



THE 29TH INTERNATIONAL CONFERENCE ON

ADVANCES IN CRITICAL CARE NEPHROLOGY

AKI & CRRT 2024

Jointly Provided by

UC San Diego

SCHOOL OF MEDICINE

and

CRRT, INC.

MARCH 12-15, 2024

MANCHESTER GRAND HYATT

SAN DIEGO, CALIFORNIA

Morning Symposium A

Plasma Exchange in Critically Ill Patients: Who, When and How?

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Disclosures

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Objectives



Understand the technical considerations for providing therapeutic plasma exchange



Be familiar with the basic principles of prescribing therapeutic plasma exchange



Understand considerations for the use of therapeutic plasma exchange in children

Quick Poll of the Room



Raise your hand if you....

- Prescribe plasma exchange
- If you prescribe plasma exchange, you prescribe it more than once a month
- You take care of adults and children in your practice
- You primarily take care of adults in your practice
- You primarily take care of children in your practice



Why you should feel great that you woke up before 7 am to come to this talk!



Transfusion and Apheresis Science 62 (2023) 103831



Contents lists available at ScienceDirect

Transfusion and Apheresis Science

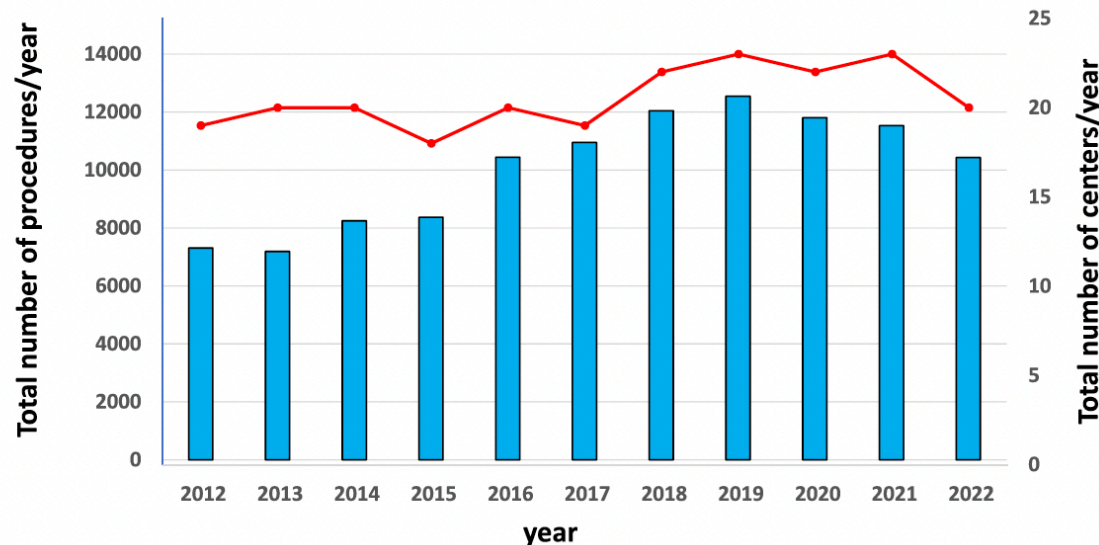
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Review

