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# Timing, dosage and withdrawal of RRT in AKI

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Barts Health NHS Trust

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# Outline – RRT for AKI in the ICU

- ☺ When to start
- ☺ How much to give
- ☺ When to stop

- ☹ Modality
- ☹ Extended Indications
- ☹ Single organ failure outside ICU

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http://www.kidney-international.org

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KDIGO Clinical Practice Guideline for Acute Kidney Injury

# Section 5: Dialysis Interventions for Treatment of AKI

**5.1.1:** Initiate RRT emergently when life-threatening changes in fluid, electrolyte, and acid-base balance exist. (*Not Graded*)

**5.1.2:** Consider the broader clinical context, the presence of conditions that can be modified with RRT, and trends of laboratory tests—rather than single BUN and creatinine thresholds alone—when making the decision to start RRT. (*Not Graded*)

**5.2.1:** Discontinue RRT when it is no longer required, either because intrinsic kidney function has recovered to the point that it is adequate to meet patient needs, or because RRT is no longer consistent with the goals of care. (*Not Graded*)

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

**5.8.2:** Provide RRT to achieve the goals of electrolyte, acid-base, solute, and fluid balance that will meet the patient's needs. (*Not Graded*)

**5.8.3:** We recommend delivering a Kt/V of 3.9 per week when using intermittent or extended RRT in AKI. (*1A*)

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

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# When to start?

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# Why Give RRT?
# Consequences of Acute & Chronic Renal Dysfunction

- Salt, Water and Acid-base balance
  - Fluid retention
  - Hyponatraemia
  - Hypertension
  - Hyperkalaemia
  - Acidosis
  - Hypermagnesemia
  - Hyperphosphataemia

- Excretion of Nitrogenous End Products
  - Uraemia
    - Anorexia, Nausea, Pruritus, Pericarditis, Polyneuropathy, Encephalopathy, Platelet dysfunction

- Endocrine / Metabolic
  - Hypertension
  - Anaemia
  - Osteomalcia, Osteodystrophy

# Absolute Indications?

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**A summary of absolute or 'rescue therapy' indications for initiation of renal replacement therapy in critically ill patients**

| Category | