Scenario 3: Dialisi pediatrica e dell'adulto e connessione all'apparecchio ECMO

CRRT
Questione di EQUIPE!
Videoconferenza LIVE per
INFERMIERI
NEFROLOGI
INTENSIVISTI ...
e tutti i Medici in Formazione Specialistica!
XII Edizione

20-21 aprile 2021

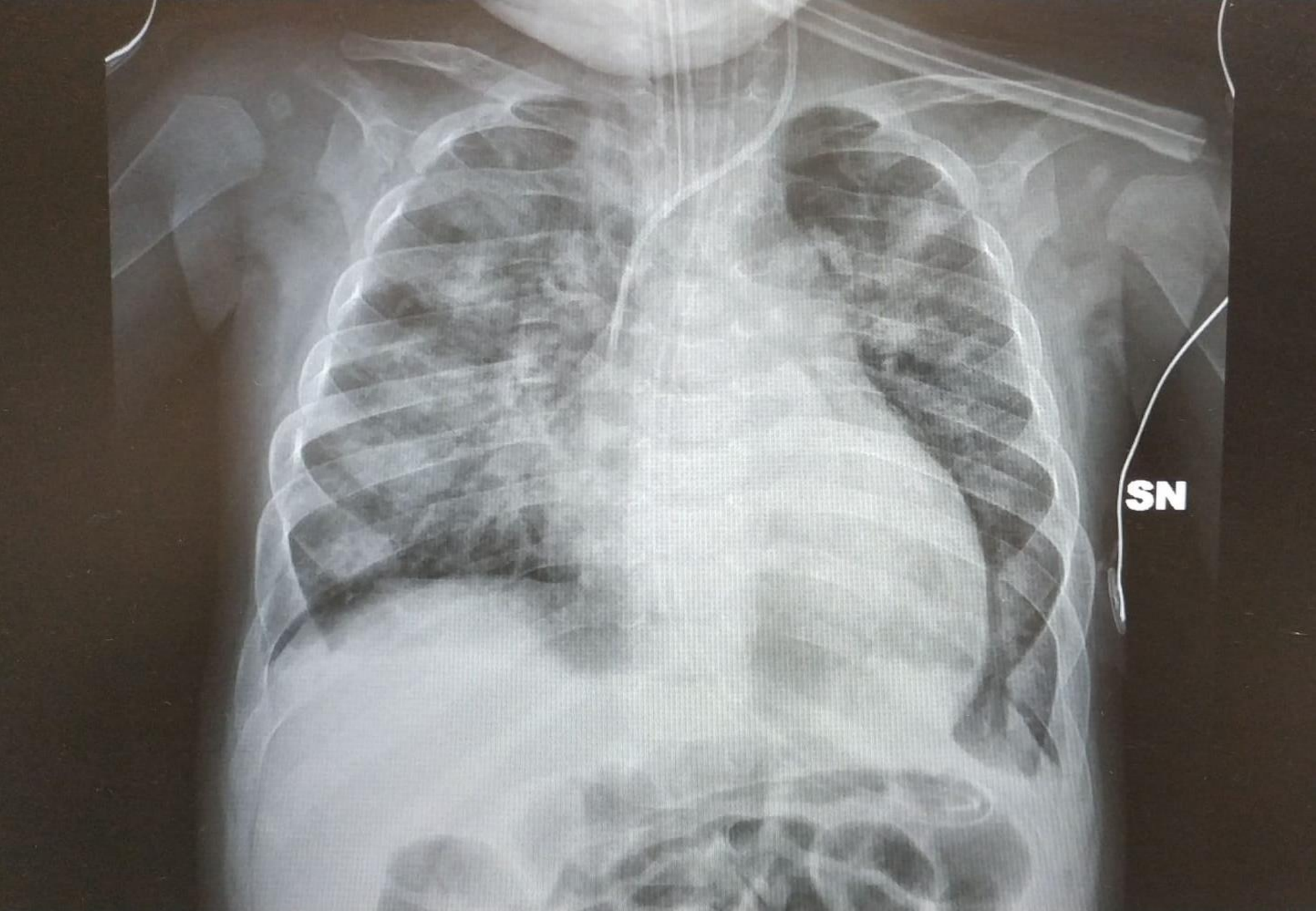
Z. Ricci
Azienda Universitario-Ospedaliera Meyer, Firenze

SCUOLA DI SPECIALIZZAZIONE IN ANESTESIA, RIANIMAZIONE TERAPIA INTENSIVA E DEL DOLORE
UNIVERSITÀ DEGLI STUDI FIRENZE

MEYER
con cura e con passione

CASO CLINICO

- Paziente di 6 mesi, 5 kg (ex-prematuro 25 settimane, 550 g alla nascita)
- Disfunzione ventricolare destra severa e segni ecografici di pressione polmonare elevata (possibilmente sistemica)
- In terapia cronica con diuretico e vasodilatatore polmonare e antiaggregante
- RICOVERO PER BRONCHIOLITE e quadro febbrile (39 C°)


SN

CASO CLINICO

- Creatinina basale 0.8 m/dl, PCR 25 mg/dL
- Necessità di intubazione e ventilazione
- Riempimento fluidico per ipotensione con sovraccarico (F.O.) del 8%
- Antibiotico-terapia empirica con vancomicina e pip/tazo
- Richiesto cateterismo per valutazione ipertensione polmonare e/o angio TC
- Diuresi < 1 ml/kg/h

EPIDEMIOLOGIA DELLA PCRRT

AWARE: 1.5% of admitted patients (no neonates, no cardiac surgery)

AWAKEN: 1% of admitted neonates (no cardiac surgery)

PICANet: 2.9% of admitted patients (from 0 to 8.6%)

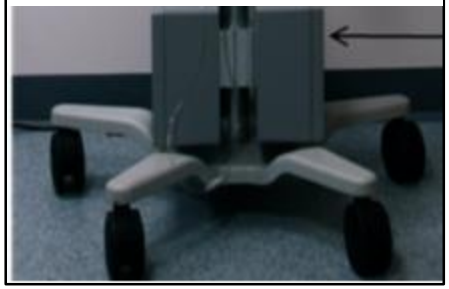
DMCCP: 2% (1.3-2.5%, including ECMO patients)

Non-Infant Specific 3rd/4th generation CRRT

Infant-Specific/Adapted Devices

Cardio Renal Pediatric Dialysis Emergency Machine (CARPEDIEM)

Newcastle Infant Dialysis and Ultrafiltration System (NIDUS)



Aquadex FlexFlow


129
23
C
STOP

CARPEDIEM:
CArdio Renal PEDIatric Emergency Machine

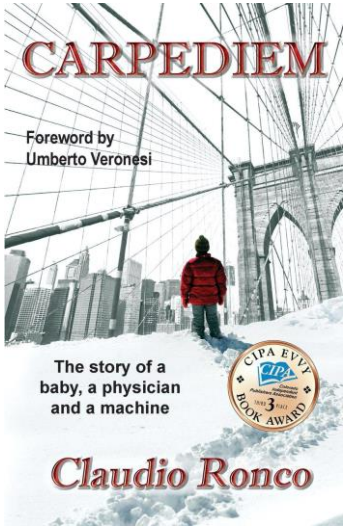
Pediatric patients
in the range of 2-10 kgs
(approximate BSA of 0.15–0.5 m^2)

DESIGNED BY THE **INTERNATIONAL RENAL RESEARCH INSTITUTE** (2011)


DIRETTORE U.O.