The world apheresis association registry, 2023 update

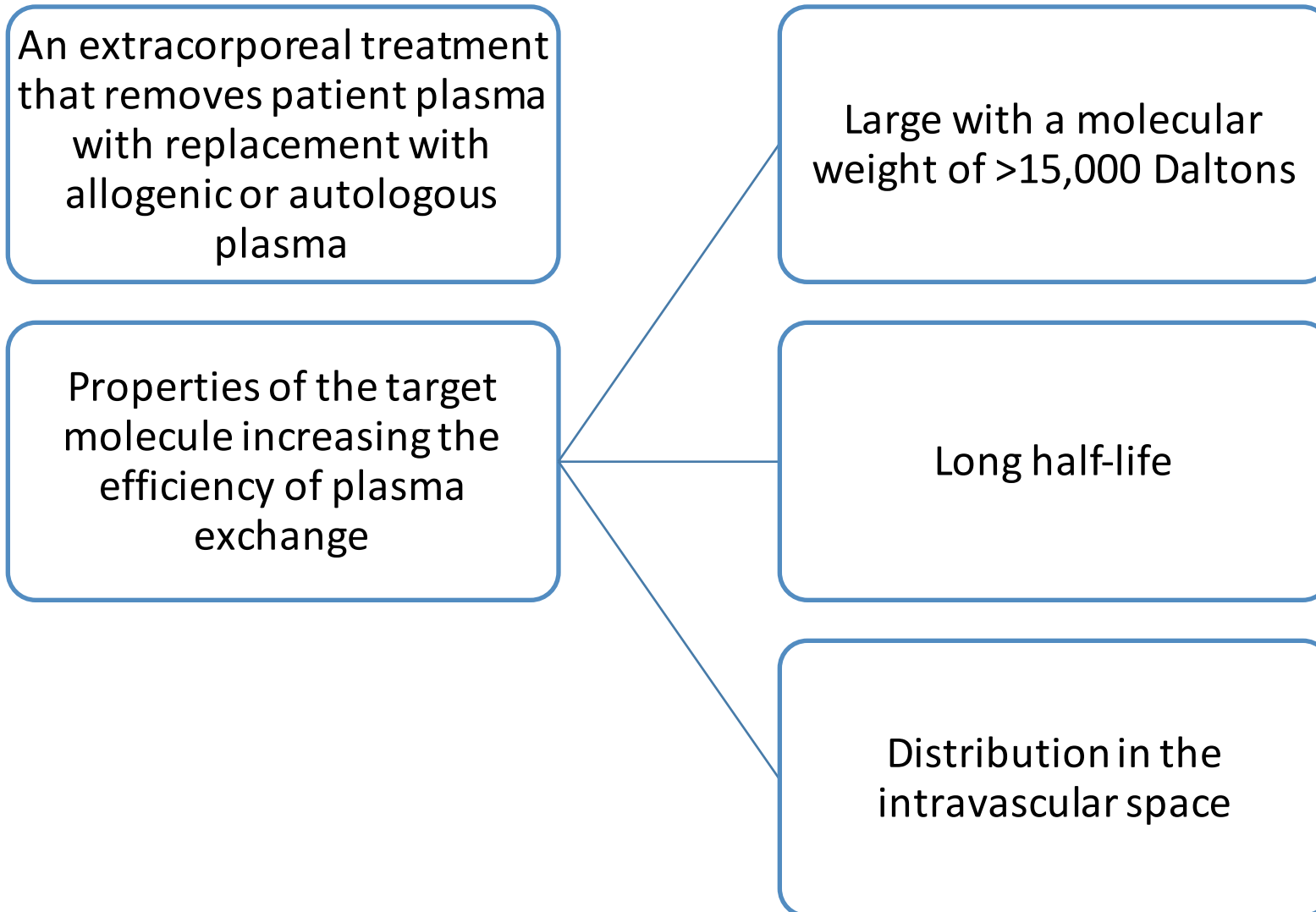
Hans Vrieling^a, Kaatje Le Poole^a, Bernd Stegmayr^{b,*}, Jan Kielstein^c, Gösta Berlin^d, Osman Ilhan^e, Guldane Cengiz Seval^e, Heinrich Prophet^f, Astrid Aandahl^g, Dries Deeren^h, Ines Bojanicⁱ, Milan Blaha^j, Miriam Lanska^j, Zdenka Gasova^k, Zdenka Bhuiyan-Ludvikova^k, Sarka Blahutova^l, Radomira Hrdlickova^l, Judita Audzijoniene^m, Antanas Griskevicius^m, Tanya Glattⁿ, Virginia Strineholm^o, Michael Ott^b, Thomas Nilsson^p, Elizabeth Newman^q, Kurt Derfler^r, Volker Witt^s, Fredrik Toss^t



- The World Apheresis Association apheresis registry contains data from > 140,000 pheresis procedures conducted in 12 different countries
- Aim: give an update on indications, type, and number of procedures and adverse events

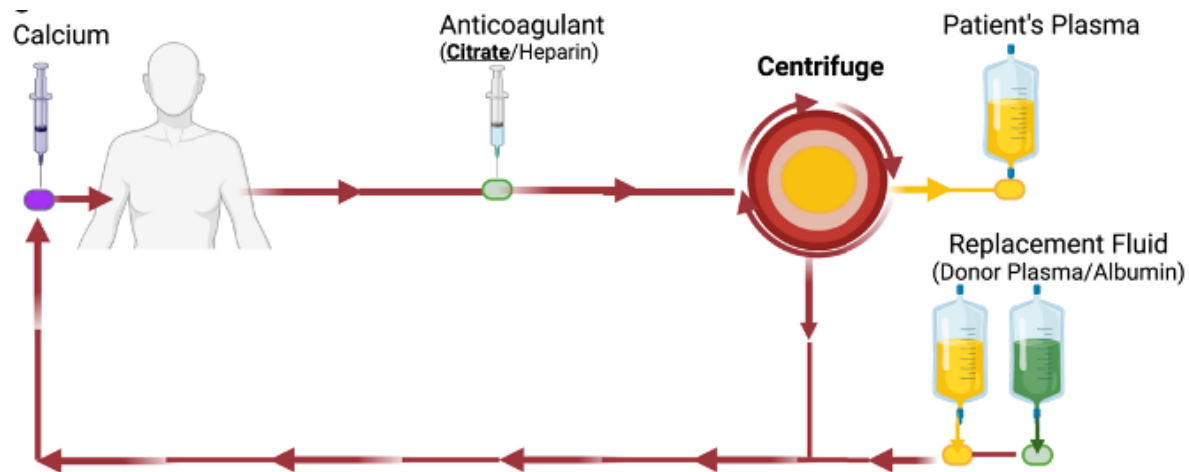
AKI & CRRT
2024

What is Therapeutic Plasma Exchange?

