Fluid Management with CRRT

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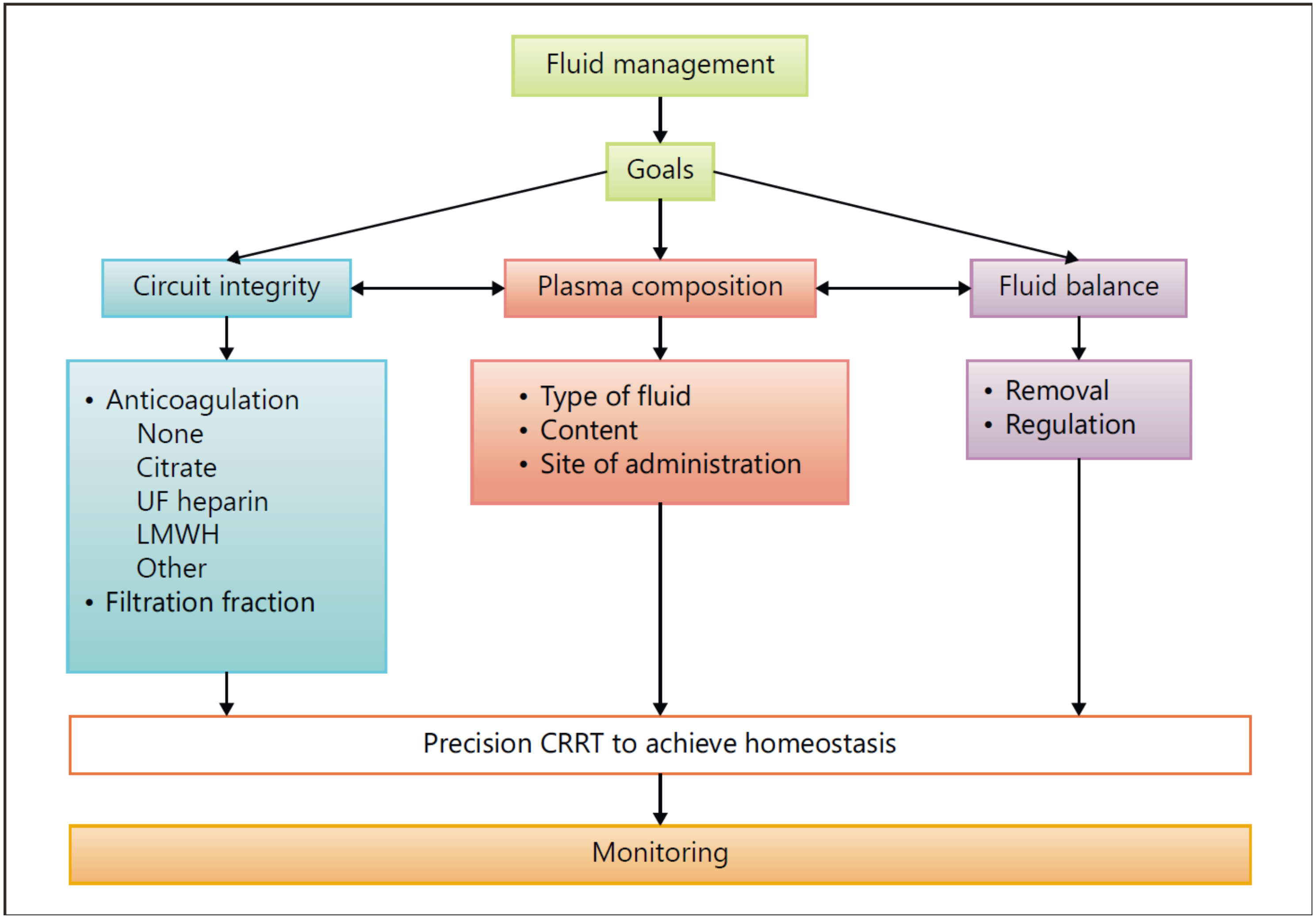
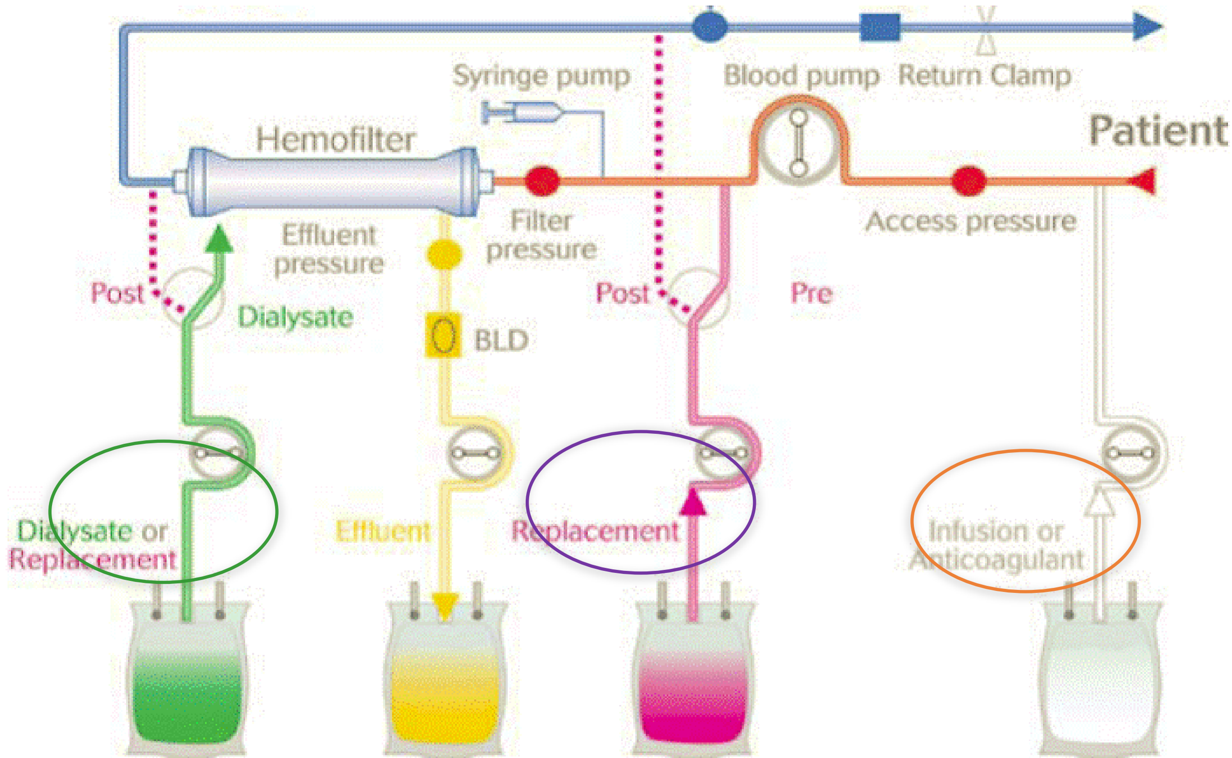


Practical Issues with Fluid Management for CRRT

- Maintaining the Circuit
- Enabling solute clearances and achieving homeostasis
- Volume control and balance with fluid regulation
- Monitoring for and preventing complications

Hydraulic Circuit for PrismaFlex: Sites for Fluid Administration



External Pumps

- Circuit related
- Non-Circuit

Integrated Pumps

Fluid Delivery in CRRT

- Circuit related
  - Anticoagulant
    - Saline, Heparin, Citrate, Other
  - Substitution fluid
    - Pre-filter *Dilution*
    - Post-Filter *Replacement*
  - Dialysate
- Non-Circuit
  - IV
    - Calcium (if Citrate)
    - Maintenance: Electrolytes and salts, Base, Blood products; Medications, nutrition
  - NG or PEG

Amount and Composition of each of these fluids can be varied to achieve homeostasis

CRRT Circuit

Maintaining the CRRT circuit is crucial for delivering CRRT effectively

- Catheter
- Filter
- Lines

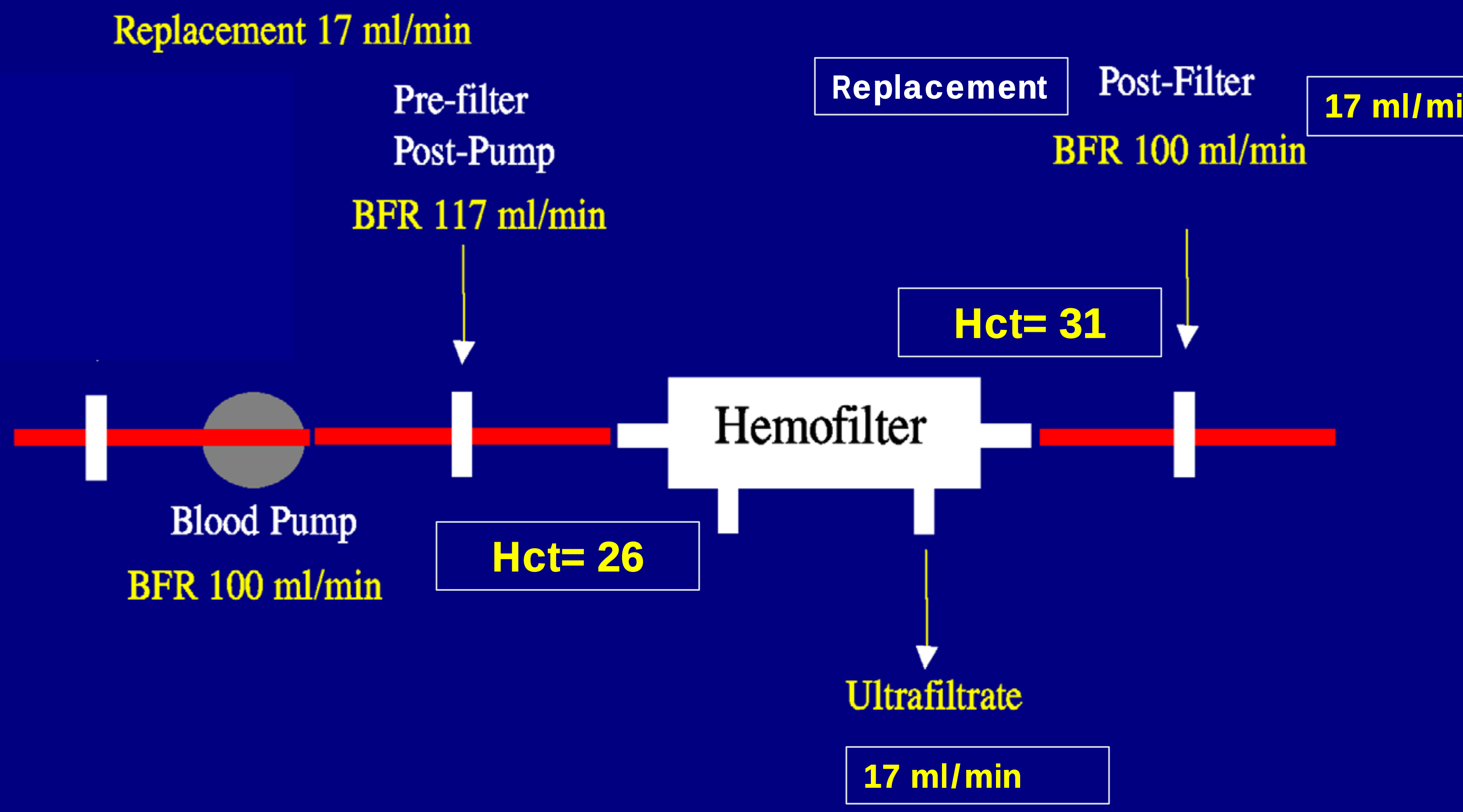
Interventions

- Anticoagulant (Saline, Heparin, Citrate, Other)
- Coated membranes
- Dilution

Fluid Management in Continuous Renal Replacement Therapy

Pre-Filter vs Post-Filter Replacement Fluid

Modality: CVVH with UFR 1L/hr



Pre-Dilution vs Post-Dilution CVVH

Filtration fraction (FF) = ultrafiltration rate/ plasma water flow rate

- FF values > 0.20 undesirable due to hemoconcentration-related effects on filter performance
  - major limitation of post-dilution CVVH
  - dependent on blood flow rate (Q_B) and hematocrit (Hct)

$$FF = \frac{\text{UF rate (ml/min)}}{\text{plasma flow rate}\left(Q_P\right)\text{(ml/min)}}$$

Table 3. Plasma flow and FF for different Q_Bs, UF rates and Hct

Hct, %	Q_B = 150 ml/min		Q_B = 200 ml/min	
	Q_P	FF	Q_P	FF
UF = 1,000 ml/h				
Hct = 25	112.5	0.15	150	0.11
Hct = 35	97.5	0.17	130	0.13
Hct = 40	90	0.19	120	0.14
UF = 2,000 ml/h				
Hct = 25	112.5	0.30	150	0.22
Hct = 35	97.5	0.34	130	0.26
Hct = 40	90	0.37	120	0.28

Q_P = Plasma flow rate in ml/min.

$$FF = \frac{\text{UF rate (ml/min)}}{\text{plasma flow rate}\left(Q_P\right)\text{(ml/min)}}$$

Table 4. Advantages and disadvantages of pre- and post-filter substitution

Pre-filter	Post-filter
Advantages	
UF rate is not limited by Q_B	Clearance of solutes is directly related to UF rate
Enhanced elimination of urea from RBC's	A higher solute clearance rate is produced
Filter life is increased as the Hct throughout the filter remains low	Delivery of specified solutes and concentrations directly to the solution
Filter life is increased which may increase filter lifespan and solute clearance, even though hourly solute clearance is decreased	
Disadvantages	
Solute concentrations are decreased and thus clearance is decreased	UF rate is limited by Qb. You cannot order too much UF because the end-filter Hct will be too high
	Because UF rate is limited by FF you may not reach optimal dose
	Filter life may be decreased by high end-filter Hct

RBC = Red blood cell. Adapted from Huang et al. [32].

Maintaining the Circuit: Summary

Select appropriate size catheter and position for individualized therapy

For Access requirements > 7 days consider tunnelled catheters

For CRRT, ***avoid high filtration fraction*** and consider pre-dilution to minimize concentration polarization and hemoconcentration

Select Anticoagulant based on expertise and available resources. Citrate has best results for circuit and filter integrity

For CRRT, ***adjust prescription for pre-dilution*** with either a FUN/BUN ratio or an empirical 15% particularly for CVVH

Practical Issues with CRRT

- Maintaining the Circuit
- Enabling solute clearances and achieving homeostasis
- Volume control and balance with fluid regulation
- Monitoring for and preventing complications

CRRT Operational Characteristics

CVVHDF

CVVHD

CVVH

Dialysate

Diffusive clearance

Ultrafiltrate

Convective Clearance

Clearance in CRRT = SC or equivalent x effluent volume (UF, dialysate, UF + dialysate) + membrane adsorption

Effluent

Sieving Coefficient = UF/Plasma concentration of solute

(1= freely permeable, 0+ not permeable).

Dialyzer and blood clearance differ based on solute and membrane characteristics

Operational Characteristics of CRRT

Parameters	SCUF	CVVH	CVVHD	CVVHDF
Solute transport mechanism	Convection	Convection	Diffusion	Diffusion and convection
Blood flow rate (Q_b), mL/min	100-200	100-250	100-250	100-250
Dialysate flow rate (Q_d), mL/h[a]	0	0	1,000-2,000	1,000-2,000
Substitution fluid rate (Q_s), mL/h	0	1,000-2,000	0	1,000-2,000
Ultrafiltration rate (Q_{uf}), mL/min[a]	2-8	16-33	2-8[b]	33-66
Net ultrafiltration rate (Q_{net}), mL/h	Q_{uf}	$Q_{ef} - Q_s$[c]	Q_{uf}[b]	$Q_{ef} - Q_s$[c]
Effluent flow rate (Q_{ef}), L/d	2-8	24-48	24-48	48-96
Components of Q_{ef}	Q_{uf}	$Q_{uf} = Q_s + Q_{net}$	$Q_d \pm Q_{net}$	$Q_{uf} + Q_d$
Sieving coefficient (S)	C_{uf}/C_p	C_{uf}/C_p	C_{ef}/C_p	C_{ef}/C_p

Abbreviations and definitions: CRRT, continuous renal replacement therapy; C_{ef}, solute concentration in effluent; C_p, solute concentration in plasma; C_{uf}, solute concentration in ultrafiltrate; CVVH, continuous venovenous hemofiltration; CVVHD, continuous venovenous hemodialysis; CVVHDF, continuous venovenous hemodiafiltration; SCUF, slow continuous ultrafiltration; Q_d, amount of fluid instilled into filter countercurrent to flow of blood; Q_s, fluid instilled pre- or postfilter to replace ultrafiltrate volume; Q_{uf}, plasma water removed from circulating blood into the effluent bag, it is driven by the machine settings to include the quantity of pre- and postdilution substitution fluids (Q_s) plus the desired net fluid removal (Q_{net}); S, ability of substance to pass through filter.

[a]Other units may be used; those listed are the usual units.

[b]The fluid removed reflects Q_{net} and adds additional solute clearance.

[c]Variable to achieve CRRT balance.

