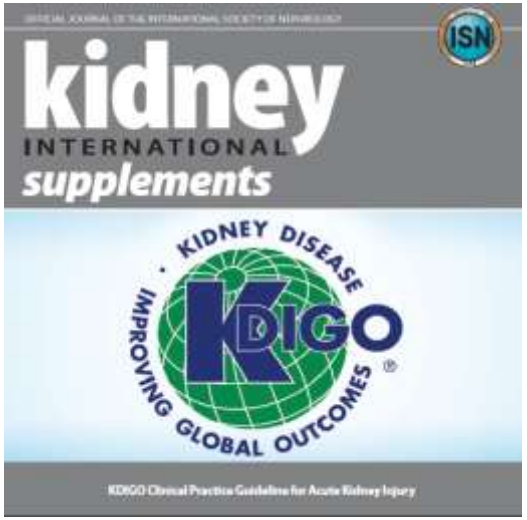
Eliminační metody – klasifikace a využití na ICU

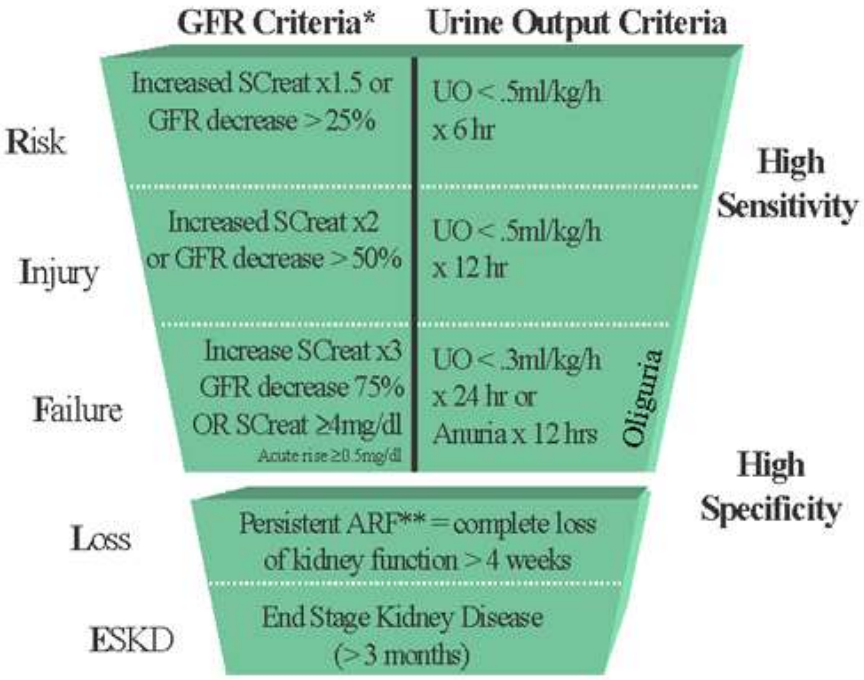
Petr Waldauf, KAR FNKV

- **AKI** = Acute Kidney Injury
- již ne ARF !
- ARF = Acute Renal Failure
- ale také Acute Respiratory Failure

