UMMC CRRT 2018

Active UMMC Protocols

1. **Standard CRRT Protocol** → **PrismaFlex & NxStage**
   - CVVH with Fixed Ratio Regional Citrate Anticoagulation
2. **No Anticoagulation Protocol** → **PrismaFlex & NxStage**
   - CVVH with No Anticoagulation

CRRT Support Protocols:

- CRRT Lab Protocol
- CRRT Antibiotic Dosing Protocol (Critical Care Pharmacy)
- Heparin Prime Protocol
- IV Magnesium Replacement Protocol

Pending Protocols and Protocols under Development

- IV Calcium Chloride/Gluconate Replacement Titration Protocol
- IV Phosphorous Replacement Titration Protocol
- CRRT Nutrition support Protocol
- Others

UMMC CRRT Protocols 2018

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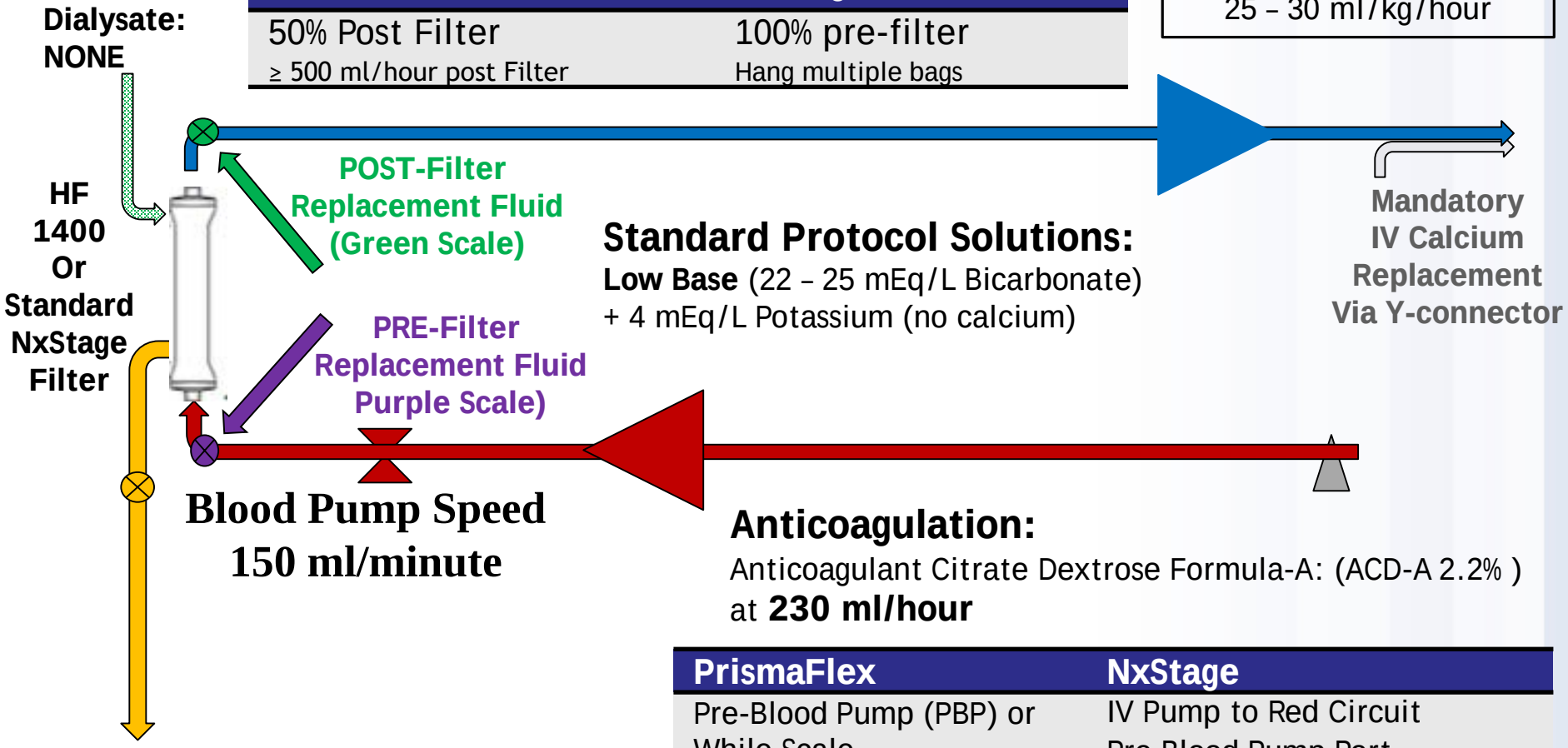
Standard UMMC Protocol

Modality – Continuous Venovenous Hemofiltration (CVVH)

Dose
Total Replacement Fluid
~ 2500 ml/hour
Adjusted based on patient weight
Ideal CRRT Dose
25 – 30 ml/kg/hour

PrismaFlex	NxStage
50% Post Filter	100% pre-filter
≥ 500 ml/hour post Filter	Hang multiple bags



Standard Protocol Solutions:
Low Base (22 – 25 mEq/L Bicarbonate)
+ 4 mEq/L Potassium (no calcium)

Anticoagulation:
Anticoagulant Citrate Dextrose Formula-A: (ACD-A 2.2%)
at **230 ml/hour**

PrismaFlex	NxStage
Pre-Blood Pump (PBP) or While Scale	IV Pump to Red Circuit Pre Blood Pump Port

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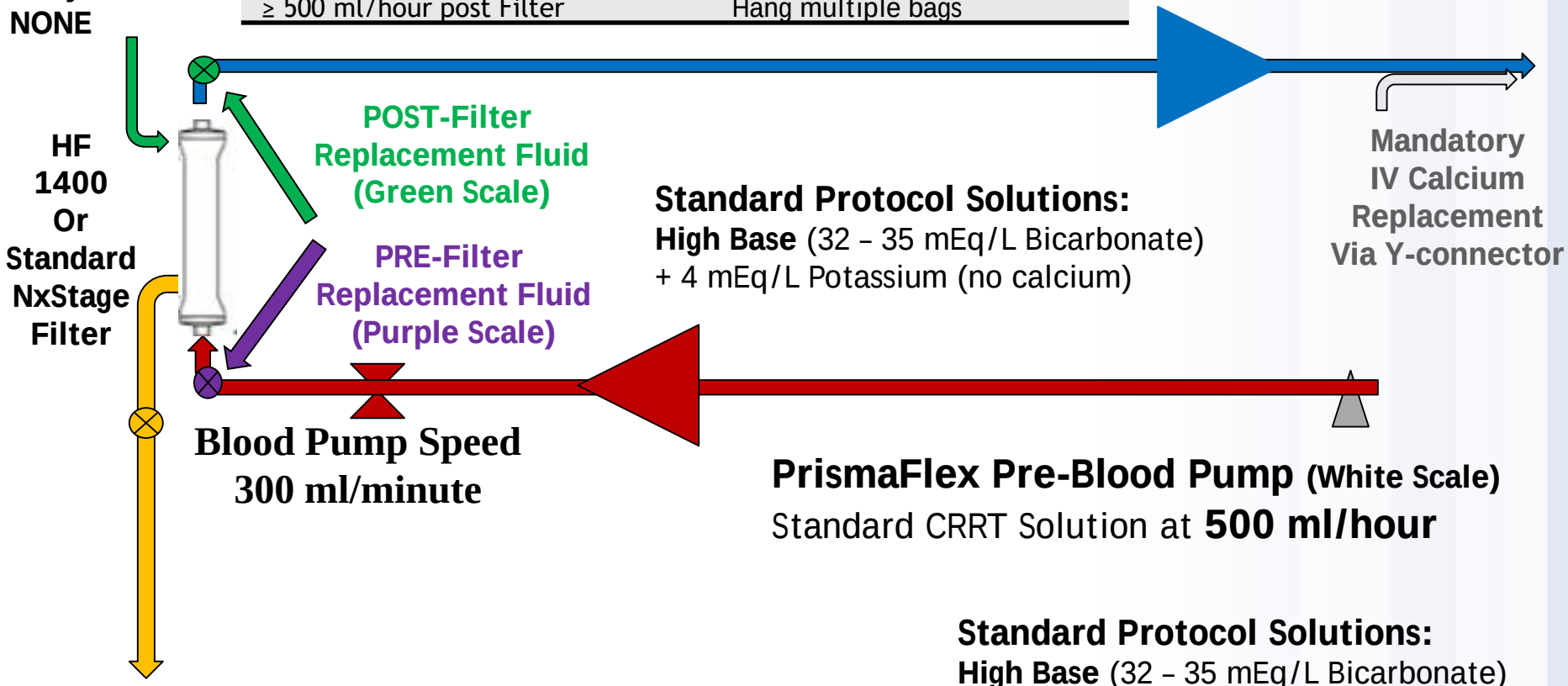
Anticoagulation Free Protocol

Modality – Continuous Venovenous Hemofiltration (CVVH)

Dose
Total Replacement Fluid
~ 2500 ml/hour
Adjusted based on patient weight
Ideal CRRT Dose
25 – 30 ml/kg/hour

PrismaFlex	NxStage
50% Post Filter	100% pre-filter
≥ 500 ml/hour post Filter	Hang multiple bags



Standard Protocol Solutions:
High Base (32 – 35 mEq/L Bicarbonate)
+ 4 mEq/L Potassium (no calcium)

PrismaFlex Pre-Blood Pump (White Scale)
Standard CRRT Solution at **500 ml/hour**

Standard Protocol Solutions:
High Base (32 – 35 mEq/L Bicarbonate)
+ 4 mEq/L Potassium (no calcium)

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UMMC CRRT → Priming CRRT circuits

Per UMMC protocol →

We prime every machine with heparin to avoid circuit clotting unless there is a specific order not to expose the patient to heparin.

