Scenario 2: Fluid overload: il concetto di ultrafiltrazione netta, aspetti di nomenclatura, come impostarla, come calcolarla, significato clinico della negativizzazione del bilancio (OMNI) - S. Romagnoli

Stefano Romagnoli, MD, PhD

UO di Nefrologia, Dialisi e Trapianto Renale
Ospedale San Bortolo - ULSS 8 Berica
International Renal Research Institute Vicenza (IRRIV)

Università degli Studi di Padova

IRRIV International Renal Research Institute Vicenza

CRRT
Questione di EQUIPE!

Videoconferenza LIVE per
INFERMIERI
NEFROLOGI
INTENSIVISTI ...
e tutti i Medici in Formazione Specialistica!
XI Edizione

Università degli Studi Firenze
SCUOLA DI SPECIALIZZAZIONE IN
ANESTESIA, RIANIMAZIONE, TERAPIA INTENSIVA E DEL DOLORE
UNIVERSITÀ DI FIRENZE

SITI ISIC
Società Italiana di Terapia Intensiva
Italian Society of Intensive Care
FONDATA NEL 1975

15-16 giugno 2020

Dip. di Scienze della Salute – Università di Firenze
Dip. di Anestesia e Rianimazione - AOU Careggi - Firenze


blood flow
arteriole
red blood cell
capillary
oxygen and nutrients
wastes
venule
blood flow
interstitial fluid
tissue cell

The NEW ENGLAND JOURNAL of MEDICINE

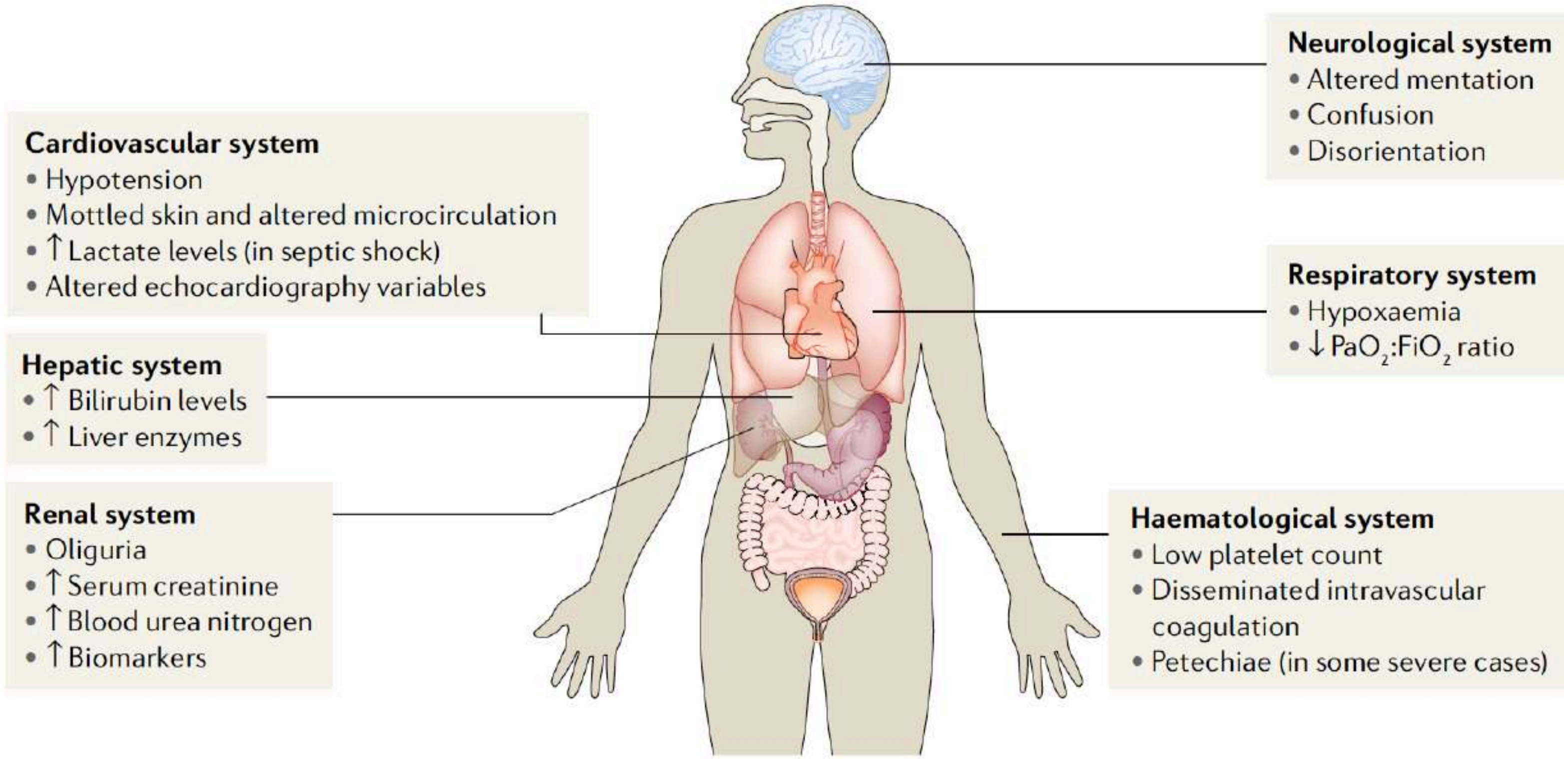
REVIEW ARTICLE

N Engl J Med 2013;369:1726-34.

	Salvage	Optimization	Stabilization	De-escalation
Phase Focus	Obtain a minimal acceptable blood pressure	Provide adequate oxygen availability	Provide organ support	Wean from vasoactive agents
	Perform lifesaving measures	Optimize cardiac output, SvO_2, lactate	Minimize complications	Achieve a negative fluid balance

Circulatory Shock

Jean-Louis Vincent, M.D., Ph.D., and Daniel De Backer, M.D., Ph.D.

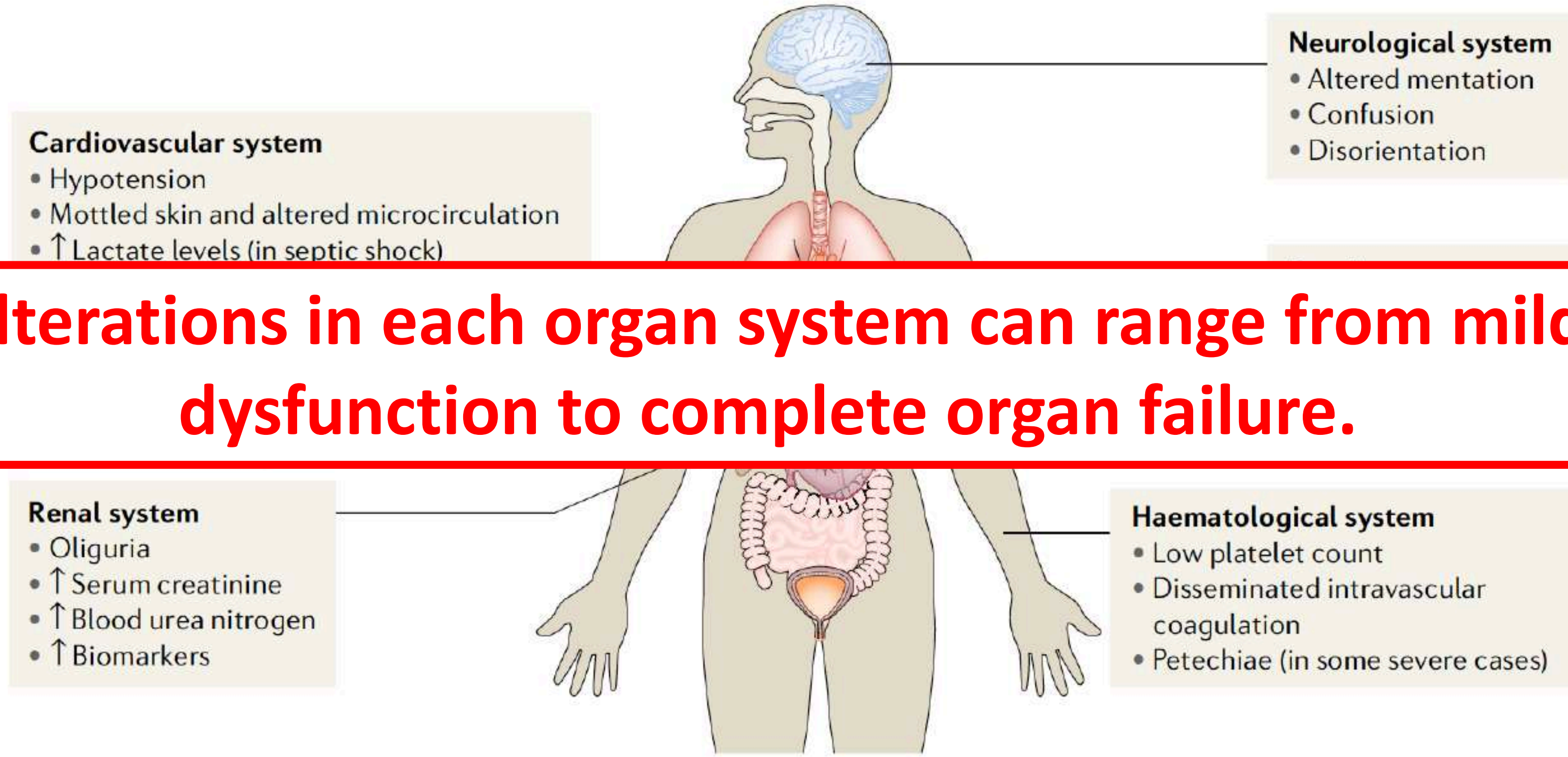


… six organ systems are usually evaluated in clinical practice and have been the most widely studied:

- Cardiovascular
- Respiratory
- Renal
- Neurological
- Haematological
- Hepatic systems

*Christophe Lelubre[1,2] and Jean-Louis Vincent[3]**

NATURE REVIEWS | NEPHROLOGY VOLUME 14 | JULY 2018 | 417



Alterations in each organ system can range from mild dysfunction to complete organ failure.

… six organ systems are usually evaluated in clinical practice and have been the most widely studied:

- Cardiovascular
- Respiratory
- Renal
- Neurological
- Haematological
- Hepatic systems

*Christophe Lelubre[1,2] and Jean-Louis Vincent[3]**

NATURE REVIEWS | NEPHROLOGY VOLUME 14 | JULY 2018 | 417

Renal replacement therapy and the support of multiple organ dysfunction

1 Fluid balance

Optimization of fluid balance is a central component of the management of critically ill patients, for example to **reduce the need for mechanical ventilation** or **reduce right ventricular filling pressure** in the context of heart failure.