Carpediem

EVOLUZIONE DEL PROGETTO



2011: PRODUZIONE DEL PRIMO PROTOTIPO

2014: PRIMO TRATTAMENTO

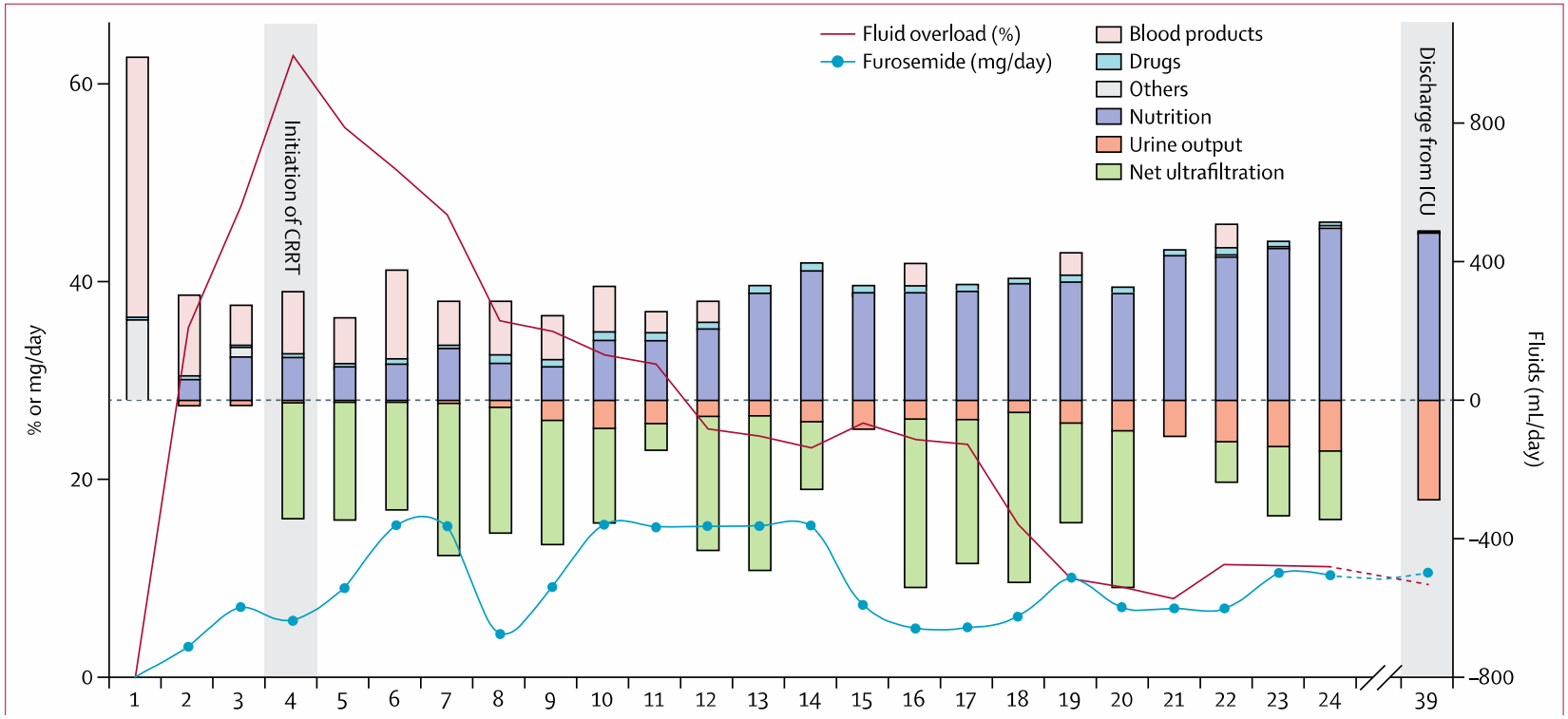
2014-2019: PUBBLICAZIONE DI 13 lavori e successivo sviluppo