Heparin Flush Protocol for Priming of the Extracorporeal Circuit

- **Heparin (10,000 units) will be added to 1L of normal saline and the circuit will be the primed with this fluid. Once the first prime is complete, the entire circuit is primed again using standard CRRT solutions (without heparin) thus flushing the excess heparin away.**
- **Contraindications to heparin prime/flush:**
  - **Suspected or diagnosed Heparin-Induced Thrombocytopenia.**
  - **Heparin allergy.**

Machine Prime & Catheter Lock	Standard = Heparin	Heparin-Free
	Standard Prime- Heparin: 1L NS with 1000 u heparin Standard Catheter Lock: Heparin 5000 units/ml	Heparin- free Prime: 1L NS with 1000 u heparin ALT Catheter Lock: Tri-Sodium Citrate 4%

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UMMC CRRT → Vascular Access

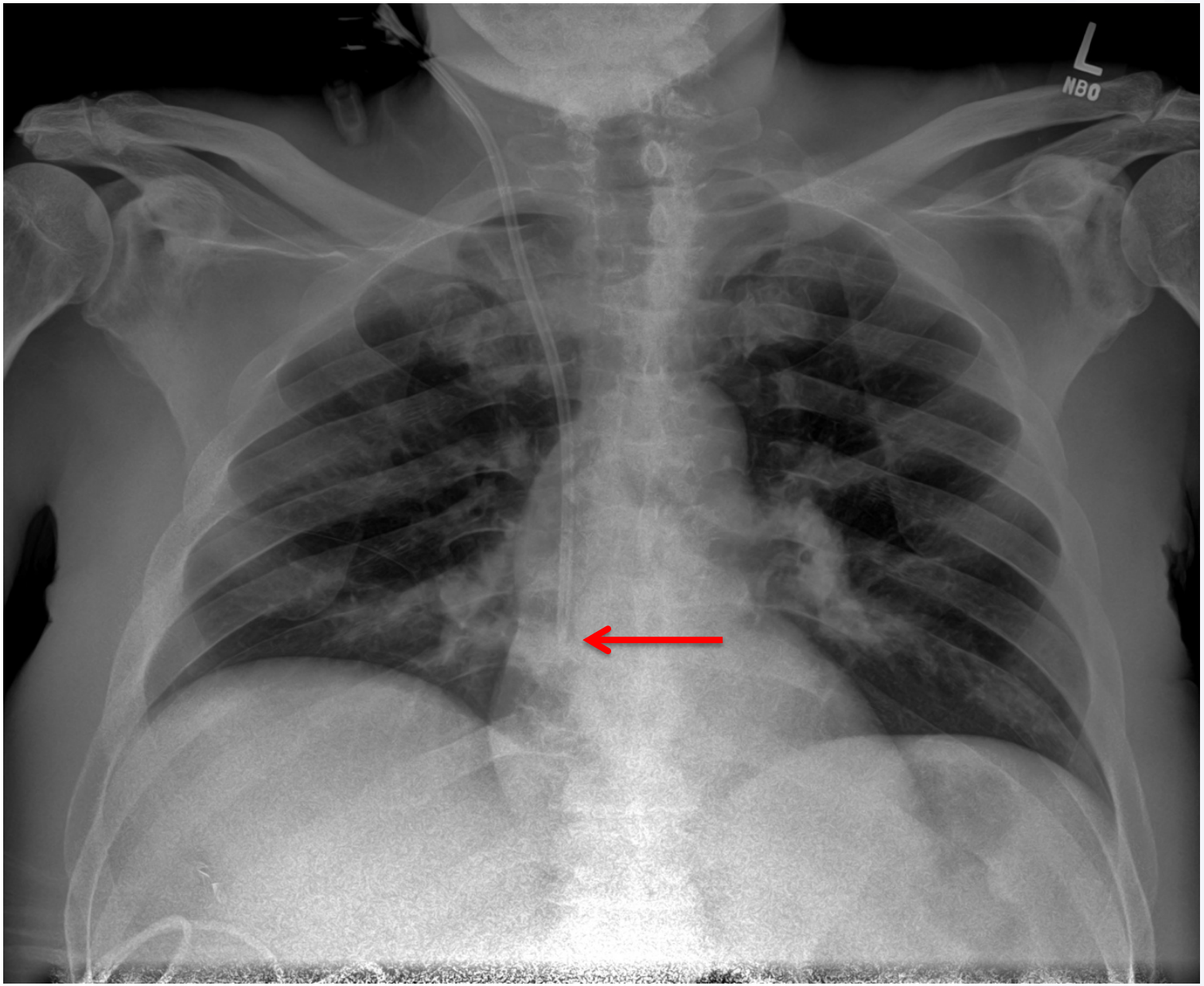
- **Nephrology must approve catheter type & position before CRRT**
- **Safety, Care and Maintenance:**
  - **Catheter associated Infections are the biggest risk to HD catheters.**
    - Only trained and approved nursing staff can access dialysis catheters.
    - Dressing should be changed per the UMMC Dialysis catheter specific policies.
  - **When patients are disconnected from CRRT, catheters should be locked immediately to prevent clotting.**
    - Standard Catheter locks is 5% Heparin (5000 units/mL) unless heparin is contraindicated.
      - The 1st alternative to heparin is trisodium citrate 4%
      - Other catheter locks require a specific order by the nephrology team.
  - **Patients can disconnect from CRRT at the catheter and loose blood.**
    - Keep Hemaclips on every catheter connection to the CRRT circuit to help prevent disconnections.
  - **Dialysis catheters clot easily if not handled properly**
    - Catheters may only be used for CRRT without express written consent from Nephrology.