Macedo and Mehta AJKD 2016

CRRT Operational Characteristics Summary of Features

- Solute concentration can be manipulated independent of fluid balance
- Plasma composition can be altered by changing composition of dialysate and substitution fluid
- Fluid regulation can occur concurrently with solute removal to maintain patient fluid balance desired

Regulation of fluid composition

	CVVHF	CVVHD	CVVHDF
Target plasma solute concentration	Composition of Replacement Fluid	Composition of Dialysate	Composition of Dialysate and Replacement Fluid
Rate of change in plasma concentration	Difference in concentration between Replacement Fluid and plasma Exchange Rate Sieving coefficient	Dialysate Flow Rate (At low Q_D) Blood Flow Rate (At high Q_D) Dialyzer Size (At high Q_B) Molecular weight Dialyzer permeability	Combined effect of replacement fluid and dialysate fluid rates and composition

Examples of Commercial Solutions for CRRT

	Gambro (Baxter)		NxStage	B. Braun
	[a]PrismaSol BGK/B22K/ BK	[b]PrismaSATE BGK/B22K/ BK	[b]RFP 400-456	[b]Duosol 4551-4556
Na^{+}, mEq/L	140	140	130-140	140-136
K^{+}, mEq/L	0-4	0-2-4	0-4	0-4
Cl^{-}, mEq/L	108-113	108-120.5	108.5-120.5	109-117
Lactate, mEq/L	3	3	0	0
Bicarbonate, mEq/L	22-32	22-32	25-35	35-25
Ca^{2+}, mEq/L	0-2.5-3.5	0-2.5-3.5	0-3	3-0
Mg^{+}, mEq/L	1.0-1.2-1.5	1.0-1.2-1.5	1-1.5	1-1.5
Dextrose, g/dL	0-1	0-1.1	1	1-0

Macedo and Mehta AJKD 2016

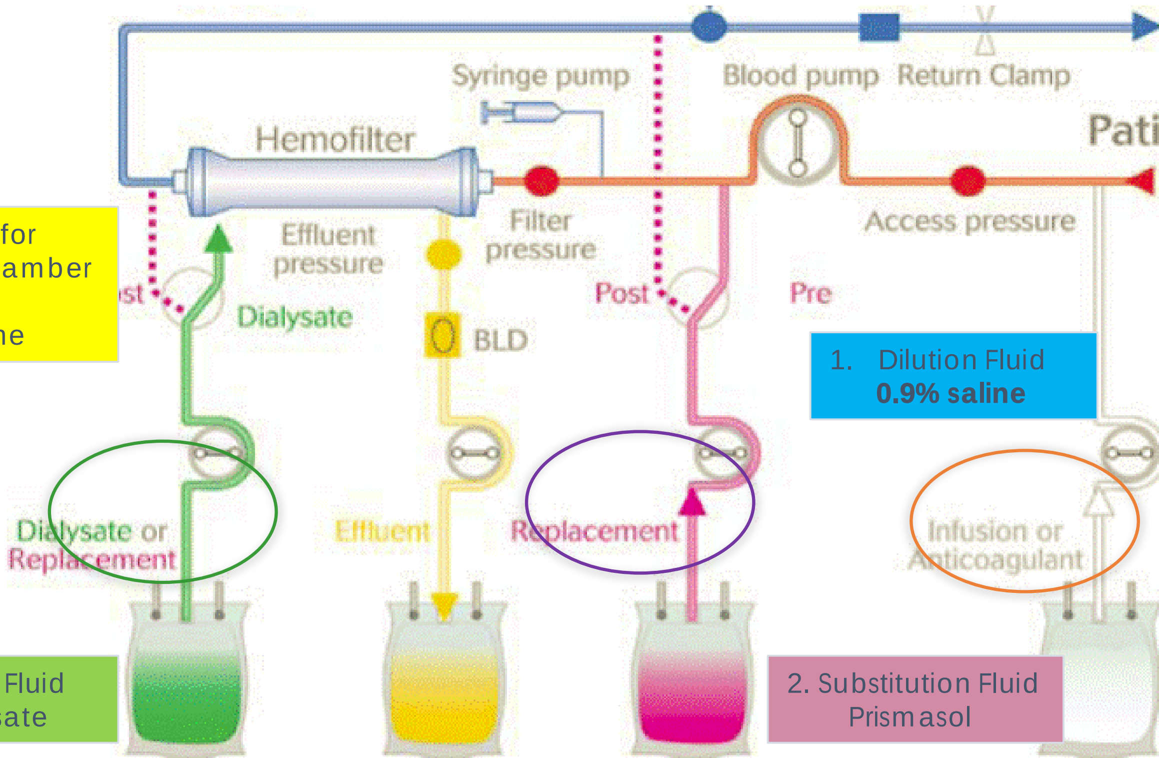
Hydraulic Circuit for PrismaFlex: Sites for Fluid Administration and modifications in fluid composition

5. IV fluids 0.95 saline; D5W; Bicarb

External Pumps
- Circuit related
- Non-Circuit

4. Post fluid for aeration chamber (200 ml/hr) 0.9% saline

1. Dilution Fluid **0.9% saline**



3. Dialysate Fluid Prismasate

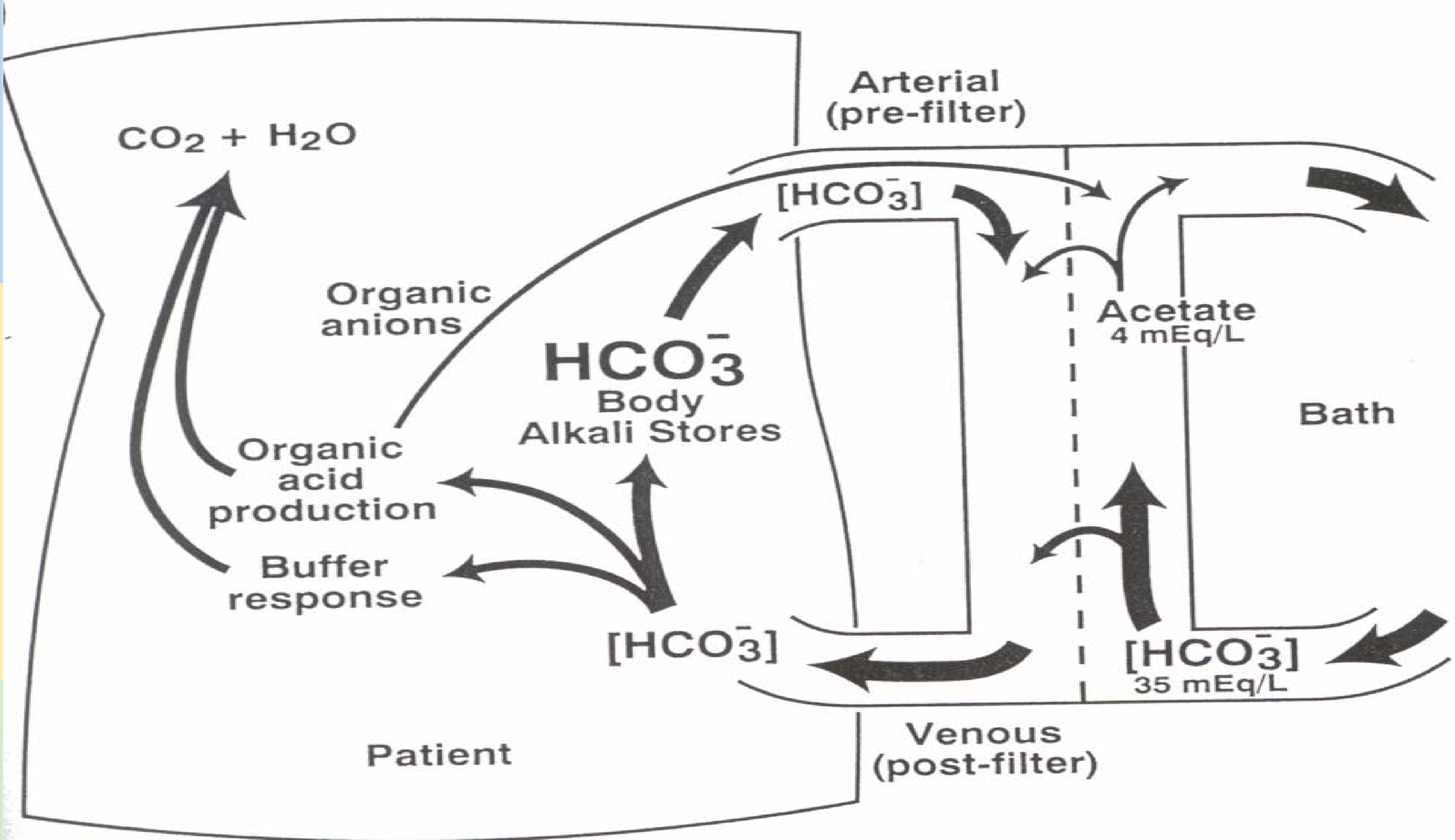
2. Substitution Fluid Prismasol

Integrated Pumps

Acid-base

- Daily non-volatile acid production around 1-1.5mmol/kg
  - ~80 milimoles
- At pH 7.1 [H^+] = 80 nanomoles/L
- Would need to clear 1,000,000 L/day if removing H^+
- CRRT controls acid-base by restoring plasma buffer or Strong Ion Difference not by removing H^+

Alkali Addition and Disposition During Hemodialysis



$$HCO_3^- \text{ added} = D_{HCO_3} \times \int_0^t (\text{Bath } [HCO_3^-] - \text{Blood } [HCO_3^-])$$

In steady state: Alkali gained = Net acid production

Modified from J Gennari

Effect of continuous venovenous hemofiltration with dialysis on lactate clearance in critically ill patients.

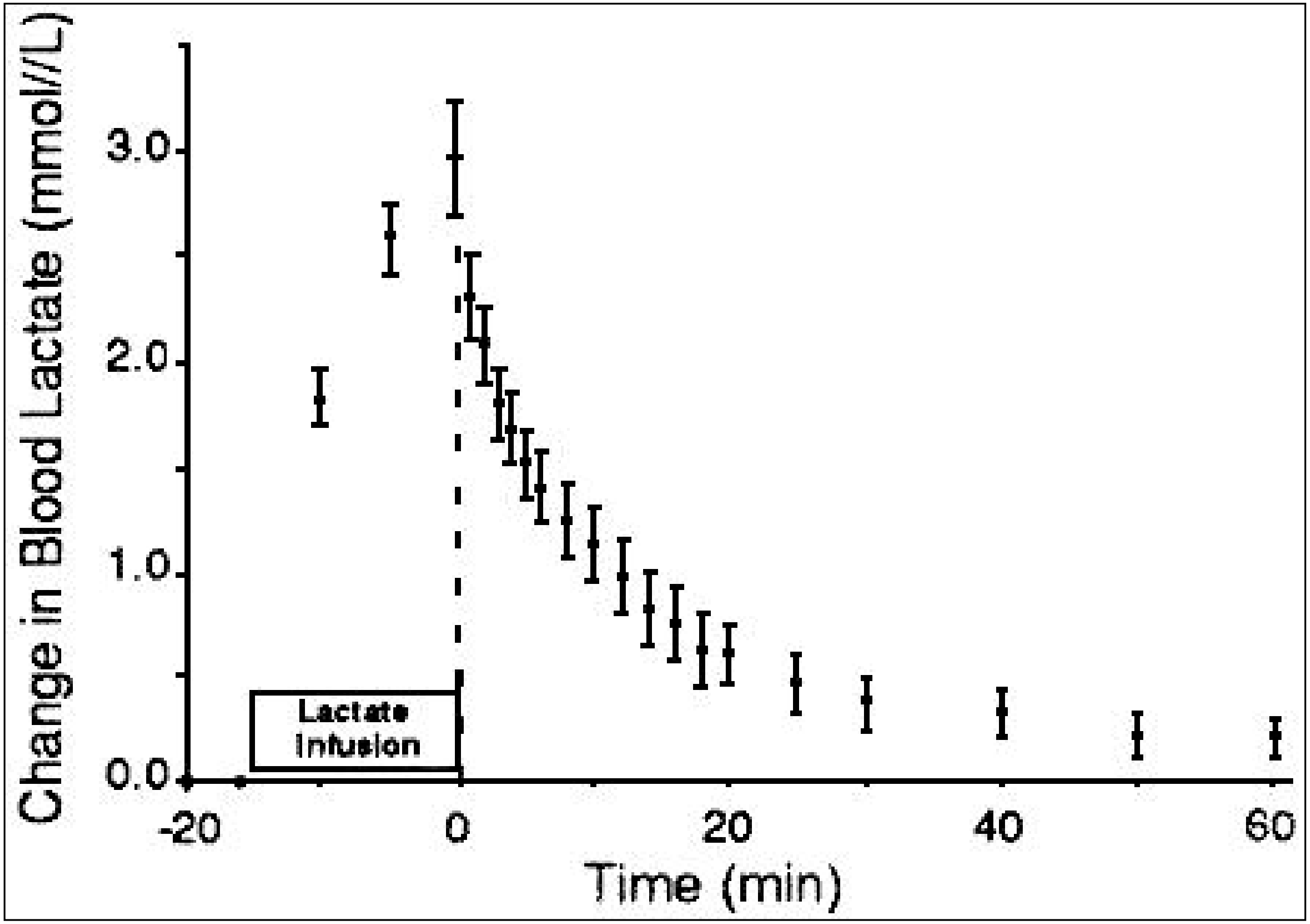
Levraut, Jacques; Ciebiera, Jean-Pierre; Jambou, Patrick; Ichai, Carole; Labib, Yasser; Grimaud, Dominique

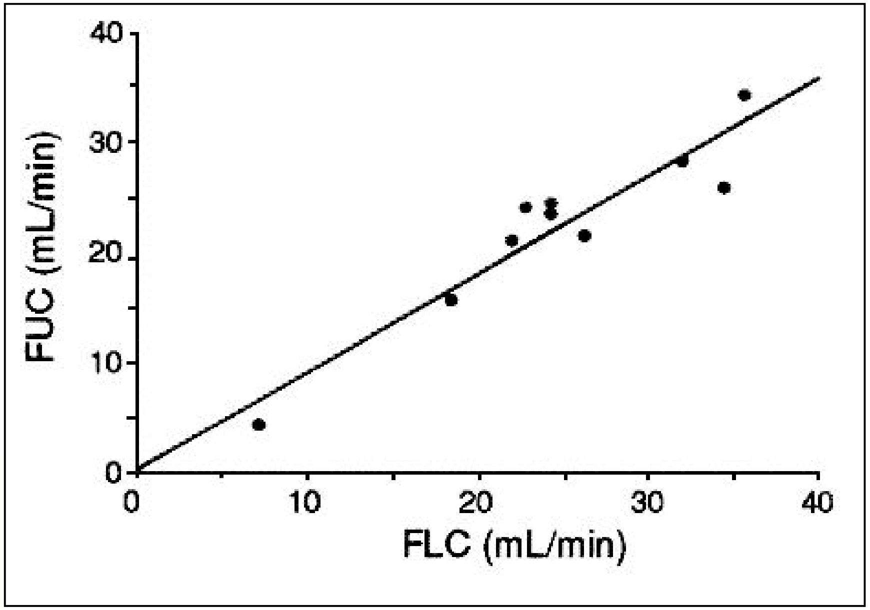
Critical Care Medicine. 25(1):58-62, January 1997.

Patient	Gender	Age (yr)	APACHE II Score	Pathology	Outcome
1	F	66	27	Crush syndrome	S
2	M	66	26	Urosurgery, MOF	D
3	M	72	22	Aortic aneurysm, circulatory failure	D
4	M	67	28	Sepsis, MOF	D
5	M	18	19	Multiple injury, crush syndrome	S
6	M	68	20	Sepsis, MOF	D
7	M	23	12	Intoxication, crush syndrome	S
8	M	70	24	Calcular pancreatitis	S
9	M	24	19	Acute severe asthma, MOF	D
10	M	67	18	Calcular pancreatitis, MOF	D

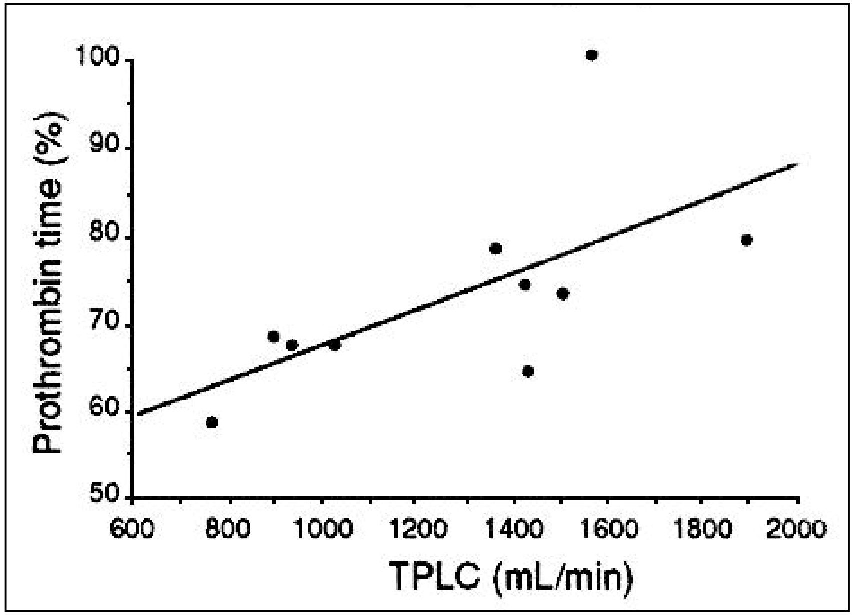
APACHE II, Acute Physiology and Chronic Health Evaluation II; S, survived; MOF, multiple organ failure; D, died.

Effect of Lactate Infusion in ARF patients on CVVHDF





Filter lactate clearance



Total plasma lactate

Lactate Production	Total Lactate Clearance	Resulting Blood Lactate Concentration (mmol/L)	
		Without CVVHD	With CVVHD
N	N	1	0.95
N × 5	N	5	4.8
N	N/5	5	4
N × 5	N/5	25	20

N, normal.

Calculations are made assuming that normal lactate production is 1 mmol/min, normal total plasma lactate clearance is 1 L/min, and filter lactate clearance is 50 mL/min.