2015: Pubblicazione del libro

2020: APPROVAZIONE FDA

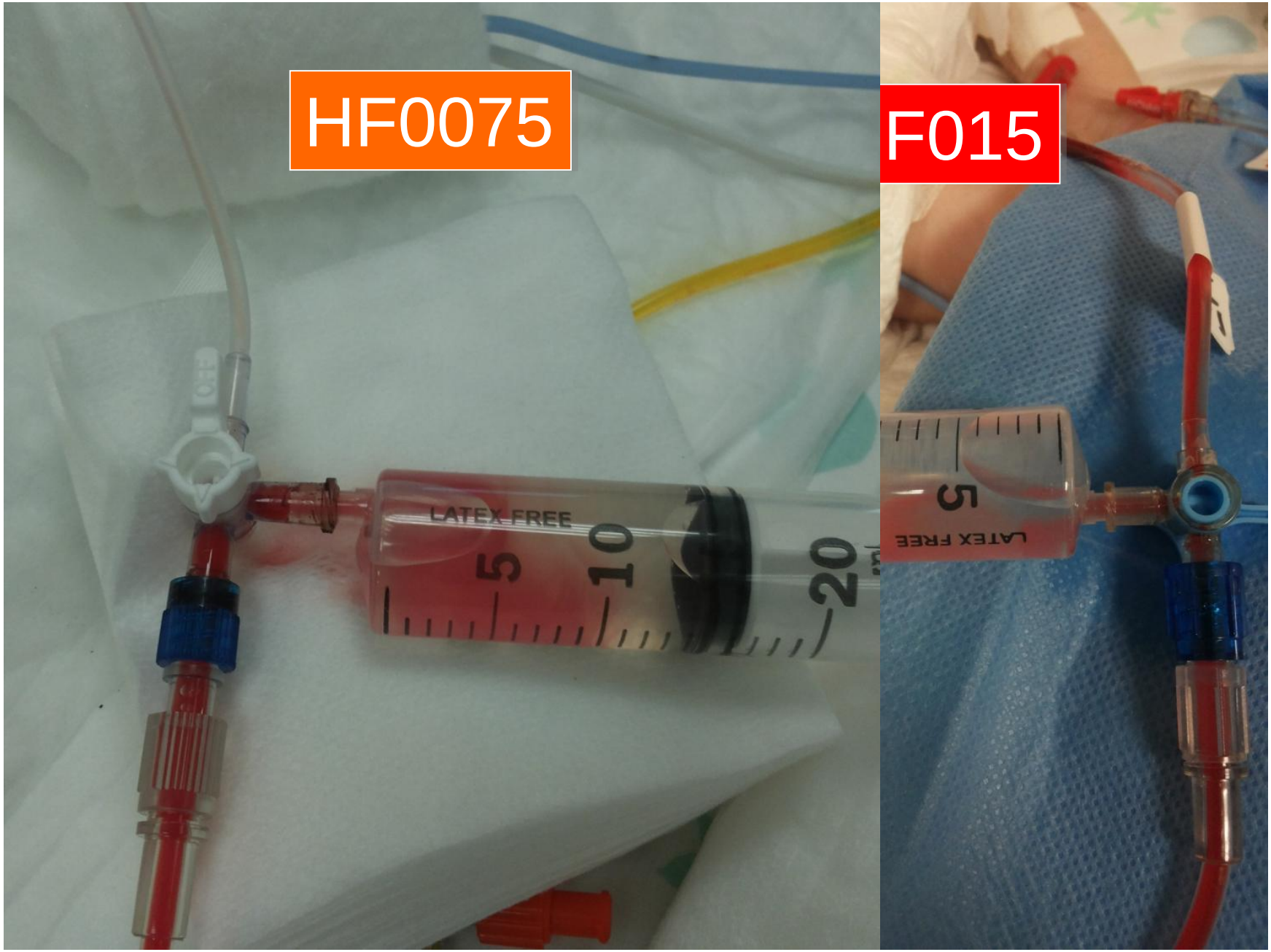
Continuous renal replacement therapy in neonates and small infants: development and first-in-human use of a miniaturised machine (CARPEDIEM)

Claudio Ronco, Francesco Garzotto, Alessandra Brendolan, Monica Zanella, Massimo Bellettato, Stefania Vedovato, Fabio Chiarenza, Zaccaria Ricci, Stuart L Goldstein



Creatinine: 0.5 2.0 1.4 0.6 1.59

Lancet, May 2014


HF0075
LATEX FREE
5
10
20
F015
LATEX FREE
5

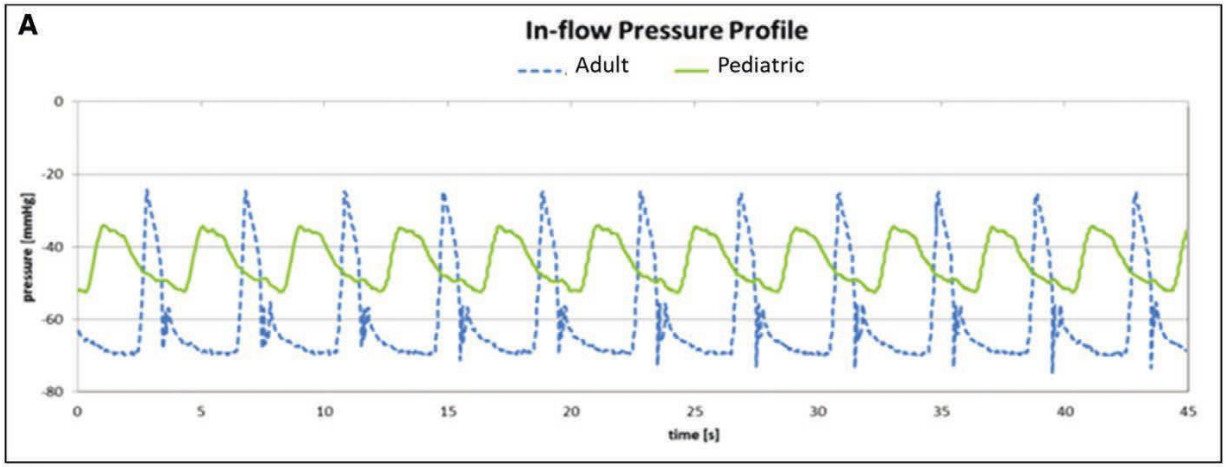

CARPEDIEM

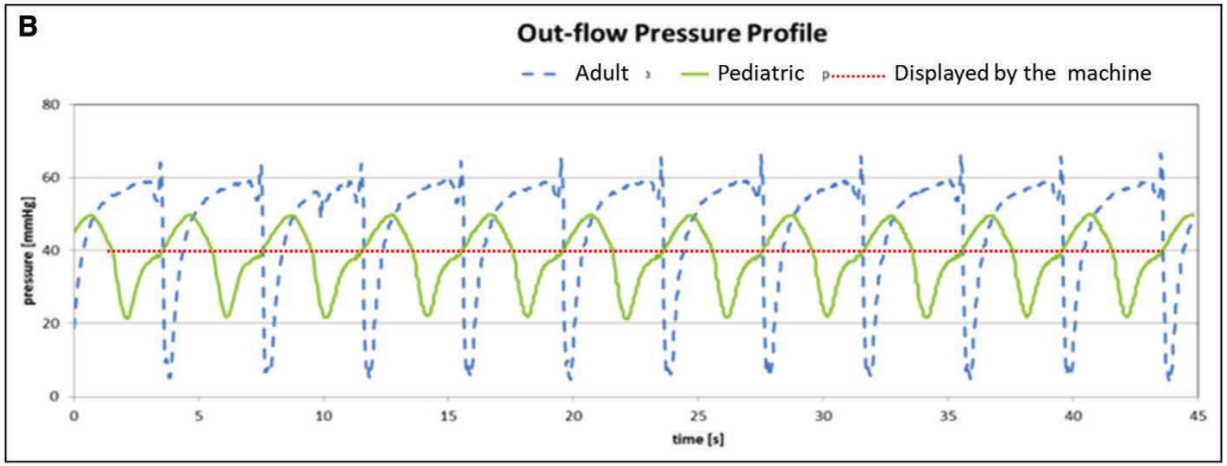

CARPEDIEM
CVVHD
13:52:45
Nessun allarme
20 ml/min
8 g
0.4 ml
Parametri Trattamento
Standby
Dati Trattamento
Allarmi e Bilance
Eparina Continua
Fine Trattamento
-45
25
45
bellco
START
STOP