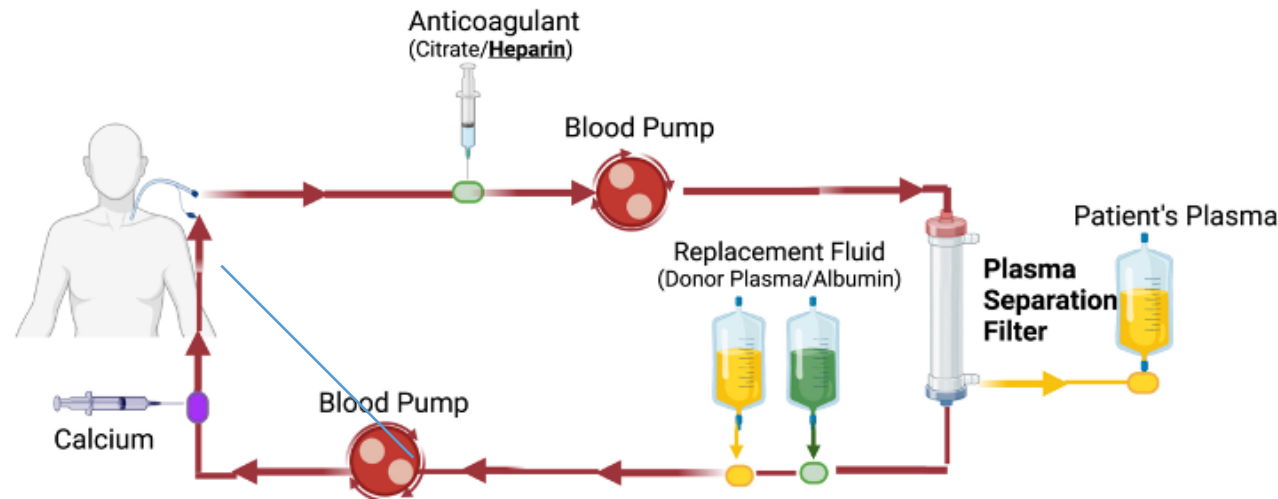


Technical Considerations

Centrifugal



Membrane-Based



Cervantes CE et al. AJKD 2023

The Prescription

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- The main indication for plasma exchange: TTP
- The preferred anticoagulant: acid citrate dextrose
- Adverse events occurred in 2.7% of cases

Priming:

- If the priming volume exceeds 10% of the blood volume, RBC priming should be considered
- BW < 10 kg

Anticoagulation:

- Citrate is preferable and most the commonly cited:
 - Circuit level ionized calcium < 0.35 mmol/L
 - Systemic ionized calcium 1.0-1.2 mmol/L

The Prescription

Generally, exchange with 1-1.5 plasma volume in a single treatment

Estimated total blood volume in adults (L) = weight (kg) x 0.065

Estimated total blood volume in children (L) = weight (kg) x 0.08

Total plasma volume (L) = Total blood volume x (1-hematocrit)

A single volume exchange will lower plasma macromolecule levels by ~65-70%

An exchange equal to 1.4 times the plasma volume will lower plasma levels by 75%

Methods to Provide CRRT + Plasma exchange

- Interrupt CRRT, perform plasma exchange through the same access and restart CRRT after plasma exchange is over
- Use 2 areas of vascular access, 2 machines simultaneously
- Tandem

