CRRT

Indications and Applications in Pediatrics

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Objectives

Patient characteristics and considerations

Indications and Goals for Acute Renal Replacement Therapy

Timing and Early Indications for Treatment Initiation

Continuous Renal Replacement Modalities

Prescription Parameters and Dosing

Access Management

Holistic and Interdisciplinary Care

AKI: Pediatric Considerations

Population
- Age, Weight, & BSA
- Challenges

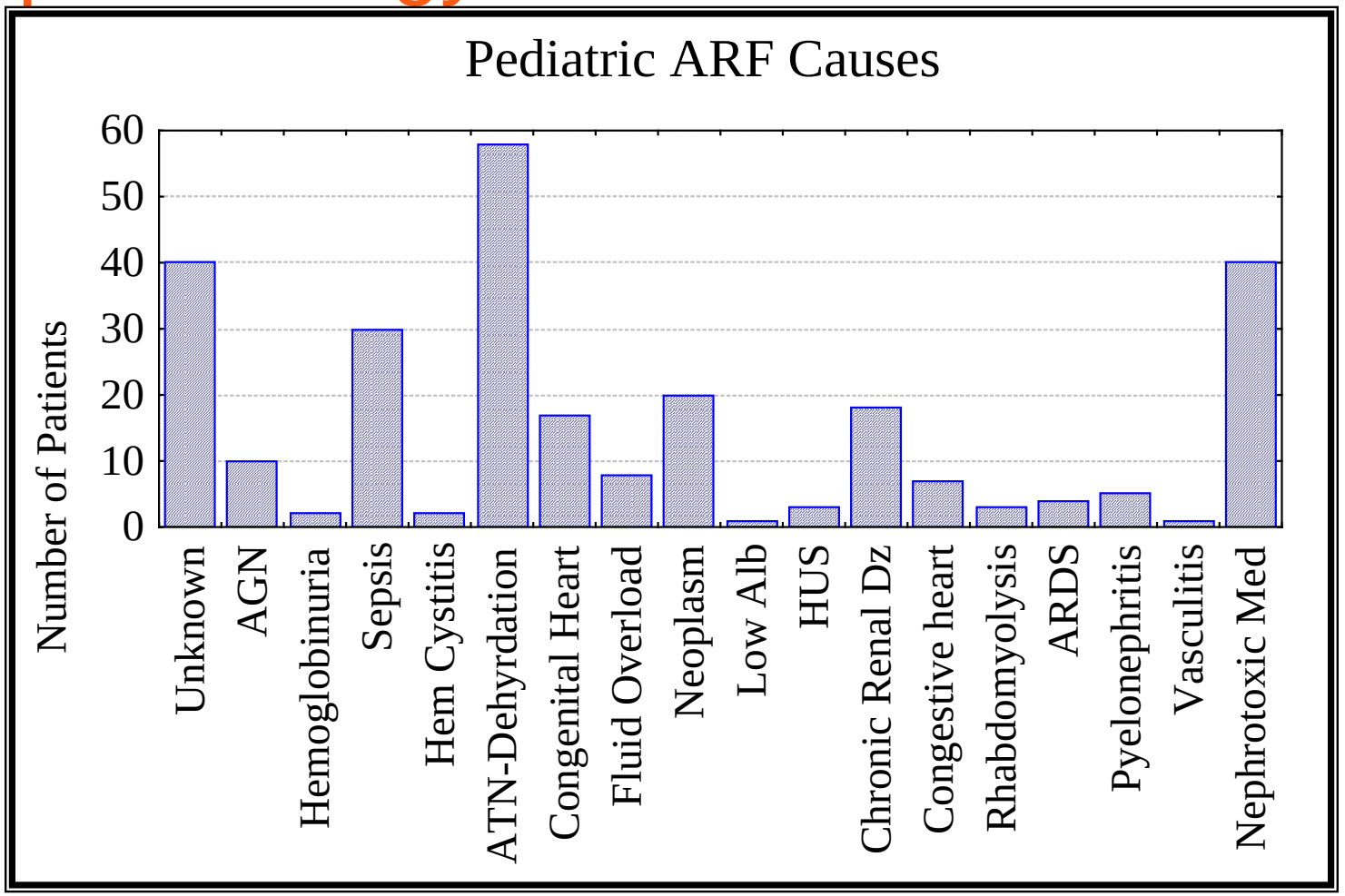
Primary conditions
- Congenital heart disease
- Inborn errors of metabolism
- Sepsis with multi-organ involvement
- Bone marrow and solid organ transplantation