Catheter Placement

		Precision
Right Internal Jugular	Hgt/10	90%
Left Internal Jugular	Hgt/10 + 4 cm	94%
Right Subclavian	Hgt/10 - 2 cm	96%
Left Subclavian	Hgt/10 + 2 cm	97%

- **Best Placement:**
  - Right Internal Jugular (IJ) for most Patients
  - The catheter tip should be:
    - Parallel to the vessel lumen
    - In the SVC at the Caval Atrial Junction (all IJs and SCs)
- **Best Catheter Length for the patient**
  - Femoral site ➔ always use a 24cm catheter
  - For IJ and Subclavian (SC) sites:
    - Use longer catheters for taller patients
    - Verify placement with Chest X-ray
  - Peres and derived formulas will provide estimated catheter length for each site
    - Deviating from the usual insertion site will cause variation in accuracy of these formulations

Czepiak et al; Chest 1995; 107:1662-64



Tip Location

Regional ACD-A Protocol for CRRT

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Fixed Dose Citrate Protocol (Modified Bunchman)

- **BFR 150 -200 ml/min (Max is 250 – Metabolic Alkalosis)**
- **PBP – 1.5 x BFR in ml/hr**
- **Dose = 25 ml/kg/hr**
- **CVVH – Pre-dilution fluids – 0 Ca**
  - ***If CVVHDF used– Predilution and HD solutions – 0 Ca***
- **CaCl – 1 gm per hour**
- **Monitor Systemic electrolytes and iCA q8 x 48 hrs – then q12**

Standard CRRT Replacement Solutions Available

Standard Protocol Solutions:

- **LOW Base (22-25 mEq/L) with 4 mEq/L K^+ and NO CALCIUM**
- **High Base (35 mEq/L) with 4 mEq/L $K^+$and NO CALCIUM**
- **High Base (35 mEq/L) with 2 mEq/L $K^+$and NO CALCIUM**

Other Available Solutions -- *Off Protocol*

- **High Base (35 mEq/L) with 4 mEq/L $K^+$and PLUS CALCIUM**
- **High Base (35 mEq/L) with 2 mEq/L $K^+$and PLUS CALCIUM**

CRRT Electrolyte Replacement 2018

- **Calcium replacement:** ***Always use a central line for CRRT calcium infusions***
  - **Calcium Chloride (10gm/500ml) continuous IV infusion** ***Currently available***
    - Standard Protocol Initial Dose is **24 gm/day**
    - ACD-A Free Initial Dose is **14 gm/day**
  - **Calcium gluconate (20gm/500ml) continuous IV infusion OR**
    - Standard Protocol Initial Dose is **72 gm/day**
    - ACD-A Free Initial Dose is **42 gm/day**
- **Phosphate replacement:**
  - **Potassium Phosphate (30mmol in 250 mL) continuous IV infusion**
    - Potassium free if hyperkalemia
  - Initial Dose is **30 mmol/day**
- **Magnesium replacement:**
  - **Magnesium sulfate 4 grams in 100 mL NS IV PRN**
    - once every 6 hours PRN magnesium level < 1.8

Titrating Calcium Chloride Replacement

- **Initial Doses:**
  - Standard Protocol (+ ACDA): **24 gm/day**
  - NO ACD-A: **14 GM/day**
- **Drug: Calcium Chloride**
  - Subject to Change per pharmacy availability
- **Target Range: Ionized Calcium 1.0 – 1.3 mmol/L**
- **Start with Normalized Calcium**
  - If iCa < 1.0 mmol/L: Calcium Chloride 1gm IV Push over 2 minutes
  - If iCa < 0.8 mmol/L: Calcium Chloride 2 gm IV Push over 4 minutes
- **Infuse IV Calcium into Y-connector on venous return line of HD catheter used for CRRT.**
  - IV calcium may also be infused into any available central line, but never into a Peripheral IV or midline.
- **Titration:**
  - Treat the trend
  - Minimize Changes to avoid errors

Titrating Potassium Phosphorous Replacement

- **Initial Dose:** **30 mmol/day by continuous infusion**
  - **When: serum phosphorous is ≤ 5 mg/dl and CRRT is running**
- **Drug:** **Potassium Phosphate**
  - 30 mmol/day delivers approximately 47.52 mEq/day of Potassium
  - Alternate: sodium phosphate with added potassium chloride 40 mEq/day
  - For hyperkalemia: sodium phosphate

Potassium Balance and CRRT

Ensure serum potassium during CRRT stays > 4.0 mg/dL

Potassium is removed in any source of Patient fluid removal (effluent)

Example: Day 1 **Patient Serum Potassium is 5.2 mg/dL**

Fluid Removed

CRRT Replacement fluid	2000 ml/hour
ACD-A	230 ml/hour
Patient Fluid Removal	300 ml/hour

2530 ml/hour * 5.2 mmol/L = 13.2 mmol/hour = 13.2 mEq/hour removed

Fluid Replaced

CRRT Replacement fluid	4 mEq/L	2000 ml/hour

2000ml/hour * 4 mEq/L = 8 mEq/hour replaced

Effect:

I am removing 5.2 mEq/Hour more potassium than I am replacing.

Day 2: 4.8 → Day 3: 4.4 → Day 4: 4.1 → Day 5: 3.7 → Day 6: 3.4

Therefore we use Potassium Phosphate to supplement potassium

Options for Ordering Fluid Removal during CRRT

- **Match Intake with Output:**

  During each 12 hour Shift - the Total Volume put into the patient and the total volume removed from the patient (including the patient fluid volume removed by CRRT) **Should be equal**

  NOTE: *NxStage will also include ACD-A Fluid Removal*

- **Net Negative Fluid Removal:**

  1) Each Hour – Remove ___ to ____ ml more than you need to remove to Match the Intake and Output for your shift. ***This range will be in the order.***

  2) Do not exceed ___ L extra fluid removal for each 24 hours. ***This is a safety check for the order #1 to ensure patients do not get dehydrated.***

  NOTE: *The CRRT Total Patient Fluid removal will represent the ordered hour fluid removal PLUS fluid removed to MATCH I&O - (NxStage will also include ACD-A Fluid Removal)*

- **No Fluid Removal**

  This means do not remove any fluid from the patient and do not match intake with output. The patient will receive additional volume from the CRRT therapy.