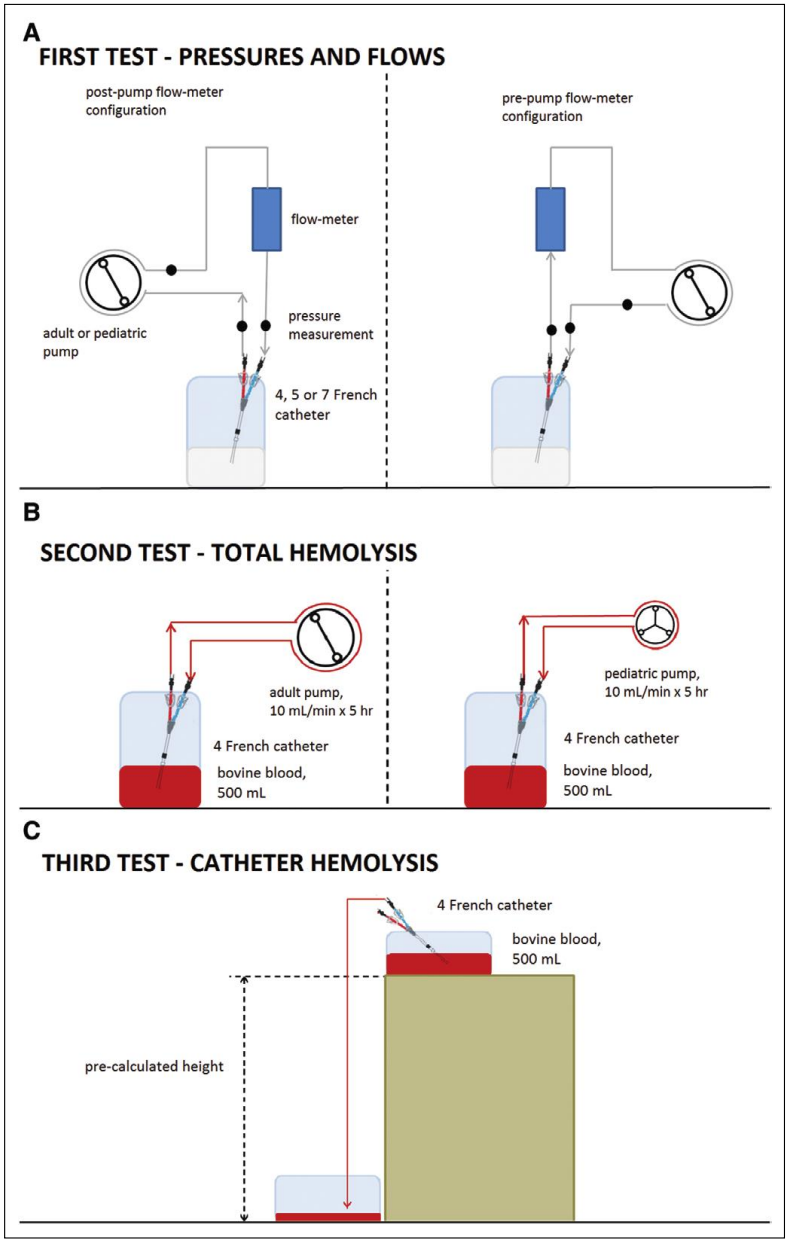
Choice of Catheter Size for Infants in Continuous Renal Replacement Therapy: Bigger Is Not Always Better

PCCM 2019

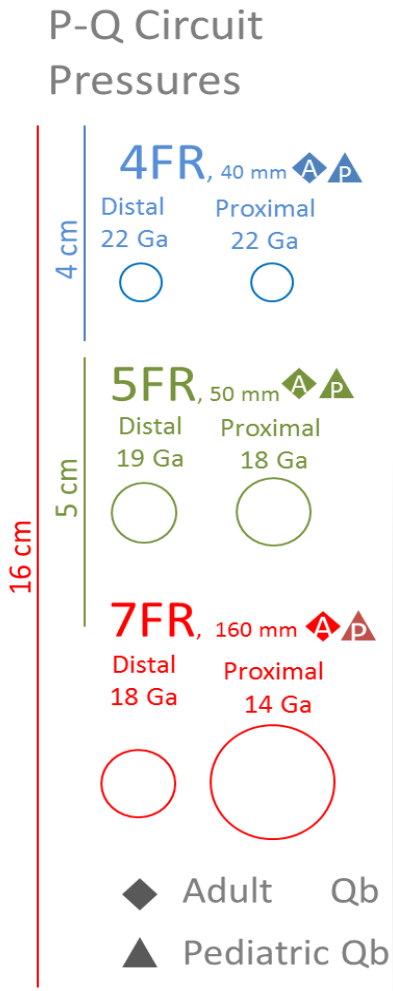
Francesco Garzotto, MSc[1–3]; Marta Zaccaria, MSc[4]; Enrico Vidal, MD, PhD[5]; Zaccaria Ricci, MD[6]; Anna Lorenzin, MSc[4]; Mauro Neri, MSc[4]; Luisa Murer, MD[5]; Federico Nalesso, MD, PhD[3,4]; Alfredo Ruggeri, MSc[7]; Claudio Ronco, MD[3,4]

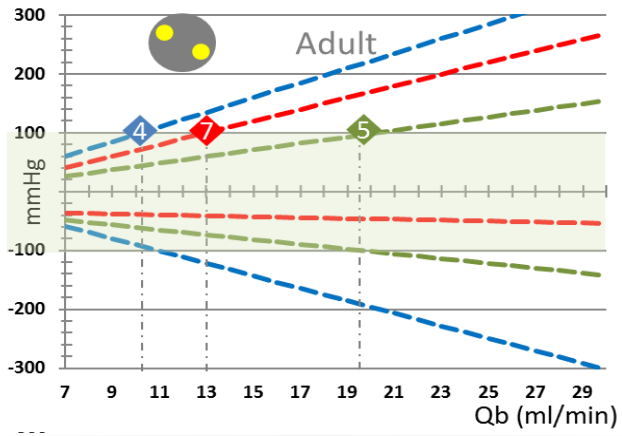






Adult VS Miniaturized Pump





The 3 roller miniaturized pump significantly optimized flows of 5 Fr bilumen catheters within the safety area (green)