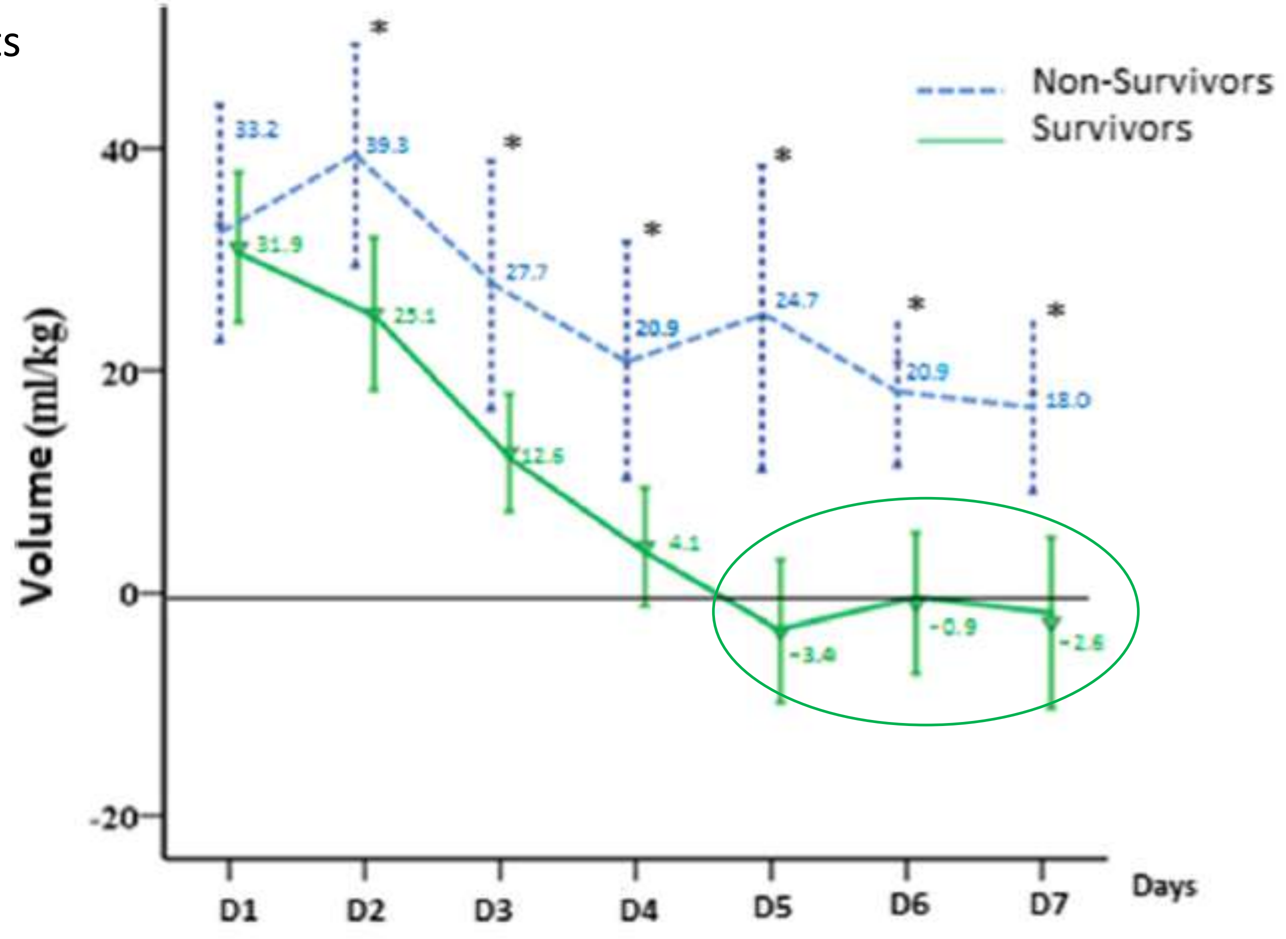
Costanzo MR et al. J Am Coll Cardiol 2017; 69:2428–2445

Early renal support may resolve fluid overload by achieving better sodium removal per unit volume than diuretic therapy.

This may improve **cardiopulmonary function** and long term outcomes; it may also facilitate nutritional support and drug delivery.

A positive fluid balance is an independent prognostic factor in patients with sepsis

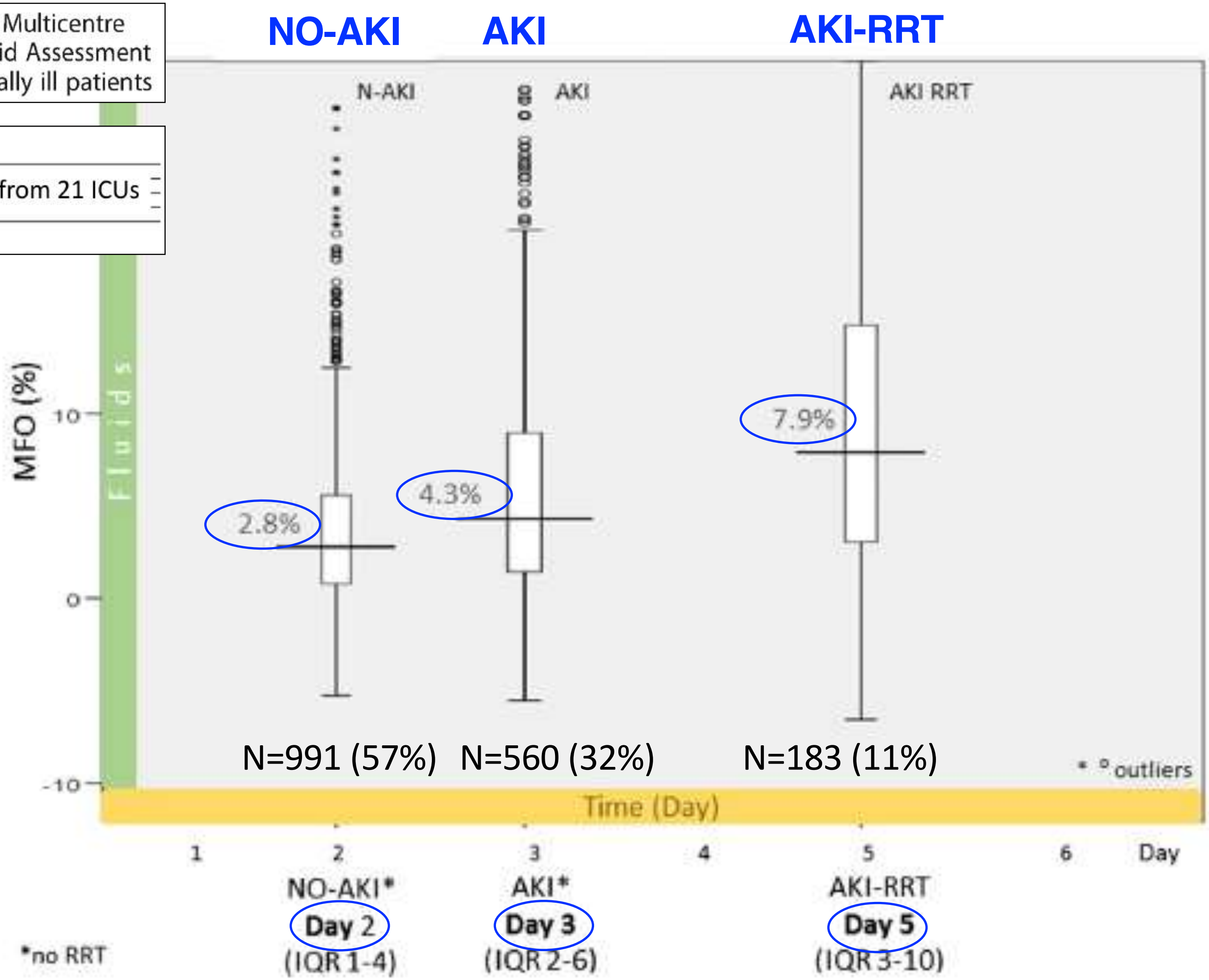
173 patients



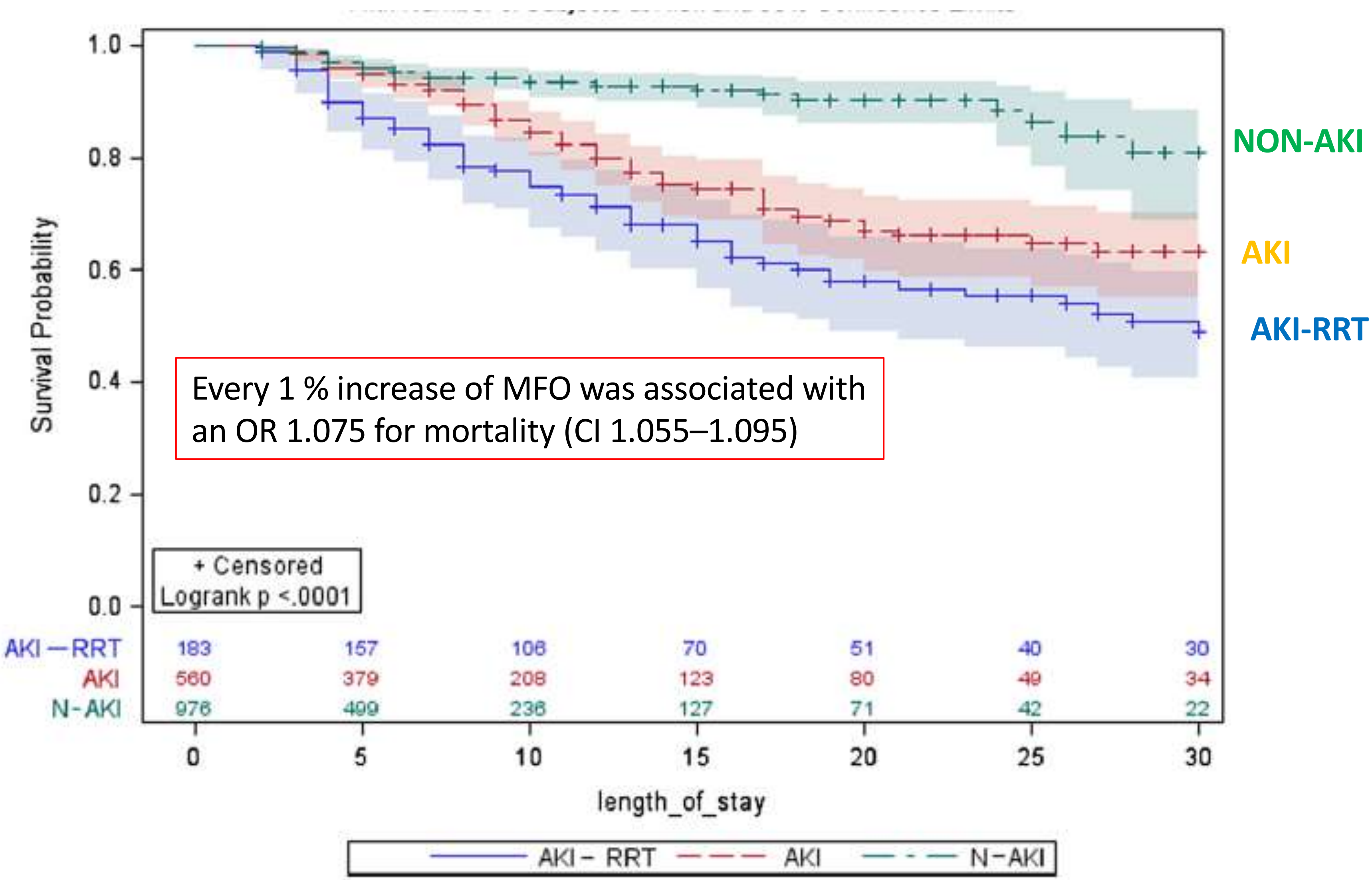
Acheampong A. & Vincent JL. Critical Care (2015) 19:251

The Dose Response Multicentre Investigation on Fluid Assessment (DoReMIFA) in critically ill patients