  EXCEPTIONS: *NxStage only – Volume from ACD-A will always be removed, even if No Fluid removal is ordered.*

Daily nursing Interventions

- **Weigh patient daily at 3 AM**
- **Update weight in Epic and the CRRT machine**
  - *Weights are part of fluid removal calculations*
- **Enter the AM hematocrit level daily into the CRRT machine.**
  - *HCT is part of the Filtration Fraction Calculation*
- **Ensure Safety and Accuracy of therapy delivery**
  - Maintain Hemasafe Clips on all circuit-access connections
  - Ensure correct delivery of therapy
  - Facilitate timely filter changes
  - Monitor circuits for signs of clotting
  - Address all alarms quickly
- **PrismaFlex should automatically interface with Epic.**
  - **Contact Epic if data interface does not work.**

CRRT Lab Monitoring 2018

Laboratory Measure		1st 48 hours		Starting at hour 49	
		Frequency	Schedule	Frequency	Schedule
CRRT Lab Panel	Serum Renal Function Panel	Every 8 hours	3AM 11AM 7PM	Every 12 hours	3 AM 3 PM
	Serum Magnesium	Every 8 hours	3AM 11AM 7PM	Every 12 hours	3 AM 3 PM
	POCT ionized Calcium	Every 8 hours	3AM 11AM 7PM	Every 12 hours	3 AM 3 PM
	Serum Complete Blood Count without Differential	Every 8 hours	3AM 11AM 7PM	Every 12 hours	3 AM 3 PM

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CRRT Quality Assessment and Performance Improvement

2014 - 2018

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Overview: CRRT Quality Targets and Outcomes

	Outcome 2017 Averages	Worst Month	Best Month	Target
Filter Life (Hours/filter)	**40**	31	63	**> 45**
Average Dose (ml/kg/hour)	**25**	18	29	**25-30**
Treatment Time Lost All reasons	**12%**	18%	6%	**< 10%**
- Bag Change Time % Therapy stopped waiting for bag changes.	**22.4%**	37%	10%	**< 3%**
–Patient Time Off Time off therapy that exceeds 180 minutes	**47%**	52%	7%	**< 20%**
Access/Return Alarms # of alarms/ # treatment days	**1.9/ tx day**	5.5	1.0	**< 1.5**
Safety	**Not quantified**			**NO Adverse Events**
Consistent Protocol Use	**< 93%**		100%	**TBD**

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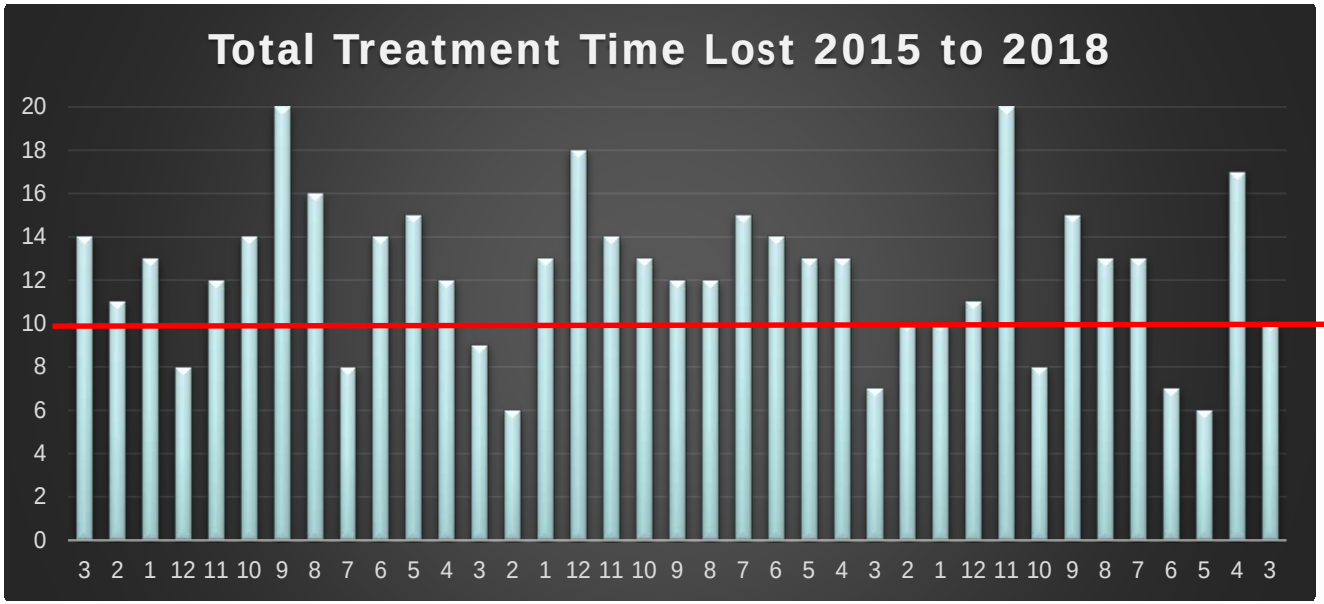
Treatment Time Lost