Tandem CRRT + Plasma Exchange

Blood Purification

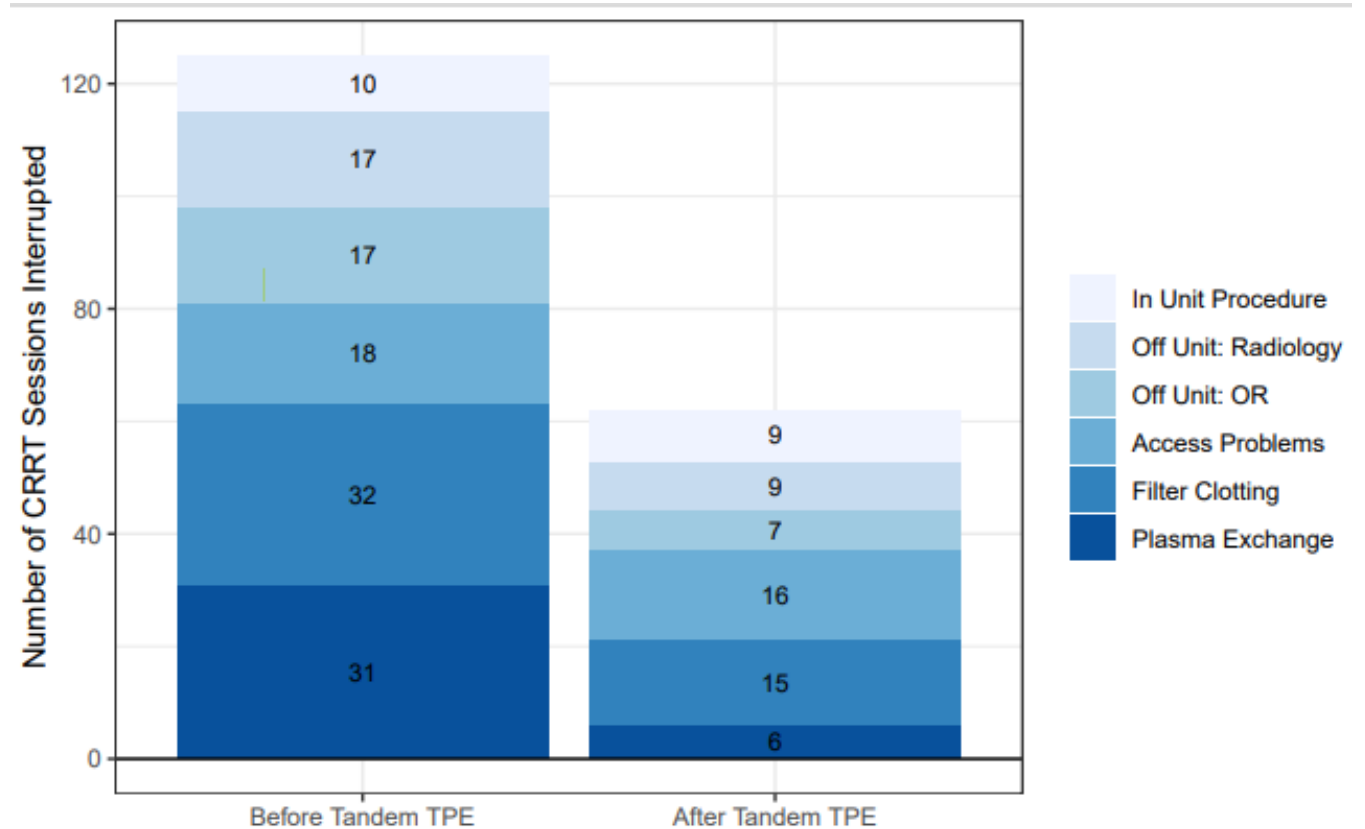
Pediatric Section – Research Article

Blood Purif 2022;51:523–530
DOI: 10.1159/000518348

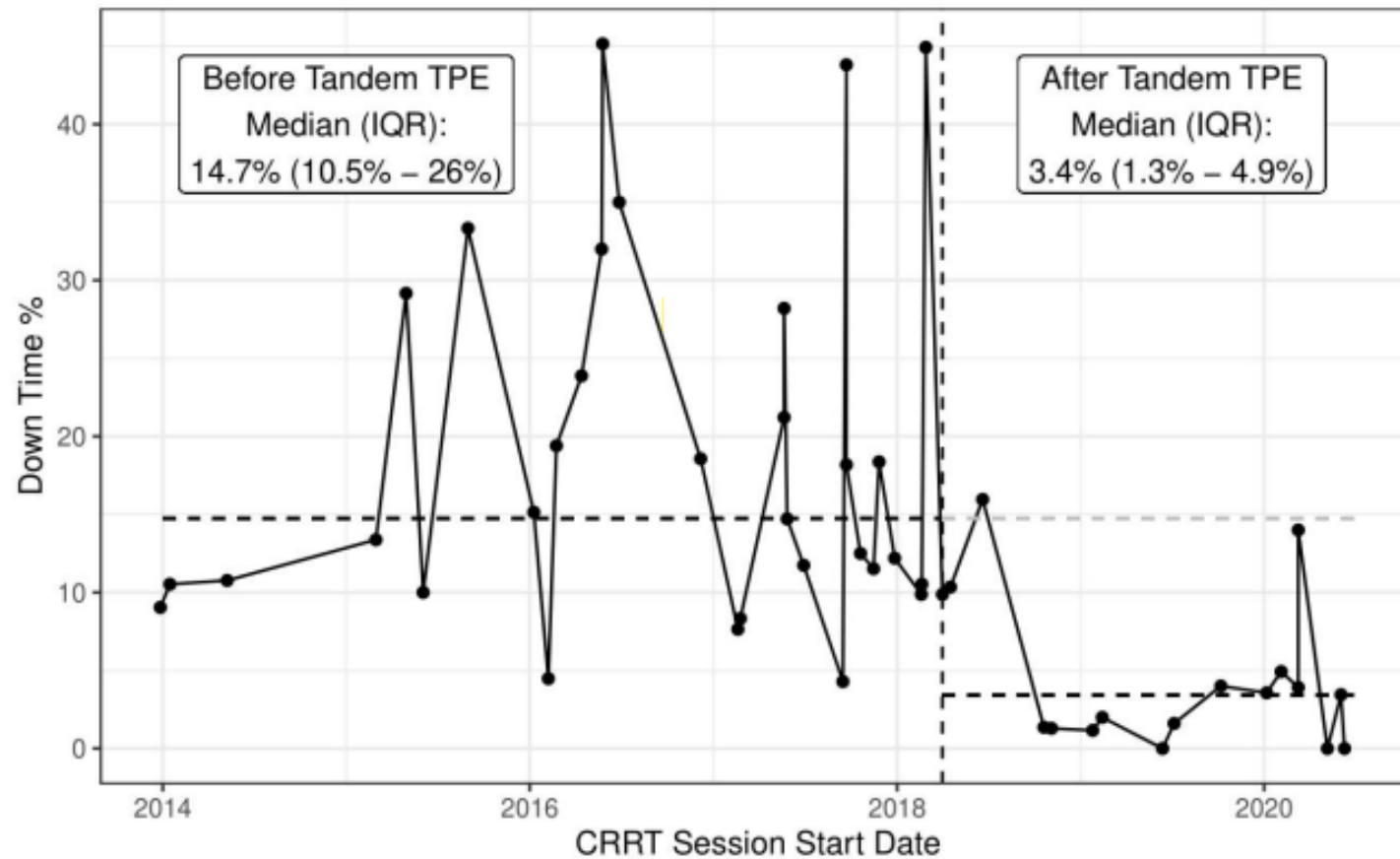
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Tandem Therapeutic Plasma Exchange Reduces Continuous Renal Replacement Therapy Downtime

Matthew J. Foglia^a Jonathan H. Pelletier^b Hülya Bayir^{a,b,c,d} Annette Fleck^{b,c}
Leslie Konyk^{b,c} Coleen McSteen^{b,c} Dawn Fisher^{b,c} Dana Y. Fuhrman^{a,b,c}



Tandem CRRT + Plasma Exchange



Considerations for Plasma Exchange in Children

The American Society for Apheresis Indications for plasma exchange are developed for adult patients

Clinical conditions where the benefit of plasma exchange has been published in children:

- Thrombocytopenia-associated multi-organ failure (TAMOF) and sepsis
- Liver failure
- Neurologic conditions
- Hemolytic uremic syndrome
- Post solid-organ rejection

Surviving sepsis campaign in Children 2020:

- “We cannot suggest for or against the use of PLEX in children with septic shock or other sepsis associated organ dysfunction with TAMOF”