Electrolytes

- Dysnatremia
- Hyperkalemia

Practical Issues with Fluid Management for CRRT

- Maintaining the Circuit
- Enabling solute clearances and achieving homeostasis
- **Volume control and balance with fluid regulation**
- Monitoring for and preventing complications

Fluid Management in the Critically Ill Patient

Strategies for intervention role of CRRT

- Fluid Removal
- Fluid Regulation

Principles For Fluid Removal with Dialysis

Removal

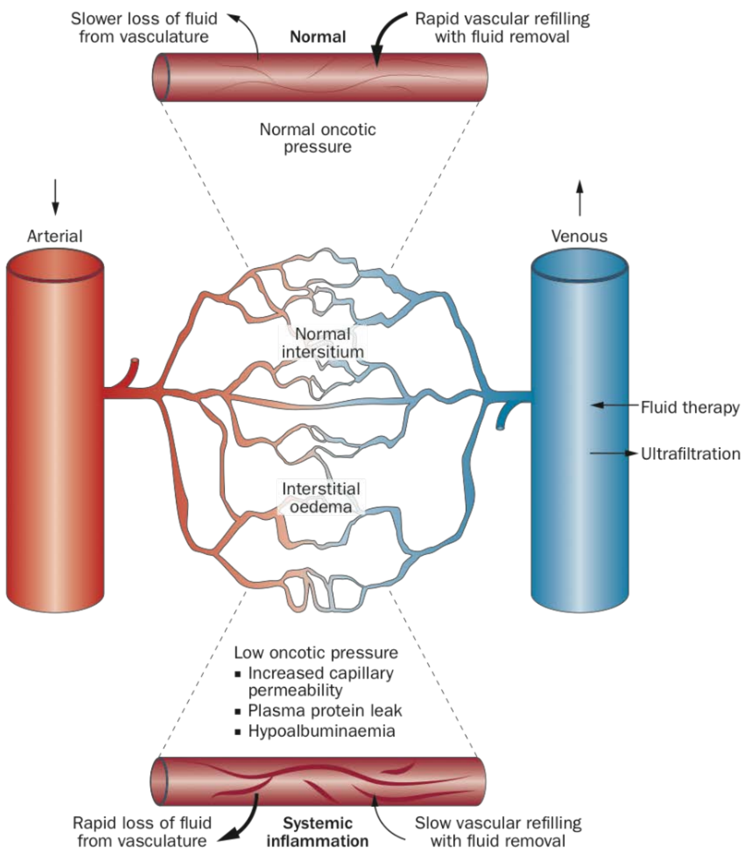
Fluid is primarily removed from intravascular compartment

Refill

Plasma refilling rates from interstitial compartment determine rate of change of intravascular blood volume

Balance

If ultrafiltration rate exceeds plasma refilling rate decreased blood volume ensues and contributes to hemodynamic instability



Prowle, J. R. *et al.* (2013) *Nat. Rev. Nephrol.* doi:10.1038/nrneph.2013.232

- Fluid is removed by UF governed by transmembrane pressure
- Volume of fluid removed is precisely regulated by volumetric balance chambers in machine
- Rate of fluid removal dictated by prescription
- Maximum fluid removal rate per hour dictated by machine limits (generally 2 L/hr)
- Fluid replacement generally not required

IHD: Since time is rate limiting factor goal is to find maximally tolerated ultrafiltration rate

- Fluid is removed by ultrafiltration governed by transmembrane pressure
- Volume of fluid removed is precisely regulated by *Gravimetric* scales outside machine (Prisma, Prismaflex, Aquarius, B. Braun) or *Volumetric* balancing chamber inside machine (NxStage)
- Rate of fluid removal dictated by prescription and operational characteristics
- Maximum fluid removal rate per hour dictated by machine limits (2-12 L/hr)
- Fluid replacement is required

CRRT: As procedure is continuous, goal is to target UF to achieve fluid balance over time

Comparisons of Fluid Management Capability

	Normal Kidney	Intermittent HD*	Peritoneal Dialysis	CRRT#
Ultrafiltration (ml/min)	120	34	14	100
Volume of Filtrate /day (L)	173	8	14	144
Volume removed /Day (L)	0.1-1.5	0-8	0-14	0-100
Regulatory mechanism	GFR Control	UFR Control	UFR control	UFR Control
	Reabsorption	-	-	Replacement Fluid
Sensing mechanism	Hemodynamic	-	-	-? hemodynamic
	Volume status	-	-	? volume status

* 4 hours /day

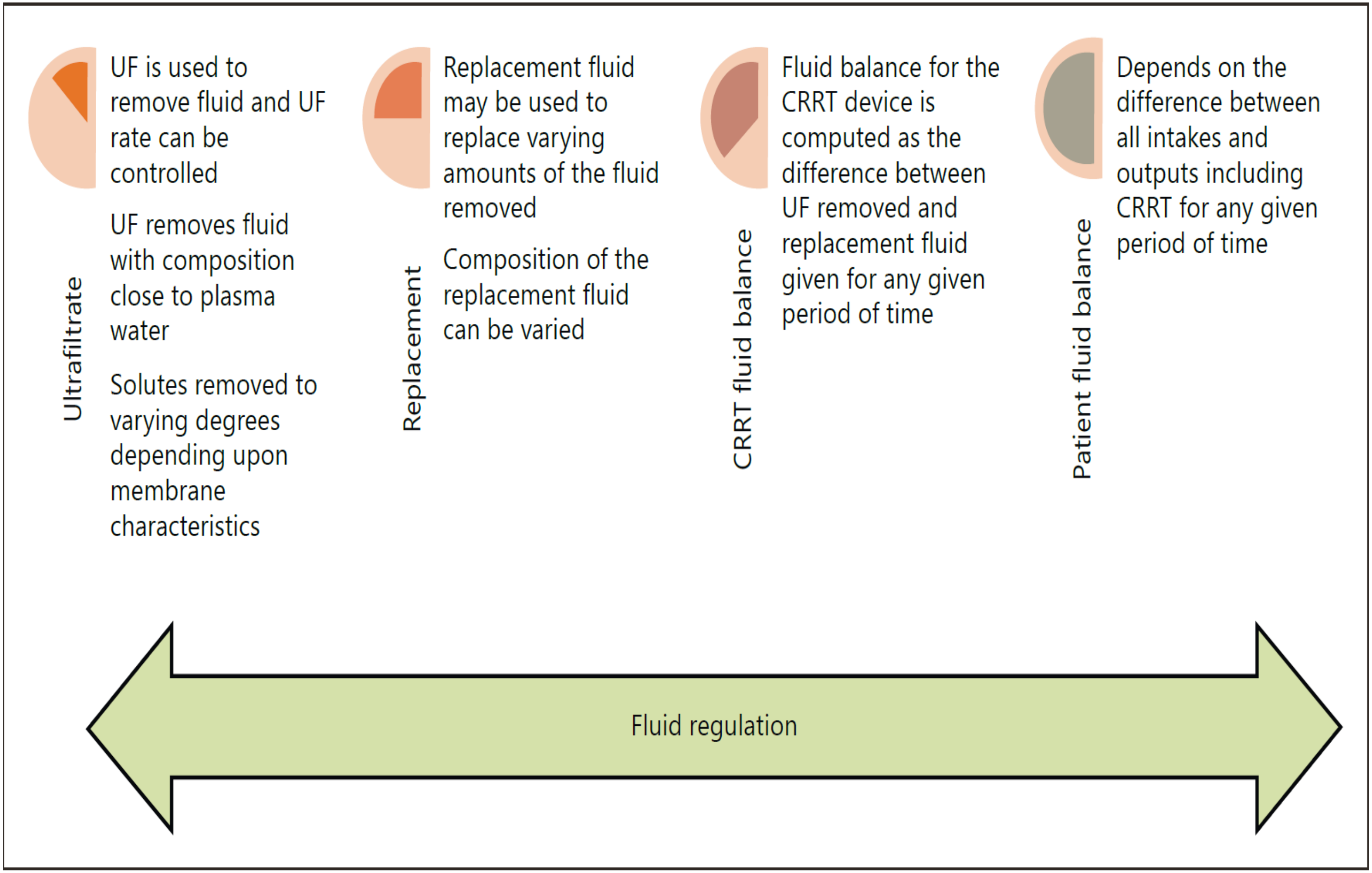
\# High volume HF 6L/hr

Table 5. Operating characteristics of CRRT – fluid removal versus fluid regulation

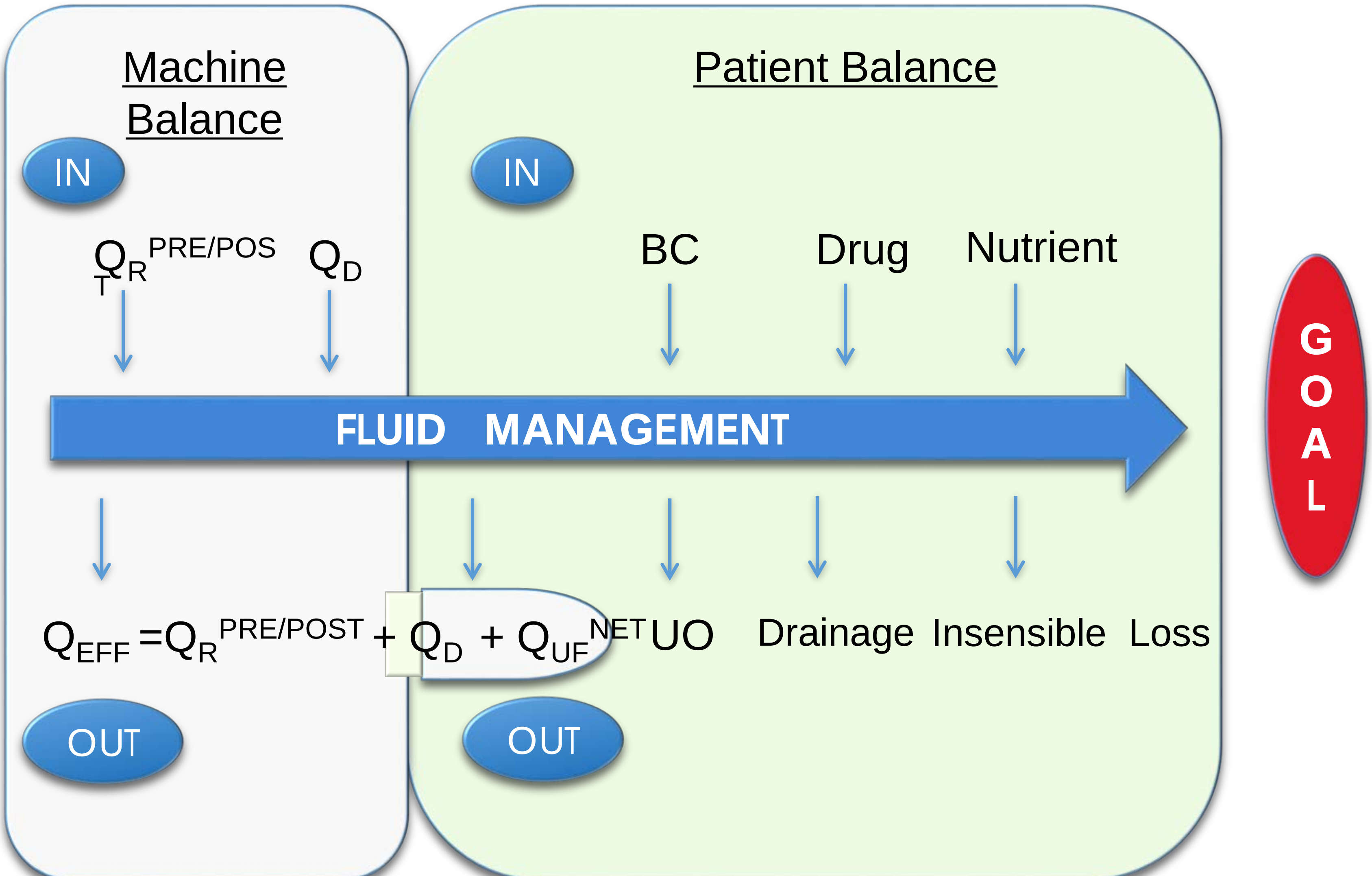
Characteristics	Fluid removal	Fluid regulation
UF rate	To meet anticipated needs based upon static weight at beginning of treatment as compared to target weight	Variable and reassessed frequently depending upon patient needs and goals of therapy
Fluid management	Adjust UF	Adjust amount of replacement fluid and/or UF
Fluid balance	Even or negative	Positive, even, or negative
Volume removed	Based on physician estimate	Driven by patient characteristics and goals
Application	Easy, similar to IHD	Requires specific tools and training

IHD = Intermittent hemodialysis.

Principles of Fluid Management with CRRT



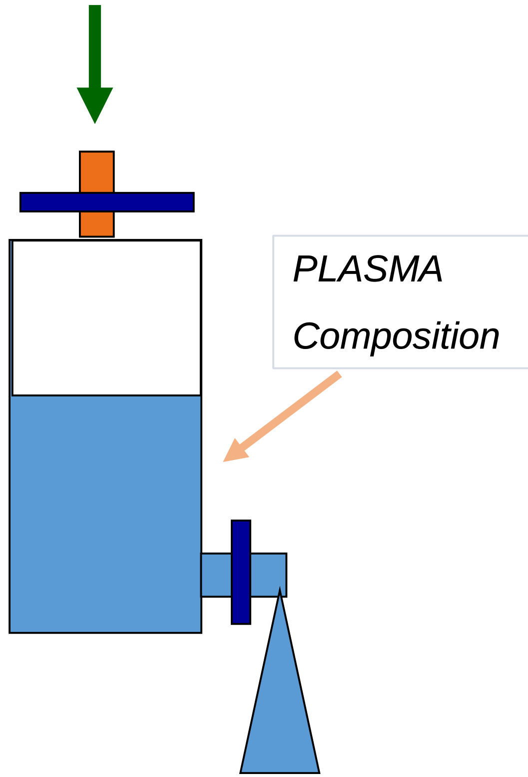
Approaches to Fluid Balance with CRRT Fluid Regulation



Approaches to Fluid Balance with CRRT Principles

Intakes

Oral; IV



Outputs

- *Urine; GI*
- *Drains; Insensible*

Patient Status

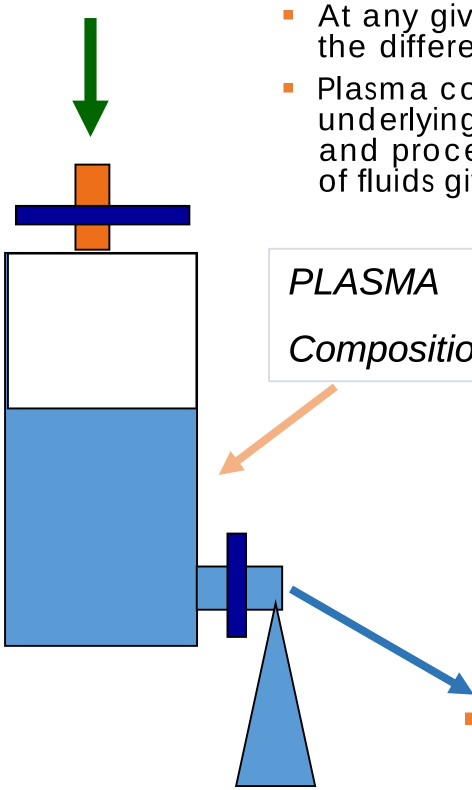
- Patient Balance
  - At any given point in time depends on the difference in intakes and outputs
  - Plasma composition determined by underlying pathophysiologic processes and process of care (amount and types of fluids given)

Approaches to Fluid Balance with CRRT Fluid Removal

Intakes

Oral; IV

- Patient Balance
  - At any given point in time depends on the difference in intakes and outputs
  - Plasma composition determined by underlying pathophysiologic processes and process of care (amount and types of fluids given)



PLASMA

Composition

Key is to integrate CRRT balance with patient fluid balance

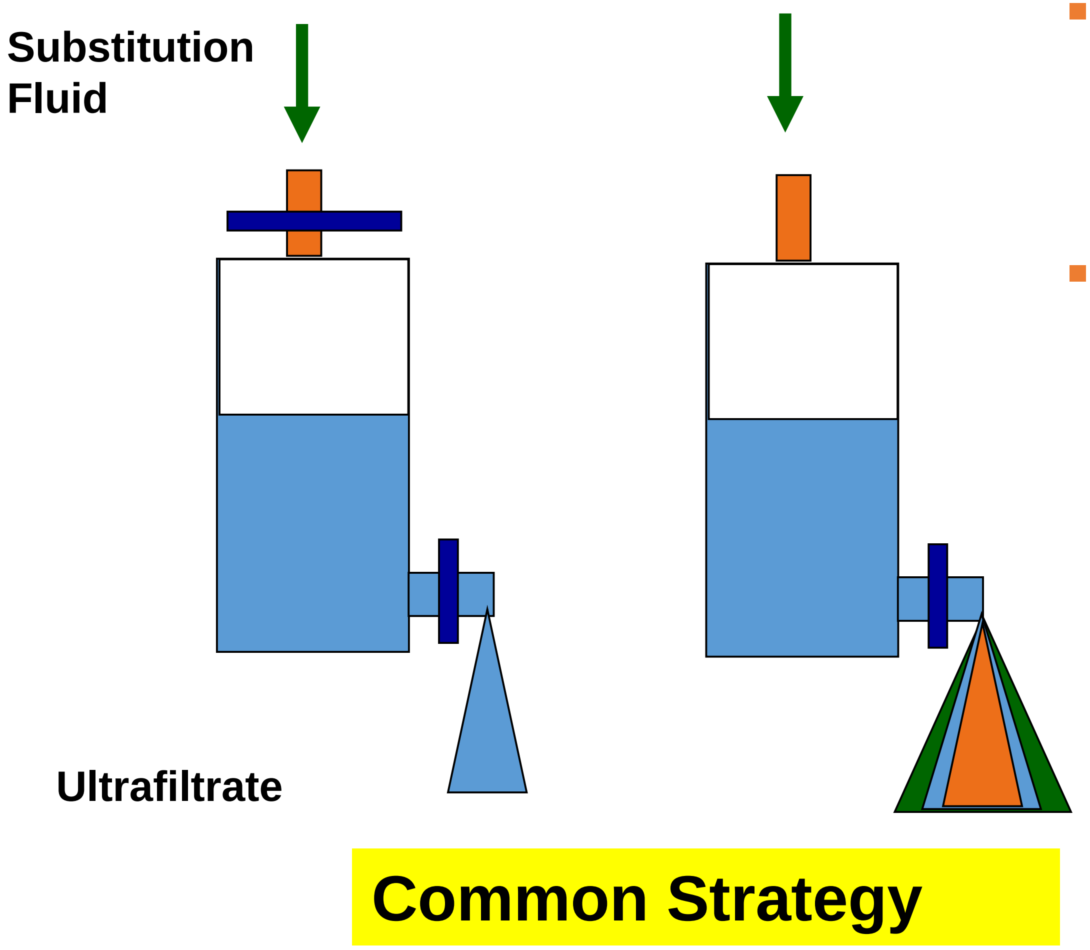
Outputs

- *Urine; GI*
- *Drains; Insensible*

Patient Status

- CRRT Addition
  - Provides a new source of fluid removal that can be adjusted
- CRRT Balance
  - Negative if fluid removal rate > replacement fluid rate
  - Zero
    - if no fluid removed and no replacement given (CVVHD)
    - fluid removal rate = replacement fluid rate