Goal
< 10%

Action Plans

1. Optimize catheters used for CRRT
2. Improve timely filter exchanges
3. Pursue Long Filter Life
4. Improve downtime due to CRRT Bag Changes

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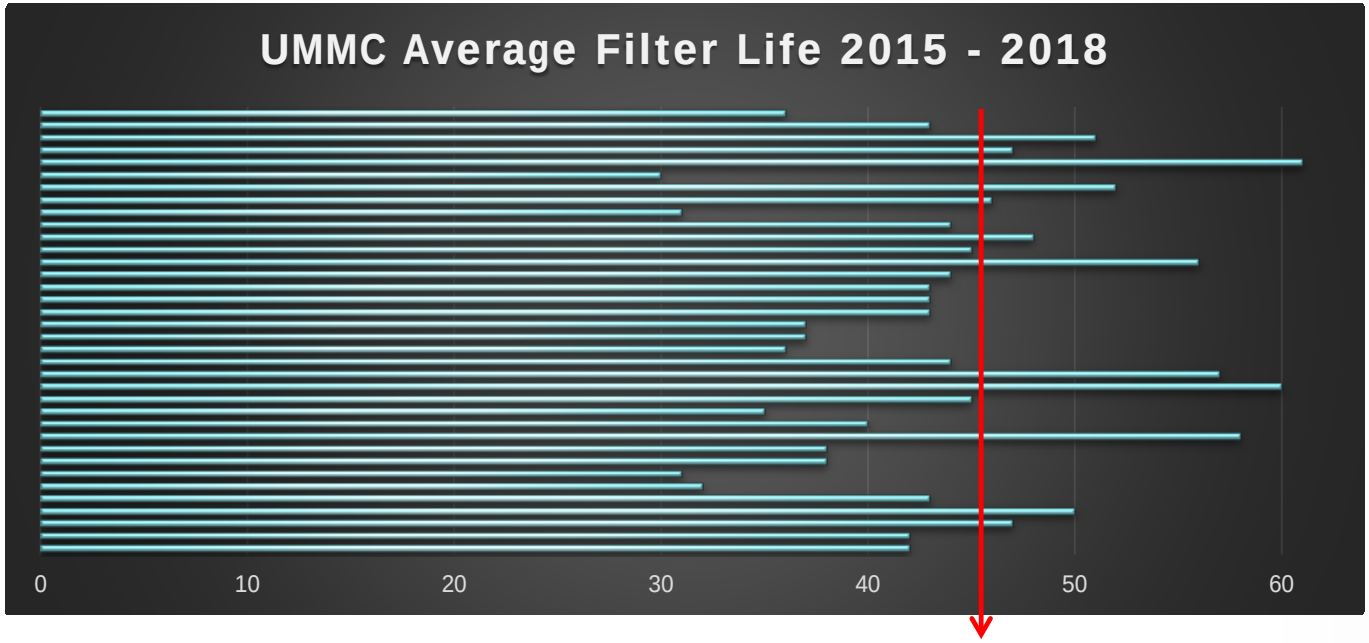
UMMC Average CRRT Filter Life



Goal :
Filter Life
> 45 hours
per Filter
Goal not met

Action Plan:

1. **Change Filters Fast – Keep the Machine Running**
2. **Consider Pre-Emptive Filter Change**
3. **Optimize every CRRT Catheter**
4. **Fix Alarms that stop the blood pump - quickly**
5. **Follow the UMMC Standard protocol when possible**

