance (Kecn)

Individual patients during 24-h SLED-RCA

KECN (ml/min)

N = 855

80% Recirculating Catheter

Days of Therapy

Patient #

1

2

3

4

5

6

7

8

9

10

11
<table>
<thead>
<tr>
<th>Patient #</th>
<th>Total Dialysis Time (hrs)</th>
<th>Total Dialysis Time (Days)</th>
<th>Hb (g/dL)</th>
<th>O2 Saturati on (%)</th>
<th>Ca/Mg Infusion (ml/hour)</th>
<th>Hourly Net Fluid Removal (ml/hour)</th>
<th>Total Fluid Removed (Liters)</th>
<th>KECN (ml/min)</th>
<th>ICA (mM/L)</th>
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<td>Total Hrs/Days</td>
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## HFH Cost of 72 hours of CRRT ($)

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<tr>
<th></th>
<th>Traditional CRRT</th>
<th>24-hour SLED-RCA</th>
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</thead>
<tbody>
<tr>
<td>Filter &amp; Tubing</td>
<td>$300 (2 x $150)</td>
<td>$45 (1.5 x $30)</td>
</tr>
<tr>
<td>Fluid/Dialysate</td>
<td>$1000 (200L x $5)</td>
<td>$50</td>
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<tr>
<td>Citrate/Ca + Lab</td>
<td>$0</td>
<td>$150 (3 x $50)</td>
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<tr>
<td>Total Cost 72 h</td>
<td>$1300</td>
<td>$245</td>
</tr>
<tr>
<td>Daily Savings</td>
<td>NA</td>
<td>≈ $350/day/pt</td>
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Savings due to alarm-free SLED-RCA with reduced CRRT technician and ICU nurse staffing costs are not considered.
1. Main Performance Features

- SLED-RCA is easy to perform & safe
- Online clearance measurement
- Costs are very low

2. Additional Benefits

- Hct and central venous O$_2$ saturation sensing
- Small dialysis catheter with blood flow 60 ml/min
- Ready to integrate second cartridge
Henry Ford Hospital
10-hour RCA-SLED Protocol
Uniform 10-hour SLED-RCA Prescription

1. SLED Prescription with high-flux filter
   - QB = 200 ml/min
   - QD = 400 ml/min (Ca-free)
   - QCit = 400 ml/h (ACD-A) (fixed)
   - QCa = 100-140 ml/h (from table)
   - QNetUF = 0-500 ml/h
   - 10-hour duration

2. Other Features w IHD mode 9h 59min
   - Online measured delivered dose of dialysis
   - Continuous online display of the hematocrit
# Lab Values of a Patient with Shock Liver Treated with 10-hour SLED-Citrate Dialysis

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>ALB Albumin, Serum g/dL</th>
<th>BUN Bun mg/dL</th>
<th>Creatinine Creat mmol/L</th>
<th>Ca,Ionized,Whole Bld mmol/L</th>
<th>TBIL Bilirubin, Total mg/dL</th>
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Ionized Calcium: 1.1 -Stat
## 10-hr SLED-RCA Solute Clearance Results

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<th>SD</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
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<td>13</td>
<td>48</td>
<td>122</td>
<td>181</td>
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<tr>
<td>TX time (hours)</td>
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<td>1.2</td>
<td>48</td>
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<td>9.0</td>
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<tr>
<td>Kinetic V (liters)</td>
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<td>19.8</td>
<td>48</td>
<td>40</td>
<td>104</td>
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<tr>
<td>Delivered Kt/V</td>
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<td>0.42</td>
<td>48</td>
<td>0.44</td>
<td>2.22</td>
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<td>Systemic Citrate (mM)</td>
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<td>0.18</td>
<td>16</td>
<td>0.06</td>
<td>0.67</td>
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<tr>
<td>Post Dialyzer Citrate (mM)</td>
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<td>0.17</td>
<td>18</td>
<td>0.38</td>
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ICU Dialysis: The Logistics

1. Increased dialysis use in the ICU
   - 0-15 short HD and 0-10 SLED treatments daily
   - 160 ICU beds now in multiple areas
   - SLED is delivered by the ICU nurse

2. Logistics Challenges
   - Communicate safely >20 ICU dialysis orders
   - Monitor treatments remotely in real time
   - Generate flow sheets, monitor data for QA & QI
Scaling Up SLED-RCA: Multimedia-Assisted Education
Blood Flow = 60 ml/min

High Flux Dialyzer

Hematocrit Chamber on Arterial Blood Line

SLED 24 hr.
Catheter connections can only be reversed for low blood flow at these points.

Calcium IV always attached to **BLUE** return blood line.