1,734 patients from 21 ICUs



Garzotto et al. Critical Care (2016) 20:196



Garzotto et al. Critical Care (2016) 20:196

An obser… es

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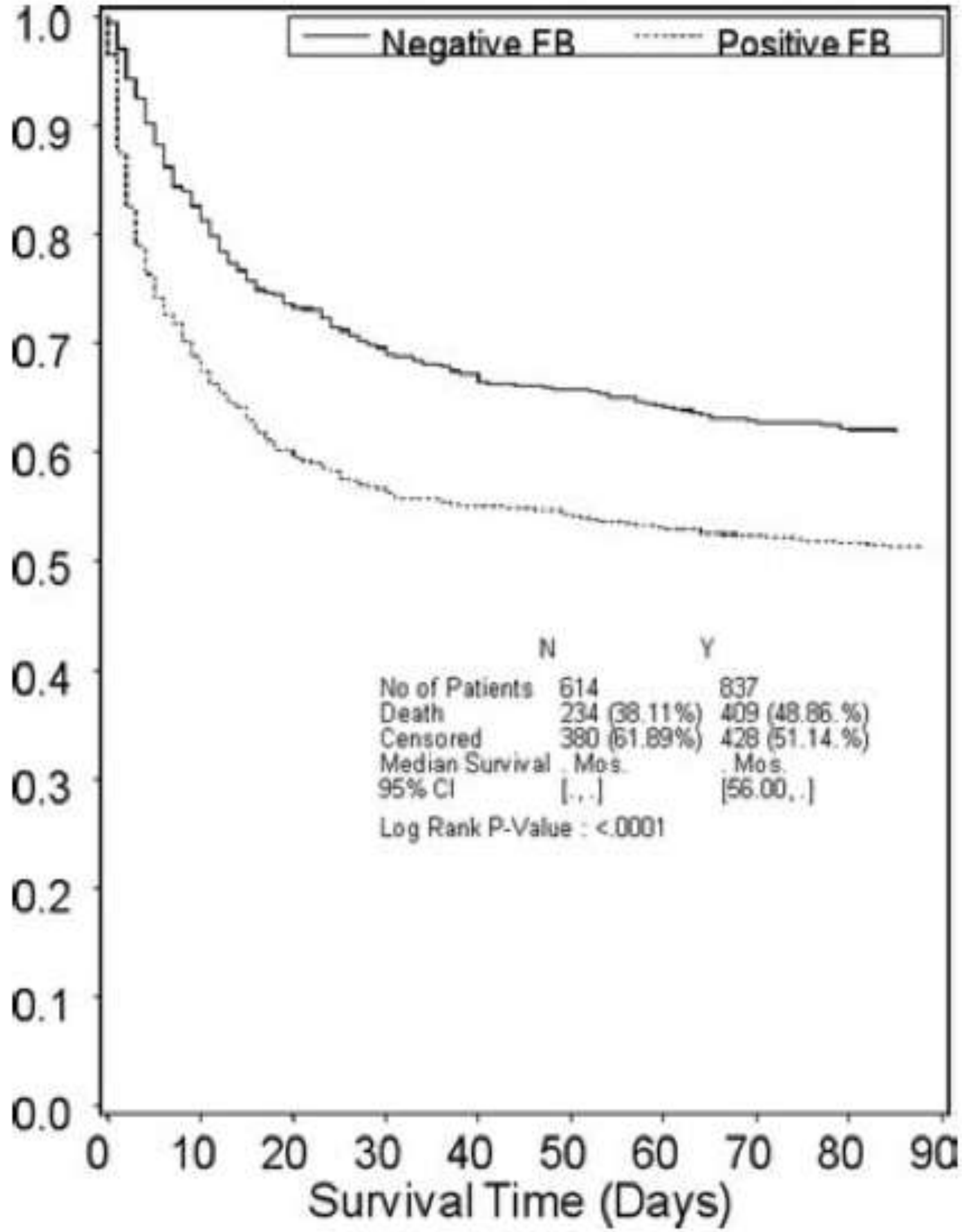
replacem…

The RENAL …



15

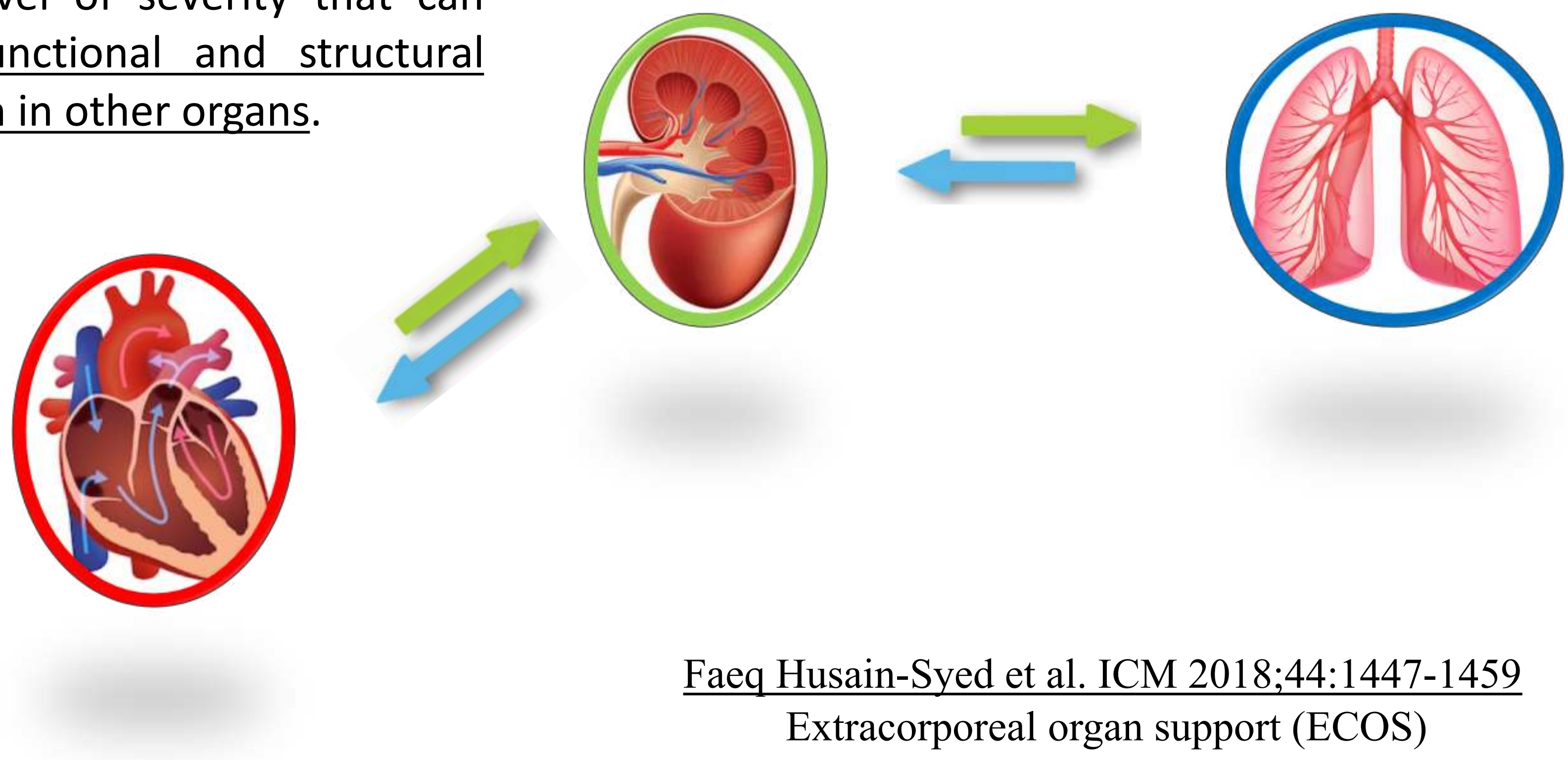
Non-surviv…
Survivors :

The kidney in organ crosstalk and multiple organ dysfunction syndrome

- Organ crosstalk is thought to have a pivotal role in maintaining body homeostasis.

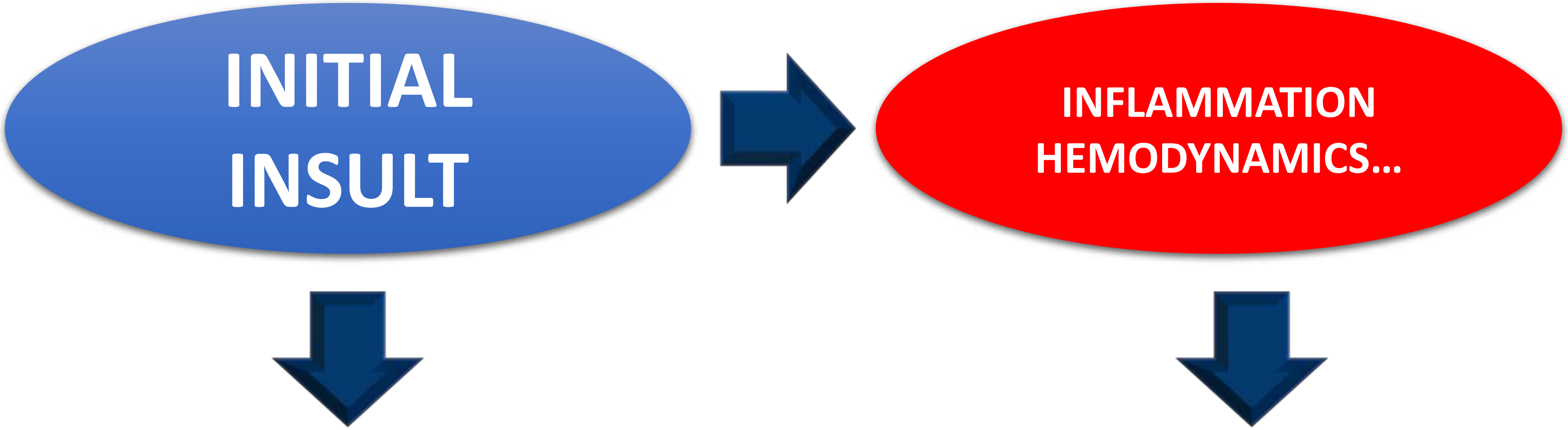
- When pathological conditions occur in one or more organs, they may reach a level of severity that can lead to functional and structural dysfunction in other organs.