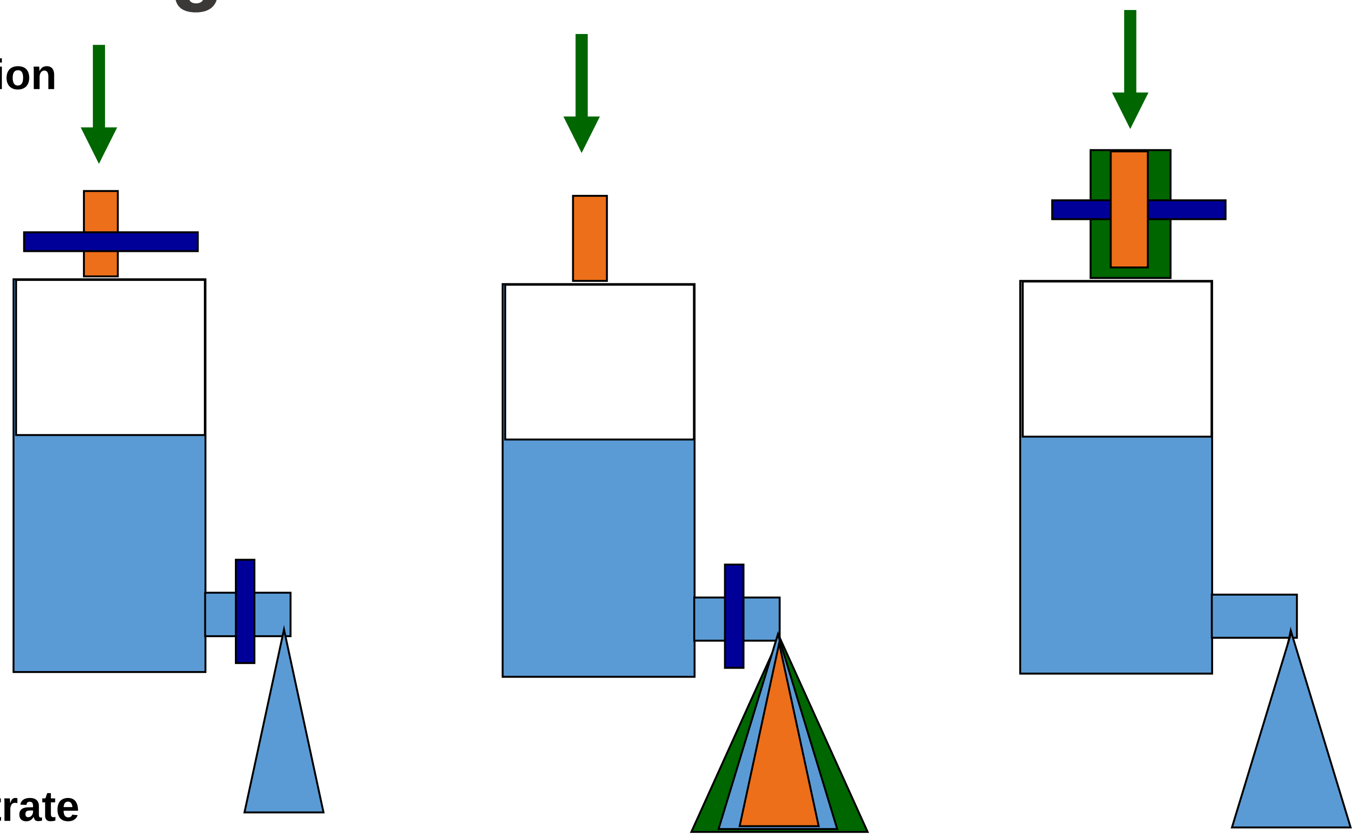
Approaches to Fluid Balance with CRRT
Fluid Regulation



- Adjust patient fluid balance using CRRT as a tool for fluid management
- Goal is to adjust fluid removal/administration to achieve patient needs

Approaches to Fluid Balance with CRRT Fluid Regulation

Substitution Fluid



Ultrafiltrate

Common Strategy

UF is Varied

Alternate Strategy

UF is fixed
Replacement is varied

Optimizing Renal Support for Fluid and Solute Management

Patient Assessment

- Desired fluid balance
- Fluid management strategy (removal, even, positive balance)
- Adjustments: Frequency
- Goals of Therapy

Goals of therapy

- Short term
- Long term

CRRT Operational Parameters

- Effluent volume
- Pump settings
- Solutions rate
- Measurements

Fluid Management in CRRT

Key Decisions

How much UF volume is required to provide solute clearance

How much UF is needed to achieve fluid balance

What fluid composition is needed to replace fluid removed

Practical Issues

Prescription

Implementing fluid management with different pumped systems

Monitoring and charting

Roles and responsibilities

Fluid and solute management in CRRT Prescription

Step 1: Determine the effluent rate (dialysate and/or ultrafiltrate) needed to meet clearance goals (recommend starting at 30 ml/kg/h)

- Monitor clearance
- Adjust effluent rate to meet clearance goals
- Monitor hemofilter performance (FUN/BUN)

Step 2: Determine fluid balance needs for the patient and determine the iBalance by incorporating machine and patient fluid balance to determine net goals

- Monitor hemodynamic response to fluid removal
- Frequent clinical assessment of fluid removal goal
- Flow sheets to monitor machine/patient balance
- Consider measures of dynamic fluid assessment

Step 3: Determine composition of replacement and/or dialysate solutions to meet goals of maintaining electrolyte and acid-base homeostasis

- Monitor serum electrolytes
- Monitor acid-base status
- Adjust fluids accordingly to meet goals

Step 4: Determine the timing for achievement of goal and monitoring parameters

- Timing based upon hemodynamic stability and imperatives based upon clinical goals
- Set fluid removal rate
- Determine best method to monitor changes

Fluid and Solute Management in CRRT Prescription Elements

Modality

- CVVH
- CVVHD
- CVVHDF

Operational Characteristics

Solute removal
- Membrane
- Blood flow
- Effluent volume (Dialysate, Ultrafiltrate)

Fluid Balance
- Ultrafiltrate
  - Substitution fluid
  - Dilution fluid
- Replacement fluid

Circuit
- Anticoagulation
- Filtration fraction
- Monitoring

Plasma Composition

- Solution content
- Flow rates
- Monitoring

Organ Support

- High Volume
- High cut off membranes and sorbents
- Temperature control

Fluid management in CRRT Prescription

Desired solute clearance

- Effluent volume
  - Dialysate
  - Ultrafiltrate

Desired Fluid balance

- Fluid removal
- Fluid regulation

Operational and safety parameters

- Monitoring and charting
- Problem avoidance and recognition

Fluid management in CRRT Prescription

How much solute clearance?

- Based on patient characteristics (catabolic state, nutritional support, underlying renal function etc)
- Calculated as desired clearance ml/min and expressed as L/hr

Compute minimal effluent volume

- Clearance requirement in L/hr = minimal effluent volume/hr
- Amount of dialysate and ultrafiltrate to meet minimal effluent volume (modality dependent)

$$FF = \frac{\text{UF rate (ml/min)}}{\text{plasma flow rate}\left(Q_P\right)\text{(ml/min)}}$$

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Hct = 25	112.5	0.30	150	0.22
Hct = 35	97.5	0.34	130	0.26
Hct = 40	90	0.37	120	0.28

Q_P = Plasma flow rate in ml/min.

Fluid management in CRRT Prescription

How much solute clearance?

- Based on patient characteristics (catabolic state, nutritional support, underlying renal function etc)
- Calculated as desired clearance ml/min and expressed as L/hr

Compute minimal effluent volume

- Clearance requirement in L/hr = minimal effluent volume /hr
- Amount of dialysate and ultrafiltrate to meet minimal effluent volume (modality dependent)

UF volume needed for fluid balance needs

- Define patient fluid balance requirements and estimate net (intake – output) amount of fluid to be removed
- Define intakes obligated to CRRT therapy e.g. citrate and calcium required for anticoagulation
- Add total fluid to be removed every hour to achieve goals
- Compute UF required for fluid balance = total fluid to be removed

Fluid management in CRRT Prescription

Set replacement fluid or UFR parameters for patient fluid balance

- Determine net fluid balance goal e.g. negative, zero or positive
- Determine CRRT fluid balance very hour
- Set replacement fluid rate or UFR to achieve patient fluid balance goal

Fluid Management in CRRT

Orders

- Components
- Standardization

Charting

- CRRT Balance
- Patient Balance
- Where is it charted

Continuous renal replacement therapy

AQUARIUS

Hôpital du Sacré-Coeur de Montréal.

MODALITY : ☐ CVVH ☐ CVVHDF ☐ Other: ____________

FILTER : ☐ 1,2m² ☐ 1,9m²

PARAMETERS AT INITIATION :

Blood flow: ________ mL/min (Usually 250ml/h, Max 450ml/h; Target filtration fraction < 30%)

Hourly Net fluid balance: ________ mL/hr

Fluid warmer: ☐ no ☐ 38°C (4L) ☐ 39°C (6L)

SOLUTION :

Solution: ☐ B0 ☐ LG-2

Add 5,5 mmol/L Dextrose if B0 is used (Dextrose already included in LG-2)

Add ______ mEq/L KCl (2 mmol/L already included in LG-2)

☐ 0,3 mL/L Na_2HPO_4

☐ **HEMOFILTRATION :**

Replacement therapy predilution: _________ mL/hr

Replacement therapy postdilution: _________ mL/hr

(Usually 1/4 pre and 3/4 post filter, Max 10L/hr)

☐ **DIALYSIS :** Dialysate : _________ mL/hr

ANTICOAGULATION :

☐ IV Heparin : Bolus ______ U, perfusion ________ U/hr and readjust

According to ☐ standard protocol ☐ cardiac surgery protocol

ANALYSES : CBC, PTT, INR, BUN, Creatinine, E⁺, Mg, P, Ionized Ca, AST, ALT, Bilirubin, ALP, Lactate, Arterial Blood Gases: **q 12h**

____________ ________________________

Date **Signature MD**

CRRT Flow Sheet: Hôpital du Sacré-Coeur de Montréal.

Continuous renal replacement therapy

Hour	Art.	Vei.	TMP		Objective for 8h	Achieved Net U.F. (1)	Out from Pt (2)	Total Out. (3)	Total In (4)	Net Balance	Cumulative Net Balance (5)	Cumulative Predicted Net Balance (6)	Adjustment
00 h					___ml/h		Urine:		PO/NG		-500	-700	
01 h					___ml/h								
02 h							Gast.:		I.V.:				
03 h					Predicted:			Achieved Net UF (1) + Out from Pt.(2)		(4) - (3)			
04 h					Achieved:		Drains:						
05 h													**Adjustment*** (5)-(6)
06 h							Others:						
07 h													
TOTAL for NIGHT SHIFT (A)					-500	2,000	500	2,500	2000	-500	-1000	-1200	200
08 h					___ml/h		Urine:		PO/NG				
09 h					___ml/h								
10 h							Gast.:		I.V.:				
11 h					Predicted:			Achieved Net UF (1) + Out from Pt.(2)		(4) - (3)			
12 h					Achieved:		Drains:						
13 h													**Adjustment*** (5)-(6)
14 h							Others:						
15 h													
TOTAL for DAY SHIFT (B)					-500	2,200	500	2,700	2000	-700	-1700	-1700	0
16 h					___ml/h		Urine:		PO/NG				
17 h					___ml/h								
18 h							Gast.:		I.V.:				
19 h					Predicted:			Achieved Net UF (1) + Out from Pt.(2)		(4) - (3)			
20 h					Achieved:		Drains:						
21 h													**Adjustment*** (5)-(6)
22 h							Others:						
23 h													
TOTAL for EVENING SHIFT (C)					-500	2,000	500	2,500	2000	-500	-2200	-2200	0

UCSD Medical Center Citrate CRRT Orders

UNIVERSITY of CALIFORNIA, SAN DIEGO
MEDICAL CENTER

PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Citrate CRRT
Orders
Page 1 of 3

Patient Identification

PHYSICIAN: Use ball point pen. Check (√) appropriate orders where given choice. Use the metric system when filling in blanks or writing additional orders. To add additional orders after signing and dating this set, use blank Physician's Orders.

Patient Parameters:

1. Diagnosis____
2. Indications: ❒ Solute Control ❒ Fluid Management ❒ Acid/Base/Electrolyte Management
   ❒ Immune Modulation ❒ Other________________________
3. Allergies: Refer to Medical Record for current list of allergies/reactions
4. Weigh patient before starting CRRT and once daily.
5. Use standard CRRT procedures/protocol of unit.
6. **Access:** ❒ Temporary Catheter ❒ Tunneled Cathether ❒ ECMO Circuit ❒ Fistula ❒ Graft ❒ Other_____
   Site: ❒ Left ❒ Right
   Location: ❒ Femoral ❒ Jugular ❒ Subclavian ❒ Arm ❒ Leg ❒ Other _______

Treatment Parameters:

7. Modality: ❒ SCUF ❒ CVVH ❒ CVVHD ❒ CVVHDF ❒ Other_______________________
8. Machine: ❒ PrismaFlex ❒ Other_______________________
9. Filter: ❒ PrismaFlex Set HF1000 ❒ Other _______________________
10. Use fluid warmer to maintain patient's temperature at 37C. Other ________________

Solutions and Flow Rate:

11. Blood flow: ❒ 100 mLs/min ❒ Other_________mLs/min (Max: 450 mLs/min)
12. (1B) Dialysate - Base solution: 0.45% NACL

*NaCL	mEq/L
*NaHCO3	mEq/L
KCL	mEq/L
Magnesium Sulfate	mEq/L
Dextrose (0.1-1%)	%
Other 1	
Other 2	

*Total NaCl/HCO3 should equal 40 mEq/L

13.

FLOW RATES	Standard (mLs/hr)	Other (mLs/hr)
(1A) Total Effluent (total of all fluids)	2700	
(1B) Dialysate	1000	
(1C) Post filter (deaereation chamber via replacement pump)	200	
(1D) Pre filter (via Pre Blood Pump)	500	
(3A) Patient fluid removal (Max 2000 mLs/hr)	1000	

( ) refers to form D6037

14. (1C) Post filter: ❒ Normal Saline ❒ Other: ________________________
15. (1D) Pre filter: ❒ Normal Saline ❒ Other: ________________________

Physician Signature/PID# Date & Time
Nurse Signature Date & Time

UCSD Medical Center Citrate CRRT Orders

UNIVERSITY of CALIFORNIA, SAN DIEGO
MEDICAL CENTER

PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Citrate CRRT
Orders
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Patient Identification

PHYSICIAN: Use ball point pen. Check (√) appropriate orders where given choice. Use the metric system when filling in blanks or writing additional orders. To add additional orders after signing and dating this set, use blank Physician's Orders.

16. Replacement Fluid - Given post filter via venous return line. Choose one scale:

Solution	pH	Serum Bicarb
Normal Saline	>	>
0.45% Normal Saline plus 75mEq/L NaBicarb		
Sterile Water plus 150mEq/L NaBicarb	<	<
Other		

17. Replacement fluid flow rates: Choose **one** method below to maintain net fluid balance:
❒ Set hourly fluid removal rate:
❒ Net negative ___ ___ ___ mL/hour for ___ ___ ___ hours.
❒ Keep even for ___ ___ ___ hours.
❒ Net positive ___ ___ ___ mL/hour for ___ ___ ___ hours.

❒ Sliding scale (below):

Parameters: ❒ MAP ❒ PAWP ❒ CVP ❒ Other ______	Suggested Hourly Fluid Target Parameters	OTHER Hourly Fluid Target Parameters
______	+ 200 mL	______
______	+ 150 mL	______
______	+ 100 mL	______
______	+ 50 mL	______
______	EVEN	______
______	- 50 mL	______
______	- 100 mL	______
______	- 150 mL	______
______	- 200 mL	______

Anticoagulant:

18. Regional CITRATE anticoagulation 0.14 molar citrate to run into 3-WAY STOPCOCK at vascular access exit at ___ ___ ___ mL/hour (usually 2 to 3% of BFR; eg: 140-180 mL/hr for a BFR = 100 mL/min) to maintain POST-FILTER IONIZED CALCIUM at 0.25-0.3 mmol/L.
NOTE: Start at lower rate (120 - 140 mL/hr) for patients with hepatic failure.

19. Check POST-FILTER IONIZED CALCIUM at initiation of CRRT and every 4 hours x 24 hours, then every 8 hours x 24 hours, then every 12 hours. Adjust CITRATE flow rate according to sliding scale below. If changes made to citrate drip, recheck postfilter ionized calcium in 2 hours, then every 4 hours for 24 hours if stable.
Citrate Replacement Sliding Scale

Postfilter Ionized Ca	Citrate Flow Rate
<0.25	Decrease by 10 mL/hour (call Renal MD)
0.25 - 0.3	NO CHANGE
0.31 - 0.4	increase by 5 mL/hour
0.41 - 0.45	increase by 10 mL/hour
>0.45	increase by 15 mL/hour (call Renal MD)

Do not decrease citrate rate below ❒ 120 mL/hour ❒ Other ______________
Do not increase citrate rate above ❒ 200 mL/hour ❒ Other ______________

SAMPLE ONLY
NOT FOR OFFICIAL USE

Physician Signature/PID# Date & Time Nurse Signature Date & Time
D1743 (6-08) WHITE - Medical Records YELLOW - Dialysis

UNIVERSITY of CALIFORNIA, SAN DIEGO
MEDICAL CENTER

PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Citrate CRRT
Orders
Page 3 of 3

Patient Identification

PHYSICIAN: Use ball point pen. Check (√) appropriate orders where given choice. Use the metric system when filling in blanks or writing additional orders. To add additional orders after signing and dating this set, use blank Physician's Orders.

20. Calcium chloride solution: 8 g $CaCl_2$ in 1000 mL 0.9% sodium chloride (1080 mL total). To run into CENTRAL LINE at ❒ 40 mL/hour ❒ Other ___________ to maintain PERIPHERAL IONIZED CALCIUM 1.12-1.2 mmol/L.

21. Check PERIPHERAL IONIZED CALCIUM at initiation of CRRT and every 4 hours x 24 hours, then every 8 hours x 24 hours, then every 12 hours. Adjust calcium chloride according to sliding scale below. If changes made to calcium chloride drip, recheck peripheral ionized calcium in 2 hours, then every 4 hours for 24 hours if stable.
Calcium Chloride Sliding Scale

Peripheral Ionized Ca	Calcium Chloride
0.85 - 0.94	increase by 10 mL/hour + 2 g Ca gluconate (call Renal MD)
0.95 - 1.04	increase by 5 mL/hour + 1 g Ca gluconate
1.05 - 1.09	increase by 5 mL/hour
1.10 - 1.2	NO CHANGE
1.21 - 1.3	decrease by 5 mL/hour
1.31 - 1.45	decrease by 10 mL/hour
>1.45	decrease by 15 mL/hour (call Renal MD)

Do not decrease calcium chloride rate below ❒ 30 mL/hour ❒ Other _______ mL/hour.
Do not increase calcium chloride rate above ❒ 80 mL/hour ❒ Other _______ mL/hour.