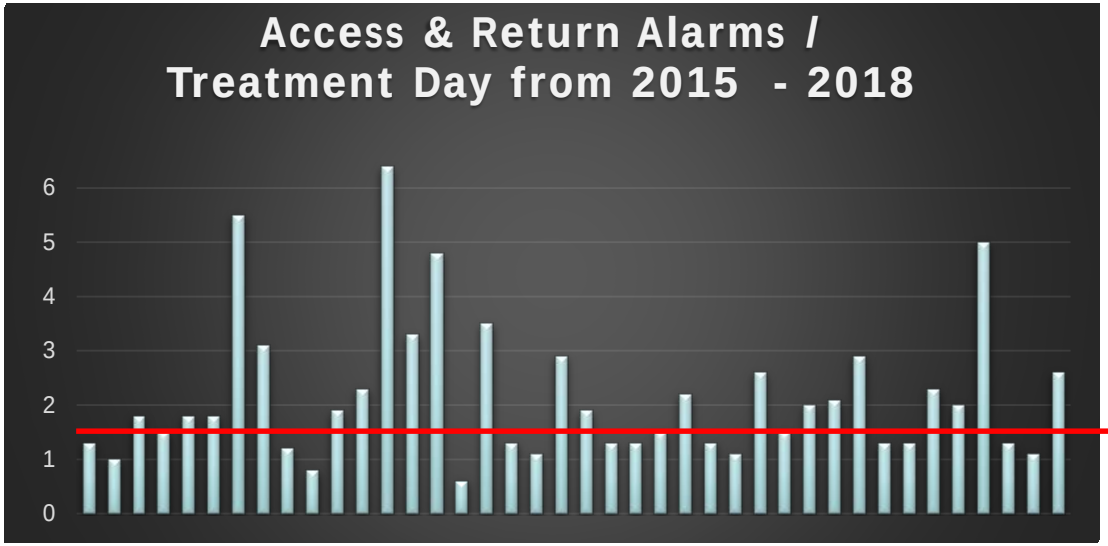
UMMC Filter Life Action Plan

Goal : Filter Life > 45 hours per Filter

Goal not met

1. **Change Filters Fast – Keep the Machine Running**
   - Complete RCA of delays in filter reset planned
2. **Consider Pre-Emptive Filter Change**
   - Definition: Up to 3 hours before filter will expire (at 72 hours)
   - Is an Order Required? **NO**
   - ***Please Communicate with AKU staff***
3. **Optimize every CRRT Catheter**
   - Do not reset filters after clotting/clogging without addressing access issues
   - Review access regularly for displacement
   - For Optimal Function During CRRT, the Catheter tip should be in the SVC near the Caval Atrial Junction and the catheter tip should be parallel to the vessel lumen. Ashany, et al. Chest 1998; 114: 820-826.
4. **Fix Alarms that stop the blood pump – quickly**
   - Blood that is not in motion will quickly begin to form clots
5. **Follow the UMMC Standard protocol when possible**
   - Protocols are designed to maximize filter performance

Access Alarms

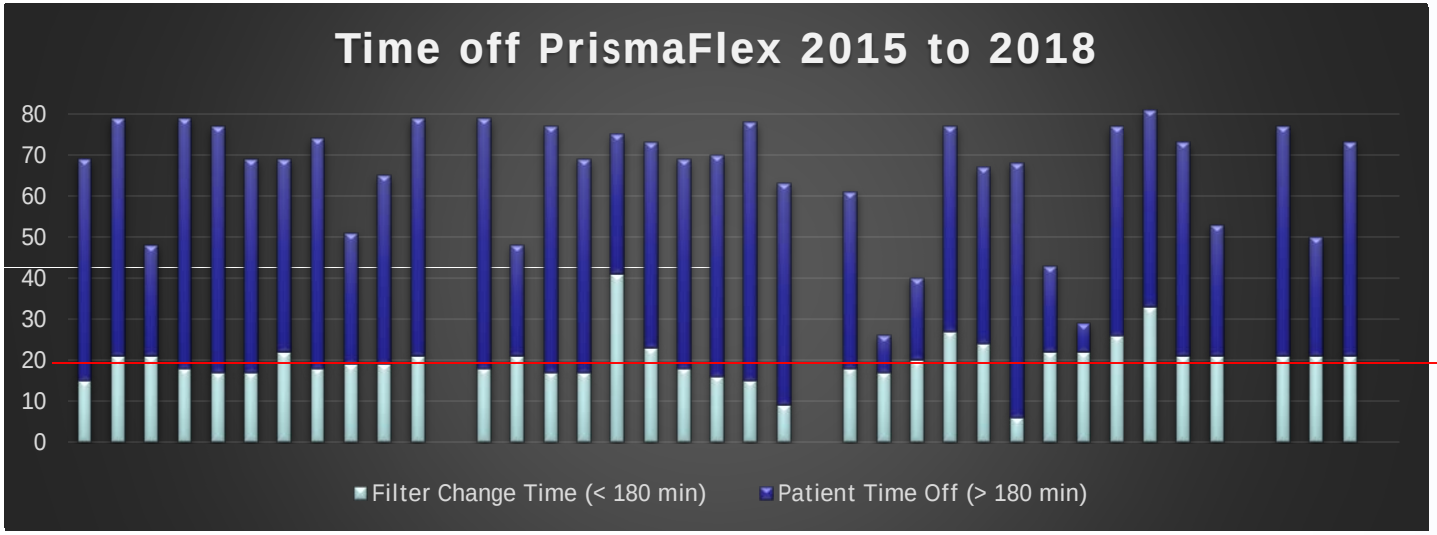


Goal : Average Access and Return Alarms < 1.5 per Treatment Day

Action Plan:

1. **Optimize Access during CRRT**
   - Review and Optimize type of short term hemodialysis catheter used for CRRT
     - Ease of Placement & Optimal flow dynamics
   - Optimize Placement of Every Catheter Used for CRRT
     - Education
     - Requirement: Nephrology approves catheters before initiation of CRRT
2. **Ongoing Nursing Education - Alarm Management**
   - Critical Care Educators

Treatment Time Lost



Goal
Patient time off
< 20%
Time off

Action Plan

1. **Improve communication between departments and disciplines**
   - Acute care communications
   - Hand-off communications
     - Develop tools for communication at nursing shift changes, physician APP handoffs, and dialysis monitoring
2. **Improve use of pre-emptive filter exchanges**
   - Up to 3 hours before usual filter exchange at72 hours