Garzotto F et al, PCCM 2019

INFANT CRRT CIRCUITS: PRISMAFLEX® vs CARPEDIEM®

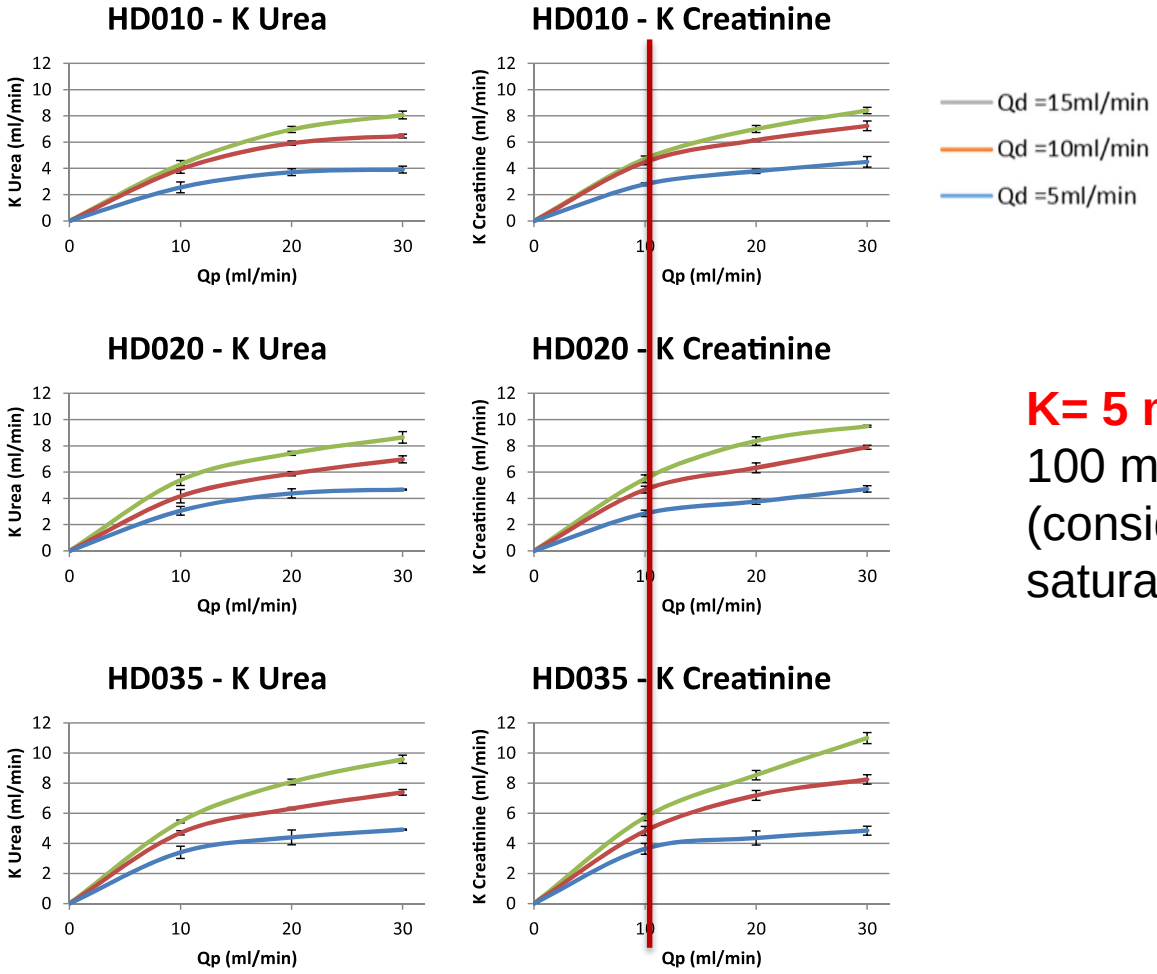
	Priming volume	Qb ml/min	Max net UF	Rep rate range (ml/h)	UF rate super vision	weight super vision	AVAILABLE MODALITY	Fluid gravimetric control
Prismaflex® HF20 (0,20 m²)	59 ml	10-100	none	0-500	TMP alarm	≤ 7 g	CVVH (pre+post), CVVHD, CVVHDF	±20 g *immediate* Or ±60 ml/*last 3 hrs*
Carpediem® 025 (0,25 m²)	41 ml	2-50	1000 ml/24 h	0-600	20% of Qb	1 g	CVVH (pre OR post), CVVHD	Steps from 4 to max 30 g
Carpediem® 015 (0,147 m²)	33 ml	2-20	1000 ml/24 h	0-240	20% of Qb	1 g	CVVH (pre OR post), CVVHD	Steps from 4 to max 30 g
Carpediem® 0075 (0,075 m²)	27 ml	2-15	1000 ml/24 h	0-150	20% of Qb	1 g	CVVH (pre OR post), CVVHD	Steps from 4 to max 30 g

STRICT EFFLUENT LIMITATION TO 20% BLOOD FLOW RATE!!!!!

CVVHD treatment with CARPEDIEM: small solute clearance at different blood and dialysate flows with three different surface area filter configurations

PED NEPH 2016

Anna Lorenzin[1] &Francesco Garzotto[1] &Alberta Alghisi[2] &Mauro Neri[1] &
Dario Galeano[1] &Stefania Aresu[3] &Antonello Pani[3] &Enrico Vidal[4] &Zaccaroa Ricci[5] &
Luisa Murer[4] &Stuart L. Goldstein[6] &Claudio Ronco[1,2,3,4,5,7]



K= 5 ml/min in a 3 kg pt=
100 ml/kg/h
(considering a 100% saturation of the dialysate….)

TPE in pediatric CHD pts?