Labs:

22. HbsAg, HCV at start of therapy times one.

23. Labs to be drawn IN SEQUENCE at **0200** hours:
a. Peripheral: CBC, differential, platelet count, Chem 7, Mg, Ca, PO_4, liver panel, & PT, PTT INR
b. Postfilter: BUN, creatinine.
c. Prefilter (postpump): BUN, creatinine.
d. Ultrafiltrate: BUN, creatinine

24. Labs to be drawn at start of every new filter and at 1400 hours. Same sequence as #23 above.
a. For peripheral labs do: BUN, creatinine, electrolytes, Ca, PO_4.
b. Filter Labs for post, pre, and ultra filtrate (UF) same as 0200.

Additional Orders: Renal MD pager # __________

25. Check blood pressure and fluid loss every 4 hours and notify Renal MD for systolic blood pressure less than ___ ___ ___ mm Hg.
26. Check for line patency and presence of peripheral pulses every 4 hours. Notify Renal MD of problems prn.
27. Special orders:____

SAMPLE ONLY
NOT FOR OFFICIAL USE

Physician Signature/PID# Date & Time Nurse Signature Date & Time
D1743 (6-08) WHITE - Medical Records YELLOW - Dialysis

UCSD Medical Center Citrate CRRT Orders

Solutions and Flow Rate:

11. Blood flow: ❒ 100 mLs/min ❒ Other__________mLs/min (Max: 450 mLs/min)

12. (1B) Dialysate - Base solution: 0.45% NACL

*NaCL	mEq/L
*$NaHCO_3$	mEq/L
KCL	mEq/L
Magnesium Sulfate	mEq/L
Dextrose (0.1-1%)	%
Other 1	
Other 2	

*Total NaCl/HCO3 should equal 40 mEq/L

13.

FLOW RATES	Standard (mLs/hr)	Other (mLs/hr)
(1A) Total Effluent (total of all fluids)	2700	
(1B) Dialysate	1000	
(1C) Post filter (deaereation chamber via replacement pump)	200	
(1D) Pre filter (via Pre Blood Pump)	500	
(3A) Patient fluid removal (Max 2000 mLs/hr)	1000	

( ) refers to form D6037

14. (1C) Post filter: ❒ Normal Saline ❒ Other: ______________________________

15. (1D) Pre filter: ❒ Normal Saline ❒ Other: ______________________________

UCSD Medical Center Citrate CRRT Orders

14. Replacement fluid composition: ❒ 0.9% sodium chloride

❒ Other 1: ______________________ ❒ Other 2: ______________________

15. Replacement fluid flow rates: Choose **one** method below to maintain net fluid balance:

❒ Set hourly fluid removal rate:

❒ Net negative ___ ___ ___ mL/hour for ___ ___ ___ hours.

❒ Keep even for ___ ___ ___ hours.

❒ Net positive ___ ___ ___ mL/hour for ___ ___ ___ hours.

❒ Sliding scale (below):

Parameters: ○ MAP ○ PAWP ○ CVP ○ Other ________	Suggested Hourly Fluid Target Parameters	OTHER Hourly Fluid Target Parameters
________	+ 200 mL	________
________	+ 150 mL	________
________	+ 100 mL	________
________	+ 50 mL	________
________	EVEN	________
________	- 50 mL	________
________	- 100 mL	________
________	- 150 mL	________
________	- 200 mL	________

NOTE: For all machines other than PRISMA: infuse fluid into replacement fluid line (prefilter, postpump).
For PRISMA: give replacement fluid postfilter via venous return line.

UCSD Medical Center CRRT Flowsheet

UCSD Medical Center

CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT) FLOWSHEET

Name
MR#
DOB

RN INITIALS	SIGNATURE	RN INITIALS	SIGNATURE	DATE	Source	Date

Patient Identification

TIME		0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	12 hour total	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	12 hour total
1A	EFFLUENT (TOTAL OF ALL FLUIDS)																										
1B	PRE ILTER DILUTION SOLUTION (INTERNAL PUMP)																										
1C	DIALYSATE INFUSED																										
1D	PATIENT FLUID REMOVAL (UF)																										
2	ADDITIONAL OUTPUT (URINE, NG, CHEST TUBES, DRAINS)																										
3 (1D+2)	TOTAL OUTPUT																										
4A	ALL INTAKE: IV, PO, etc. EXCEPT REPLACEMENT																										
4B	PRE FILTER DILUATION SOLUTION (EXTERNAL PUMP)																										
4C	= 4A+B																										
5 (3-4C)	HOURLY FLUID BALANCE																										
6-MD ORDER	DESIRED OUTCOME (+ OR -)																										
7 (6-5)	PATIENT FLUID REPLACEMENT GIVEN																										
8 (5+7)	ACTUAL NET FLUID BALANCE																										
	CVP PAWP MAP																										
	ACCURA PRISMA BRAUN																										
	ACCESS ACCESS PRESSURE PA																										
	PREFILTER FILTER PRESSURE PBE																										
	FILTRATE EFFLUENT PRESSURE PD2																										
	RETURN RETURN PRESSURE PV																										
	BLOOD FLOW / CONNECTIONS CHECK																										
	IONIZED CALCIUM - PERIPHERAL																										
	IONIZED CALCIUM - POST																										
	CITRATE FLOW / CALCIUM CHLORIDE FLOW																										
	RN INITIALS																										

D6037(12-04)

UCSD Medical Center CRRT Flowsheet

RN INITIALS	SIGNATURE	RN INITIALS	SIGNATURE	DATE

TIME				0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	12 hour total
1A	EFFLUENT (TOTAL OF ALL FLUIDS)															
1B	PRE ILTER DILUTION SOLUTION (INTERNAL PUMP)															
1C	DIALYSATE INFUSED															
1D	PATIENT FLUID REMOVAL (UF)															
2	ADDITIONAL OUTPUT (URINE, NG, CHEST TUBES, DRAINS)															
3 (1D+2)	TOTAL OUTPUT															
4A	ALL INTAKE: IV, PO, etc. EXCEPT REPLACEMENT															
4B	PRE FILTER DILUATION SOLUTION (EXTERNAL PUMP)															
4C	= 4A+B															
5 (3-4C)	HOURLY FLUID BALANCE															
6-MD ORDER	DESIRED OUTCOME (+ OR -)															
7 (6-5)	PATIENT FLUID REPLACEMENT GIVEN															
8 (5+7)	ACTUAL NET FLUID BALANCE															
	CVP	PAWP	MAP													
	ACCURA	PRISMA	BRAUN													
	ACCESS	ACCESS PRESSURE	P A													
	PREFILTER	FILTER PRESSURE	P B E													
	FILTRATE	EFFLUENT PRESSURE	P D 2													
	RETURN	RETURN PRESSURE	P V													
	BLOOD FLOW / CONNECTIONS CHECK															
	IONIZED CALCIUM - PERIPHERAL															
	IONIZED CALCIUM - POST															
	CITRATE FLOW / CALCIUM CHLORIDE FLOW															
	RN INITIALS															

UCSD Medical Center

CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT) FLOWSHEET

Name
MR#
DOB

RN INITIALS	SIGNATURE	RN INITIALS	SIGNATURE	DATE	Source	Date

Patient Identification

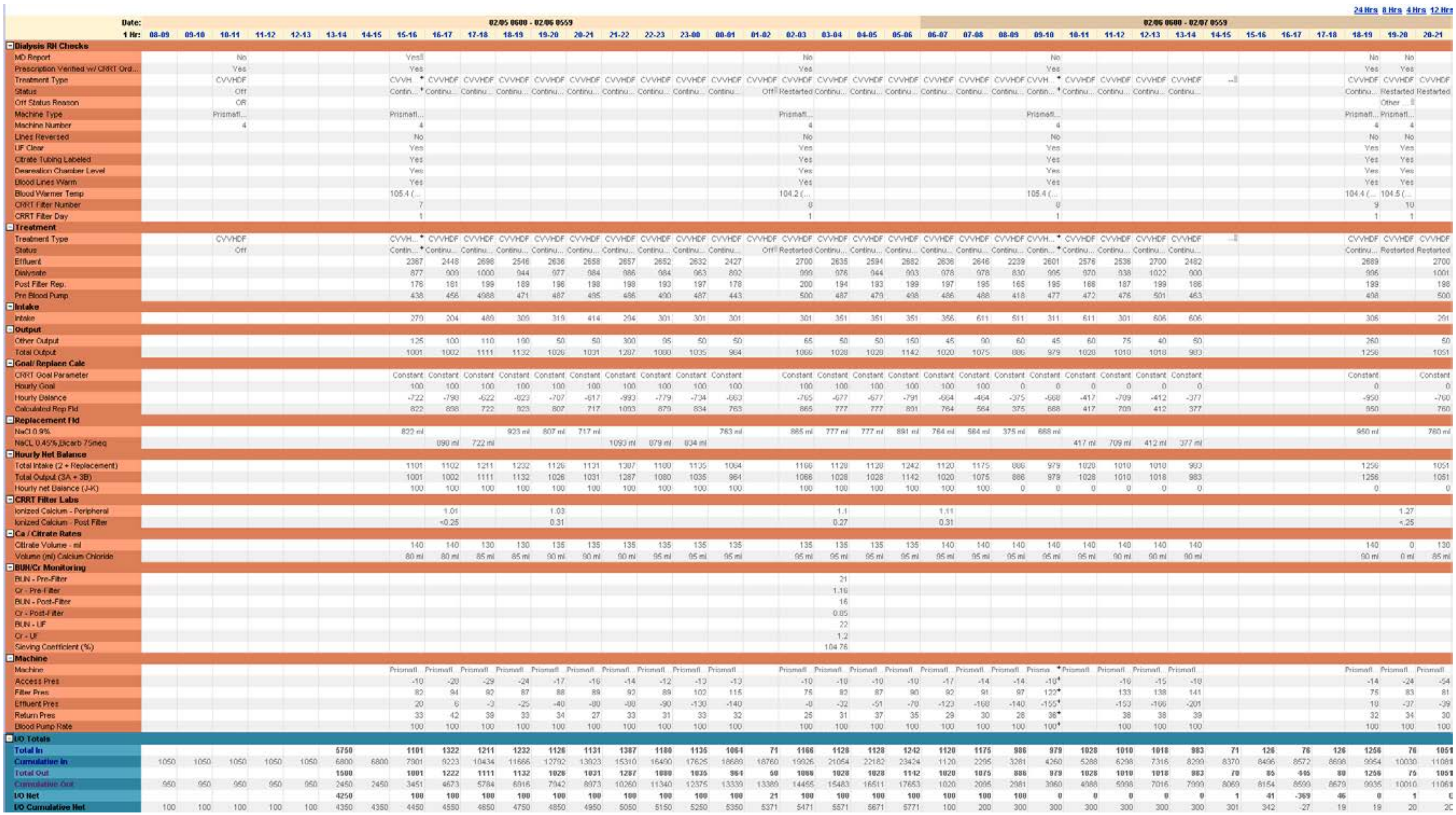
	TIME	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	12 hour total
1A	EFFLUENT (TOTAL OF ALL FLUIDS)	2348	2415	2416	2501	2264		2126	2264	2416	2277	2322	2500	
1B	PRE FILTER DILUTION SOLUTION (INTERNAL PUMP)	470	480	458	502	454	CLOTTED	424	456	484	446	468	503	
1C	DIALYSATE INFUSED	935	961	921	1000	909		853	907	966	906	932	1001	
1D	PATIENT FLUID REMOVAL (UF)	940	974	919	999	901		849	901	964	925	922	996	
2	ADDITIONAL OUTPUT (URINE, NG, CHEST TUBES, DRAINS)	15	10	15	8	8		0	0	22	9	13	14	
3 (1D+2)	TOTAL OUTPUT	955	984	934	1007	909	OFF	849	901	986	934	935	1010	10404
4A	ALL INTAKE: IV, PO, etc. EXCEPT REPLACEMENT	253	318	318	320	220		948	351	428	382	372	570	
4B	PRE FILTER DILUTION SOLUTION (EXTERNAL PUMP)	X	X	X	X	X	X	X	X	X	X	X	X	
4C	= 4A+B TOTAL INTAKE	253	318	318	320	220		948	351	428	382	372	570	4480
5 (3-4C)	HOURLY FLUID BALANCE TOTAL	-702	-666	+616	-687	-689		+99	+550	-558	-552	-563	-440	
6-MD ORDER	DESIRED OUTCOME (+ OR -)	EVEN	EVEN	EVEN	EVEN	-200		EVEN	-150	-200	-200	-200	-200	-1150
7 (6-5)	PATIENT FLUID REPLACEMENT GIVEN	702	666	616	687	889		0	-700	-758	-752	-763	-640	-7173
8 (5+7)	ACTUAL NET FLUID BALANCE	EVEN	EVEN	EVEN	EVEN	-200		EVEN	-150	-200	-200	-200	-200	
	~~CVP~~ ~~PAWP~~ SBP MAP	97	97	98	99	159	CVP 14 BPS	102	CVP 18	CVP 20	CVP 20	CVP 19	CVP 21	
	ACCURA / PRISMA / BRAUN	PF	PF	PF	Flex Prisma	PRISMA FLEX		PRISMA FLEX	PRISMA FLEX	PRISMA FLEX	PRISMA FLEX	PRISMA FLEX	PRISMA FLEX	
	ACCESS — ACCESS PRESSURE — PA	0	-2	-6	-3	-7	Filter Blood	-5	-2	2	0	-1	-2	
	PREFILTER — FILTER PRESSURE — PBE	98	99	110	110	128		111	101	104	101	105	102	
	FILTRATE — EFFLUENT PRESSURE — PD2	-114	-114	-120	-133	-158	Ad	-10	-17	-11	-7	-3	-14	
	RETURN — RETURN PRESSURE — PV	39	40	42	43	43		39	41	48	42	42	42	
	BLOOD FLOW / CONNECTIONS CHECK	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓		100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	
	IONIZED CALCIUM - PERIPHERAL													
	IONIZED CALCIUM - POST													
	CITRATE FLOW / CALCIUM CHLORIDE FLOW	155 / 70	155 / 90	155 / 90	155 / 90	155 / 90		155 / 90	155 / 90	155 / 90	155 / 90	160 / 85	160 / 85	
	RN INITIALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

+99

	TIME	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	12 hour total
1A	EFFLUENT (TOTAL OF ALL FLUIDS)	2086	3499	2278	2224	2024	2500	3196	3500	2421	2416	2522	2226	
1B	PRE FILTER DILUTION SOLUTION (INTERNAL PUMP)	416	498	457	444	414	496	432	501	467	485	467	467	
1C	DIALYSATE INFUSED	833	1000	908	877	809	999	880	996	975	965	944	902	
1D	PATIENT FLUID REMOVAL (UF)	831	1001	923	883	801	1005	878	1006	967	966	945	907	
2	ADDITIONAL OUTPUT (URINE, NG, CHEST TUBES, DRAINS)	7	5	7	30	40	15	17	5	35	30	15	15	
3 (1D+2)	TOTAL OUTPUT	838	1006	930	913	841	1020	895	1011	1002	996	960	922	11,334
4A	ALL INTAKE: IV, PO, etc. EXCEPT REPLACEMENT	468	373	343	328	328	378	318	~~255~~ 340	315	320	320	372	4,203.
4B	PRE FILTER DILUTION SOLUTION (EXTERNAL PUMP)	X	X	X	X	X	X	X	X	X	X	X	X	X
4C	= 4A+B TOTAL INTAKE	468	373	343	328	328	378	318	340	315	320	320	372	4203
5 (3-4C)	HOURLY FLUID BALANCE TOTAL	+370	-633	587	585	513	642	577	671	687	676	640	550	
6-MD ORDER	DESIRED OUTCOME (+ OR -)	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-2400
7 (6-5)	PATIENT FLUID REPLACEMENT GIVEN	-570	-833	-787	785	713	842	777	-871	887	876	840	750	9531
8 (5+7)	ACTUAL NET FLUID BALANCE	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-2400
	~~CVP~~ ~~PAWP~~ SBP MAP	CVP 20	21	23	21	21	21	22	21	23	21	21	22	
	ACCURA / PRISMA / BRAUN	PRISMA FLEX	FLEX	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	ACCESS — ACCESS PRESSURE — PA	0	-3	-24	-31	-54	-64	-52	-77	-67	-75	-57	-47	
	PREFILTER — FILTER PRESSURE — PBE	102	103	106	114	103	114	114	111	116	113	110	118	
	FILTRATE — EFFLUENT PRESSURE — PD2	-75	-12	-12	-97	-22	-31	-21	-29	-21	-26	-36	-29	
	RETURN — RETURN PRESSURE — PV	47	49	44	44	43	42	51	46	51	50	49	43	
	BLOOD FLOW / CONNECTIONS CHECK	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	100 / ✓	
	IONIZED CALCIUM - PERIPHERAL	1.36				1.32			1.07					
	IONIZED CALCIUM - POST	0.30				0.28			0.26					
	CITRATE FLOW / CALCIUM CHLORIDE FLOW	160 / 85	160 / 75	160 / 75	160 / 75	160 / 75	160 / 75	160 / 65	160 / 65	160 / 70	160 / 70	160 / 70	160 / 70	
	RN INITIALS	[illegible]	MK	MK	MK	MK	MK	MK	MK	MK	MK	MK	MK	

D6037(12-04)