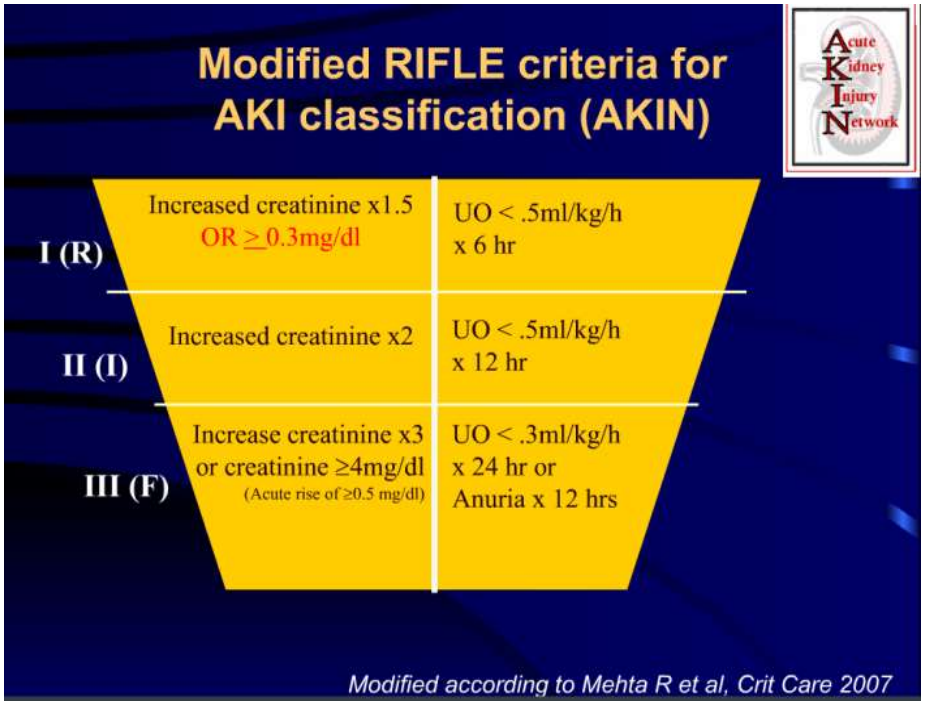


Skórování AKI

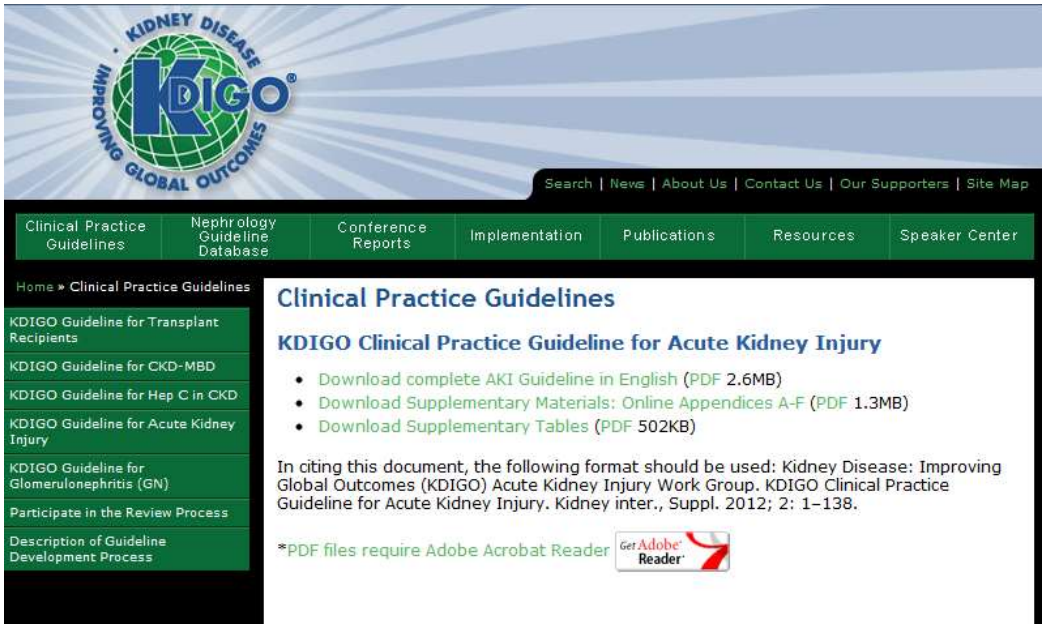
RIFLE kriteria

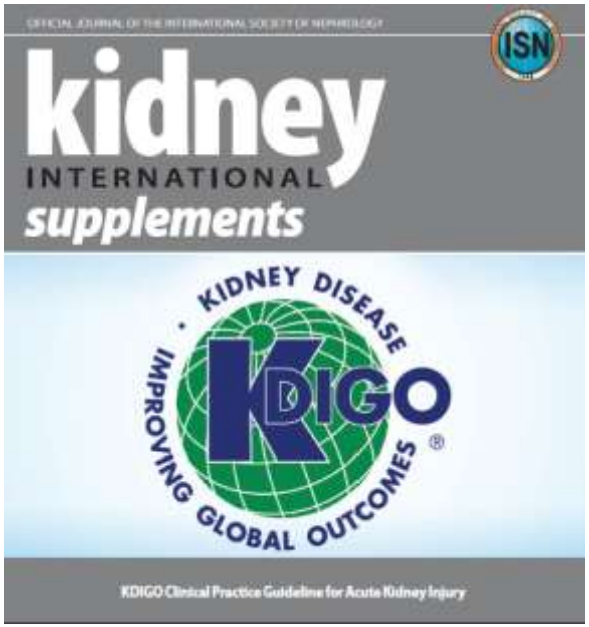


AKIN kriteria



0,3 mg/dL = 26,5 umol/L
0,5 mg/dL = 44 umol/L
4 mg/dL = 354 umol/L





- **5.2.2: We suggest not using diuretics to enhance kidney function recovery, or to reduce the duration or frequency of RRT. (2B)**

http://www.kdigo.org/

(1–3 mg/kg/min)

- **3.5.1: We recommend not using low-dose dopamine to prevent or treat AKI. (1A)**

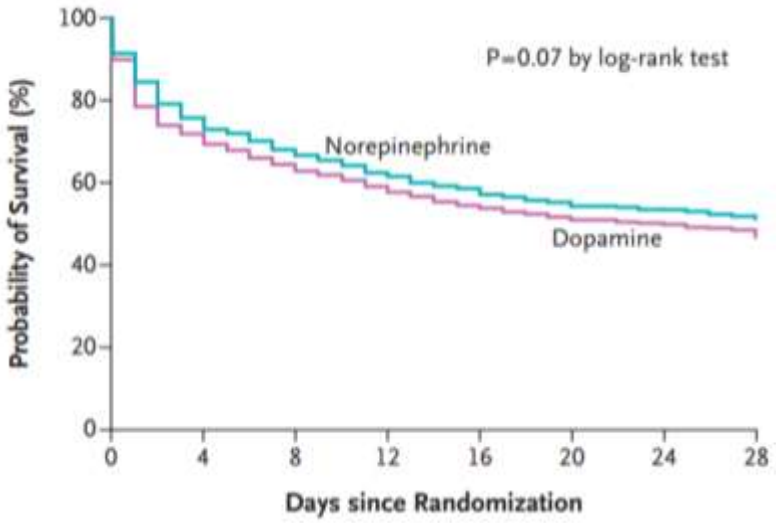
The NEW ENGLAND JOURNAL of MEDICINE

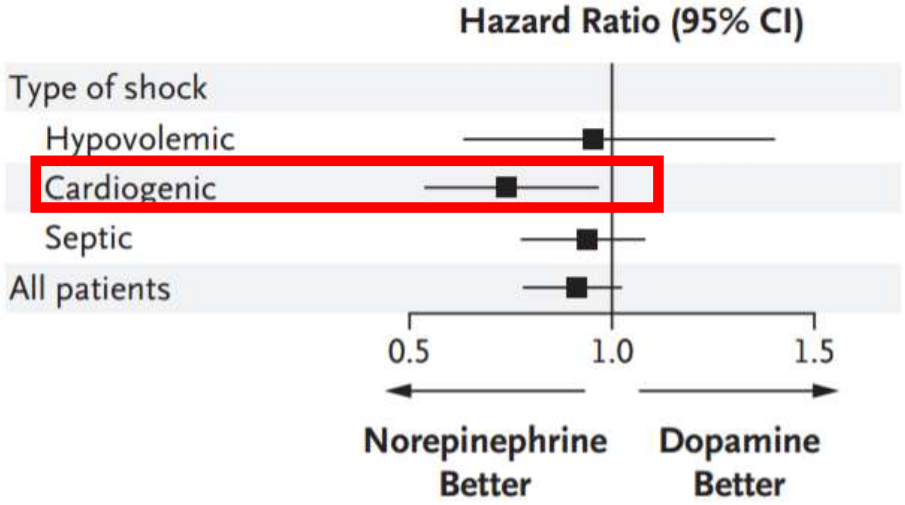
ESTABLISHED IN 1812 MARCH 4, 2010 VOL. 362 NO. 9

Comparison of Dopamine and Norepinephrine in the Treatment of Shock

Daniel De Backer, M.D., Ph.D., Patrick Biston, M.D., Jacques Devriendt, M.D., Christian Madl, M.D., Didier Chochrad, M.D., Cesar Aldecoa, M.D., Alexandre Brasseur, M.D., Pierre Defrance, M.D., Philippe Gottignies, M.D., and Jean-Louis Vincent, M.D., Ph.D., for the SOAP II Investigators*