Citrate IV always attached to **RED** intake blood line.
Scaling Up SLED-RCA: “In The Cloud” Electronic Prescription Generation and Database Archival
# Search: Nephrology Rounding Results

<table>
<thead>
<tr>
<th>Name</th>
<th>Mrn</th>
<th>Date of Entry</th>
<th>Pri Res.</th>
<th>Room</th>
<th>Round Active</th>
<th>Reason</th>
<th>Last Update</th>
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<td>-</td>
<td>H201</td>
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<td>SLED-Route...</td>
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<td>DAILY TEST...NEW</td>
<td>04/09/2010 10:03:04</td>
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<td>-</td>
<td>H2100</td>
<td>Y</td>
<td>Order Form...NEW</td>
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</tbody>
</table>

[Click Here to Order a Dialysis Treatment]
**24•hr SLED WITH CITRATE ANTICOAGULATION ORDER/NOTE**

**ADD IPD DIALYSIS ORDER**

Entry Date: 10/27/2010 02:26:24 PM  
User Log: bszamos1: Add 10/27/10

**Name:** (L, F) **Patient Test**  
**MRN:** 15184704  
**Room Number:** 1000c

**Treatment Type:** 24 HOUR SLED WITH CITRATE

- Set machine in Hemodialysis Mode for 9 hours 59 minutes *(Re-setup every 10 hours for continuous treatment)*

**Contact Isolation:**  
- NO  
- YES Cause: _[Optional field]_

**Required values to calculate infusion rates**

- **Hb:** 26 g/dl  
- **Hgb:** 91 g/dl  
- **HCO3:** 18 mEq/L

- **Citrate Dextrose (ACD-A) at 150 ml/hr**

- **37** mL/Hr
  
  136 mM Ca in 0.9% saline *(10 gm CaCl2 + 2 gm MgCl2/500 mL)*

**Calculate Infusion**

(Select initial Calcium infusion rate from the 24-hour SLED-RCA Table.  
Adjust the Ca/Mg infusion rate per 24-hour SLED-RCA protocol.)

**Ultrafiltration CALCULATOR**

- Desired NET UltraFiltration Goal: **200** ml/hr as tolerated
- Effective NET UltraFiltration Goal: **200** ml/hr
- TOTAL goal in 10 hours: **3870** ml *(Net goal + remove Citrate 1200 or 1500 + Ca/Mg ~400 ml infused in 10 hours)*

**Dialysate temperature 36.5 C Sodium Program: No**

**Fluid Flow Rates & Dialyzer**

- Rhexed 15-SX FILTER
- 60 Blood Flow (ml/min)
- 400 Dialysate Flow (ml/min)

**Dialysate Bath**

- Potassium: 2 mEq/L  
- Calcium: 0 mEq/L  
- Phosphorus: 3.2 mg/dL

- Sodium: **142** mEq/L  
- Bicarbonate: **32** mEq/L

**Special Orders**

- **Age:** 69  
- **Sex:** Male  
- **Height:** 180 (cm)

- **Weight:** 90 kg  
- **Calculate Volume**  
  
  **Vol.: 45** (L)

1. **Document DELIVERED Kt/V**
2. **Document Average QB/Kcml (Ionic dialysance)**
3. **Measure Access Recirculation**

**Labs Date:** 10/26/2010

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<th>Test</th>
<th>Value</th>
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<tr>
<td>Magnesium</td>
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<td>Ionized Calcium</td>
<td>1.12 mmol/L</td>
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<td>Phosphorus</td>
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<tr>
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<td>137 mEq/L</td>
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<tr>
<td>K</td>
<td>4.3 mEq/L</td>
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<tr>
<td>Cl</td>
<td>105 mEq/L</td>
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<td>PROTEIN</td>
<td>6.2 mg/dL</td>
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<tr>
<td>BUN</td>
<td>57 mg/dL</td>
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</table>
SUSTAINED LOW EFFICIENCY DIALYSIS (SLED) WITH REGIONAL CITRATE ANTIocoAGULATION (RCA) ORDER/NOTE
Room Number: 1000c

Treatment Type: 24 HOUR SLED WITH CITRATE
- Set machine in HEMODIALYSIS Mode for 9 hours 59 minutes (Re-setup every 10 hours for continuous treatment)

Isolation: ☑ NO ☐ YES Cause:
- Citrate and Calcium infusion rates during RCA
- Citrate Dextrose (ACD-A) at 150 ml/hr
- Calcium/Magnesium (Ca/Mg) in 0.9% saline (10 gm CaCl₂ + 2 gm MgCl₂ /500 mL)

Ca/Mg Infusion RATE: 37 mL/Hour
(Select initial Ca/Mg infusion rate from 24-hour SLED-RCA Table 1. Adjust the Ca/Mg infusion rate per 24-hour RCA protocol.)