Bidirectional interactions between distant organs

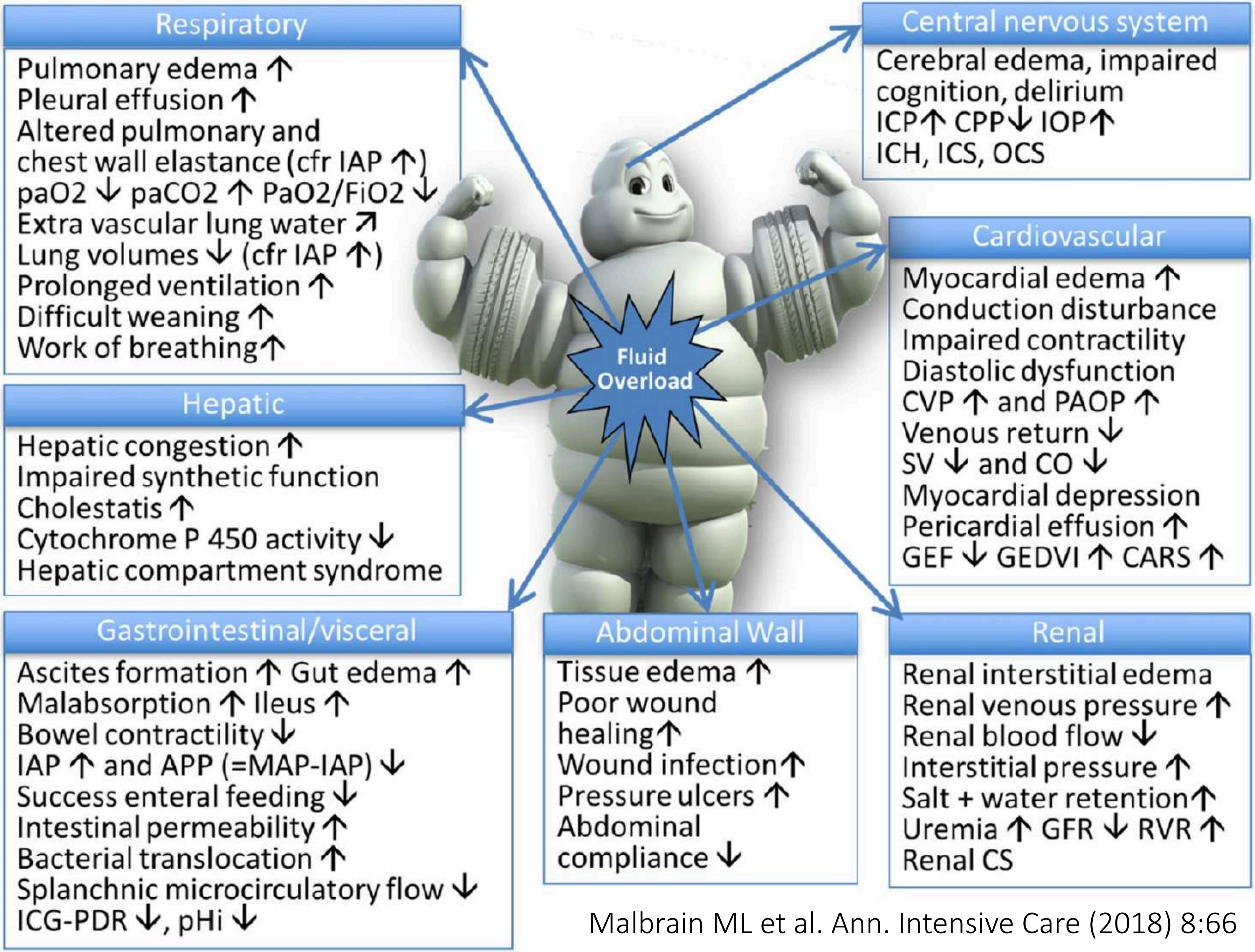


Faeq Husain-Syed et al. ICM 2018;44:1447-1459

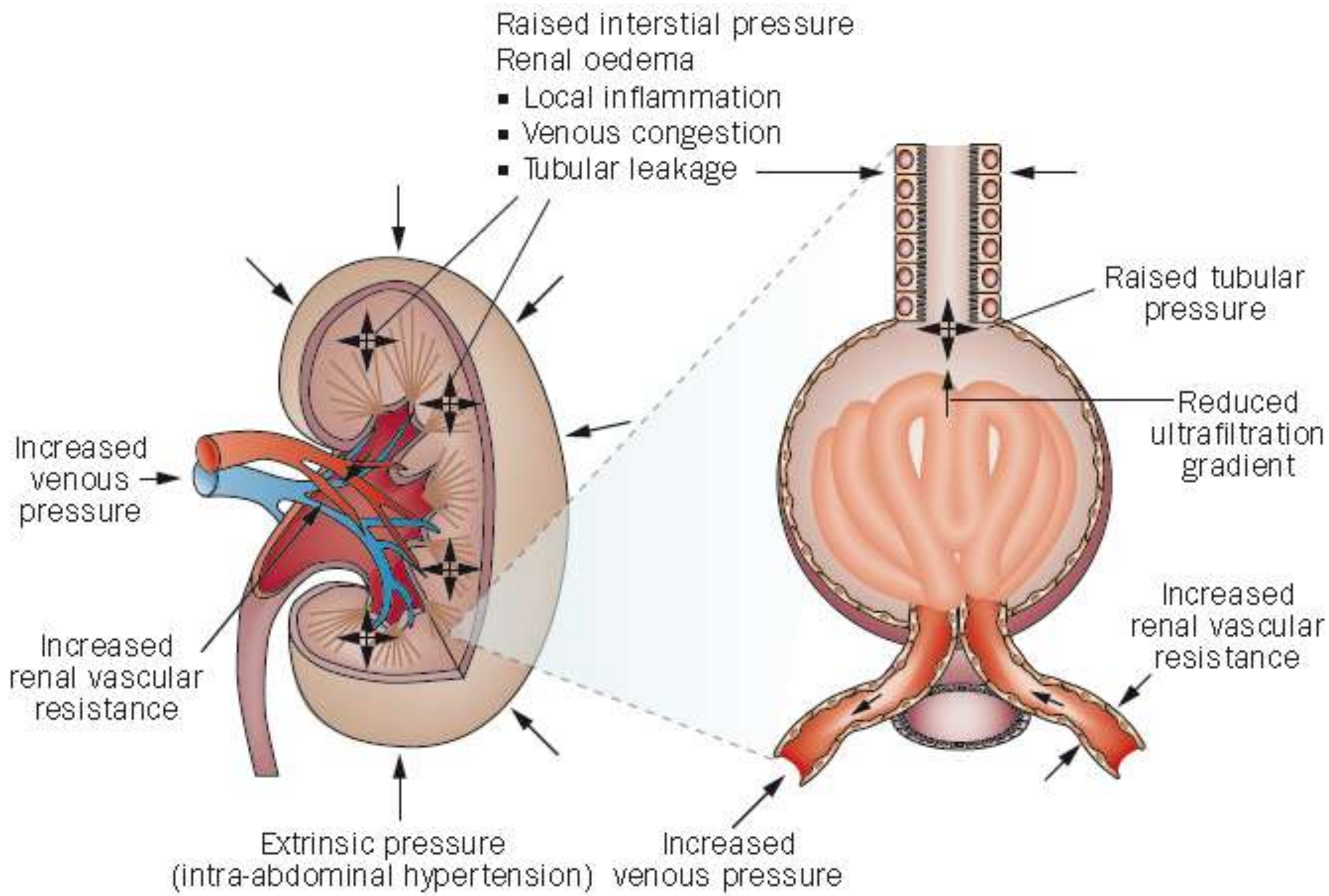
Extracorporeal organ support (ECOS)



DISTANT ORGAN EFFECT
(*mortality*)



Malbrain ML et al. Ann. Intensive Care (2018) 8:66



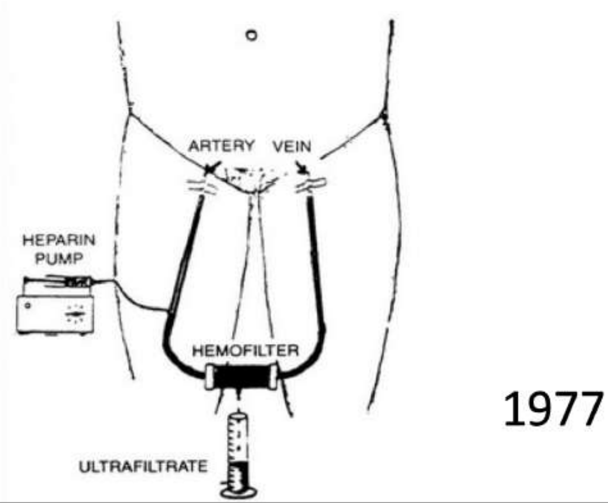
Prowle JR. et al.

Prowle, J. R. et al. Nat. Rev. Nephrol. 10, 37–47 (2014)

A number of studies have reported an association between a more positive <u>fluid balance and mortality</u> risk in sepsis

Acheampong et al. Crit. Care 19, 251 (2015).
Brotfain, E. et al. Am. J. Emerg. Med.34, 2122–2126 (2016).
Sakr, Y. et al. Crit. Care Med. 45, 386–394 (2017).

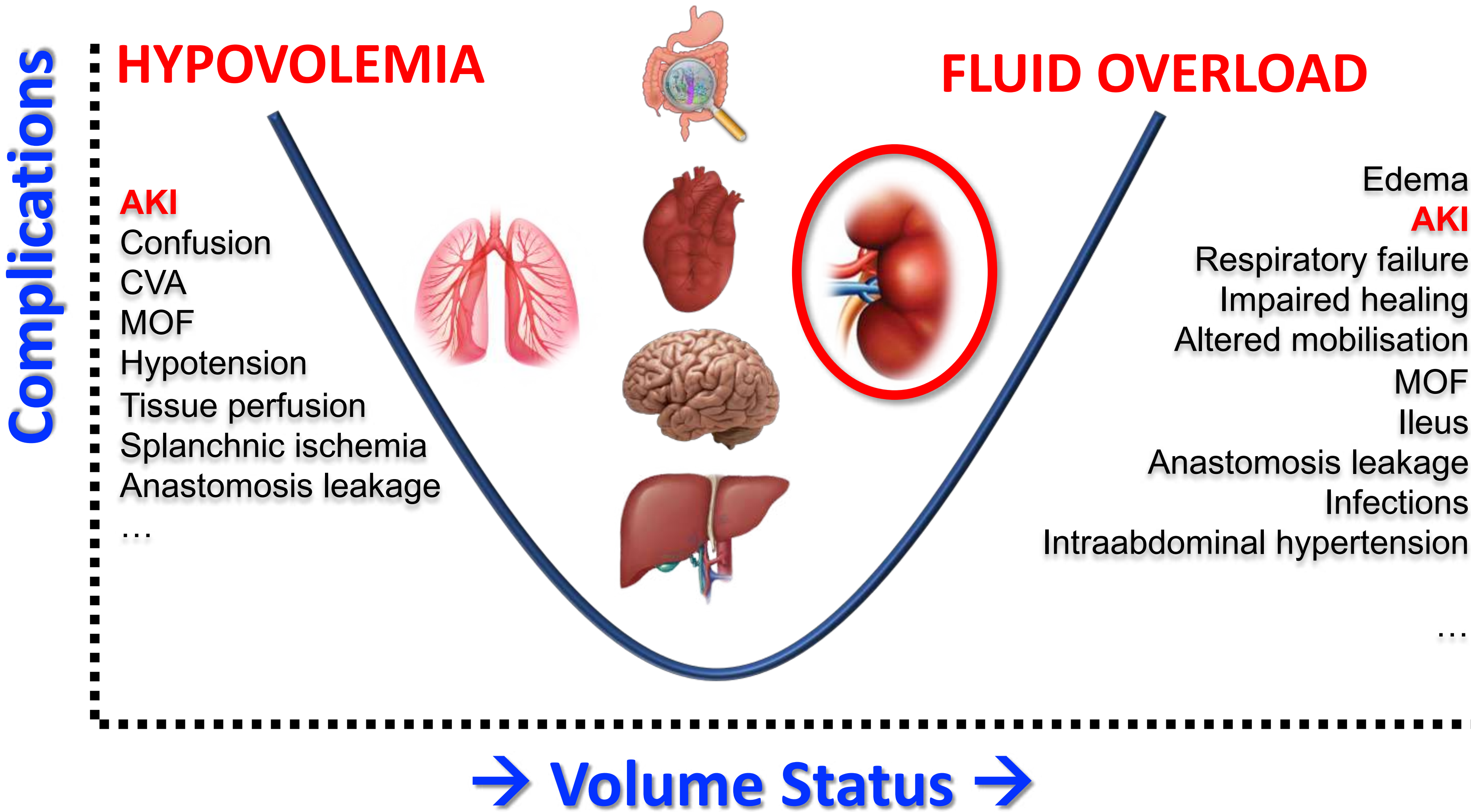
Kramer P, Wigger W, Rieger J, Matthaei D, Scheler F. [Arteriovenous haemofiltration: a new and simple method for treatment of over-hydrated patients resistant to diuretics]. *Klin Wochenschr*. 1977 Nov 15;55(22):1121–1122.