1. Hyperbilirubinemia in pts already undergoing CRRT (liver failure, neonatal jaundice, associated liver disease)
2. Sepsis with thrombocytopenia (in anuric patients)
3. Immuno-mediated HTx rejection

Therapeutic Plasma Exchange in Neonates and Infants: Successful Use of a Miniaturized Machine

BPU 2017

Enrico Vidal[a] Francesco Garzotto[b, d] Mattia Parolin[a] Chiara Manenti[d, e]
Anna Zanin[c] Massimo Bellettato[c] Giuseppe Remuzzi[f] Stuart L. Goldstein[g]
Luisa Murer[a] Claudio Ronco[b, d]

Table 1. Patients' characteristics and therapeutic plasma exchange parameters

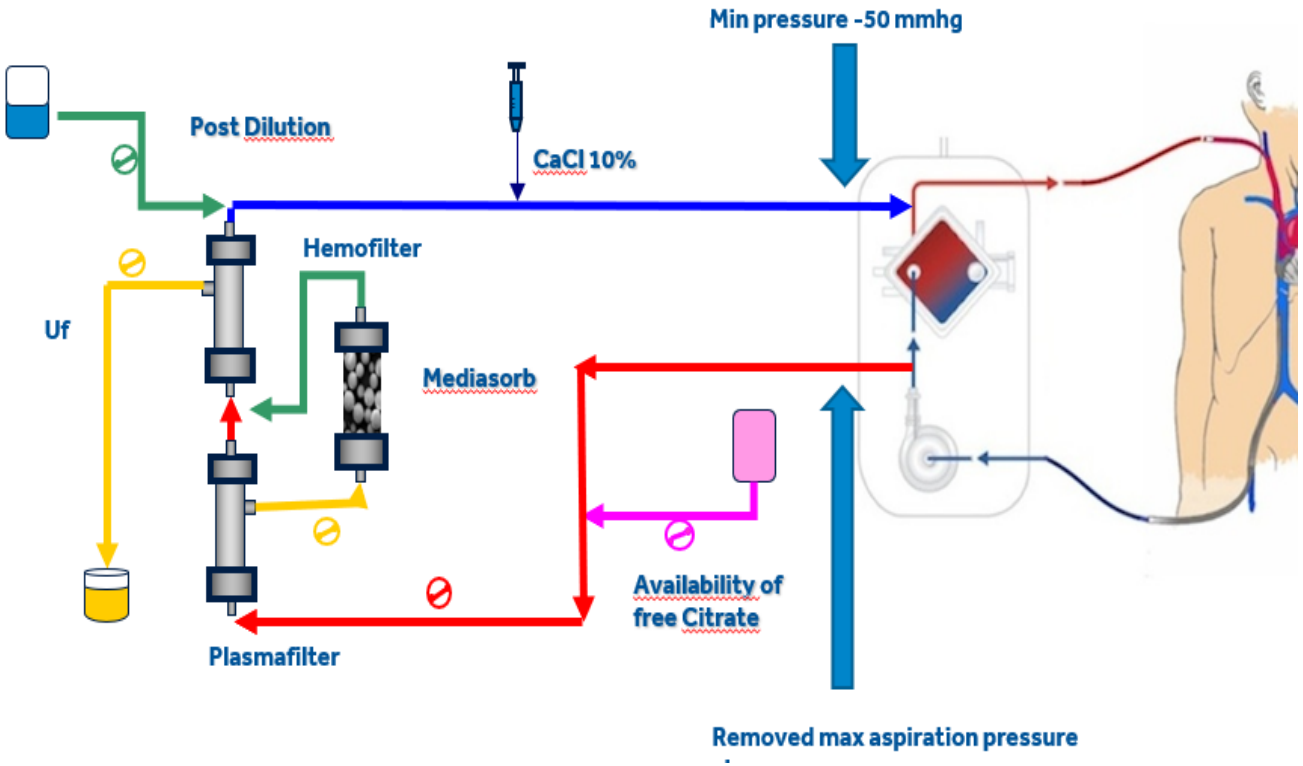
	Case 1	Case 2
Age (days of life), years	10	45
Body weight at birth, g	3,165	2,765
Body weight at TPE start, g	3,960	3,490
Indication	Severe hyperbilirubinemia	Atypical hemolytic-uremic syndrome
Central venous catheter		
Site	4 Ch	5 Ch
Size	Right femoral vein	Right jugular vein
Lenght	5 cm	5 cm
TPE parameters		
Replacement fluid	Fresh frozen plasma	Fresh frozen plasma
Replacement volume, mL	270	200
Plasmafilter (surface area)	Plasmart 05 (0.05 m^2)	Plasmart 05 (0.05 m^2)
Qb, mL/min	12	10
Exchange rate – Q_P, mL/min	1.2	1
In-flow pressure – P_{IN}, mm Hg	–115 to –80	–100 to –80
Out-flow pressure – P_{OUT}, mm Hg	105 to 125	55 to 75
Drop pressure, mm Hg	10 to 15	20 to 35
Alarms	None	None
Priming lines		
Volume, mL	34	50
Solution	Normal saline	4% albumin
Anticoagulation		
Heparin bolus, U/kg	0	20
Heparin infusion, U/kg/h	7	15
Number of TPE sessions performed	4	5
Technical and/or clinical complications	None	None
Outcome	Normal psychomotor development chronic renal failure	Normal renal function