Children develop MODS early in ICU course
- Maximum number of organ failures occurs within 72 hours of ICU admission (87% of patients)

Children die with MODS very early in ICU course
- 88.4% of deaths occur within 7 days of MOSF diagnosis

Proulx et al: Crit Care Med 22:1025, 1994

Epidemiology



Stickle SH et al: Am J Kid Dis 45:96-101, 2005

Emerging Indications

Fluid Overload: Hypervolemia with respiratory involvement or failure

Metabolic Acidosis and Electrolyte imbalance

Acuity/Degree of Kidney Injury
- reduction in GFR and elevated creatinine
- reduction in urine output

Uremia and Multiple Organ Failure

Intoxications, Inborn errors of Metabolism (IEM), Sepsis

Nutritional support

Walters et. al. Peds Neph 2008

Timing and Intervention

*pRIFLE criteria: a new validated criteria of AKI to help identify pediatric patients at risk for ARF and to promote early intervention

*Fluid Overload: Independent risk factor associated with mortality

*Uremia: Adult data supports early initiation (BUN </= 60 mg/dL)

pRIFLE: Pediatric Modified RIFLE--definition

GFR per Schwartz equation: GFR= Ht (cm) X constant / serum creat (mg/dl)

Pediatric Modified RIFLE Criteria		
	CrCl	Urine output
Risk	GFR decrease by 25%	<0.5ml/kg/hour for **8 hours**
Injury	GFR decrease by 50%	<0.5ml/kg/hour for **16 hours**
Failure	GFR decrease by 75% or **GFR<35ml/min/1.73m ^{2}**	<0.3 ml/kg/hour for **24 hours** or anuric for 12 hours
Loss	Persistent ARF > 4 weeks	
End stage	End Stage Renal Disease (>3 months)	