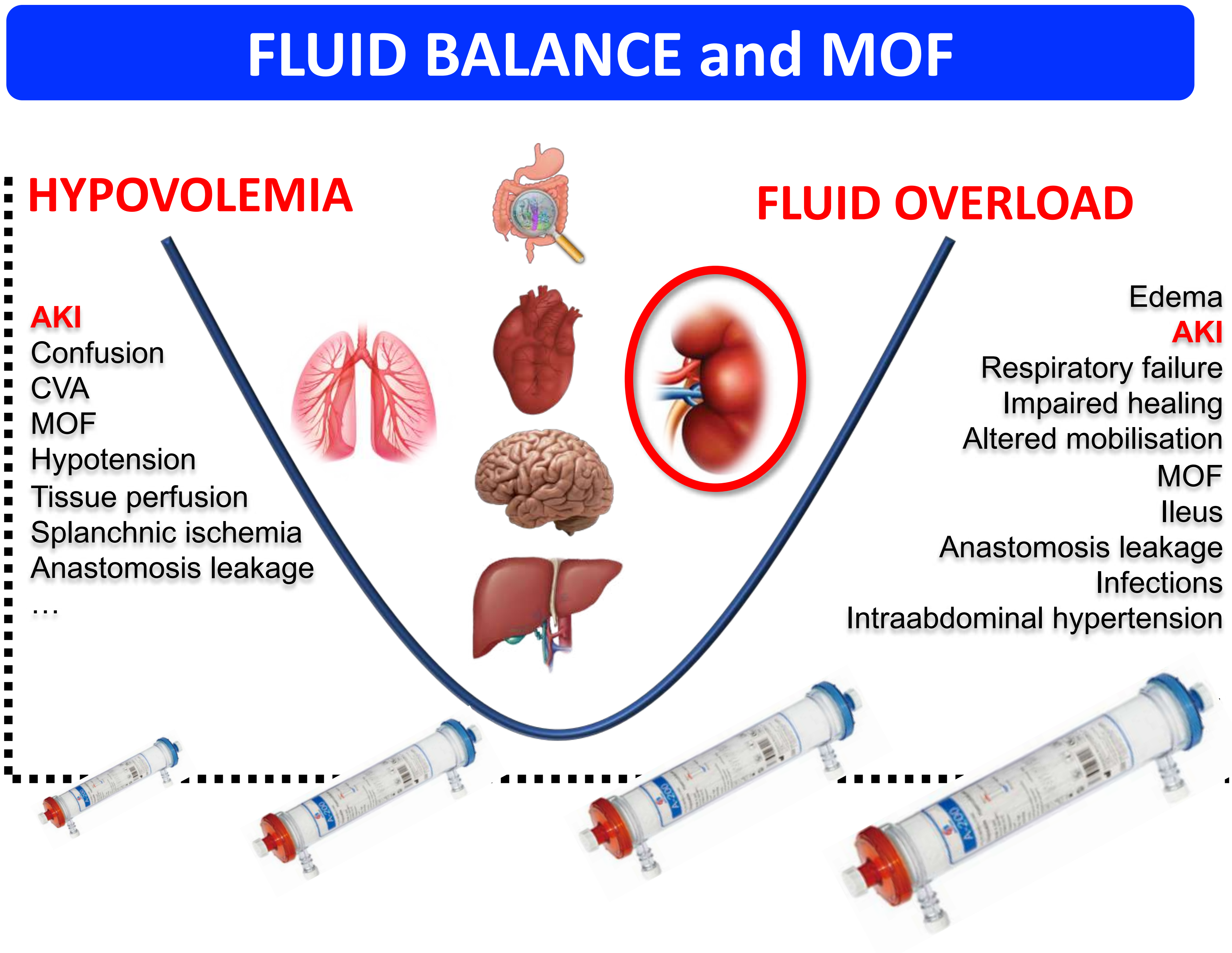
CAVH

Courtesy of Prof. C. Ronco

FLUID BALANCE and MOF

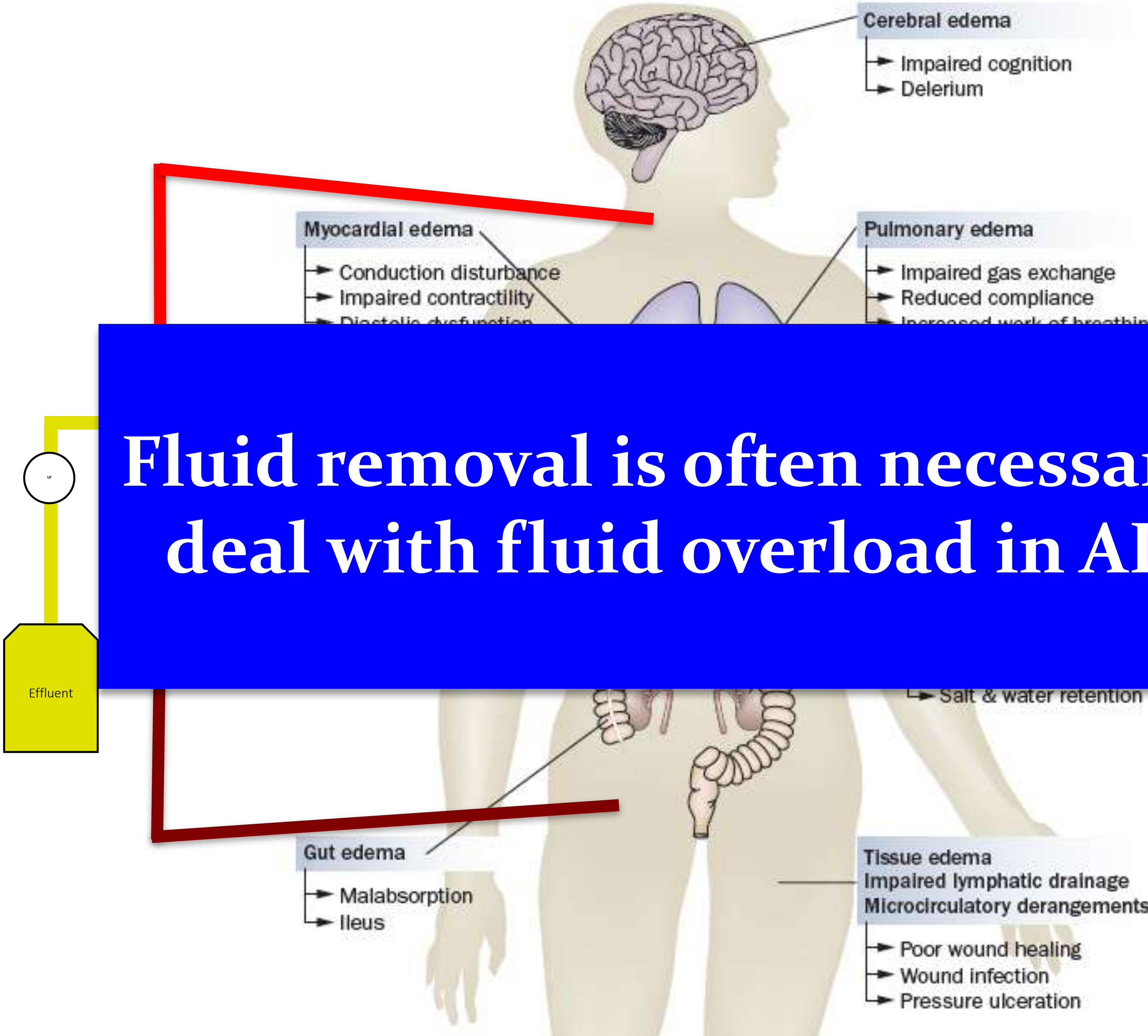


Bellamy MC. British Journal of Anaesthesia (2006) - (Modif.)



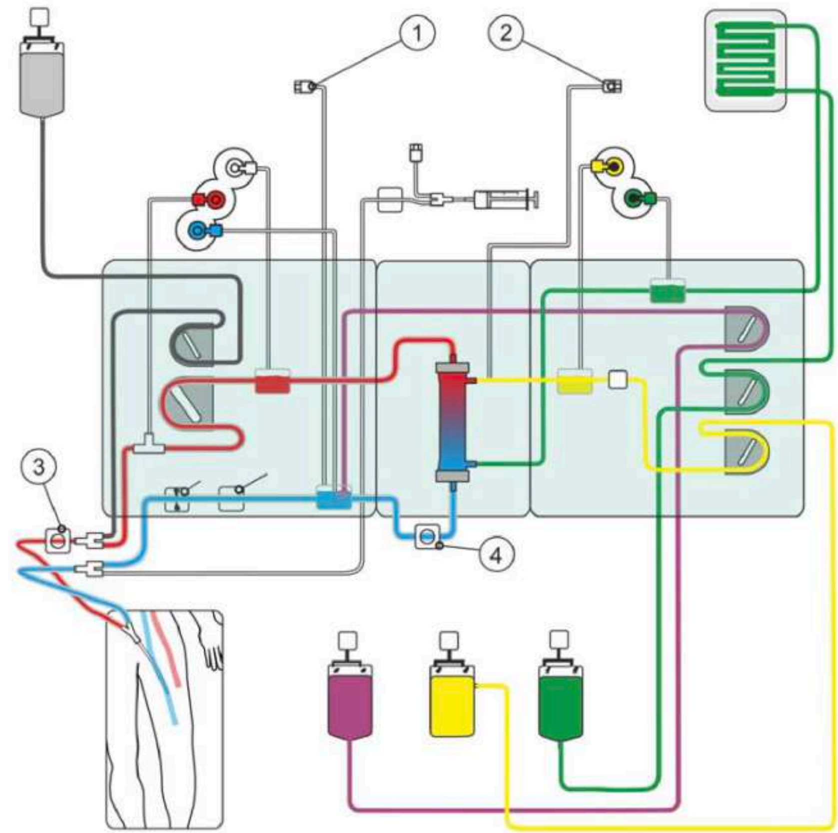
FLUID BALANCE and MOF
HYPOVOLEMIA
AKI
Confusion
CVA
MOF
Hypotension
Tissue perfusion
Splanchnic ischemia
Anastomosis leakage
…
FLUID OVERLOAD
Edema
AKI
Respiratory failure
Impaired healing
Altered mobilisation
MOF
Ileus
Anastomosis leakage
Infections
Intraabdominal hypertension

Fluid removal is often necessary to deal with fluid overload in AKI !



-32
mmHg
TMP
HEPARIN
BOLUS
B|BRAUN
OMNI

Arterial Pressure
-30 mmHg
Blood Flow
150 ml/min
Pre-Filter Pressure
125 mmHg
TMP
125 mmHg
Venous Pressure
118 mmHg
Next bag change
12:34 hh:mm



1
2
3
4

CRRT therapies
SCUF
CVVH pre, post, pre/post, post/post
CVVHD
CVVHDF

Anticoagulation modes	
Heparin ✓	
Heparin ✓	
Heparin ✓	Citrate ✓
Heparin ✓	Citrate ✓

OMNI therapy modes: Flexibility

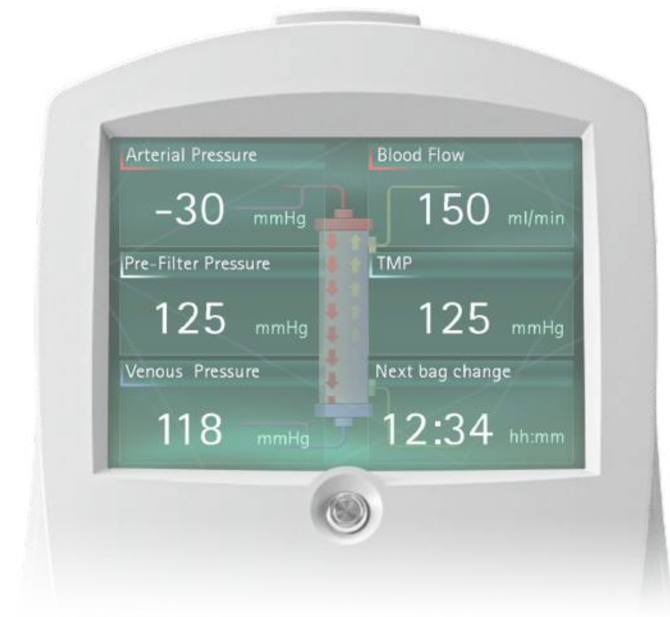
Therapeutic Plasma Exchange

HP in course of CRRT
(Cytosorb, Jafron, Alteco)

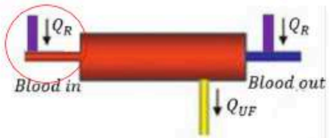
CO_2 Removal in course of CRRT

OMNI therapy modes: Flexibility

CRRT therapies	Anticoagulation modes
SCUF	Heparin ✓
CVVH pre, post, pre/post, post/post	Heparin ✓
CVVHD	Heparin ✓ Citrate ✓
CVVHDF	Heparin ✓ Citrate ✓
Therapeutic Plasma Exchange	
CO_2 Removal in course of CRRT	
HP in course of CRRT (Cytosorb,Jafron,Alteco)	



REAL
RENAL
DOSE (RRD)



$$\frac{\frac{postDV}{t} + \frac{DV}{t} + \frac{NFRV}{t} + \frac{\frac{PreDV}{t}}{1 + \frac{\frac{PreDV}{t}}{\frac{BV}{t}}}}{m}$$