1679 pacientů
multicentrická
randomizovaná studie
obnova BP
outcome: mortalita





Acute Renal Failure in Critically Ill Patients

A Multinational, Multicenter Study

FULL TEXT JAMA

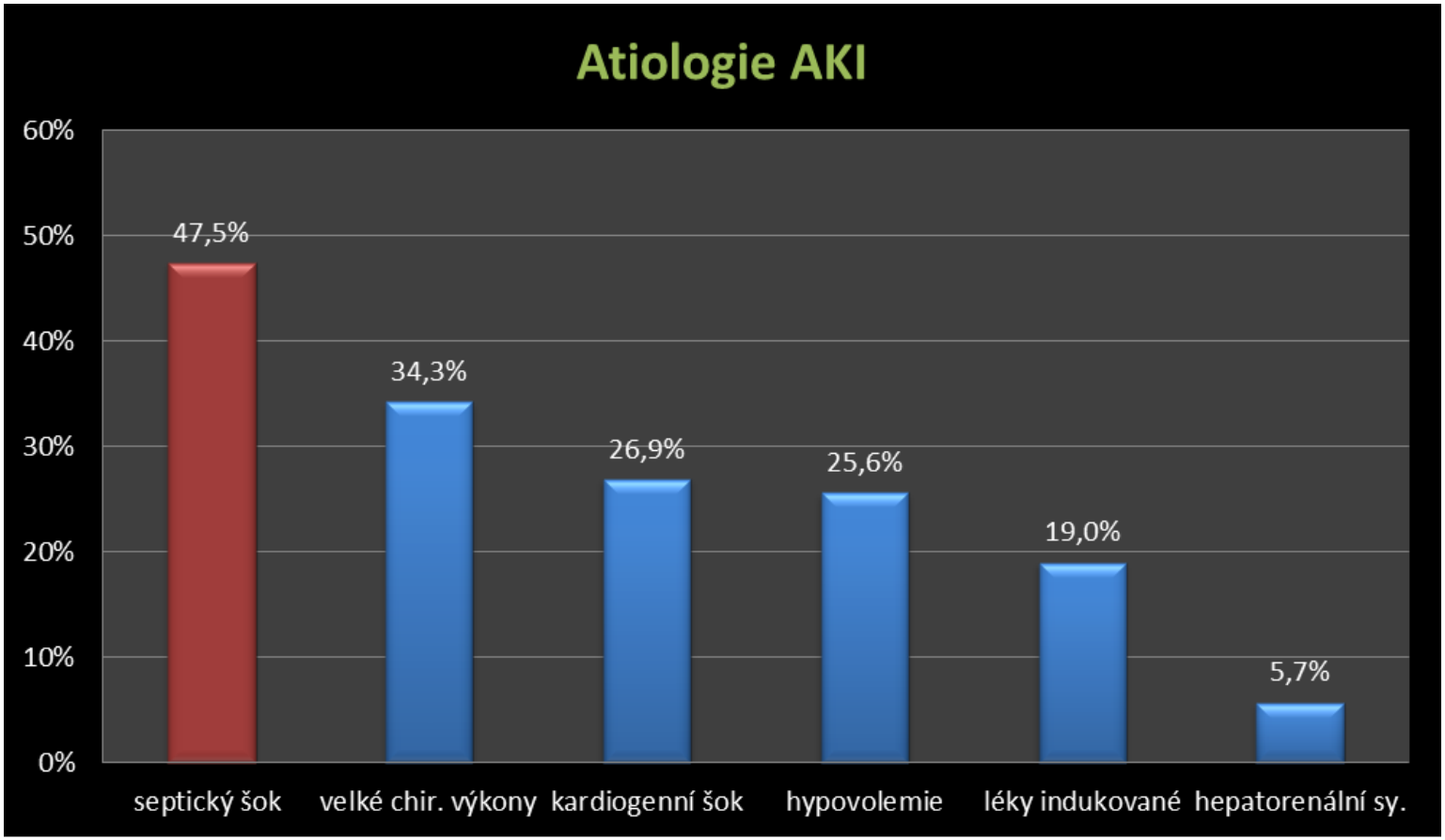
JAMA 2005, Uchino & BEST Kidney

Prospective observational study, from September 2000 to December 2001 at 54 hospitals in 23 countries

- více jak 29 tis. pacienů,
- **5,7% rozvinulo AKI a 4,3% vyžadovali RRT**
- 30% mělo renální dysfci před přijetím na ICU
- nemocniční mortalita 60%

Acute Renal Failure in Critically Ill Patients

A Multinational, Multicenter Study



Dominantní příčinou AKI na ICU je hypoperfuze (prerenální renální selhání)

RRT = Renal Replacement Therapy

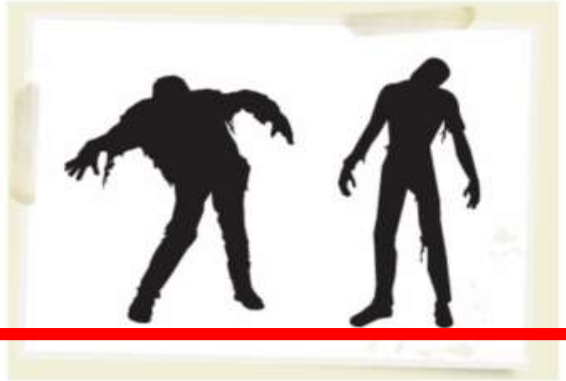
(SLED)

	CRRT	PIRRT	IHD/IHDF
doba	24 hod	6-12 hod	3-4 hod
frekvence	denně	denně	3-4 x t
Qb ml/min	100-250	200-250	300-350
Qd ml/min	16-50	200-300	500-800
Qf ml/min	16-50	30-45	70-80

PIRRT

Problems with terminology

- SLEDD
  - slow low efficiency dialysis
  - sustained low efficiency dialysis
- EDD
  - extended daily dialysis
- Go Slow dialysis
- Hybrid dialysis
- PIRRT
  - Prolonged intermittent renal replacement therapy



IHD/CRRT

bez rozdílu v mortalitě a renal recovery

- 5.6.1: Use continuous and intermittent RRT as complementary therapies in AKI patients. (Not Graded)

- 5.6.2: We suggest using **CRRT**, rather than standard intermittent RRT**, for hemodynamically unstable patients.** (2B)

- 5.6.3: We suggest using **CRRT**, rather than intermittent RRT, for AKI patients with **acute brain injury or other causes of increased intracranial pressure or generalized brain edema**. (2B)

Schwenger et al. Critical Care 2012, 16:R140
http://ccforum.com/content/16/4/R140

CRITICAL CARE

RESEARCH Open Access

Sustained low efficiency dialysis using a single-pass batch system in acute kidney injury - a randomized interventional trial: the REnal Replacement Therapy Study in Intensive Care Unit PatiEnts

Monocentrická studie,
232 AKI pacinetů,
Surgical ICU

Table 3 Primary and secondary outcomes.

	All (n = 232)	SLED (n = 115)	CVVH (n = 117)	*P*
Death from any cause by day 90	122 (52.6 %)	57 (49.6 %)	65 (55.6 %)	0.434**
Death from any cause up to 30 August 2009	155 (66.8 %)	76 (66.1 %)	79 (67.5 %)	0.926**
In-hospital mortality	119 (51.3 %)	57 (49.6 %)	62 (53.0 %)	0.696**
Mortality in ICU	98 (42.2 %)	49 (42.6 %)	49 (41.9 %)	0.984**
Mechanical ventilation	205 (88.4%)	101 (87.8%)	104 (88.9%)	0.962**
Days of mechanical ventilation	1 9.4 ± 19.7	17.7 ± 19.4	20.9 ± 19.8	0.047*
Days in intensive care unit	21.7 ± 21.1	19.6 ± 20.1	23.7 ± 21.9	0.038*
Recovery of kidney function in days after RRT initiation	10.2 ± 14.5	10.0 ± 15.2	10.5 ± 14.0	0.049*
BP syst pre-treatment (mmHg)	124.8 ± 14.0	125.1 ± 14.6	124.6 ± 13.5	0.434*
BP syst after treatment (mmHg)	126.3 ± 16.4	128.3 ± 17.1	124.3 ± 15.6	0.051*
BP diast pre-treatment (mmHg)	60.7 ± 10.3	60.7 ± 10.7	60.7 ± 10.0	0.420*
BP diast after treatment (mmHg)	61.1 ± 10.7	61.8 ± 11.3	60.3 ± 10.2	0.250*
Hypotensive episodes	1.6 ± 1.5	1.5 ± 1.4	1.8 ± 1.6	0.077*

All values are expressed as number (percent) or mean ± SD; statistical analyses were performed for SLED versus CVVH. *One-tailed Wilcoxon test; **2 × 2 table Chi-Square test with Yates' correction. BP syst: systolic blood pressure; BP diast: diastolic blood pressure; SLED: sustained low efficiency dialysis; CVVH: continuous veno-venous hemofiltration.