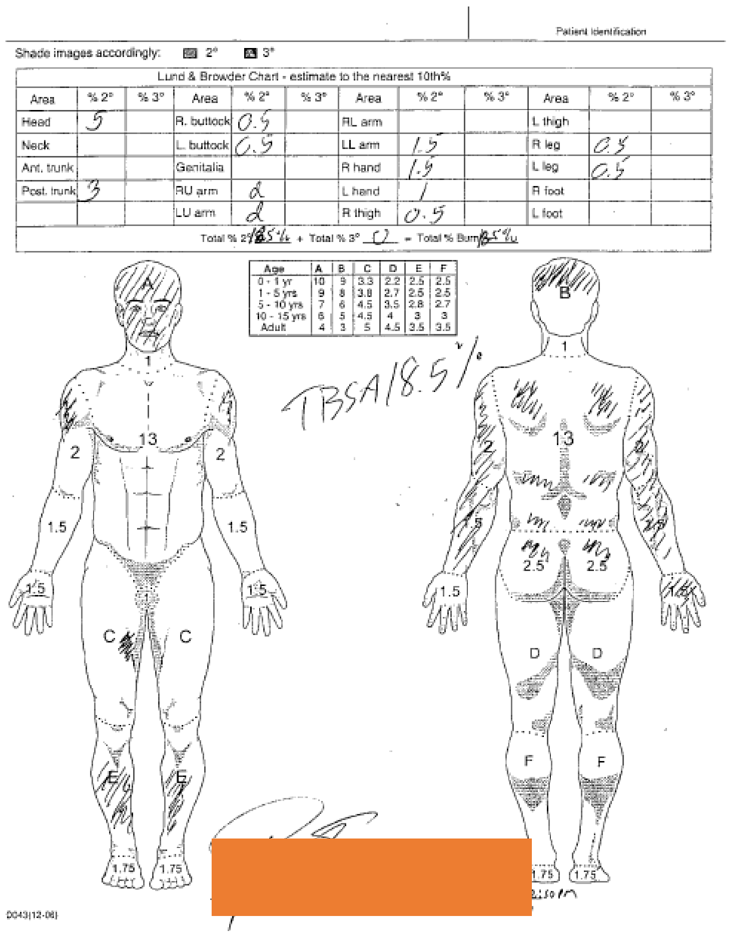
CRRT Flow sheets in EMR



Case Study

- 74 yo HF was admitted with 25% total body surface area burns in a structure fire, smoke inhalation.
- She was in the structure fire for unknown time, her husband died in the fire.
- She has burn injury to face, dorsum of both arms and legs.
- She received large volume resuscitation and is about 40 L + since admission
- She is intubated and sedated in the burn unit on a fentanyl and versed drip
- HR 90, BP 135/80 , Temp 99, FiO2 70%
- Burns on face, back, arms
- S1S2, Lungs bilateral diffuse rhonchi
- Abdomen obese marked edema and bowel sounds present
- Legs marked edema to thighs
- Labs: Sodium 146, Potassium 4, Chloride 109, Bicarb 35, BUN 18, Creatinine 0.54, Glucose 154, Calcium 8.6
- WBC 9.7, hemoglobin 9, platelet 144

Case Study



Patient Identification

Shade images accordingly: 2° 3°

Lund & Browder Chart - estimate to the nearest 10th%											
Area	% 2°	% 3°	Area	% 2°	% 3°	Area	% 2°	% 3°	Area	% 2°	% 3°
Head	5		R. buttock	0.5		RL arm			L thigh		
Neck			L. buttock	0.5		LL arm	1.5		R leg	0.5	
Ant. trunk			Genitalia			R hand	1.5		L leg	0.5	
Post. trunk	3		RU arm	2		L hand	1		R foot		
			LU arm	2		R thigh	0.5		L foot		

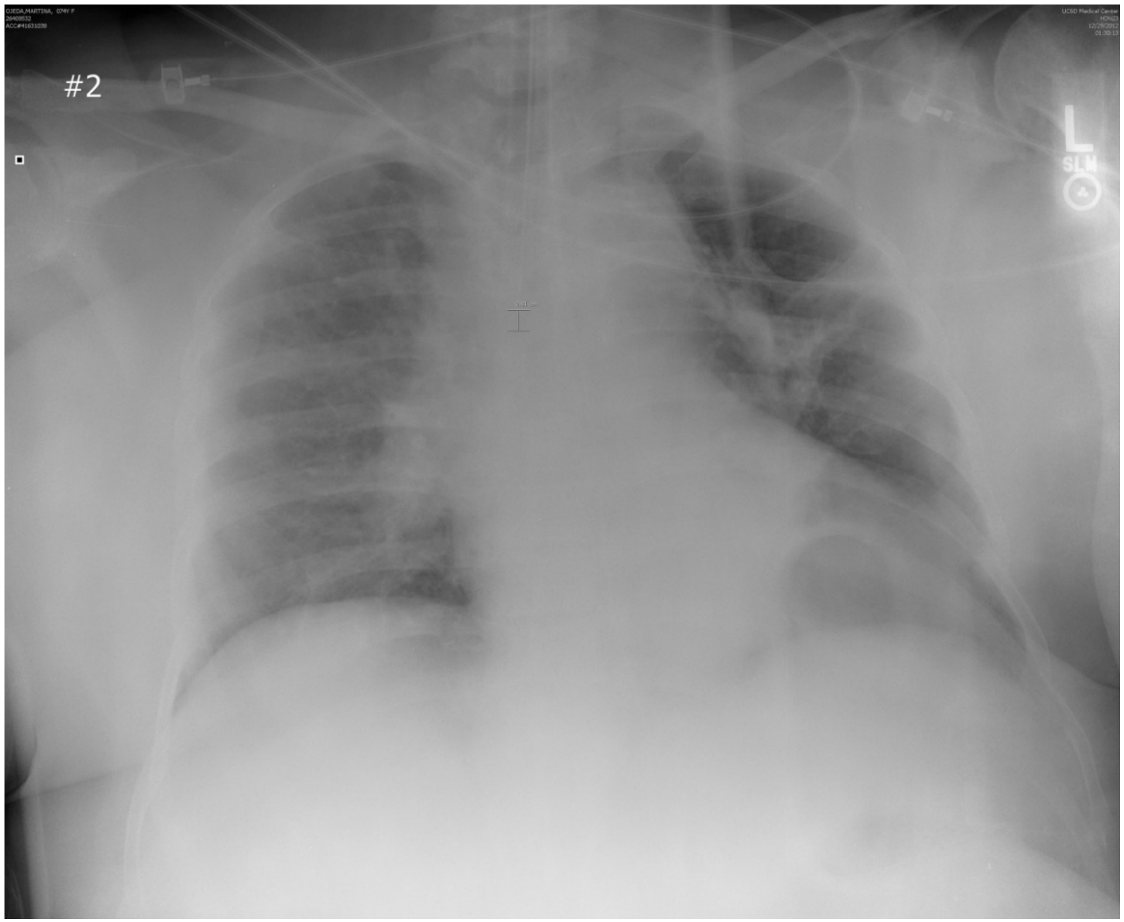
Total % 2° 18.5% + Total % 3° 0 = Total % Burn 18.5%

Age	A	B	C	D	E	F
0 - 1 yr	10	9	3.3	2.2	2.5	2.5
1 - 5 yrs	9	8	3.8	2.7	2.5	2.5
5 - 10 yrs	7	6	4.5	3.5	2.8	2.7
10 - 15 yrs	6	5	4.5	4	3	3
Adult	4	3	5	4.5	3.5	3.5

TBSA 18.5%

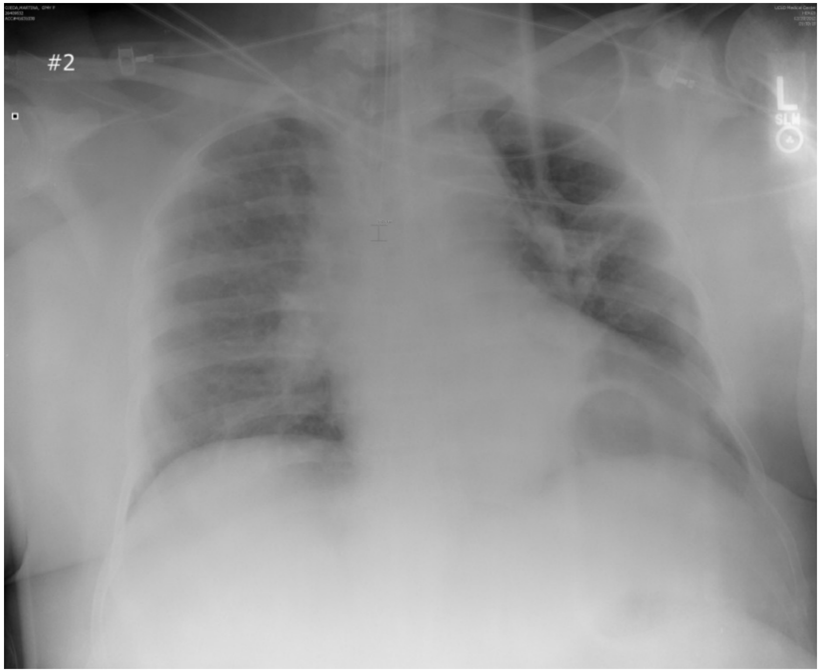
D043(12-08)

Case Study

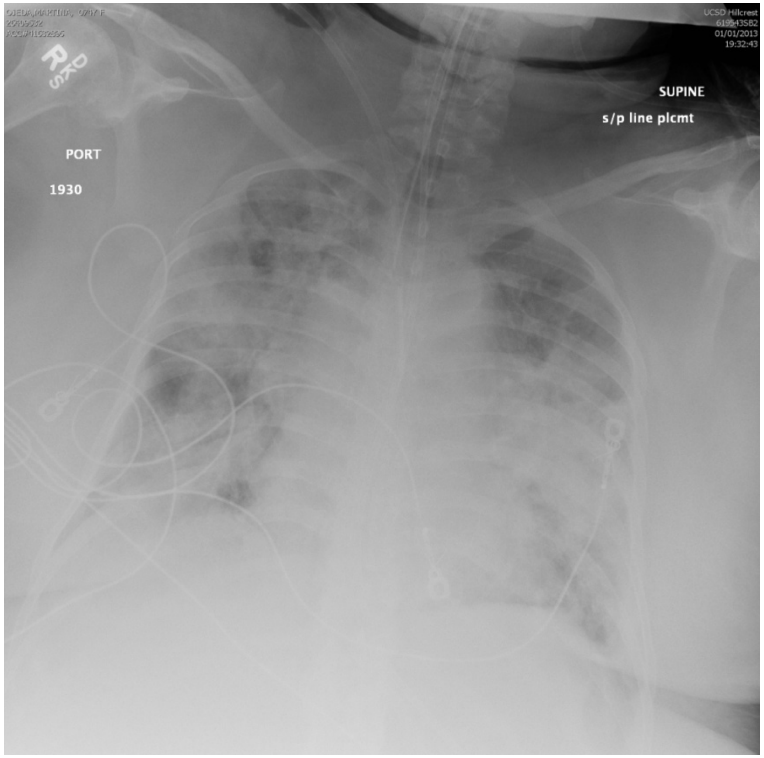


Case Study

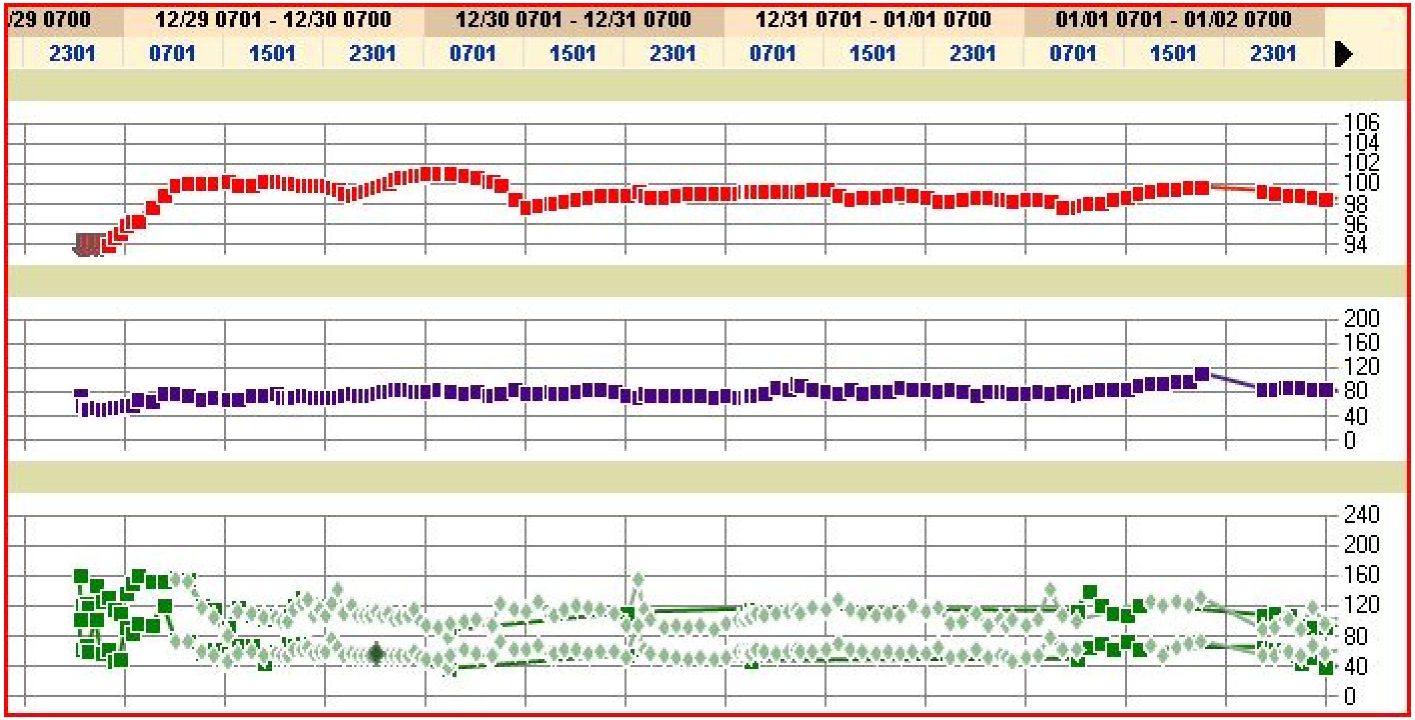
Dec 29



Jan 1



Case Study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12/29 0701 - 12/30 0700
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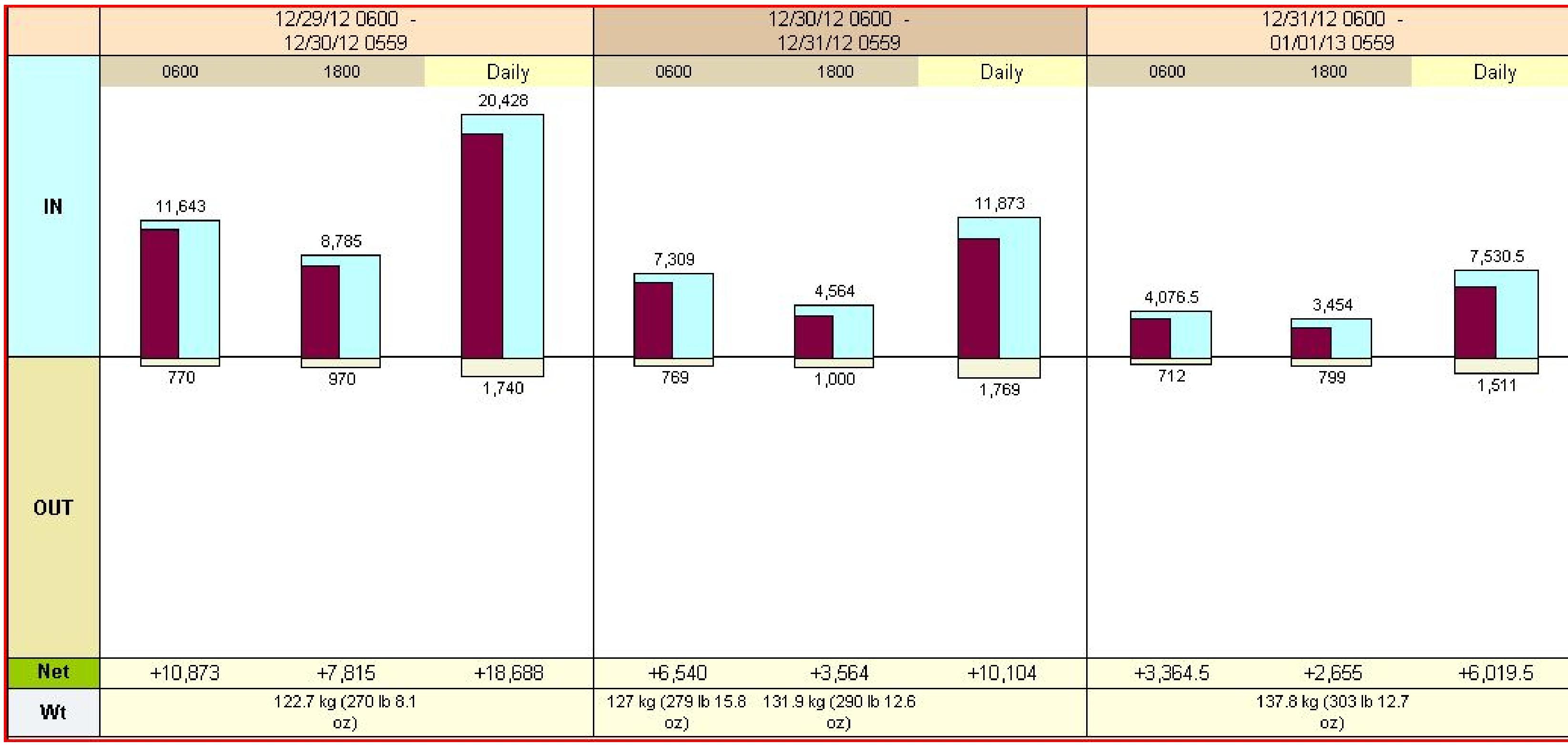
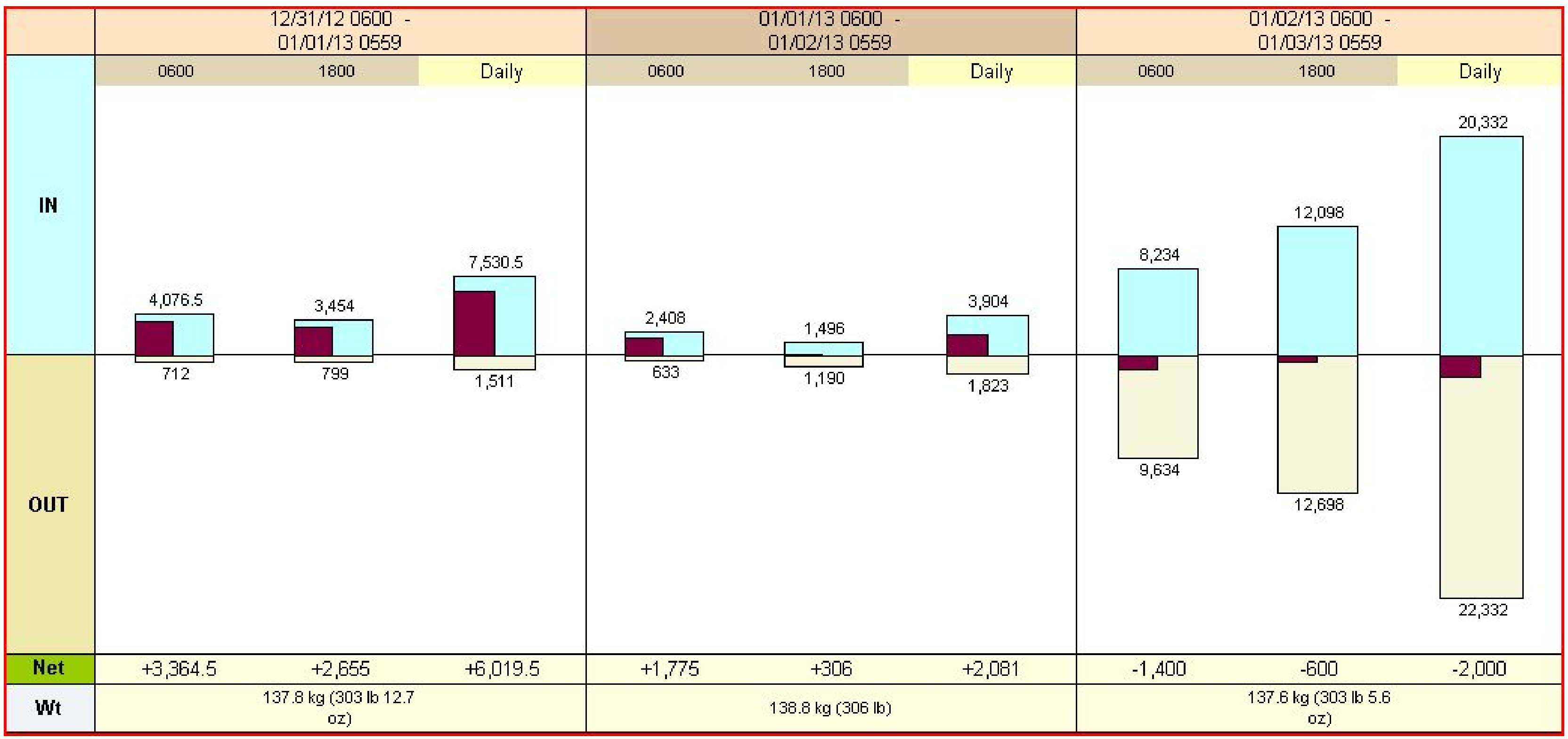
12/31 0701 - 01/01 0700
01/01 0701 - 01/02 0700
2301
0701
1501
2301
0701
1501
2301
0701
1501
2301
0701
1501
2301
106
104
102
100
98
96
94
200
160
120
80
40
0
240
200
160
120
80
40
0