PostDV = postDilutionalVolume DV = Dialysate Volume BV = Blood Volume

t = Time of treatment NFRV = UF^{NET} PreDV = preDilutionalVolume

m = patient's weight

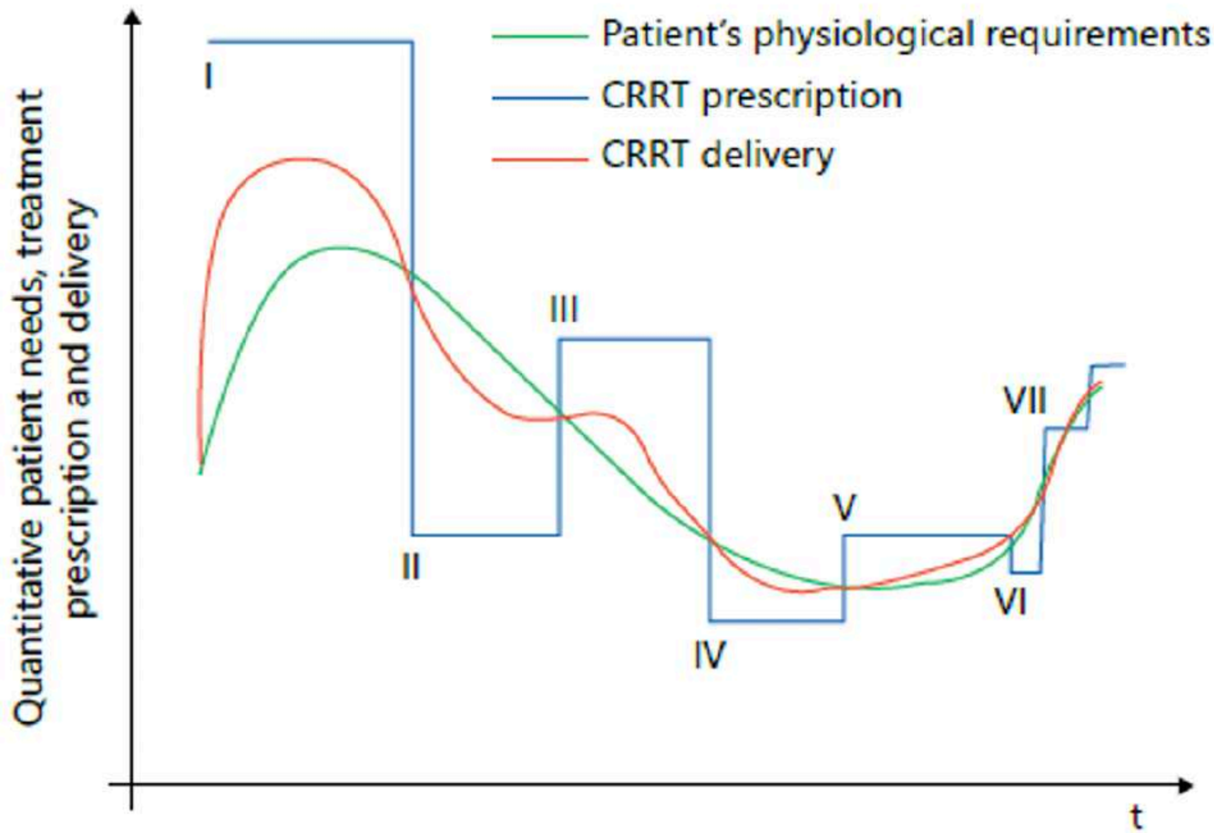
t = Duration of treatment

INTERRUPTION OF TREATMENT

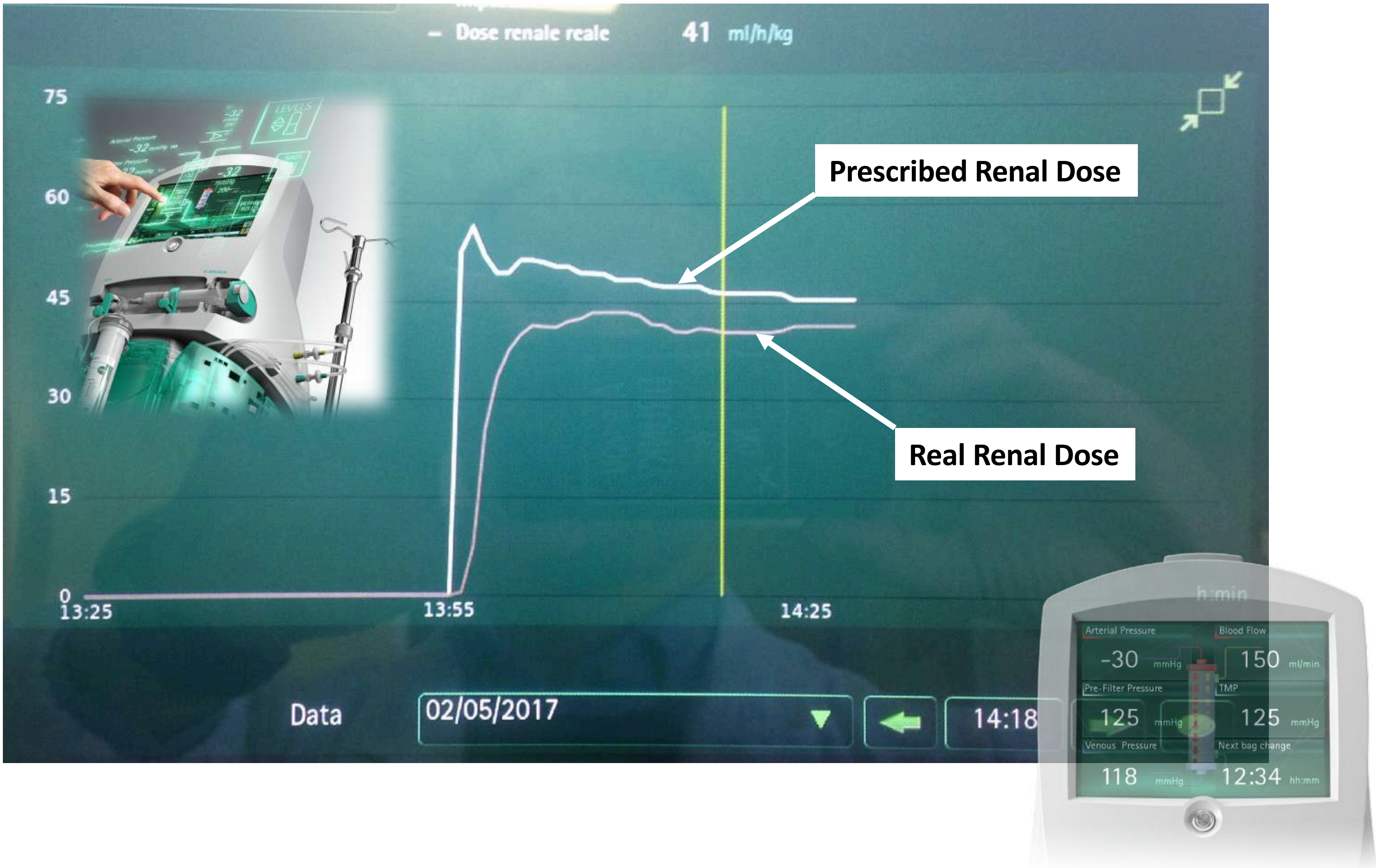
"down time"

Venkataraman R et al. Journal of Critical Care, 2002:246-250

- ✓ ***Pump's stop***
- ✓ ***Fluid Balance alarms***
- ✓ ***Syringe changes***
- ✓ ***Patient's mobilization***
- ✓ ***Bag's change anytime***
- ✓ ***Stop for diagnostics***
- ✓ ***Stop for surgical / internetional procedures***

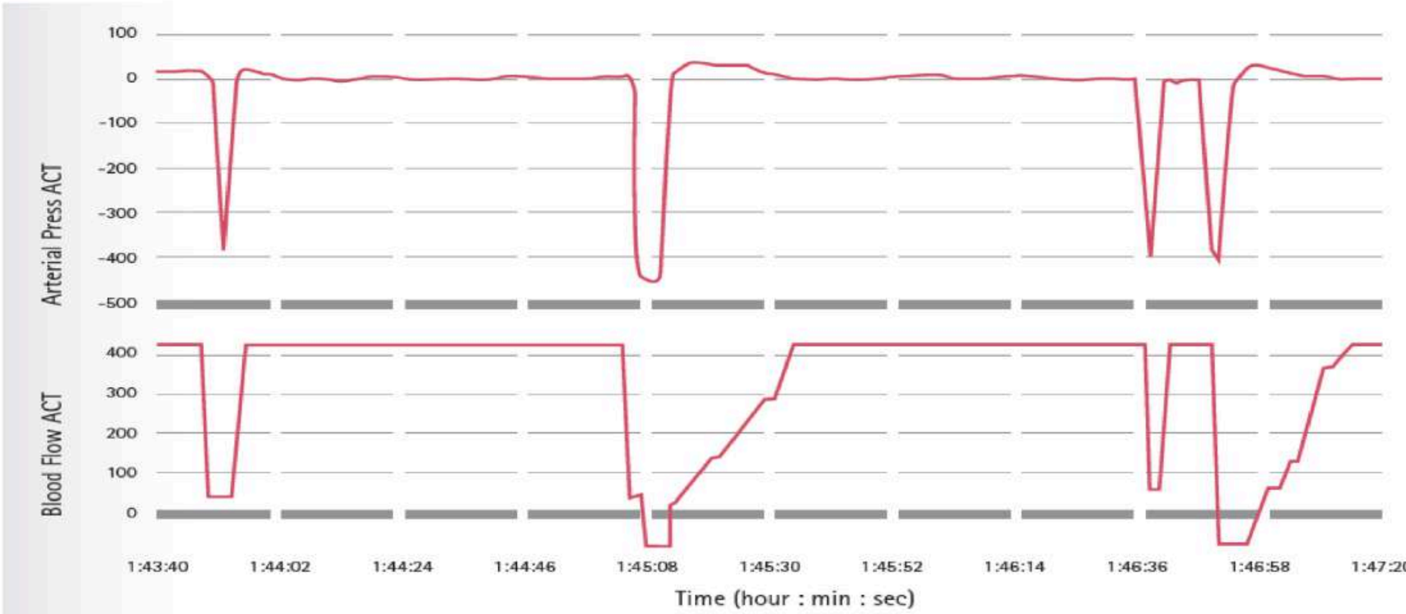


Courtesy Dr. Villa



– Dose renale reale
41 ml/h/kg
75
60
45
30
15
0
13:25
13:55
14:25
Prescribed Renal Dose
Real Renal Dose
Data
02/05/2017
14:18
h:min
Arterial Pressure
-30 mmHg
Blood Flow
150 ml/min
Pre-Filter Pressure
125 mmHg
TMP
125 mmHg
Venous Pressure
118 mmHg
Next bag change
12:34 hh:mm

Automatic Blood Flow Reduction



- Blood flow automatically reduced by 25% as compared to current blood flow
- Maximum at 60 ml/min lower

Lines kinked
During patient mobilization

Original Paper

Blood Purif 2017;43:11–17
DOI: 10.1159/000451053

A First Evaluation of OMNI®, A New Device for Continuous Renal Replacement Therapy

Pierre Schläpfer[a, b] Jean-Daniel Durovray[b] Valery Plouhinec[a] Cristiano Chiappa[a] Rinaldo Bellomo[c] Antoine Schneider[a]

[a]Adult Intensive Care Unit, and [b]Anesthesiology Department, Centre Hospitalier Universitaire Vaudois (CHUV), Lausanne, Switzerland; [c]Intensive Care Unit, Austin Health, Heidelberg, Vic., Australia

Key Words
Acute kidney injury · Renal replacement therapy · Blood purification · Renal dose

Abstract
Background: Omni® (B. Braun, Germany) is a new-generation, continuous renal replacement therapy (CRRT) machine designed to improve user interface, minimize downtime and optimize renal dose delivery. It was never tested in humans. ***Methods:*** We used Omni® to provide CRRT in 10 critically ill patients. We collected therapy data, metabolic parameters and evaluated user's satisfaction with a survey. ***Results:*** CRRT was delivered using Omni® in CVVH-heparin (6 patients) and CVVHD-citrate (4 patients) modes for a total duration of 617.7 h. No adverse event was observed. The mean filter life was 22.8 (CVVH-heparin) and 33.5 (CVVHD-citrate) h. Alarms-related downtime corresponded to 5.9% of total therapy time. Delivered renal dose was 96.6% of prescribed. Satisfactory metabolic control and fluid removal were achieved. Overall, users evaluated interface, design and usability as excellent. ***Conclusion:*** CRRT in CVVH-heparin and CVVHD-citrate modes was provided using Omni® in a safe and efficient way for 10 critically ill patients.
Video Journal Club 'Cappuccino with Claudio Ronco' at http://www.karger.com/?doi=451053.