Sustained low-efficiency dialysis in the ICU: Cost, anticoagulation, and solute removal

AN Berbece[1] and RMA Richardson[1,2]

[1]University of Toronto, Toronto, Canada and [2]Division of Nephrology, University Health Network, Canada

Table 3 | Daily and weekly cost of SLED and CRRT

	SLED ($)	CRRT citrate ($)	CRRT heparin ($)
Supply cost/day	69.75	402.80	334.95
HD RN cost/day	168.75[a]	37.50	37.50
Total cost/day	238.50	440.30	372.45
Total cost/week	1431	3089	2607

CRRT, continuous renal replacement therapy; HD, hemodialysis; RN, registered nurse; SLED, sustained low-efficiency dialysis.

[a]*Note:* Based on one HD nurse treating two patients.

Žilní přístup

- 5.4.2: When choosing a vein for insertion of a dialysis catheter in patients with AKI, consider these preferences (Not Graded):
  - **First choice: right jugular vein;**
  - **Second choice: femoral vein;**
  - **Third choice: left jugular vein;**
  - **Last choice: subclavian vein with preference for the dominant side.**

- 5.4.3: We recommend using **ultrasound** guidance for dialysis catheter insertion. (1A)

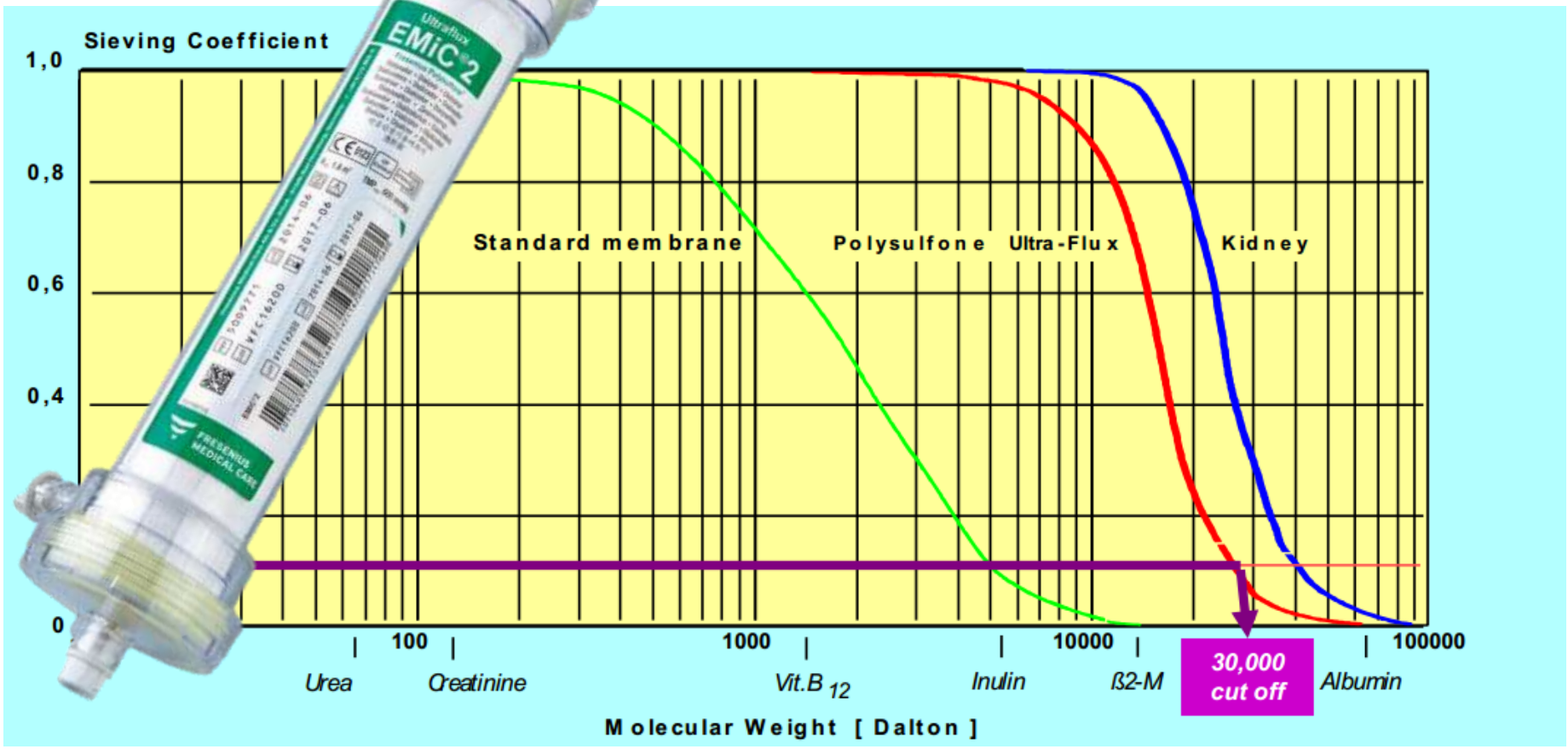
Režimy RRT

- **CVVHD** = kontinuální venovenozní **hemodialýza**
  - hl. difuze (efektivní hl. pro malé molekuly)
  - high-flux filtry
- **CVVH** = kontinuální venovenozní **hemofiltrace**
  - konvekce/ultrafiltrace
  - substituční tekutina
    - prediluce (před filtr)
    - postdiluce (za filter) – více efektivní, ale riziko hemokoncentrace
- **CVVHDF** = kontinuální venovenozní **hemodiafiltrace**
  - kombinace

t.č. nejsou dostatečně silná data prokazující superioritu žádného z režimu

Filter patency: CVVHD>CVVHDF>CVVH dáno velikostí filtrační frakce …

Ultraflux AV 600S / 1000S EMIC2



- U **CVVHD** by pro zajištění optimální efektivity dialýzy měl být poměr dialýzy v ml/hod a blood flow v ml/min cca 20
  - Např.: dialýza 2000 ml/hod → blood flow 100 ml/min

- U **CVVH** by měl být koncentrační poměr (ultrafiltrace (v ml/min) / blood flow (v ml/min))

  < 20% (až 25%)
  - např při blood flow 150 ml/min by UF neměla být větší než 150 * 0.2 = 30 ml/min = 1800 ml/hod

- **Ultrafiltrace**
  - **Celková (total)** – celkový profiltrovaný objem (zpravidla z velké části substituovaný)
  - **Čistá (net)** ≈ diuréza

Intensive Care Med (2007) 33:1563–1570
DOI 10.1007/s00134-007-0754-4

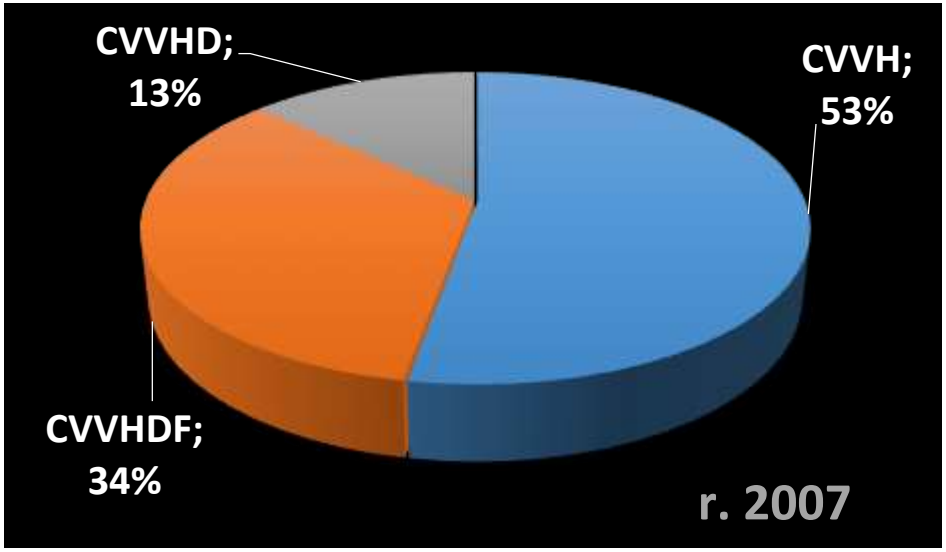
ORIGINAL

Shigehiko Uchino
Rinaldo Bellomo
Hiroshi Morimatsu
Stanislao Morgera
Miet Schetz
Ian Tan
Catherine Bouman