Considerations for Plasma Exchange in Children

Use of Therapeutic Plasma Exchange in Children With Thrombocytopenia-Associated Multiple Organ Failure in the Turkish Thrombocytopenia-Associated Multiple Organ Failure Network

Esra Sevketoglu, MD¹; Dincer Yildizdas, MD²; Ozden Ozgur Horoz, MD²;
Hasan Serdar Kihdir, MD¹; Tanil Kendirli, MD³; Suleyman Bayraktar, MD⁴;
Joseph A. Carcillo, MD⁵

- Thrombocytopenia and new-onset organ failure of ≥ 3 organs
- Retrospective cohort analysis of patients with TAMOF at 3 PICUs in Turkey comparing those that received TPE and those that did not
- Inclusion: platelet count $\leq 100 \times 10^3/\mu\text{L}$, Organ Failure Index Score ≥ 3
- n=42

47.6% of patients meeting these criteria had AKI requiring CRRT

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TABLE 3. Multivariate Analysis of Survivors Versus Nonsurvivors

Descriptions	P	OR	95% CI	
			Lower	Upper
Not receiving plasma exchange	0.048	1.81	0.20	16.29
Pediatric logistic organ dysfunction day 1	0.684	0.97	0.86	1.11
Pediatric Risk of Mortality 24	0.013	1.74	1.13	2.69
Total OFI score	0.168	0.30	0.06	1.66
OFI Neurologic involvement ^a	0.599	0.03	0.001	1.12