Introduction

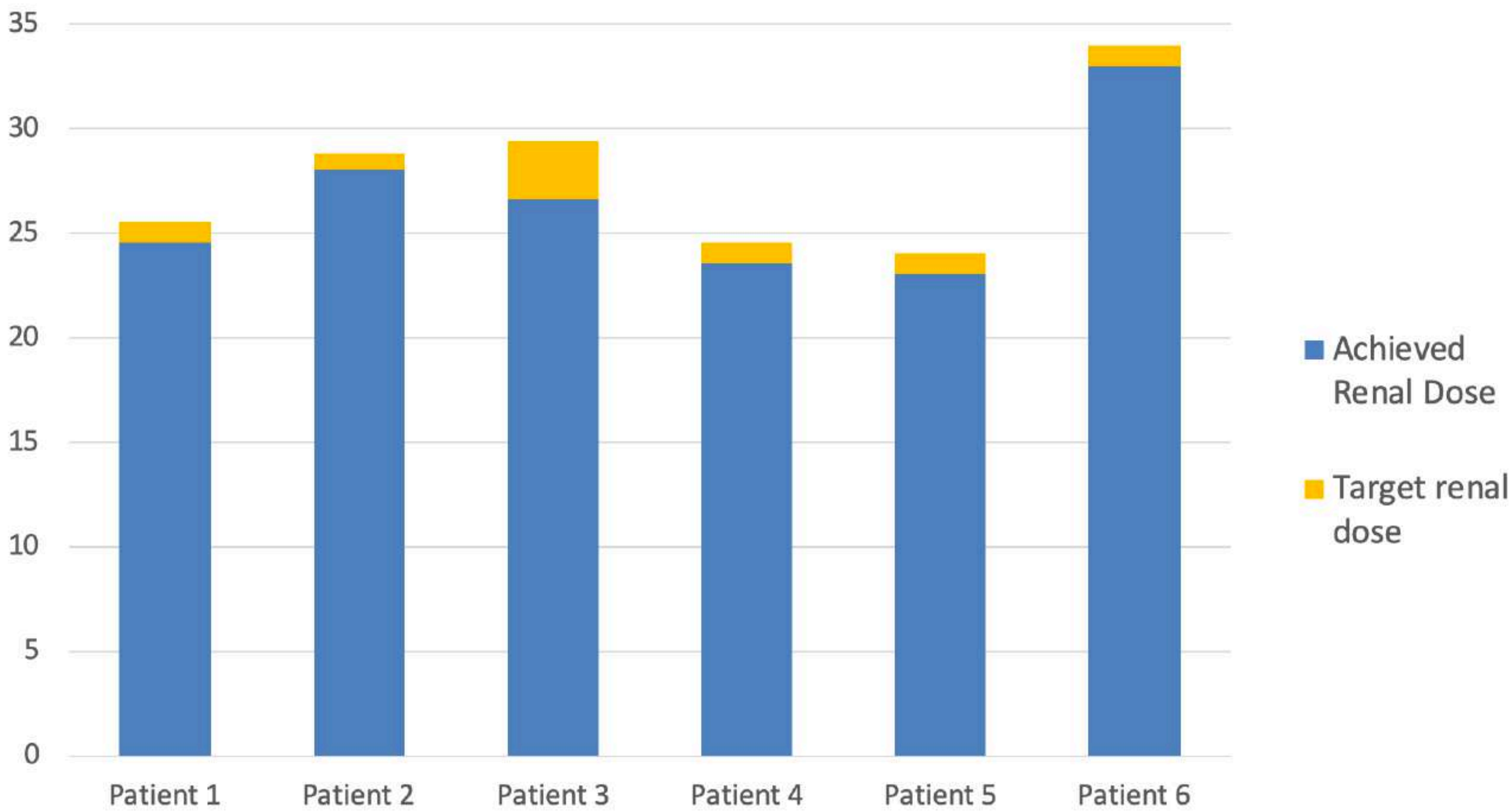
Since the first description of continuous renal replacement therapy (CRRT) by Kramer et al. [1], several generations of devices have gradually improved the safety and feasibility of CRRT for critically ill patients with acute kidney injury. Among these improvements, the use of double lumen catheters (eliminating the need for an arterial access), the implementation of volumetric pumps into the RRT device, and the overall precision of weighing scales may be recognized as major steps. More recently, the implementation of citrate anticoagulation [2–4] protocols [5–7] built in to RRT devices has increased filter life and made therapy delivery safer and more reli able [8–10]. However, several challenges remain to opt mize RRT in critical illness [11]. Among these, impr ing fluid balance precision [12], optimizing alarms m agement and minimizing therapy downtime have identified as critical. In addition, the need to si therapy management, decrease nursing workl improve user interface remains an important ation [13, 14].

Omni® (B. Braun, Melsungen, Germany eration CRRT device, has recently been de aim of improving therapy accuracy a management. Such improvements a

Dr. Antoine Schneider
Adult Intensive Care Unit
Centre Hospitalier Universitaire Va
21, Avenue du Bugnon, CH–101
E-Mail antoine.schneider@

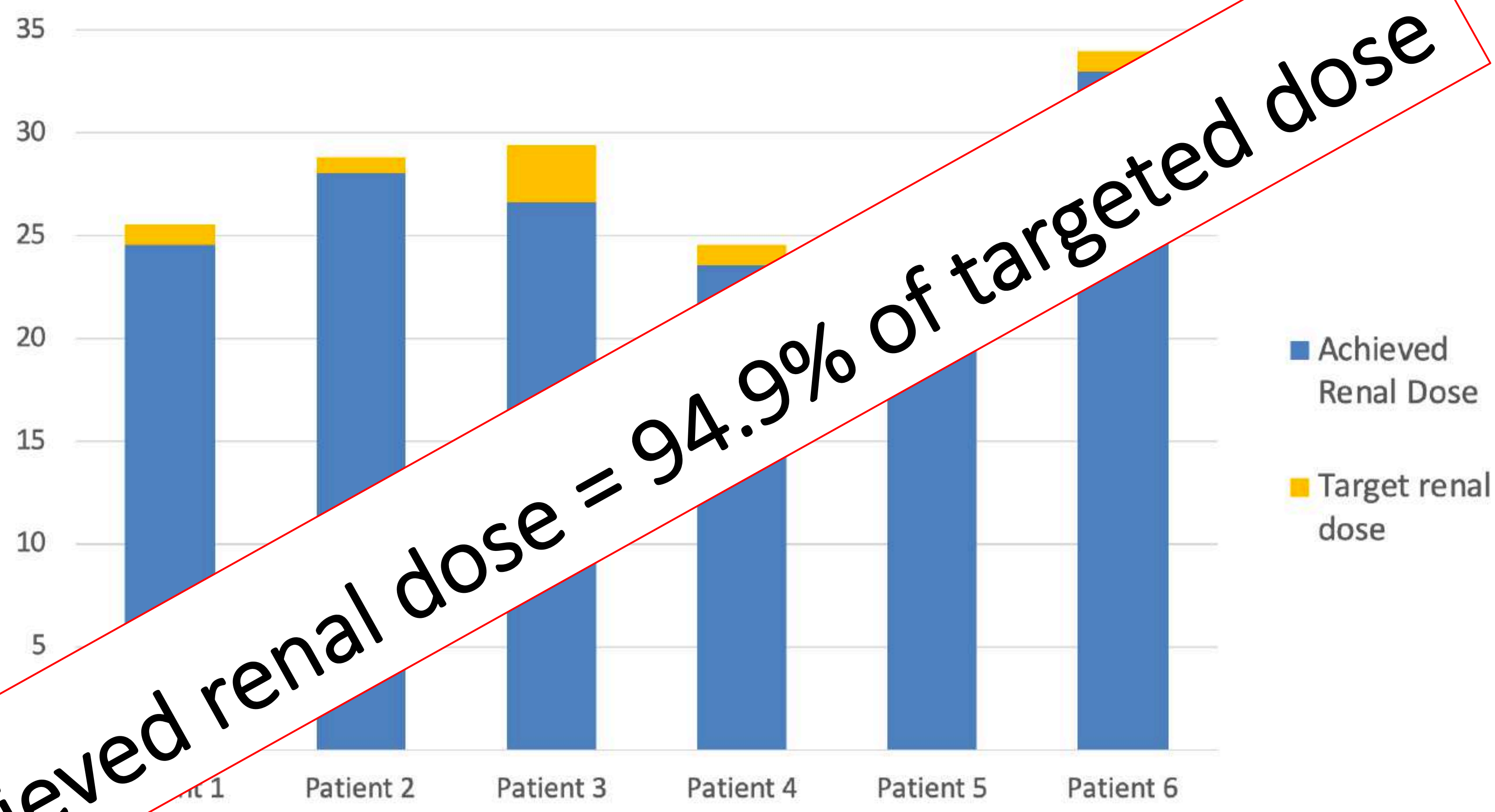
Schlapfer P et al. Blood Purif 2017; 43:11-17

Renal Dose



Schlapfer P et al. Blood Purif 2017; 43:11-17

Renal Dose



Achieved renal dose = 94.9% of targeted dose

Schlapfer P et al. Blood Purif 2017; 43:11-17

Organ crosstalk

- Importantly, **dysfunction of a single organ is rare**, in part because of the existence of '**organ–organ crosstalk**' or interorgan crosstalk such that the failure of one organ leads to the dysfunction of another organ.

- Consequently, the function of several organ systems is usually disrupted simultaneously.

Vincent, J. L. et al. Sepsis in European intensive care units: results of the SOAP study. Crit. Care Med. (2006).

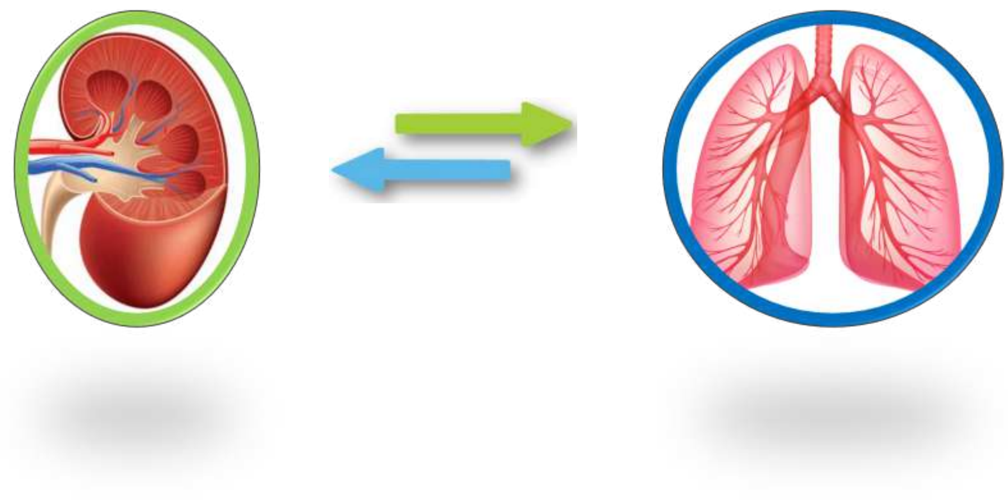
- The pattern of failing organs can influence outcomes, and **the greater the number of organs that are affected, the higher the mortality**

Vincent, J. L. et al. Crit. Care Med. 34, 344–353 (2006).
Sakr, Y. et al. Crit. Care 16, R222 (2012).

The kidney in organ crosstalk and multiple organ dysfunction syndrome

Bidirectional interactions between distant organs

- Organ crosstalk is thought to have a pivotal role in maintaining body homeostasis.
- When pathological conditions occur in one or more organs, they may reach a level of severity that can lead to functional and structural dysfunction in other organs.