Continuous renal replacement therapy: A worldwide practice survey

The Beginning and Ending Supportive Therapy for the Kidney (B.E.S.T. Kidney) Investigators

r.2007, 54 ICUs, 23 zemí, 1006 pacientů



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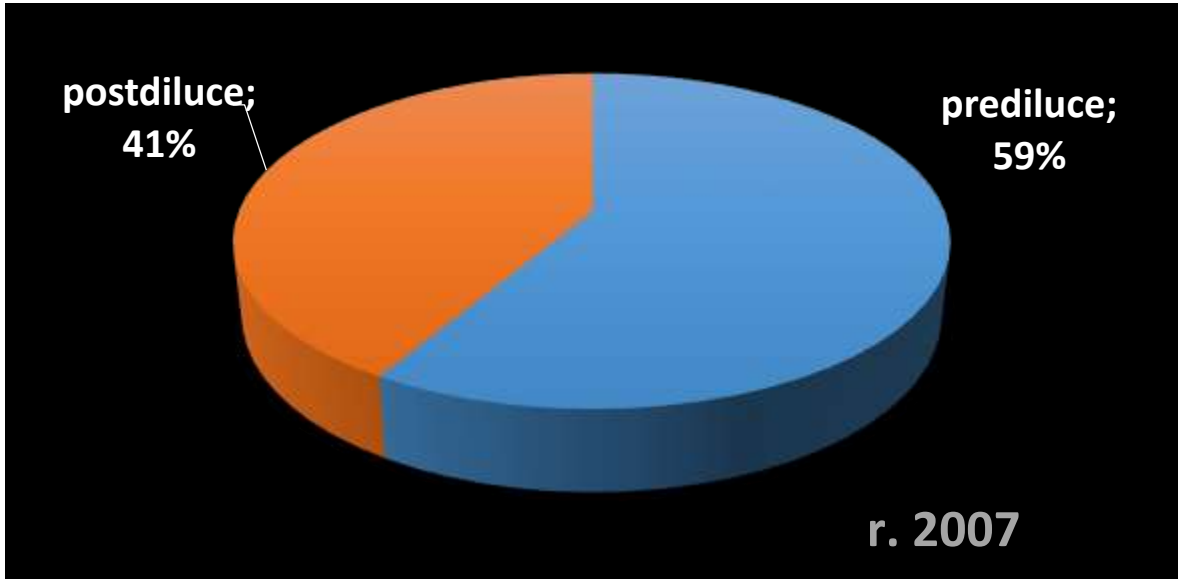


Pufer

- 5.7.2: We recommend using **bicarbonate**, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and **circulatory shock**. (1B)

- 5.7.3: We suggest using **bicarbonate**, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI **and liver failure and/or lactic acidemia**. (2B)

CRRT - antikoagulace

u pacientů **bez rizika krvácení**:

- 5.3.2.1: For anticoagulation in **intermittent RRT**, we recommend **using either unfractionated or low-molecular weight heparin**, rather than other anticoagulants. (1C)

- 5.3.2.2: For anticoagulation in **CRRT**, we suggest using regional **citrate anticoagulation rather than heparin** in patients who do not have contraindications for citrate. (2B)

- 5.3.2.3: For anticoagulation during **CRRT** in patients who **have contraindications for citrate**, we suggest using **either unfractionated or low-molecular-weight heparin**, rather than other anticoagulants. (2C)

CRRT - antikoagulace

u pacientů **s rizikem krvácení:**

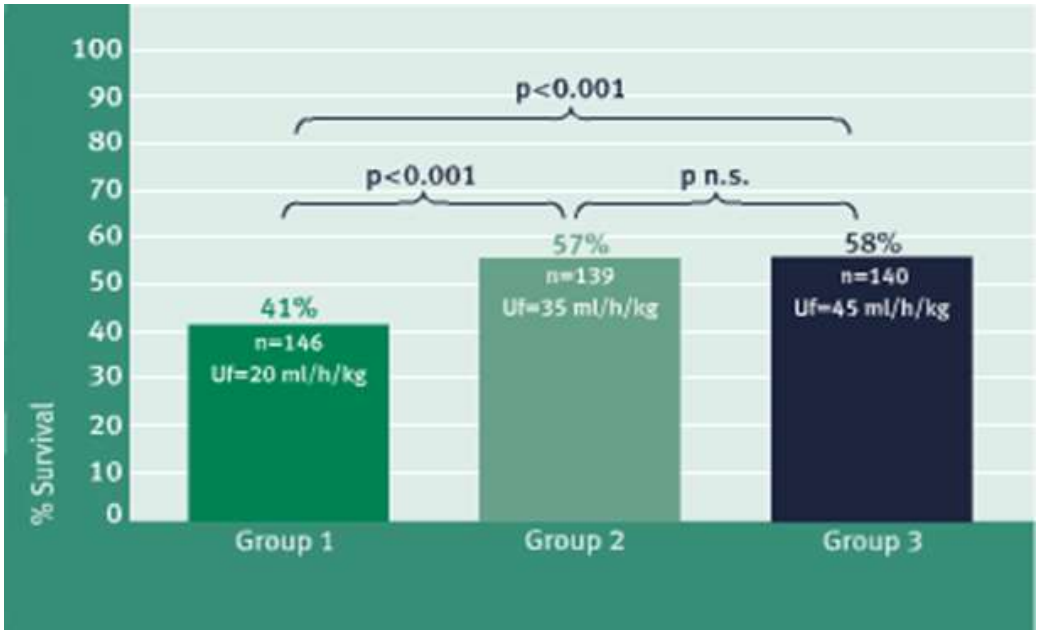
- 5.3.3.1: We suggest using **regional citrate anticoagulation, rather than no anticoagulation, during CRRT** in a patient without contraindications for citrate. (2C)
- 5.3.3.2: We suggest **avoiding regional heparinization during CRRT** in a patient with increased risk ofbleeding. (2C)

Dávka CRRT

Effects of different doses in continuous veno-venous haemofiltration on outcomes of acute renal failure: a prospective randomised trial

Claudio Ronco, Rinaldo Bellomo, Peter Homel, Alessandra Brendolan, Maurizio Dan, Pasquale Piccinni, Giuseppe La Greca