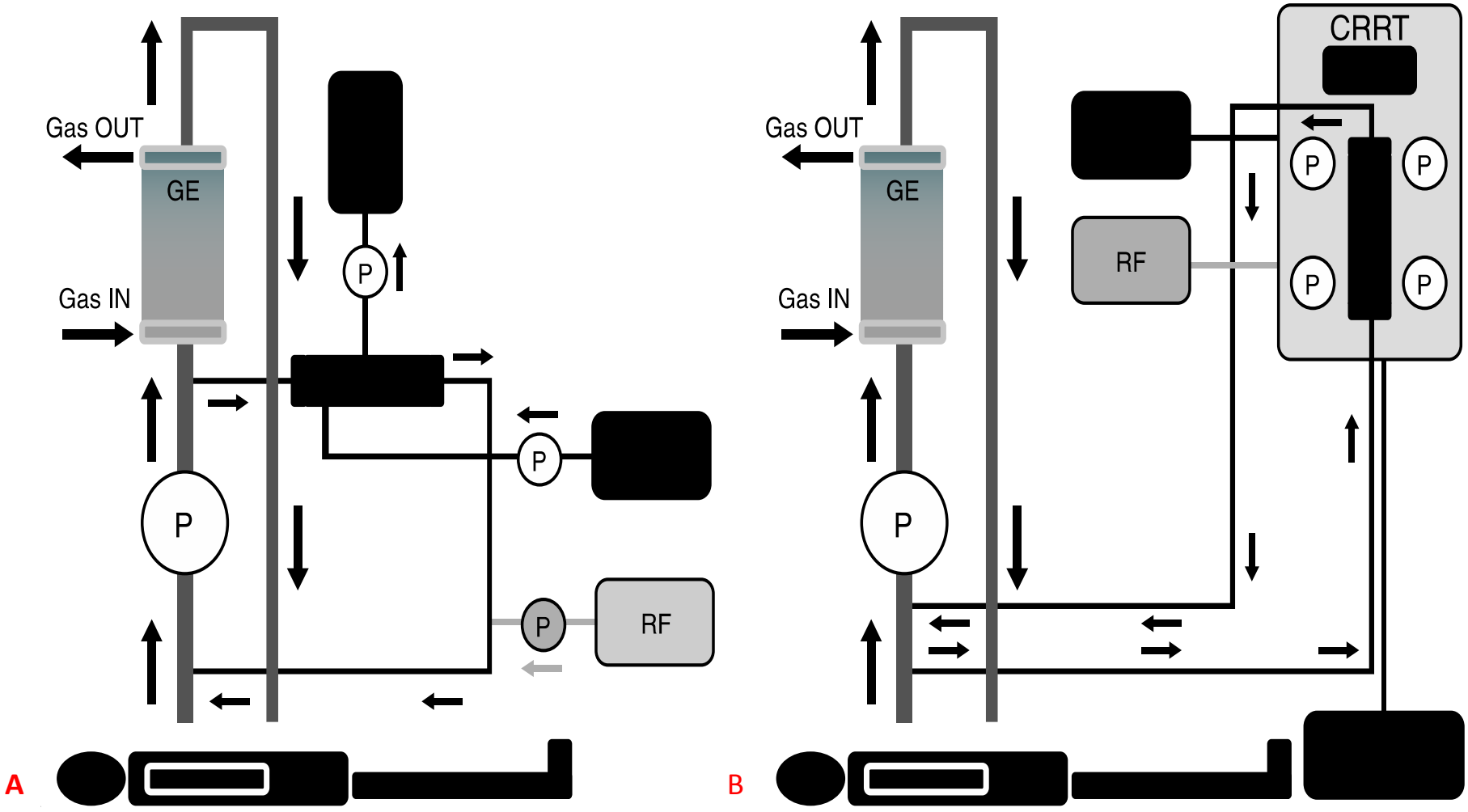
CASO CLINICO

- Desaturazione severa (<85%) con peggioramento della disfunzione ventricolare destra e bassa gittata refrattaria a terapia vasoattiva
- ECMO V-A
- Necessità di proseguire la CRRT

❑Connessione ECMO

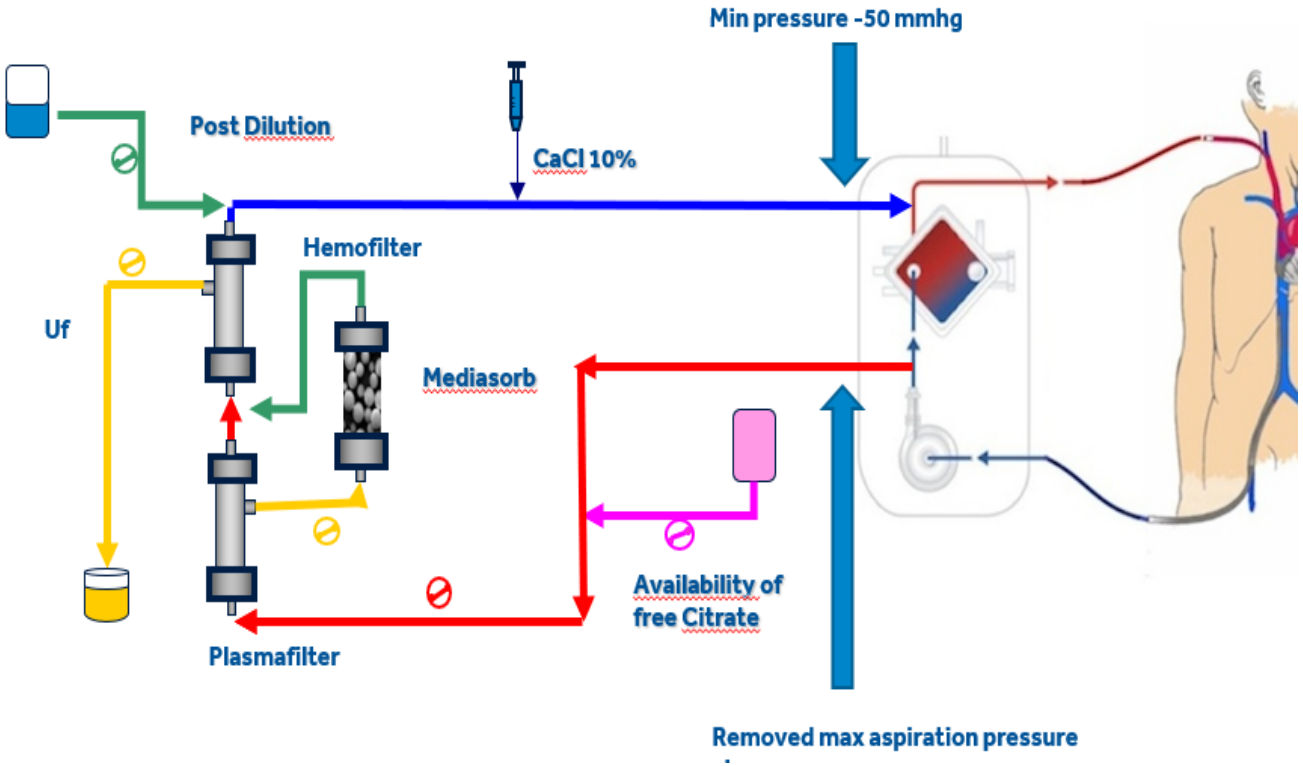
Tutti i TRATTAMENTI disponibili sono applicabili in modalità ECMO




Gas OUT
GE
Gas IN
P
P
P
P
RF
A
CRRT
Gas OUT
GE
Gas IN
RF
P
P
P
P
P
B

❑Connessione ECMO

Tutti i TRATTAMENTI disponibili sono applicabili in modalità ECMO



Continuous Renal Replacement Therapy in Venovenous Extracorporeal Membrane Oxygenation: A Retrospective Study on Regional Citrate Anticoagulation

ASAIO 2019

Marco Giani,* Vittorio Scaravilli,† Flavia Stefanini,‡ Gabriele Valsecchi,‡ Roberto Rona,* Giacomo Grasselli,†§ Giacomo Bellani,*‡ Antonio M. Pesenti,†§ and Giuseppe Foti*‡