Ackan-Arikan et al: *Kid Int* 2007

Timing: Fluid Overload as Early Indicator

Percent Fluid Overload Calculation

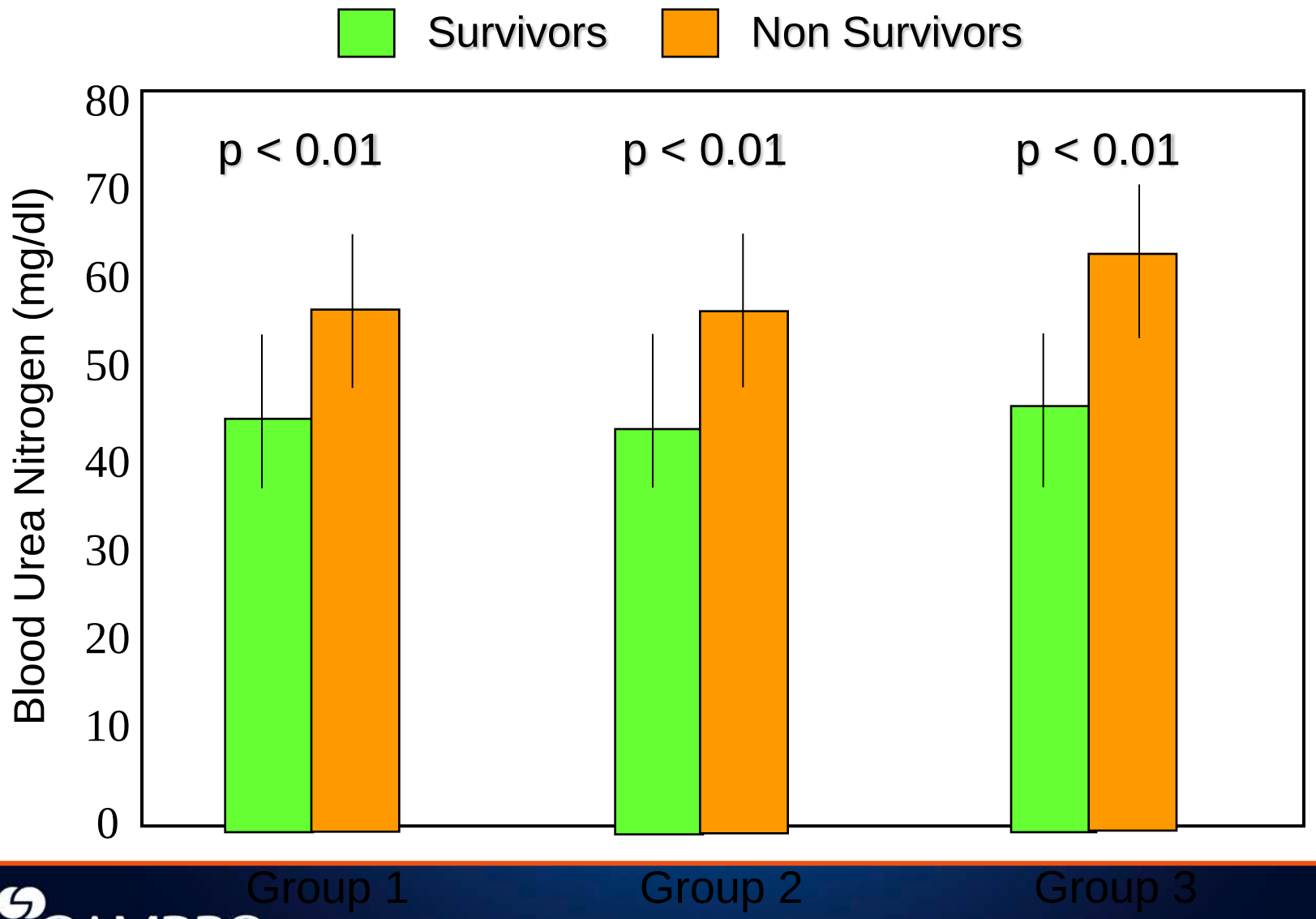
$$\%\ \text{FO at CVVH initiation} = \left[\frac{\text{Fluid In - Fluid Out}}{\text{ICU Admit Weight}} \right] * 100\%$$

Fluid In = Total Input from ICU admit to CRRT initiation
Fluid Out = Total Output from ICU admit to CRRT initiation

Pediatrics 2001;107;1309-1312

Effects of different doses in CVVH on outcome of ARF - *Ronco & Bellomo study. Lancet . july 00*

Effect of BUN at CVVH Initiation on Survival



Clinical Application

Pediatrics

Continuous Renal Replacement Therapy (CRRT)

“"Any extracorporeal blood purification therapy intended to substitute for impaired renal function over an extended period of time and applied for or aimed at being applied for 24 hours/day.”

Bellomo R., Ronco C., Mehta R, Nomenclature for Continuous Renal Replacement Therapies, AJKD, Vol 28, No. 5, Suppl 3, Nov 1996

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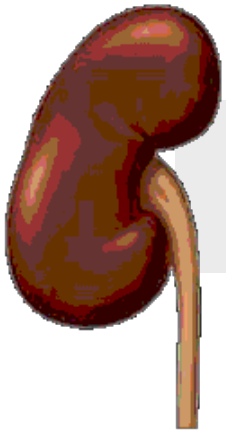
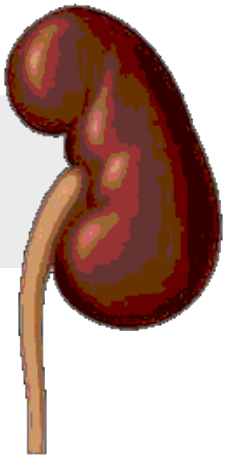
Why CRRT?