THE LANCET • Vol 356 • July 1, 2000



20 x 35 ml/kg/hod

Dávka CRRT ATN study

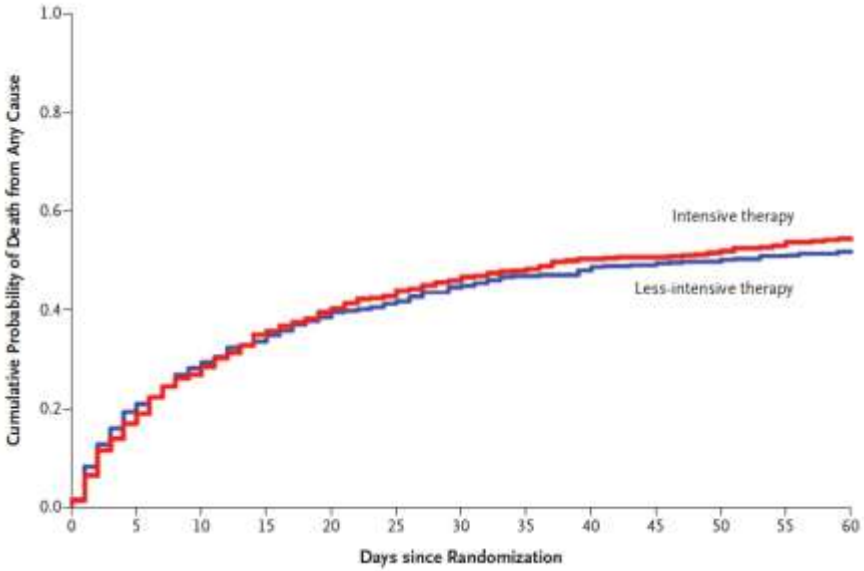
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JULY 3, 2008 VOL. 359 NO. 1

r. 2008

Intensity of Renal Support in Critically Ill Patients with Acute Kidney Injury

The VA/NIH Acute Renal Failure Trial Network*



n=1124

25 x 35 ml/kg/hod,

mortalita po 60 dnech

odds ratio: 1.09 (0.86-1.40)

P = 0.47

Dávka CRRT RENAL study

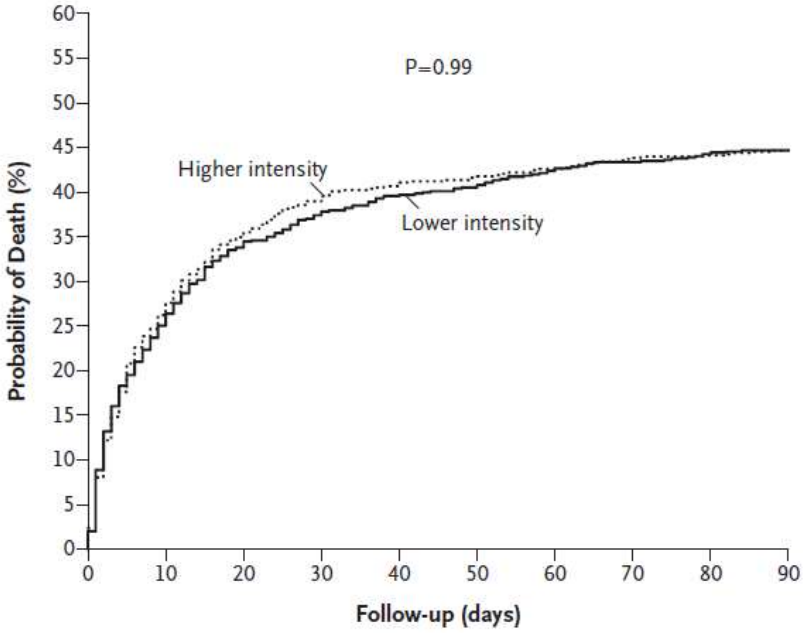
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 OCTOBER 22, 2009 VOL. 361 NO. 17

r. 2009

Intensity of Continuous Renal-Replacement Therapy in Critically Ill Patients

The RENAL Replacement Therapy Study Investigators*



n=1508

20 x 40 ml/kg/hod,

mortalita po 90 dnech

odds ratio: 1 (0.81-1.23)

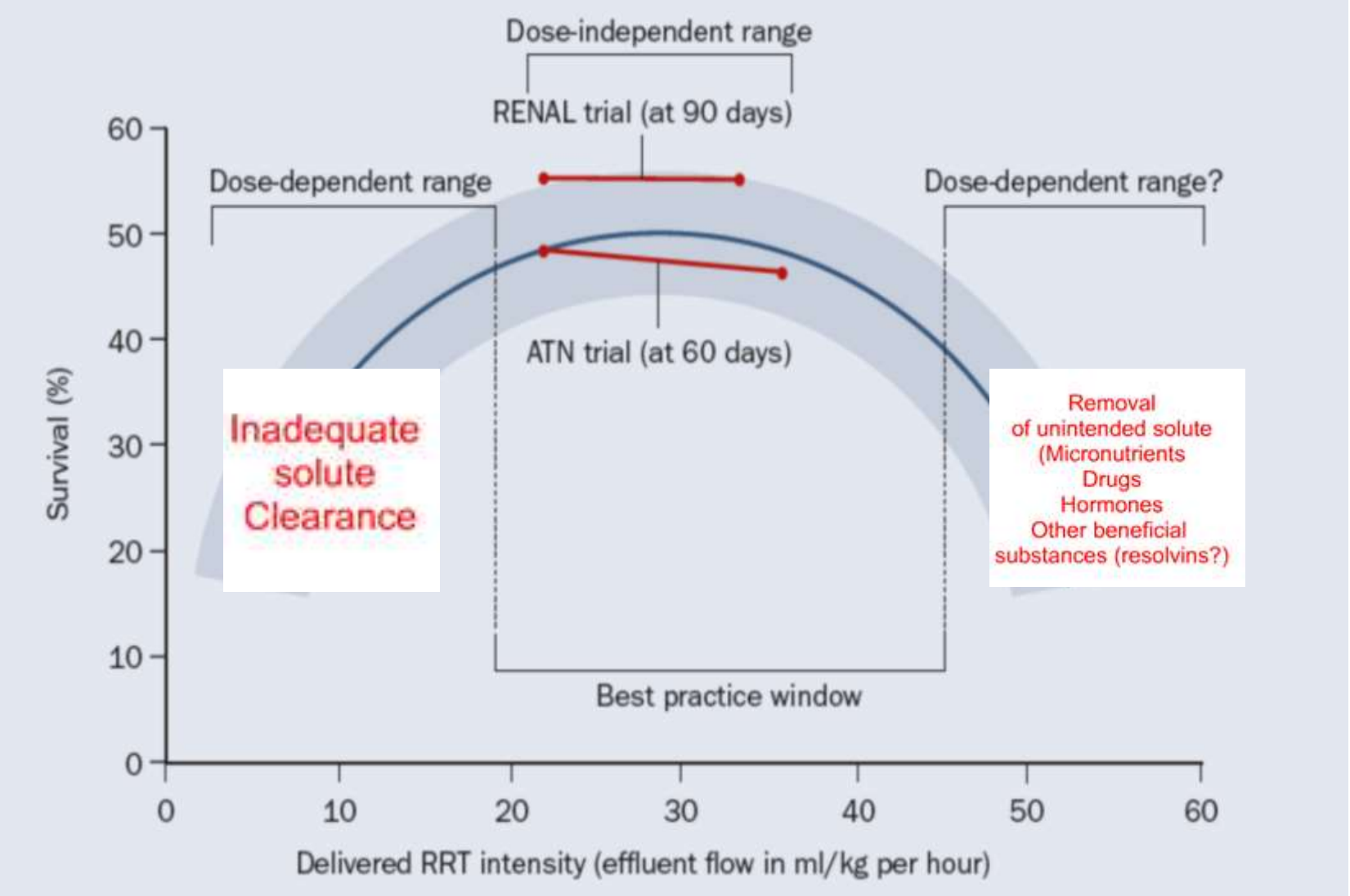
P = 0.99

Nature Reviews Nephrology **6**, 191-192 (April 2010) | doi:10.1038/nrneph.2010.15

Dávka CRRT

Dialysis: Results of RENAL—what is the optimal CRRT target dose?