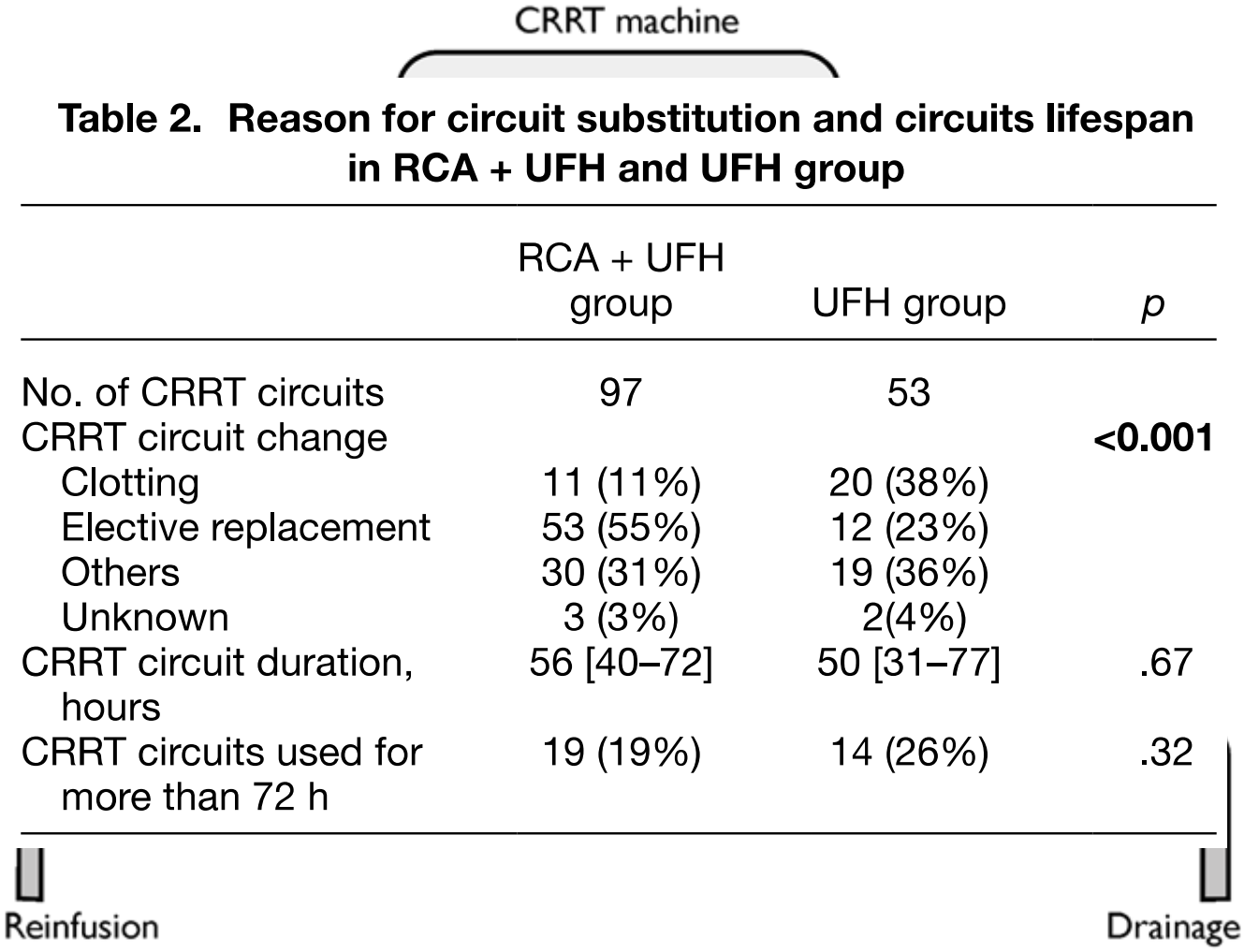
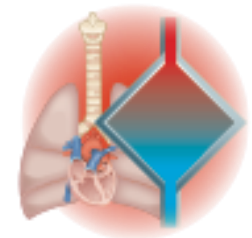


Table 2. Reason for circuit substitution and circuits lifespan in RCA + UFH and UFH group

	RCA + UFH group	UFH group	*p*
No. of CRRT circuits	97	53	
CRRT circuit change			**<0.001**
Clotting	11 (11%)	20 (38%)	
Elective replacement	53 (55%)	12 (23%)	
Others	30 (31%)	19 (36%)	
Unknown	3 (3%)	2(4%)	
CRRT circuit duration, hours	56 [40–72]	50 [31–77]	.67
CRRT circuits used for more than 72 h	19 (19%)	14 (26%)	.32

-Clotting: increase of pressure across the filter (*e.g.* pressure drop > 150 mmHg) or presence of visible clots that required circuit replacement to continue CRRT treatment
-Unscheduled change: before 72 hours uninterrupted CRRT

- 48 patients CRRT during vv-ECMO in the study period.
- CRRT circuit clotting was 11% in the 22 RCA + UFH group *vs.* 38% in the 15 UFH group ($p < 0.001$). -11 received both and were exclud-
- No complication with citrate anticoagulation

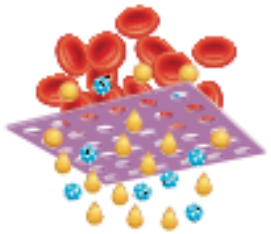


ECMO

Risk of
- Oxygenator clotting
- Pulmonary embolism during VV-ECMO
- Arterial embolism during VA-ECMO

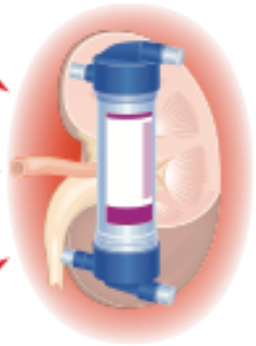
$ECCO_2R$

Risk of
- Oxygenator clotting
- Pulmonary embolism during AV-$ECCO_2R$



Plasmapheresis

- Loss of micronutrients / antibiotics / catecholamines
- Volume expansion with necessity of UFR adjustment
- Increased coagulability with use of FFP
- Allergic reaction to substitute solution



RRT

RRT clinical alterations
- Loss of micronutrients / antibiotics / catecholamines
- Hypophosphataemia
- Risk of hemolysis, thrombosis and DIC when connected to ECOS circuits
- Risk of Na overload, hypocalcaemia, metabolic alcalosis/acidosis during RCA

RRT technical issues
- Flow turbulence
- Circuit pressures alteration
- Malfunction of the system

ARTIFICIAL-ARTIFICIAL ORGAN INTERACTION

Courtesy of dr Faeq Husain-Syed

CONCLUSIONE

- Problema cardio-polmonare in paziente pediatrico
- Sindrome cardio-renale di tipo 1 e 2
- Necessità di MULTI-ORGAN SUPPORT
- Evoluzione delle moderne piattaforme al fine di adattarsi alle esigenze di differenti pazienti nelle diverse fasi cliniche di malattia
- **NECESSITA' DI GESTIRE CRRT pediatrica con apparecchi dedicati e non adattati**