Faeq Husain-Syed et al. ICM 2018;44:1447-1459

Extracorporeal organ support (ECOS)

CONFERENCE REPORTS AND EXPERT PANEL

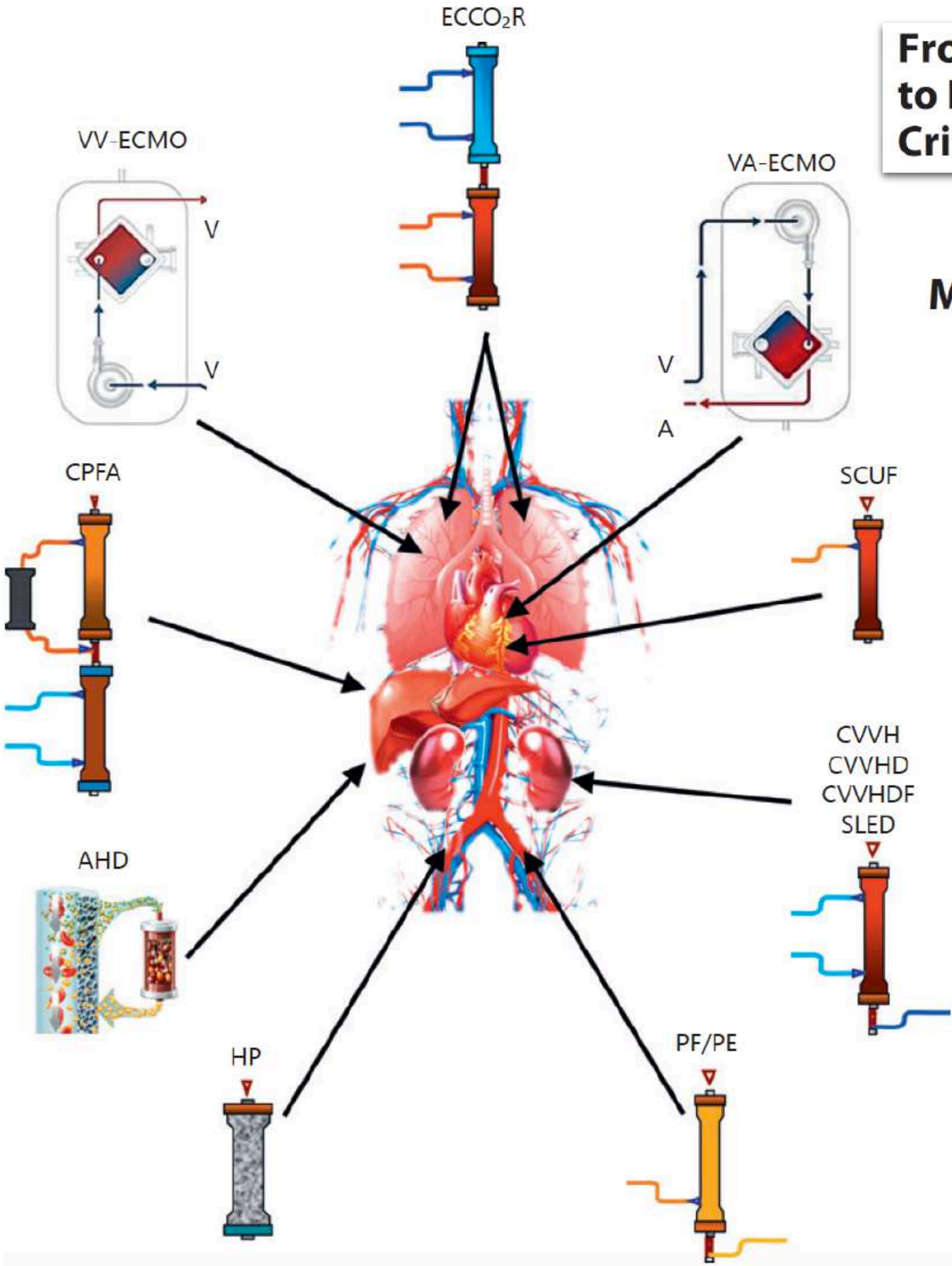
Lung–kidney interactions in critically ill patients: consensus report of the Acute Disease Quality Initiative (ADQI) 21 Workgroup

- In critically ill patients, both lung and kidney organ injury and/or dysfunction are common and associated with significant morbidity and mortality.

- Patients with acute kidney injury are **twice** as likely to require invasive mechanical ventilation.

- Patients with **acute respiratory failure/acute respiratory distress syndrome** are at increased risk of AKI, especially where IMV is required, influenced by haemodynamic, neurohormonal, and inflammatory effects

Joannidis M et al. Intensive Care Med (2019)



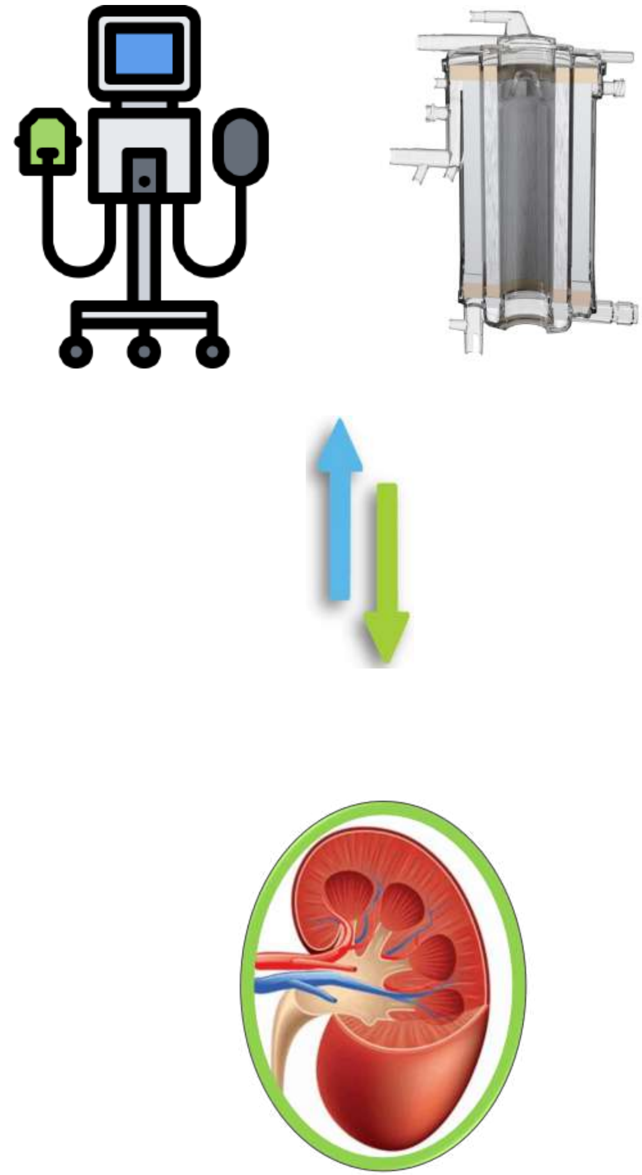
From Multiple Organ Support Therapy to Extracorporeal Organ Support in Critically Ill Patients

Ronco C et al. Blood Purif (2019)

Mltpl Org Supp in IC – Review Article

Blood Purification

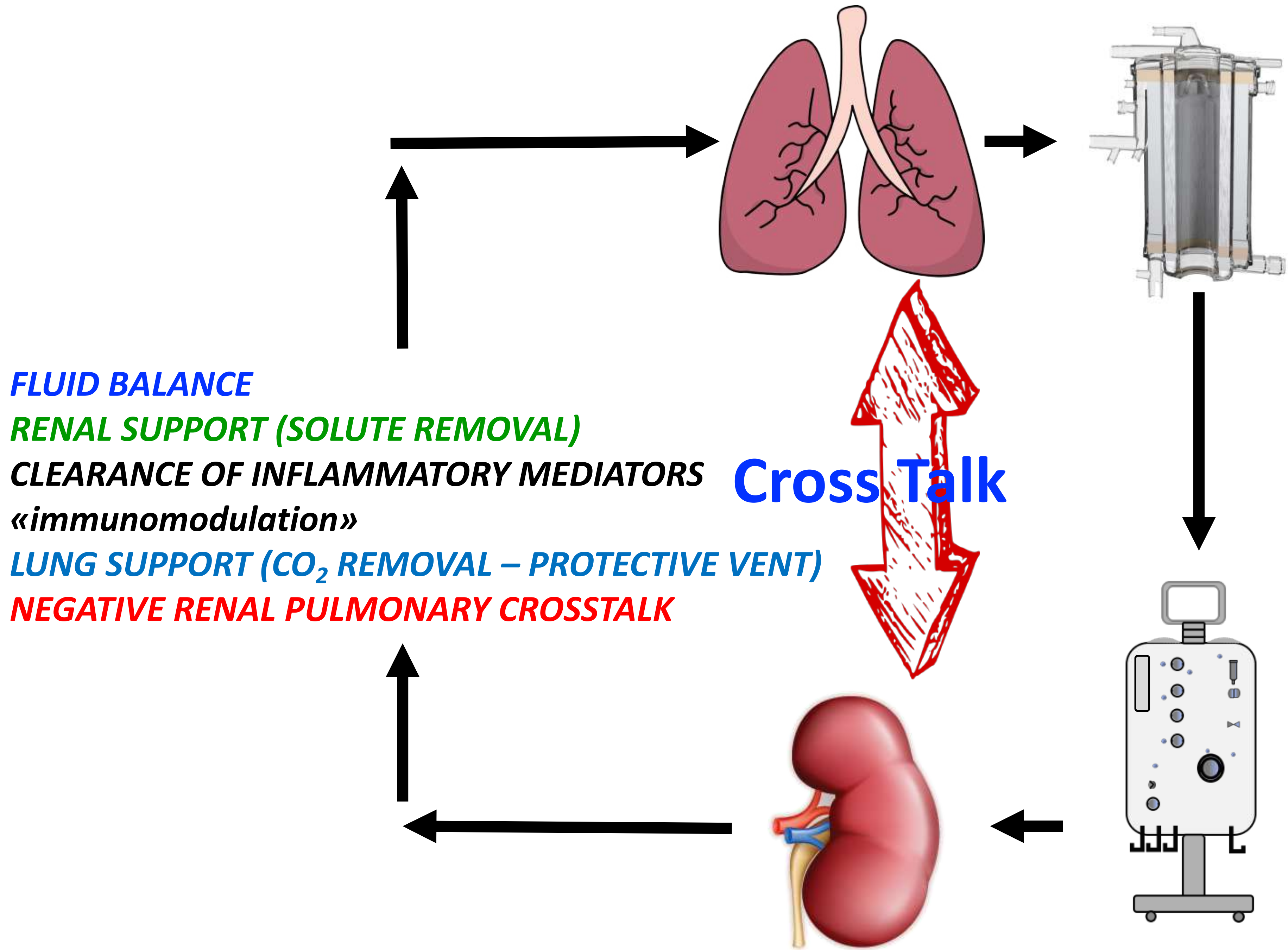
Effects of extracorporeal devices



Recommendations for research

1. Future work should aim to determine if there is any impact of current RRT practices [continuous renal replacement therapy (CRRT), slow extended dialysis (SLED) and intermittent haemodialysis (IHD)] on lung function and determine which approach to acute RRT is most beneficial for the lung.
2. The application of different reinfusion/dialysate solutions should be evaluated in patients with hypercapnia (COPD or permissive hypercapnia).
3. Further research on CO_2 removal techniques should be undertaken as an ancillary measure in hypercapnic patients receiving RRT.

Joannidis M et al. Intensive Care Med (2019)


FLUID BALANCE
RENAL SUPPORT (SOLUTE REMOVAL)
CLEARANCE OF INFLAMMATORY MEDIATORS
«immunomodulation»
LUNG SUPPORT (CO_2 REMOVAL – PROTECTIVE VENT)
NEGATIVE RENAL PULMONARY CROSSTALK
Cross Talk

OMNIset $ECCO_2R$

- **Preassembled OMNIset with 1.6 m^2 hemofilter**
- **Oxygenator (Euroset): 1.81 m^2 polymethylpentene**
- **Blood Flow: up to 500 mL/min**
- **Anticoagulation: heparin**
- **Max treatment time: 72 h**
- **CRRT modes: CVVH pre/post, CVVHD, CVVHDF**
- **Integrated heater**
- **Priming without Oxy: 187 mL**
- **Priming Oxy: 148 mL**

B.Braun patent: «Decap® in course of CRRT»

EXCLUSIVITY: B.Braun $ECCO_2R$ therapy is covered by industrial patent "Decap® in course of CRRT" (

The exclusivity of our patent is related to the position of the filters: first oxygenator (CO_2 removal) before the hemofilter (CRRT).

- increases the avarage blood flow (higher CO_2 removal rate)
- reduces risk of clotting in the filters/circuit (lower pressure)
- improves the acid-basic ratio
- maitains «physologic» blood through the oxygenator (no haemo-concentration as competition setting due to UF rate)

Allardet-Servent J et all. *Crit Care Med (*2015)

GERMANY
QUALITY

Scenario 2: Fluid overload: *il concetto di ultrafiltrazione netta, aspetti di nomenclatura, come impostarla, come calcolarla, significato clinico della negativizzazione del bilancio (OMNI) - S. Romagnoli*

Stefano Romagnoli, MD, PhD

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CRRT
Questione di EQUIPE!

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