Ultrafiltration CALCULATION: UF RATE 387 ml/hr
Patient NET Goal PER HOUR 200 ml/hr (as tolerated)
TOTAL goal in 10 hours 3870 ml (Net goal + remove Citrate 1200 or 1500 ml + Ca/Mg ~400 ml infused in 10 hours)
Dialysate temperature 36.5 C Sodium Program: No TESTS & MEDICATIONS
1.
2.
3.

Patient Evaluation: History:
60 y.o male status post CABG 10/12/2010; course complicated by HAP, VDRF and anuric AKI. CRRT was started 10/20/2010.

Exam: T : 36.5 BP: 100 / 50 HR: 110 RR: 18 W: 90 kg

Attending Physician Attestation:
1. Patient Seen on Dialysis Init: ___ hr: ___ min: ___
Scaling Up SLED-RCA: Treatment Telemetry and Database Archival
1. Features of dialysis telemetry
   - Commercial computer and software
   - Secure communication to data server
   - Ability to interface with medical records, billing, laboratory

2. Main quality improvements
   - Real-time monitoring of treatments & alarms
   - Real-time tracking of resource utilization
   - Automated flow sheet generation
# Telemetry: Machine Status

## Blood
- Sensed: **√**
- Blood Pressure: **0/0**
- Flow Rate: **60.00**
- Volume: **235.00**

## Vitals
- Blood Pressure: **0/0**
- MAP: **0**
- Temp: **36.60**
- Pulse: **0**

## Dialysate
- Flow Rate: **400**
- Temp: **36.60**

## Pressure
- Arterial: **4.00**
- Venous: **34.00**
- TMP: **97.00**
- Conductivity: **13.50**

## Ultrafiltration
- Active: **√**
- Rate: **280**
- Goal: **2,820**
- Removed: **174**

## BTM
- T: **34.4**
- Tven: **34.6**
- Tbody: **0**
- Engy: **0**

## OLC
- Keu: **0.00**
- KTAV: **0.00**
- Plasma Na: **0.00**
- VSA: **0.00**

## Alarms
- Arterial: **☐**
- Venous: **☐**
- TMP: **☐**
- BP: **☐**
- Air: **☐**
- Bl Alm: **☐**
- Con Alm: **☐**
- Temp: **☐**
- Df Alm: **☐**
# Telemetry: Flowsheet Data

![Telemetry Flowsheet](image-url)

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<th>Ven</th>
<th>UFR</th>
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<td>14.00</td>
<td>31.2</td>
<td>30.6</td>
<td>.0</td>
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<td>O/O</td>
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<td>0</td>
<td>60</td>
<td>-43.00</td>
<td>41.00</td>
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<td>0</td>
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<td>280</td>
<td>14.00</td>
<td>31.3</td>
<td>30.6</td>
<td>.0</td>
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</tbody>
</table>

16:27 NAME ON DIALYZER (Y / N)=n
16:27 VERIFY DISINFECTION (Y / N)=y
16:27 STRILANT NEG. (Y / N)=y
16:27 VEN.LINE DETECTOR ARMED (Y / N)=y
SLED with RCA at HFH

Nephrology orders SLED with RCA in CarePlus NG (EHR)

- CRRT Technician Team sets up system
- ICU Team notified of SLED order and progress
- Pharmacy notified of SLED order and progress

SLED is performed by ICU RN per protocol with CRRT Team support

- Telemetry by CRRT Team
- Automatic charting in ICU electronic HR
- Clinical Monitoring

Nephrology modifies SLED with RCA as needed
24-hr SLED-RCA is CRRT and More!
# 24-hr SLED-RCA is CRRT and More!

<table>
<thead>
<tr>
<th>Feature</th>
<th>24-hr SLED-RCA</th>
<th>Traditional CRRT</th>
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<tbody>
<tr>
<td>Continuous</td>
<td>Yes; QB = 60 ml/min</td>
<td>Yes; QB ≥ 100 ml/min</td>
</tr>
<tr>
<td>Clearance</td>
<td>3 L/hr (fixed)</td>
<td>1-4 L/hr</td>
</tr>
<tr>
<td>Convection</td>
<td>≈ 10-30% (hidden)</td>
<td>0-100%</td>
</tr>
<tr>
<td>Automated RCA</td>
<td>Coming soon!</td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Online Clearance</td>
<td>Standard</td>
<td>Not Available</td>
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<tr>
<td>Telemetry</td>
<td>Available</td>
<td>Available Soon?</td>
</tr>
<tr>
<td>Diagnostic Use Of CRRT</td>
<td>Hct sensing; VO(_2) saturation</td>
<td>Not Implemented</td>
</tr>
</tbody>
</table>
HFH “Citrate Group”

- Balazs Szamosfalvi, MD
- Stanley Frinak, MSEE
- Jerry Yee, MD
- Tom Lubkowski
- Gary Zasuwa
- CRRT Technician Team
- ICU Teams
- Greenfield Health System