CRRT closely mimics the native kidney in treating ARF and fluid overload



- Removes large amounts of fluid and waste products over time
- Tolerated well by hemodynamically unstable patients
- Slow, gentle and well tolerated by hypotensive patients

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CRRT Defined

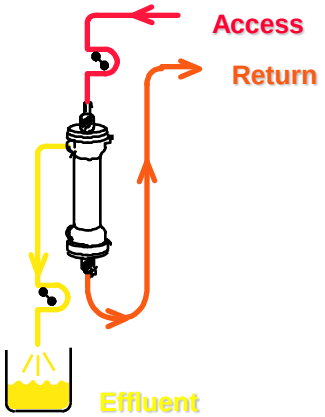
SCUF - *Slow C**ontinuous* U*ltrafiltration***

CVVH - *Continuous V**eno-V**enous* H**emofiltration**

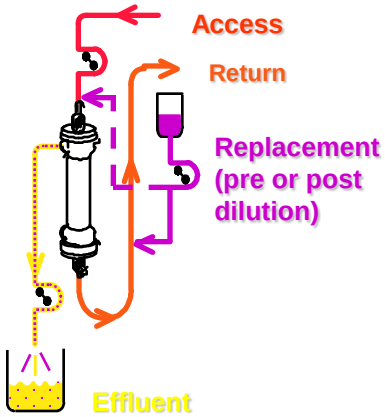
CVVHD - *Continuous V**eno-V**enous* H**emoD**ialysis**