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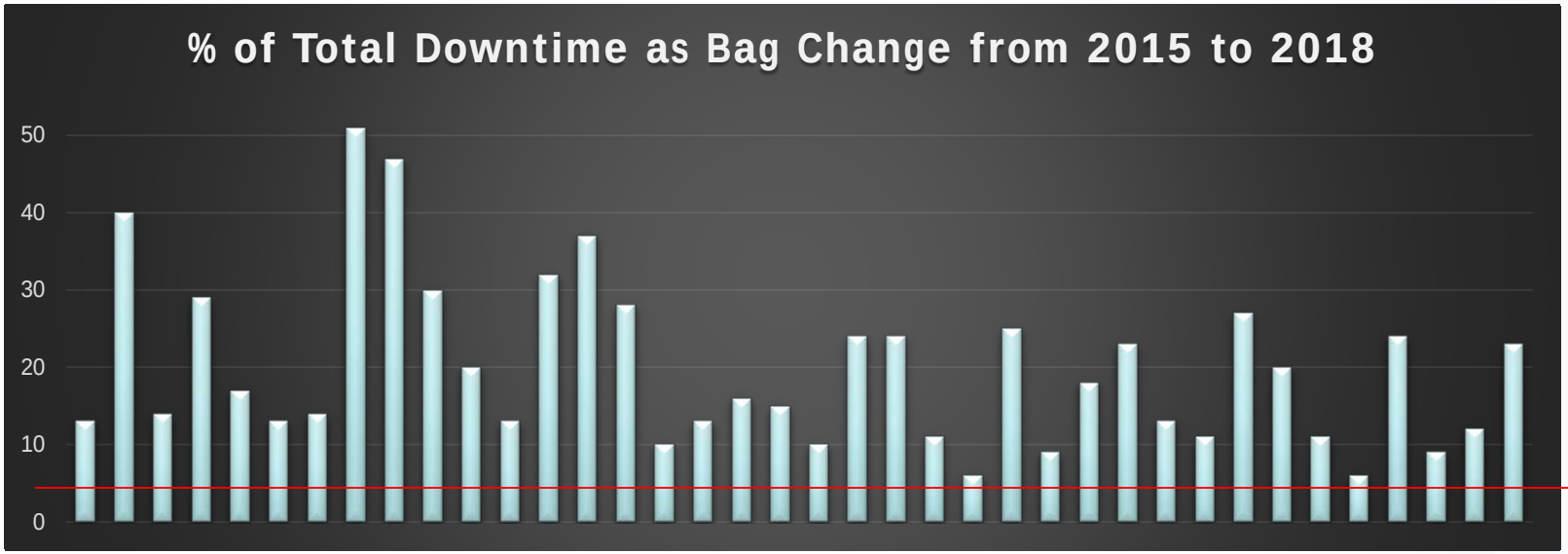
Bag Change Time



Goal < 3% Bag Change Time

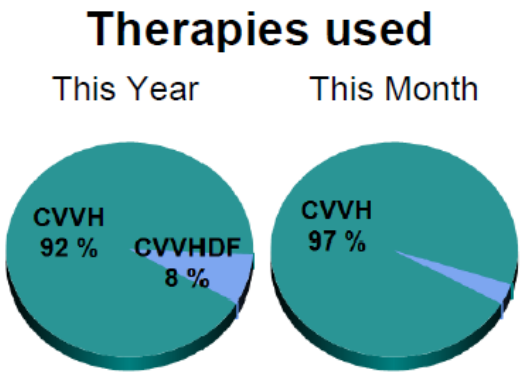
Action Plan:

- **Education (Ongoing):**
  - Initial Education (2015): Gambro/Baxter Superuser Training
  - Critical Care Orientation Classes
  - Baxter Education for AKU/ICU/Superusers - As needed
- **Awareness (Ongoing):**
  - **Education:** Unattended Bag Change Alarms Stop the Therapy
  - MICU Educators – encourage staff accountability
- **Track and Trend**
  - Compare Staffing Patterns to Fluctuations in Bag Change Time

Protocol Use

Targets:

- Maximize use of CRRT protocols
- 100% of CRRT will have post-filter replacement fluid rate ≥ 200 ml/hour
- Eliminate CRRT related safety events

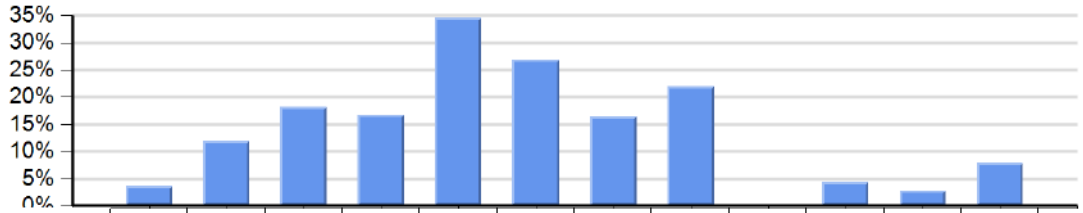


Post Replacement Rate:

This Year

13%

% All < 200ml/hour



	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
% All < 200ml/hour	4%	12%	18%	17%	35%	27%	16%	22%	0%	4%	3%	8%
All Filters < 200ml/hour	1	5	2	6	9	11	10	9	0	2	1	5
All Filters	27	42	11	36	26	41	61	41	35	45	36	63

Action Plan

- **Rebuild Epic Ordersets to Encourage use of UMMC Protocols**
  - Educate prescribers with CRRT privileges as ordersets are released
  - Educate nurses caring for CRRT patients on UMMC protocols

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Action Plans - Overview

- **Filters that Last Close to 72 hours**
  - Average Filter Life consistently > 45 hours/filter
- **Keep CRRT machines running – Goal is 24 hours/day**
  - **Investigate specific causes of downtime**
    - delays in changing filters
    - bag change time
  - **Optimize CRRT vascular Access**
  - **Communicate**
- **Improve Safety and Quality with Protocols**
  - Rebuild Epic Ordersets
  - Ongoing Protocol Education