Therapeutic Plasma Exchange in Children With Thrombocytopenia-Associated Multiple Organ Failure: The Thrombocytopenia-Associated Multiple Organ Failure Network Prospective Experience

James D. Fortenberry, MD, MCCM¹; Trung Nguyen, MD²; Jocelyn R. Grunwell, MD, PhD¹; Rajesh K. Aneja, MD³; Derek Wheeler, MD⁴; Mark Hall, MD⁵; Geoffrey Fleming, MD⁶; Rod Tarrago, MD⁷; Sandra Buttram, MD⁸; Heidi Dalton, MD⁹; Yong Han, MD¹⁰; Kirk A. Easley, MS¹¹; Andrea Knezevic, MS¹¹; Tian Dai, PhD¹¹; Matthew Paden, MD¹; Joseph A. Carcillo, MD³; for the Thrombocytopenia-Associated Multiple Organ Failure (TAMOF) Network Study Group

- Observational longitudinal cohort study including 81 children with sepsis-induced thrombocytopenia – associated multiple organ failure
- Compare outcomes in those that received therapeutic plasma exchange (TPE) to those that did not

TPE was associated with a decrease in organ dysfunction and lower 28 day all cause

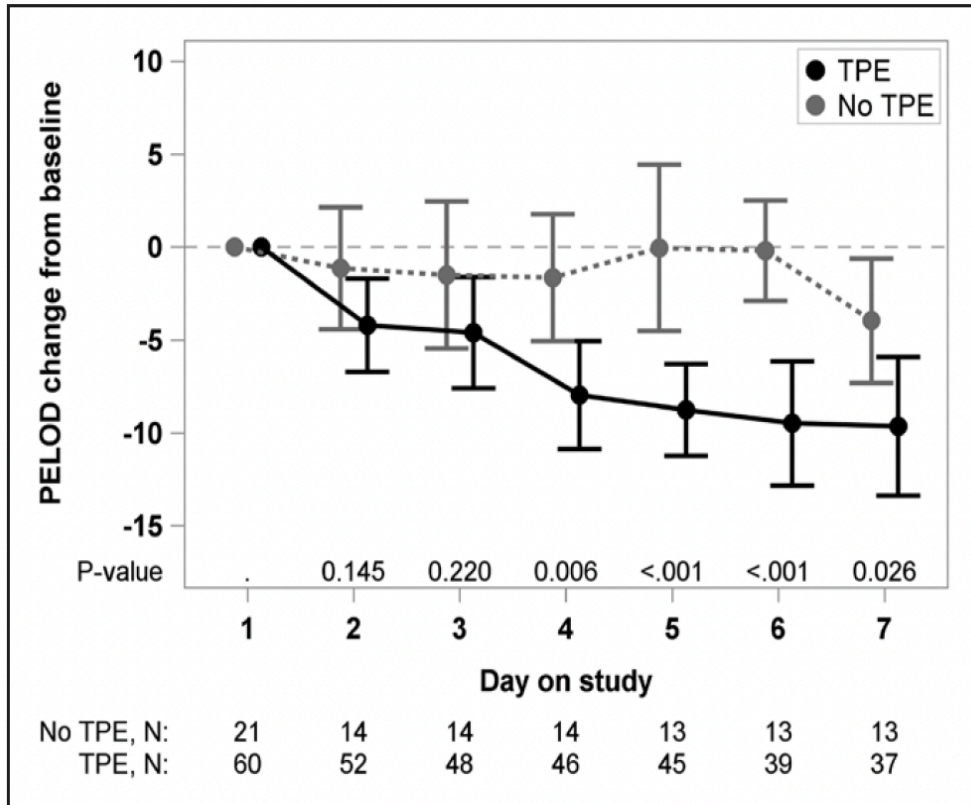


TABLE 3. Risk Factors for 28-Day All-Cause Mortality for 81 Children With Thrombocytopenia-Associated Multiple Organ Failure

Risk Factors	Regression Coefficient	SE	Adjusted Relative Risk	95% CI	p	% Reliability ^a
Standard multivariable analysis using modified Poisson regression						
TPE	-0.7954	0.3506	0.45	0.23-0.90	0.02	61
Baseline PELOD ^b	0.0519	0.0119	1.30	1.15-1.46	<0.001	99
Extracorporeal membrane oxygenation	0.2407	0.3229	1.27	0.68-2.40	0.46	17
Continuous renal replacement therapy	0.4663	0.3891	1.59	0.74-3.42	0.23	30
Methicillin-resistant <i>Staphylococcus aureus</i> infection	0.3044	0.2916	1.36	0.77-2.40	0.30	38
Propensity score adjusted with propensity score specified as a continuous covariate						
TPE	-0.7740	0.3808	0.46	0.22-0.97	0.04	-
Baseline PELOD ^b	0.0487	0.0130	1.28	1.12-1.45	<0.001	-
Propensity score adjusted with inverse probability of treatment weighting						
TPE	-0.7775	0.3256	0.46	0.24-0.87	0.02	-
Baseline PELOD ^b	0.0509	0.0142	1.29	1.12-1.48	<0.001	-