Case Study



12/29/12 0600 - 12/30/12 0559
12/30/12 0600 - 12/31/12 0559
12/31/12 0600 - 01/01/13 0559
0600
1800
Daily
IN
OUT
11,643
8,785
20,428
7,309
4,564
11,873
4,076.5
3,454
7,530.5
770
970
1,740
769
1,000
1,769
712
799
1,511
Net
+10,873
+7,815
+18,688
+6,540
+3,564
+10,104
+3,364.5
+2,655
+6,019.5
Wt
122.7 kg (270 lb 8.1 oz)
127 kg (279 lb 15.8 oz)
131.9 kg (290 lb 12.6 oz)
137.8 kg (303 lb 12.7 oz)

Case Study

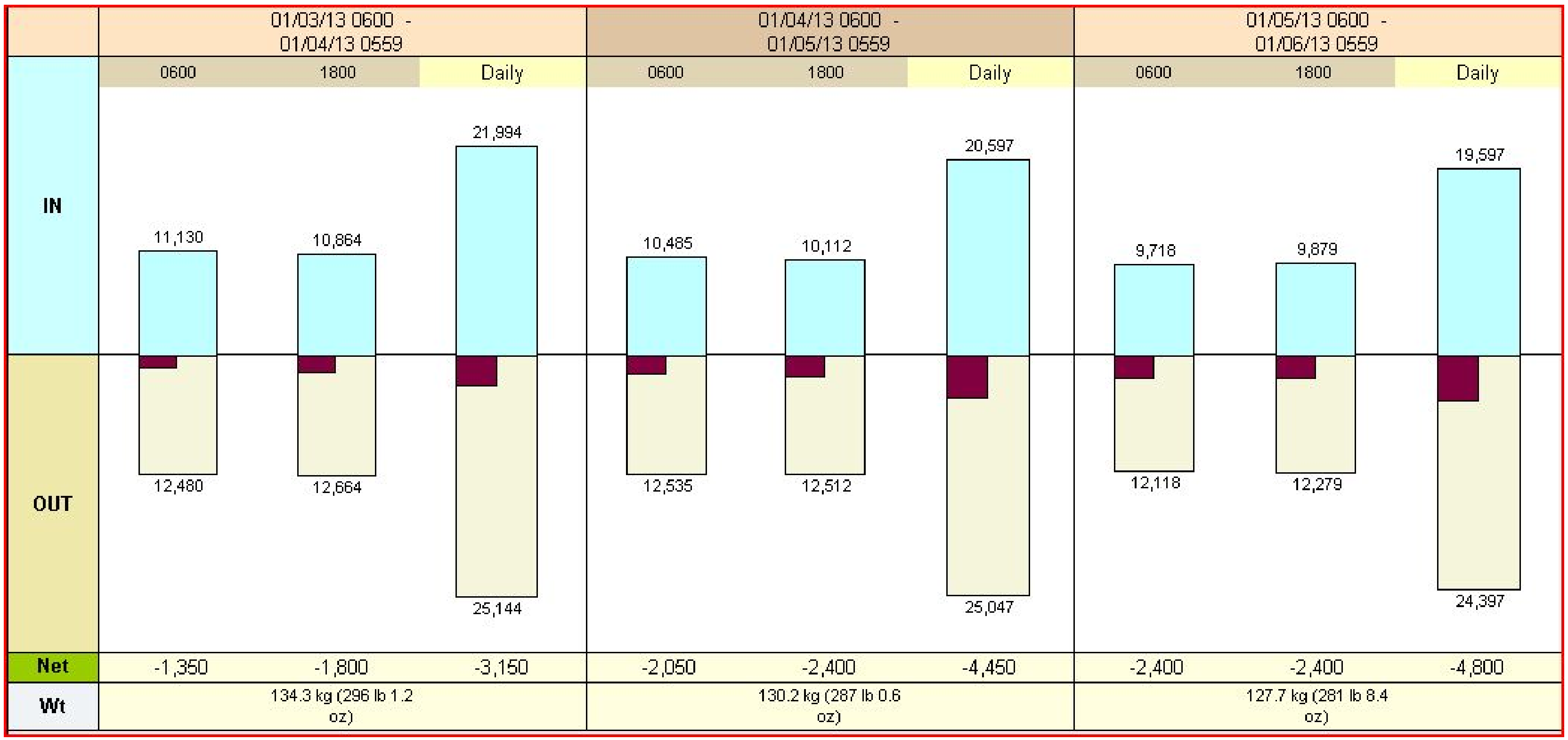


12/31/12 0600 - 01/01/13 0559
01/01/13 0600 - 01/02/13 0559
01/02/13 0600 - 01/03/13 0559
0600
1800
Daily
0600
1800
Daily
0600
1800
Daily
IN
OUT
4,076.5
3,454
7,530.5
2,408
1,496
3,904
8,234
12,098
20,332
712
799
1,511
633
1,190
1,823
9,634
12,698
22,332
Net
+3,364.5
+2,655
+6,019.5
+1,775
+306
+2,081
-1,400
-600
-2,000
Wt
137.8 kg (303 lb 12.7 oz)
138.8 kg (306 lb)
137.6 kg (303 lb 5.6 oz)

Case Study

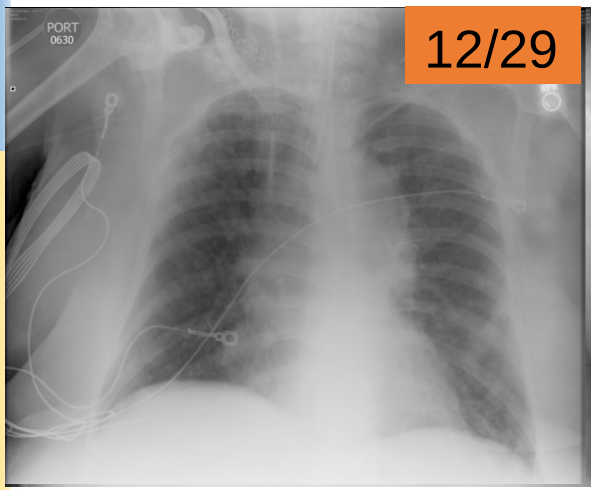
Graph (12/29/12 0130 - 2/11/13 0215)
Creatinine
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0130 12/29/12
2051 1/6/13
1612 1/15/13
1133 1/24/13
0654 2/2/13

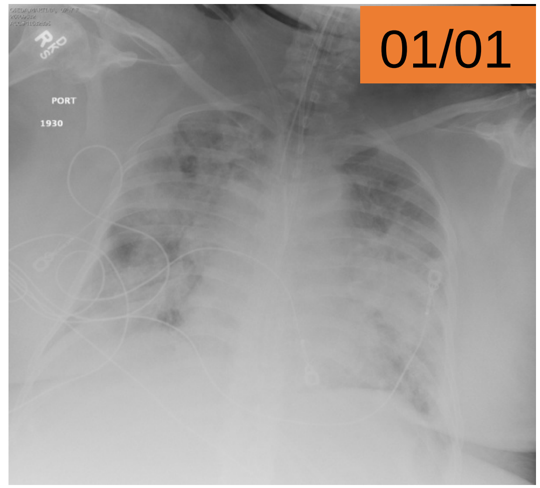
Case Study

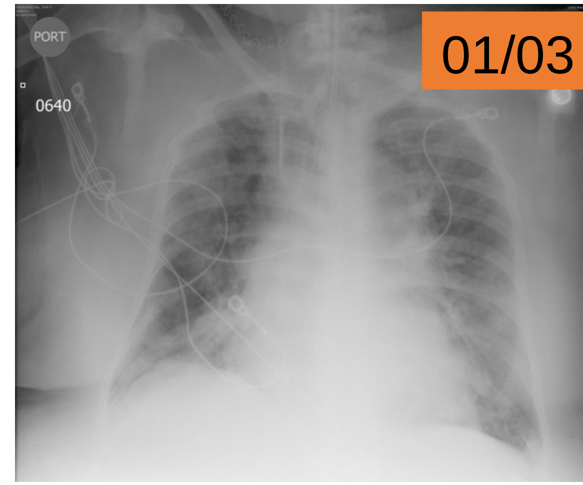


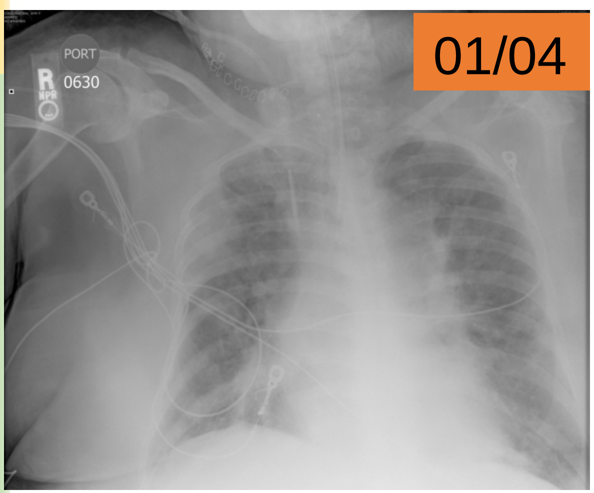
01/03/13 0600 -
01/04/13 0559
01/04/13 0600 -
01/05/13 0559
01/05/13 0600 -
01/06/13 0559
0600
1800
Daily
0600
1800
Daily
0600
1800
Daily
IN
OUT
11,130
10,864
21,994
10,485
10,112
20,597
9,718
9,879
19,597
12,480
12,664
25,144
12,535
12,512
25,047
12,118
12,279
24,397
Net
-1,350
-1,800
-3,150
-2,050
-2,400
-4,450
-2,400
-2,400
-4,800
Wt
134.3 kg (296 lb 1.2 oz)
130.2 kg (287 lb 0.6 oz)
127.7 kg (281 lb 8.4 oz)