John A. Kellum & Claudio Ronco



Dávka CRRT

- 5.8.4: We recommend delivering an effluent volume of **20–25 ml/kg/h for CRRT in AKI** (1A). This will usually requirea higher prescription of effluent volume. (Not Graded)

- podaná dávka je většinou nižší než ordinovaná často až o 5-10 ml/kg/min

Dávka

- 25 ml/kg/hod
- ≈ 2 L/ hod
- ≈ 40 L/den 40 L ≈ objem tělesné vody

CRRT – načasování zahájení

- RIFLE F/AKIN III = 3x zvýšený krea
- RIFLE R/I /AKIN I-II = 1,5-2 x zvýšený krea
  - při rychlé progresi
  - při přetížení tekutinami
  - nízká pravděpodobnost renal recovery

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Initiation Strategies for Renal-Replacement Therapy in the Intensive Care Unit

2016
Multicentrická RCT
severe AKI (AKIN 3)
620 pacientů

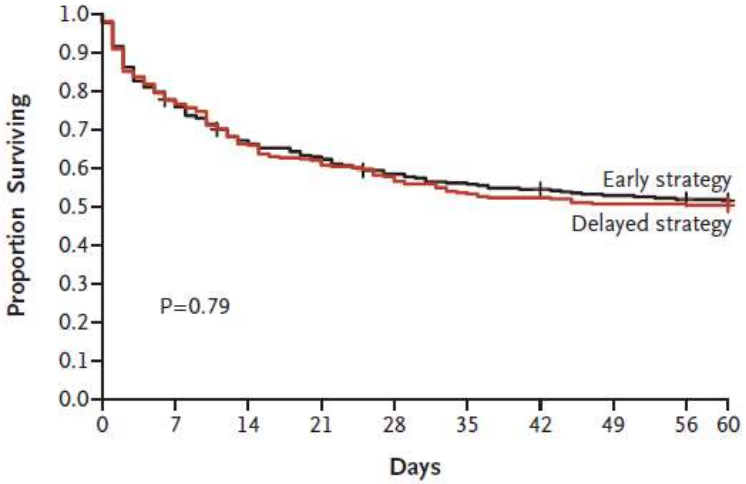
- Po randomizaci:
  - Early RRT: ihned RRT
  - Late RRT: pouze pokud:
    - těžká hyperkalemie/MAC, plicní edém, urea >40, oligurie > 72 hod

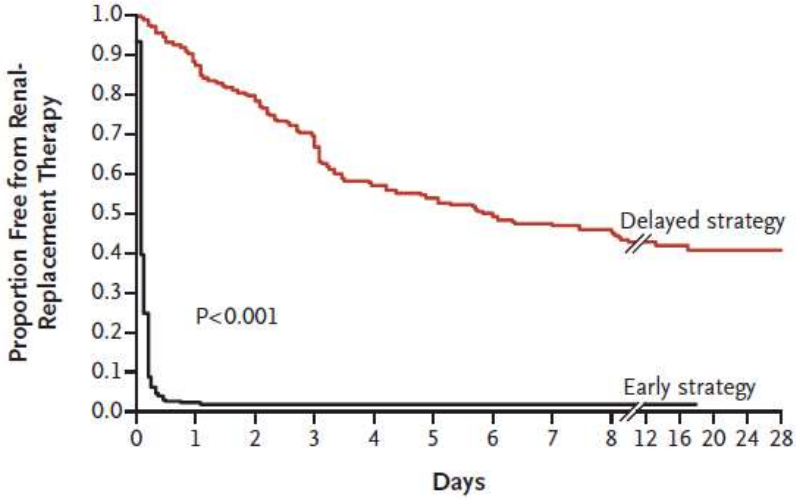
- Mortalita po 60ti dnech stejná
- 49% pacientů v late group nedospělo k RRT
- Katetrová sepse v early 10% v late 5%
- Diuréza se obnovila dříve v late RRT group

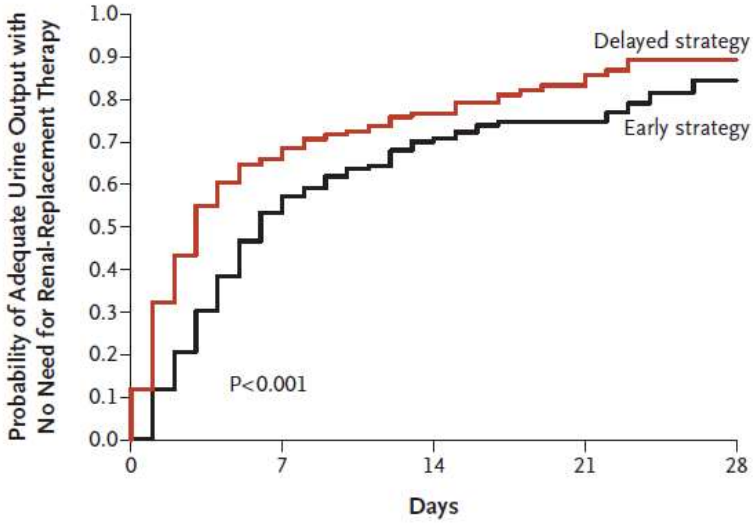
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Initiation Strategies for Renal-Replacement Therapy in the Intensive Care Unit