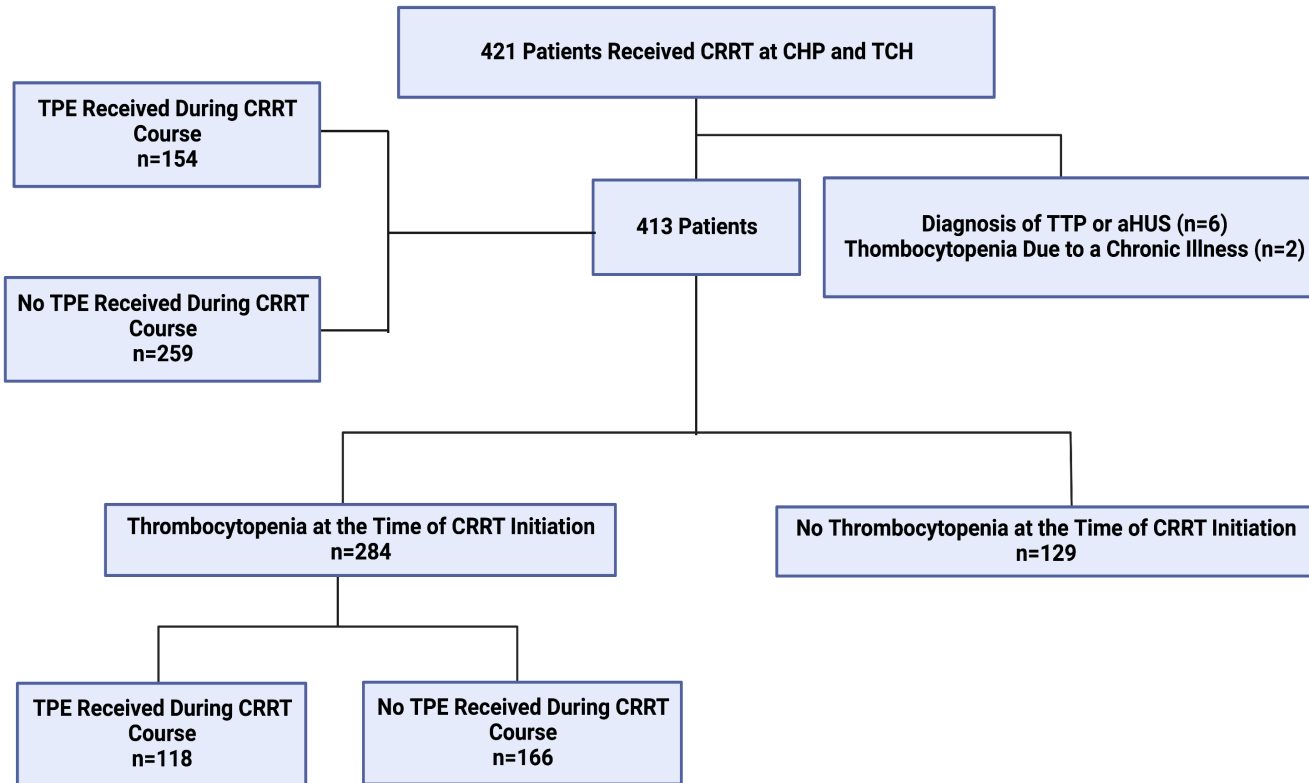
57% of patients on CRRT

Therapeutic Plasma Exchange Is Associated With Improved Major Adverse Kidney Events in Children and Young Adults With Thrombocytopenia at the Time of Continuous Kidney Replacement Therapy Initiation

Fuhrman, Dana Y. DO, MS¹⁻³; Thadani, Sameer MD⁴; Hanson, Claire MD¹; Carcillo, Joseph A. MD^{1,3}; Kellum, John A. MD³; Park, Hyun Jung PhD⁵; Lu, Liling MS⁶; Kim-Campbell, Nahmah MD, MS¹; Horvat, Christopher M. MD, MHA^{1,7}; Arikan, Ayse Akcan MD^{4,8}

Author Information

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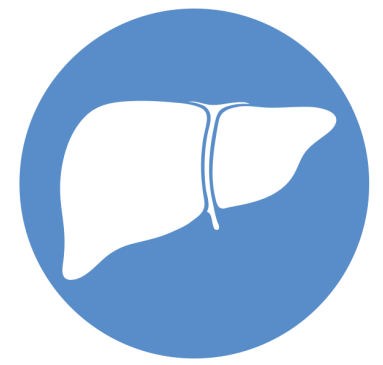