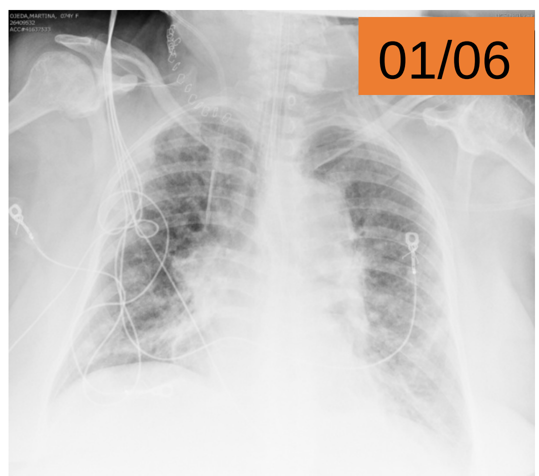
Case Study

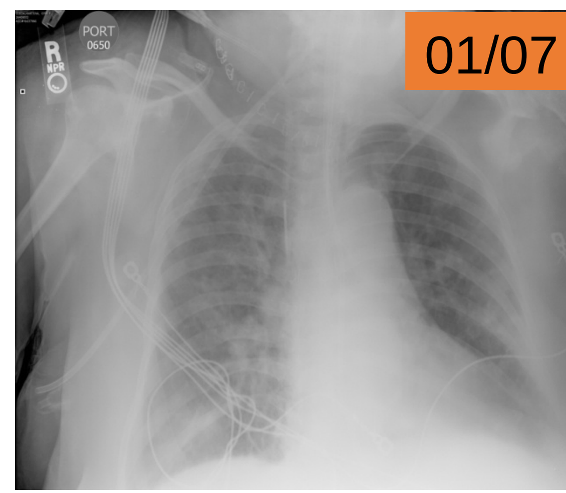

12/29
PORT
0630


01/01
PORT
1930

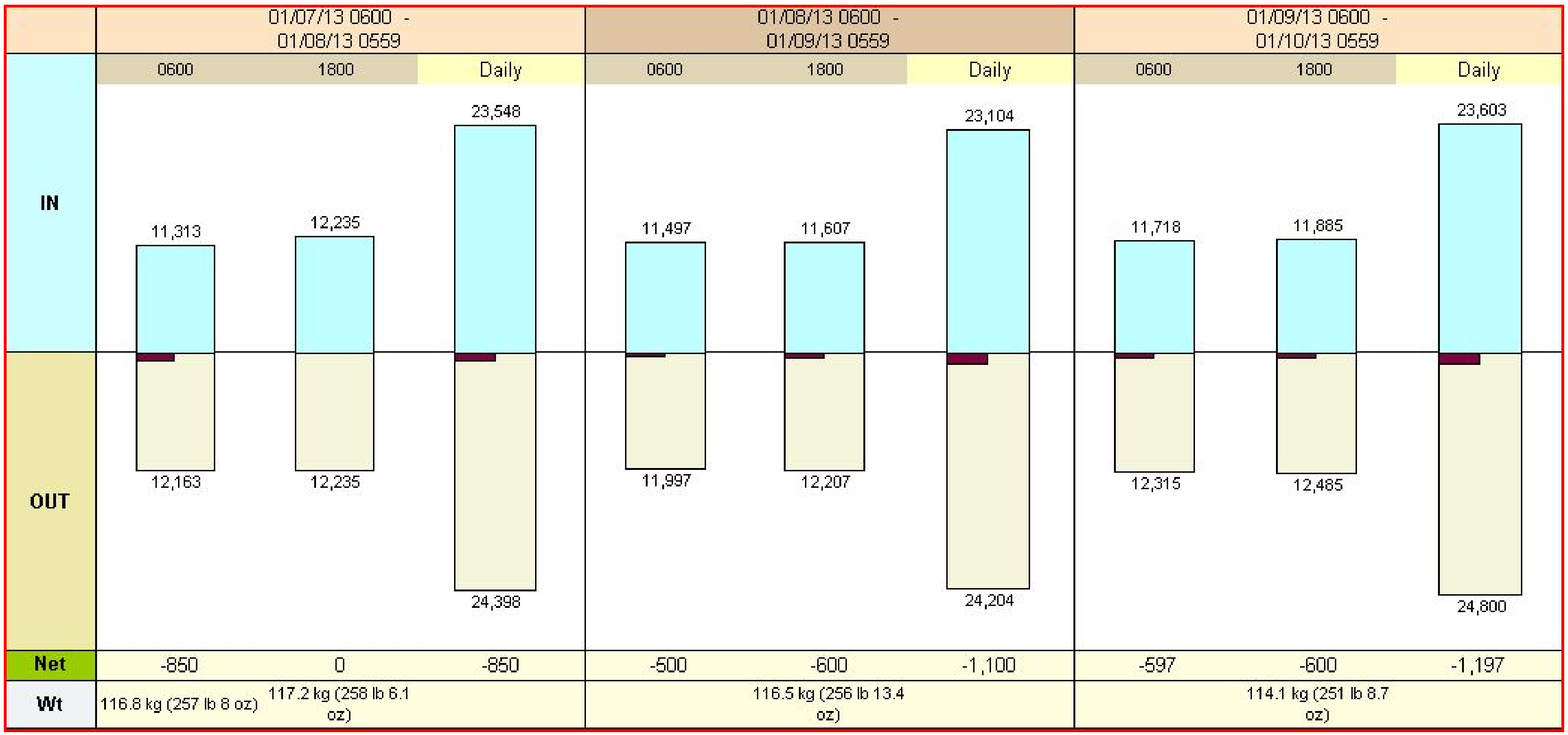

01/03
PORT
0640


01/04
PORT
0630

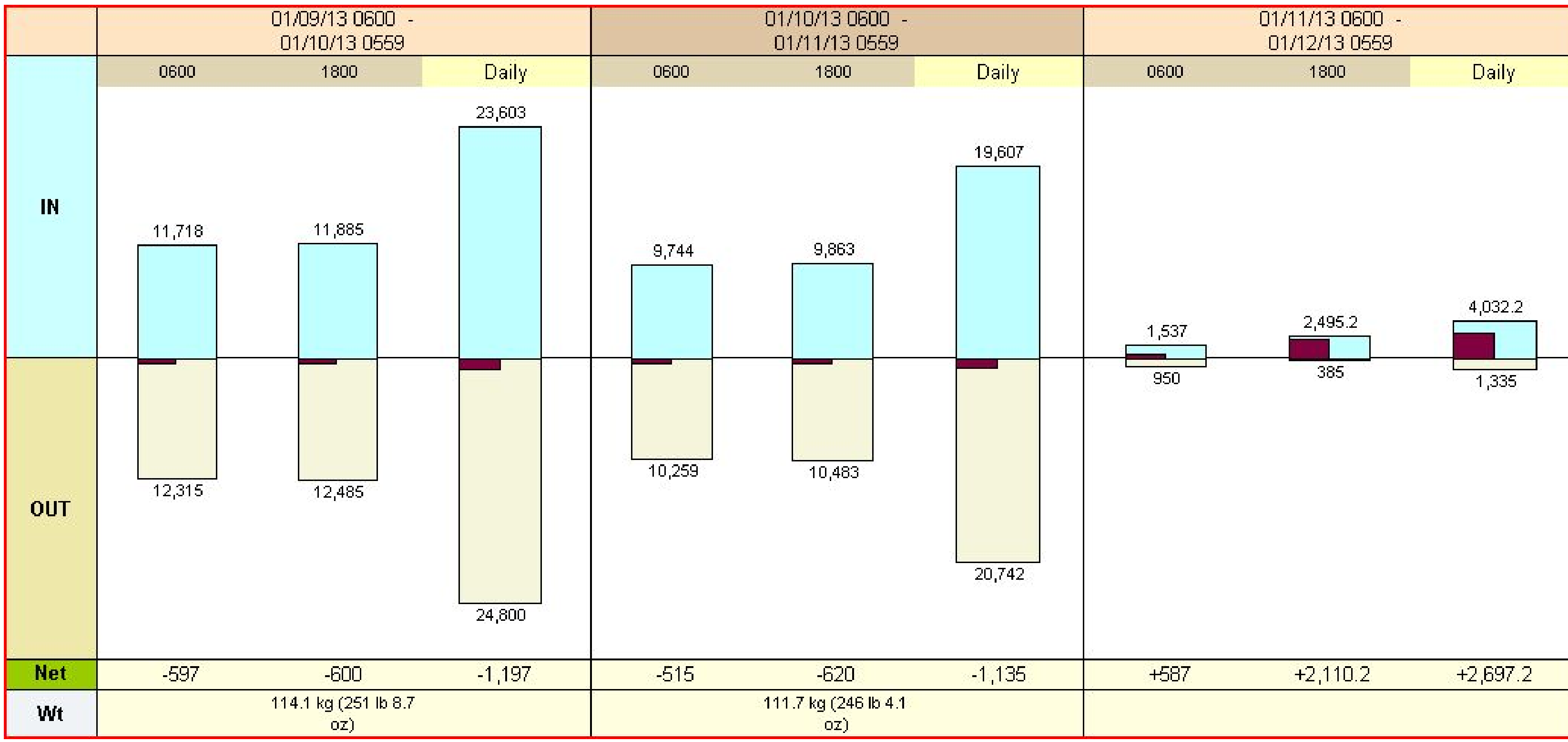

01/06


01/07
PORT
0650

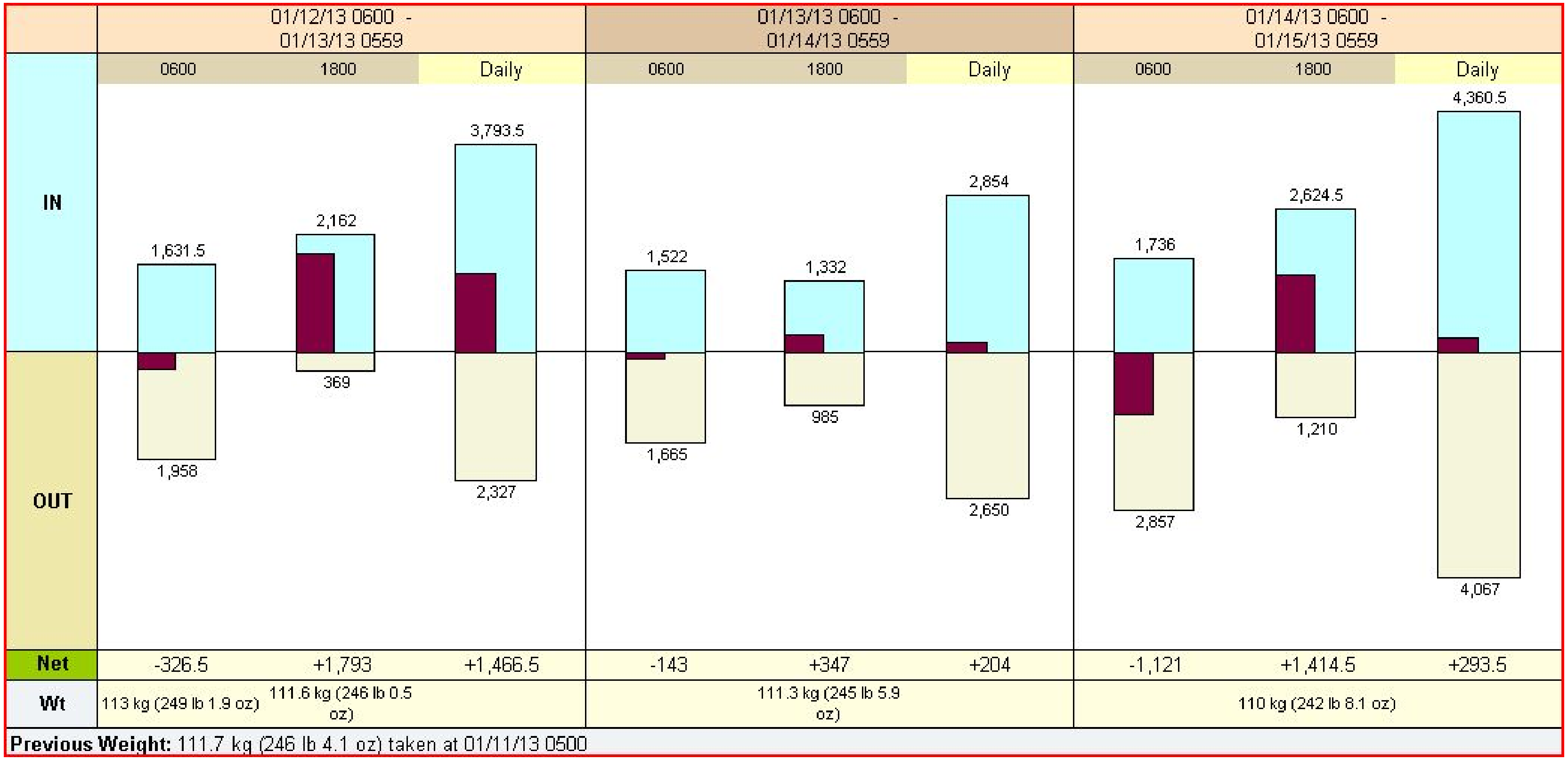
Case Study


01/07/13 0600 - 01/08/13 0559
01/08/13 0600 - 01/09/13 0559
01/09/13 0600 - 01/10/13 0559
0600
1800
Daily
0600
1800
Daily
0600
1800
Daily
IN
11,313
12,235
23,548
11,497
11,607
23,104
11,718
11,885
23,603
OUT
12,163
12,235
24,398
11,997
12,207
24,204
12,315
12,485
24,800
Net
-850
0
-850
-500
-600
-1,100
-597
-600
-1,197
Wt
116.8 kg (257 lb 8 oz)
117.2 kg (258 lb 6.1 oz)
116.5 kg (256 lb 13.4 oz)
114.1 kg (251 lb 8.7 oz)

Case Study

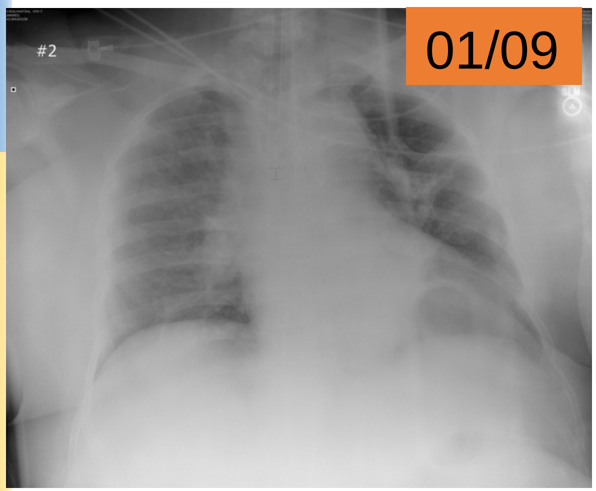

01/09/13 0600 - 01/10/13 0559
01/10/13 0600 - 01/11/13 0559
01/11/13 0600 - 01/12/13 0559
0600
1800
Daily
IN
OUT
11,718
11,885
23,603
12,315
12,485
24,800
9,744
9,863
19,607
10,259
10,483
20,742
1,537
2,495.2
4,032.2
950
385
1,335
Net
-597
-600
-1,197
-515
-620
-1,135
+587
+2,110.2
+2,697.2
Wt
114.1 kg (251 lb 8.7 oz)
111.7 kg (246 lb 4.1 oz)

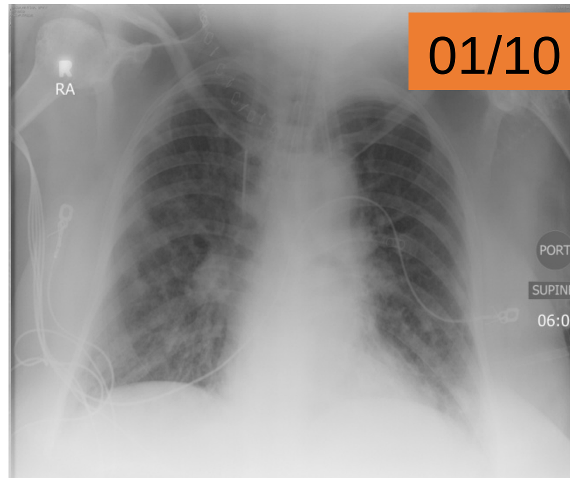
Case Study

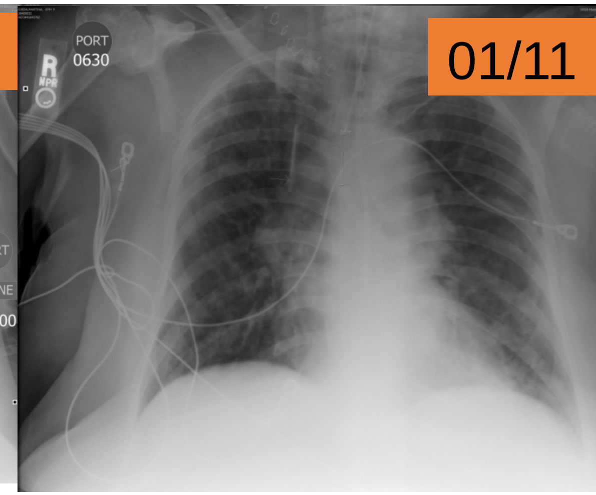


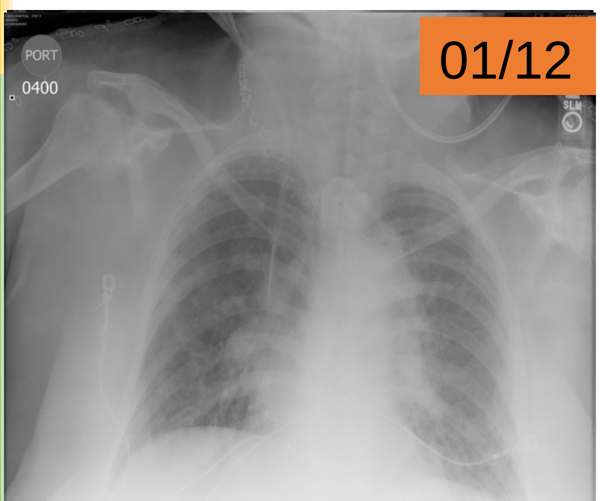
01/12/13 0600 - 01/13/13 0559
01/13/13 0600 - 01/14/13 0559
01/14/13 0600 - 01/15/13 0559
0600
1800
Daily
IN
OUT
1,631.5
2,162
3,793.5
1,522
1,332
2,854
1,736
2,624.5
4,360.5
1,958
369
2,327
1,665
985
2,650
2,857
1,210
4,067
Net
-326.5
+1,793
+1,466.5
-143
+347
+204
-1,121
+1,414.5
+293.5
Wt
113 kg (249 lb 1.9 oz)
111.6 kg (246 lb 0.5 oz)
111.3 kg (245 lb 5.9 oz)
110 kg (242 lb 8.1 oz)
Previous Weight: 111.7 kg (246 lb 4.1 oz) taken at 01/11/13 0500

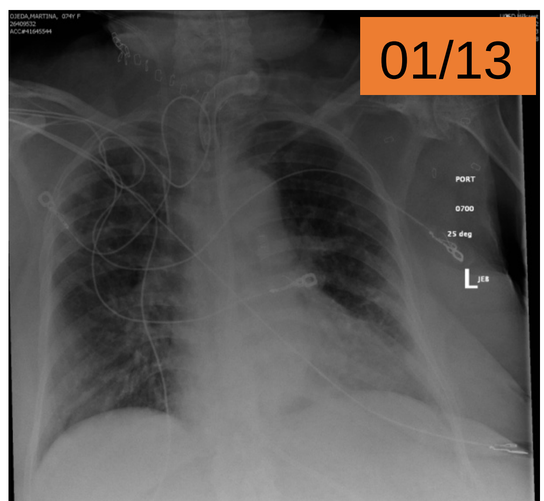
Case Study

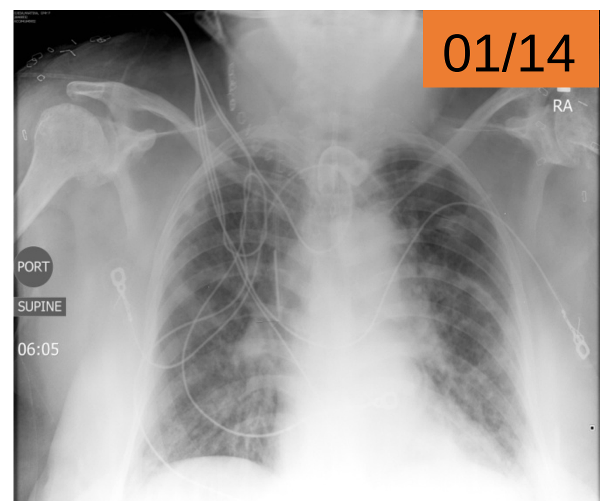

01/09
#2


01/10
RA
PORT
SUPINE
06:00

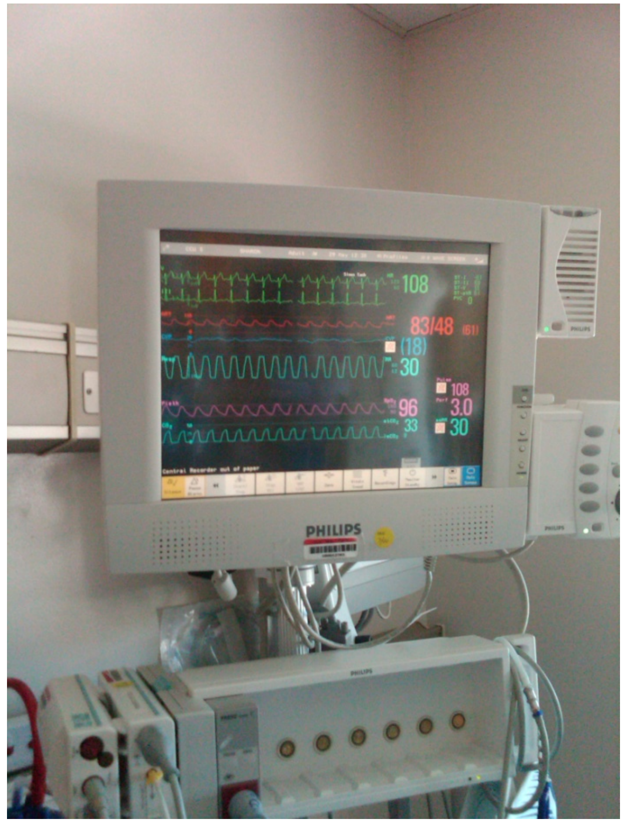

01/11
PORT
0630


01/12
PORT
0400

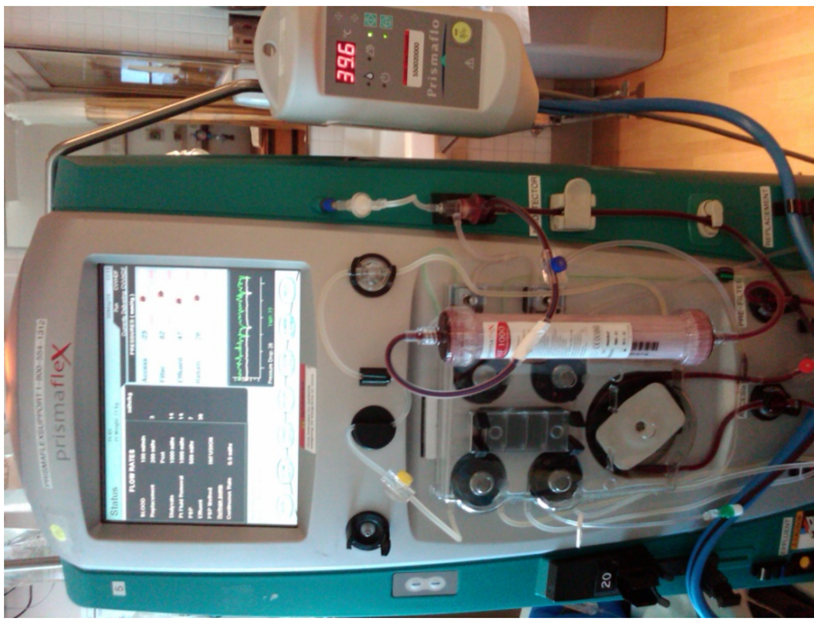

01/13
PORT
0700
25 deg


01/14
RA
PORT
SUPINE
06:05

SVV to Guide Fluid Management in CRRT



SVV to Guide Fluid Management in CRRT



Fluid Management with CRRT

Summary

- Fluid management is an important and integral part of renal support with dialysis
- Wide variation in current approach to fluid management with dialysis
- CRRT techniques can be adapted to achieve any given fluid balance and tailor the therapy to patient needs dynamically