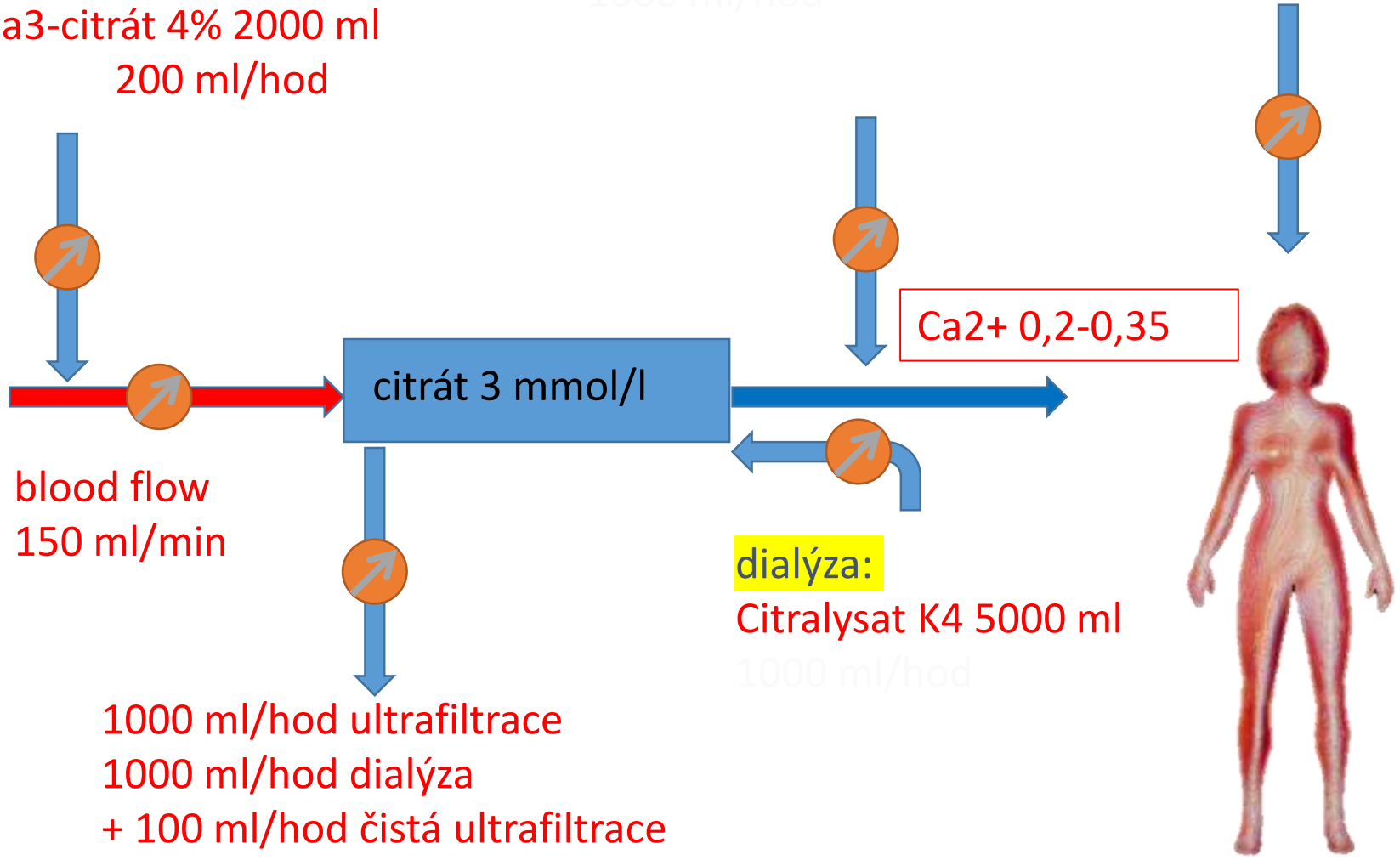
CVVHDF

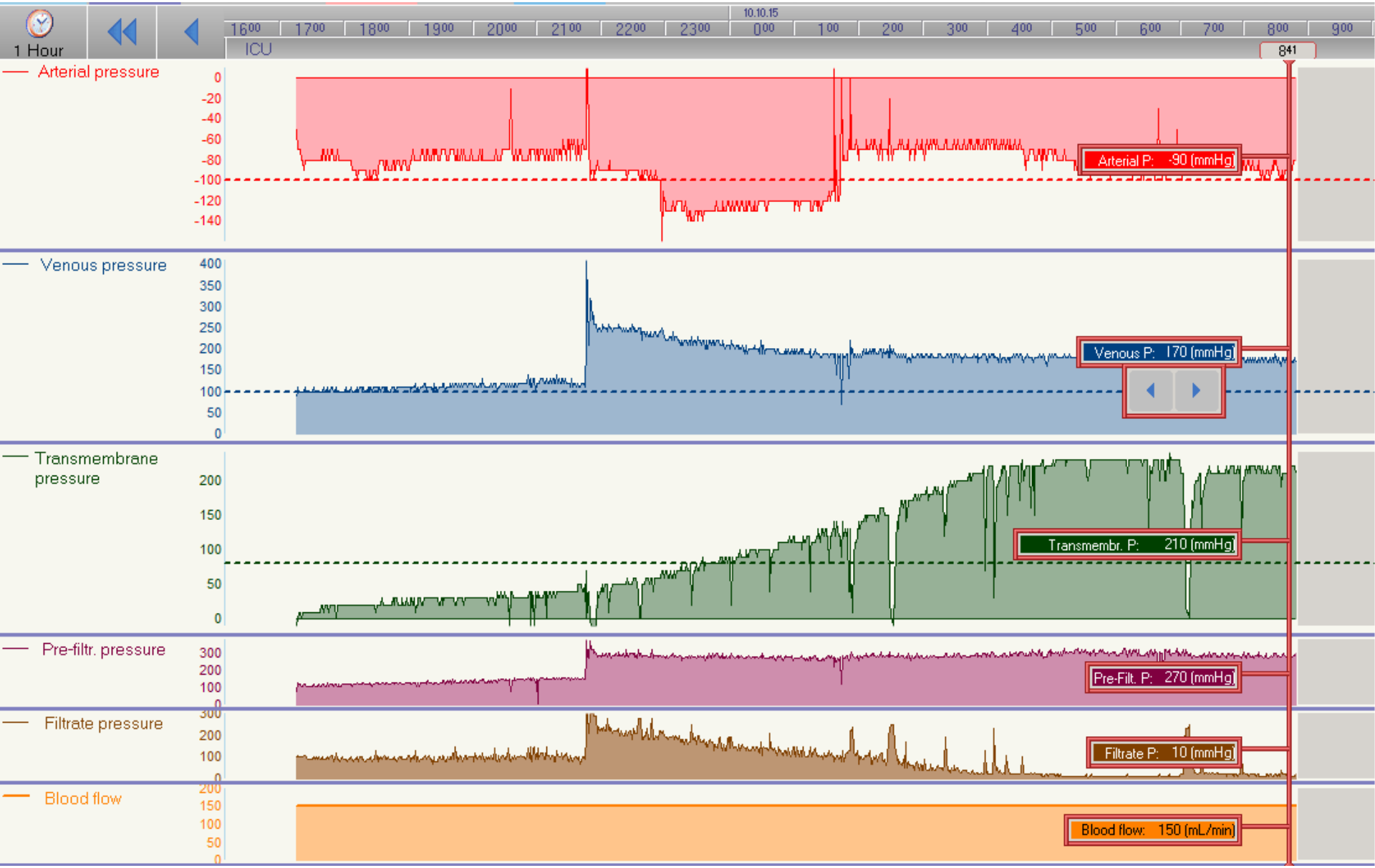
substituce ultrafiltrace:
Bi4 5000 ml
+ 100 ml NaHCO3 8,4%
1000 ml/hod

$CaCl_2$ 5 ml/hod

Ca2+ 1,1-1,2

Na3-citrát 4% 2000 ml
200 ml/hod




1 Hour
10.10.15
1600
1700
1800
1900
2000
2100
2200
2300
000
100
200
300
400
500
600
700
800
900
ICU
841
Arterial pressure
0
-20
-40
-60
-80
-100
-120
-140
Arterial P: -90 (mmHg)
Venous pressure
400
350
300
250
200
150
100
50
0
Venous P: 170 (mmHg)
Transmembrane pressure
200
150
100
50
0
Transmembr. P: 210 (mmHg)
Pre-filtr. pressure
300
200
100
0
Pre-Filt. P: 270 (mmHg)
Filtrate pressure
300
200
100
0
Filtrate P: 10 (mmHg)
Blood flow
200
150
100
50
0
Blood flow: 150 (mL/min)

Děkuji za pozornost …