Multivariable Regression for MAKE-90

Characteristic (n=284)	Adjusted OR (95% CI); P-Value
Baseline Serum Creatinine	1.30 (0.79-2.13); 0.31
Chronic Kidney Disease	7.51 (0.94-59.73); 0.06
PELOD-2 Score at CKRT Initiation	1.10 (1.02-1.19); 0.02
Therapeutic Plasma Exchange During CRRT Course	0.35 (0.20-0.60); <0.001
MRSA During ICU Admission	1.87 (0.71-4.91); 0.21

In a propensity adjusted multivariable logistic regression (n=210) → adjusted OR (95% CI): 0.31 (0.16-0.59)

Plasma Exchange in Pediatric Liver Failure



- Clear protein-bound toxins, pro-inflammatory molecules and prothrombotic mediators
- American Society of Apheresis:
 - Use in liver failure: Category III Recommendation
 - Fulminant liver failure with hemolysis in Wilson's Disease: Category I Recommendation
- We use TPE to improve the coagulation profile
- Exchange 1.5 times the patient's calculated blood volume on day 1 followed by a single volume exchange on subsequent days
- There is no clear evidence in children regarding high volume vs standard volume plasma exchange

Combined Therapeutic Plasma Exchange and Continuous Renal Replacement Therapy in Children With Dengue-Associated Acute Liver Failure and Shock Syndrome: Single-Center Cohort From Vietnam*

Luan Thanh Vo, MD¹

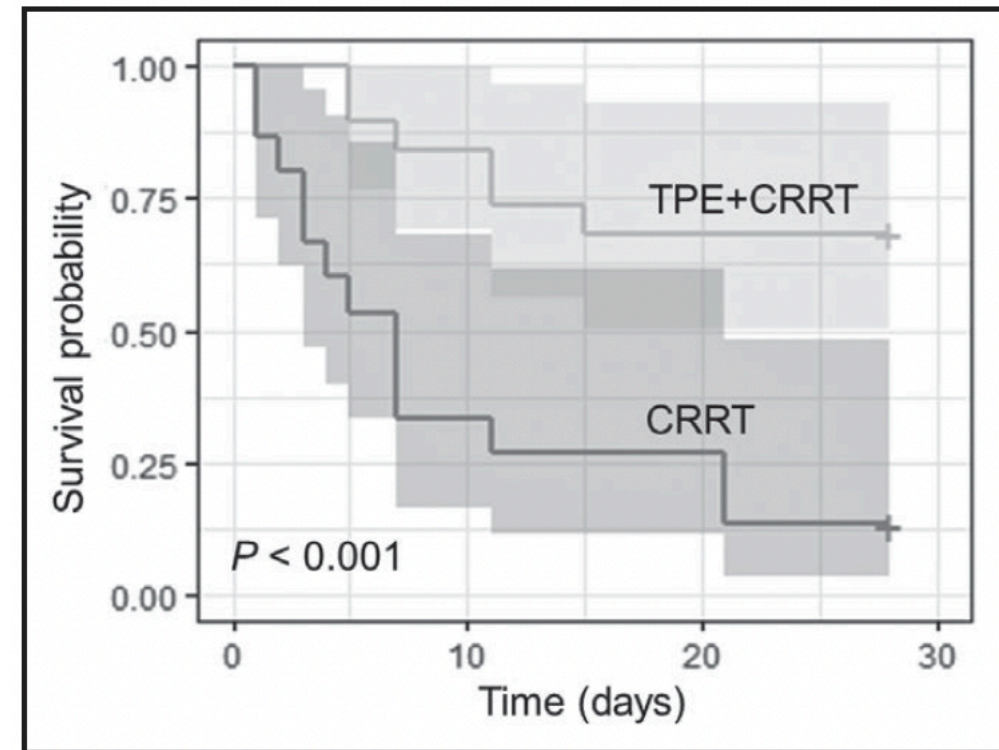
Viet Chau Do, MD¹

Tung Huu Trinh, MD¹

Thien Vu, PhD^{2,3}

Thanh Tat Nguyen, MD^{1,4}

- N=35 children with dengue-associated acute liver failure and shock
- Combined plasma exchange and CRRT was associated with improvements in encephalopathy, liver transaminases, coagulation profiles and blood lactate and ammonia levels



Conclusions

The use of plasma exchange is growing both in pediatric and adult populations

Plasma exchange may be necessary in critically ill patients, some of whom may also require CRRT

The use of tandem techniques for plasma exchange and CRRT can increase the ease of therapy

There may be utility in pediatric MODS/Sepsis

Thank you!



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