CVVHDF - *Continuous V**eno-V**enous* H**emoD**ia**F**iltration**

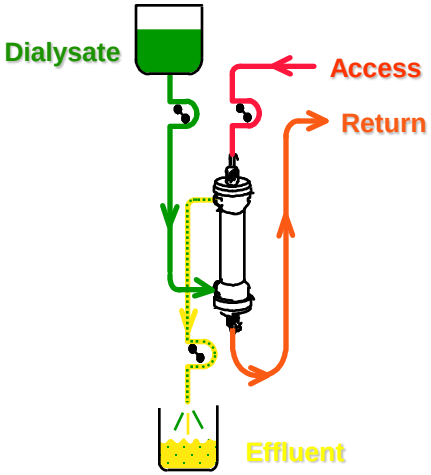
CRRT Modalities



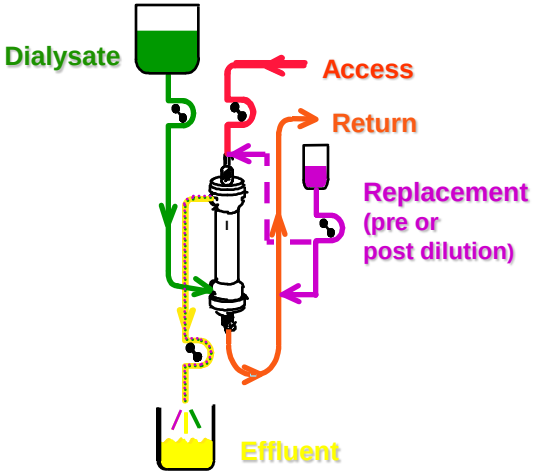
SCUF



CVVH

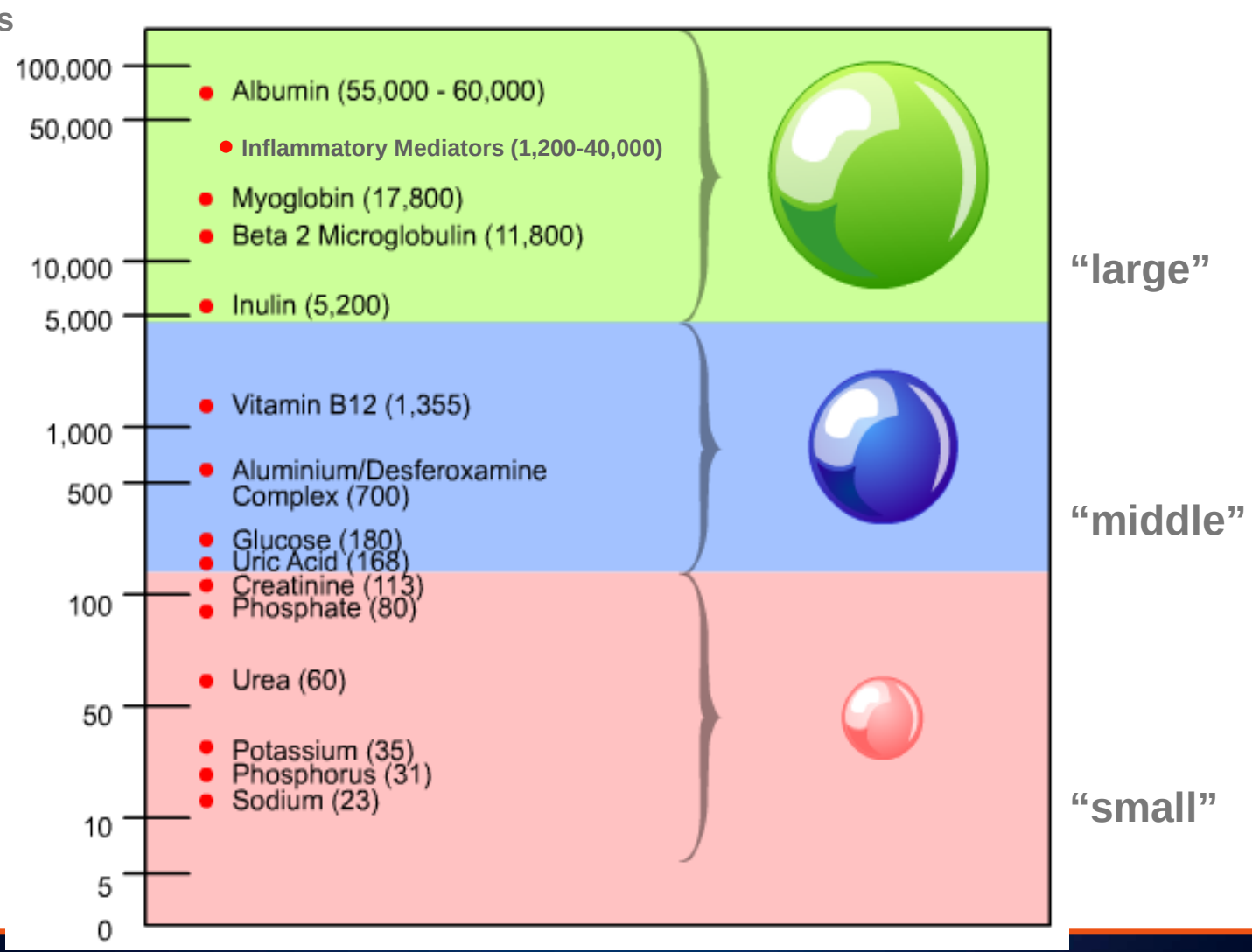


CVVHD

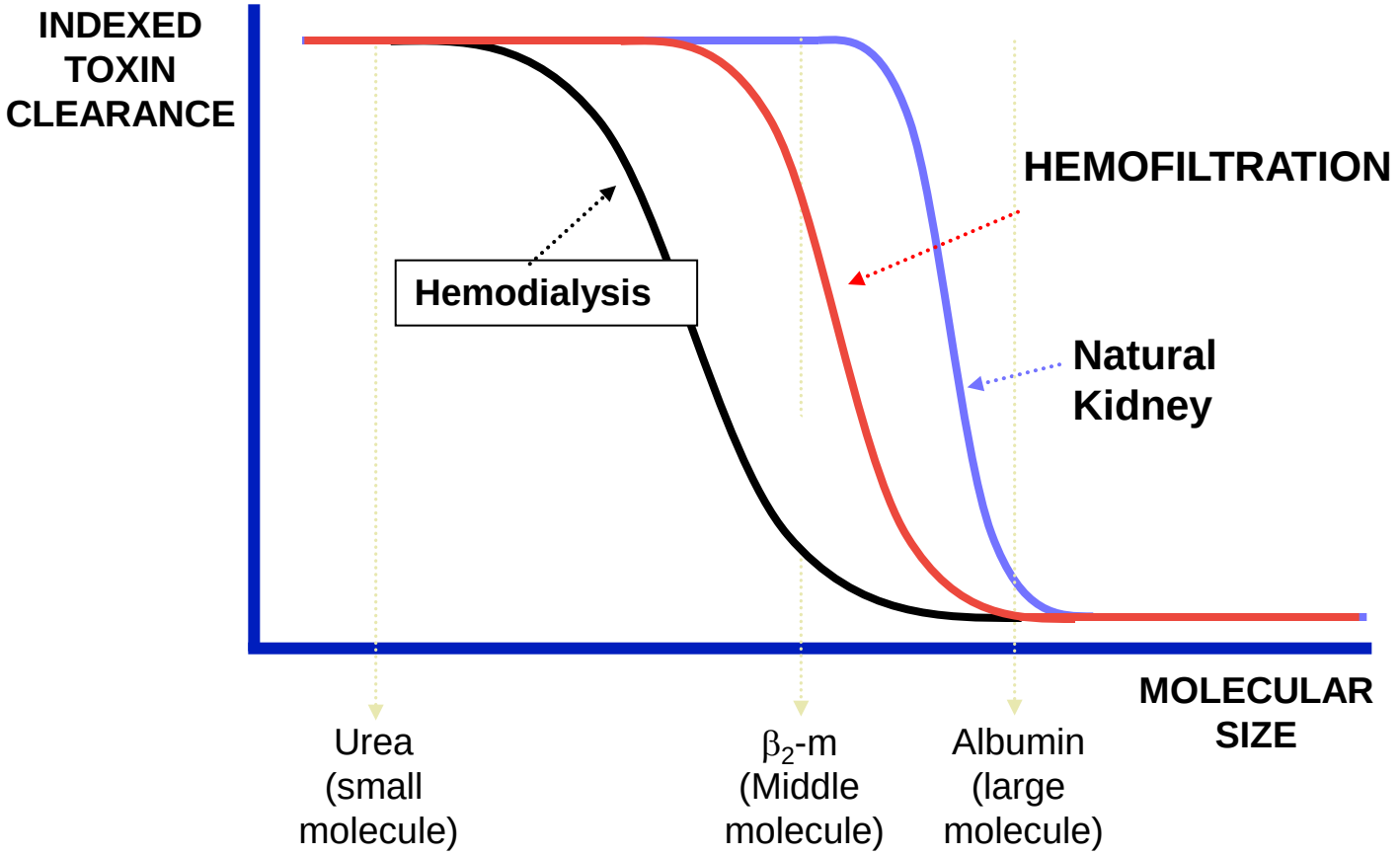


CVVHDF

Molecular Weights



Clearance profiles by modality



Pediatric Prescription Parameters

Hemofilter Membrane: M10, M60, M100, HF1000

Priming Methods: Bypass, Recirculation, 1:1 PRBC / 5% Albumin

Blood Flow Rate (BFR) = 4 -10 ml/kg/min

Werner et al.,1994, Critical Care Medicine, 22, 320-325

Dose: Dialysate and Replacement Rates

2000ml per 1.73m2/hour equates to Roncos 35ml/kg/hour

Ultrafiltration Rate (UFR) = 1 – 2 ml/kg/hour

Donckerwolke –Ped Neph 8:103-106,1994

Anticoagulation: Heparin, Citrate,

Access Management

Size and location need to be considered!

Options: Internal Jugular, Femoral, Subclavian

Vessel diameter vs. age

Patent Access = Optimal outcomes

Hackbarth, R et al: IJAIO 30: 1116-21, 2007

PATIENT SIZE	CATHETER SIZE & SOURCE	SITE OF INSERTION
NEONATE	~~Single-lumen 5 Fr (COOK)~~	~~Femoral artery or vein~~
	Dual-Lumen 7.0 French (COOK/MEDCOMP)	Femoral vein
3-6 KG	Dual-Lumen 7.0 French (COOK/MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
	Triple-Lumen 7.0 Fr (MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
6-30 KG	Dual-Lumen 8.0 French (KENDALL/ARROW)	Internal/External-Jugular, Subclavian or Femoral vein
>15-KG	Dual-Lumen 9.0 French (MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
>30 KG	Dual-Lumen 10.0 French (KENDALL, ARROW)	Internal/External-Jugular, Subclavian or Femoral vein
>30 KG	Triple-Lumen 12 French (KENDALL/ ARROW)	Internal/External-Jugular, Subclavian or Femoral vein

Simplicity is Key!

To enhance Safety and Level of Comfortability at the bedside

References and Resources:

1. Pediatric Speakers' Bureau
2. Prisma/PrismaFlex Operator Manual
3. www.pcrrt.com
4. www.pediatricnephrology.com
5. www.ADQI.com

Thank you…..

Questions welcome for seminar discussion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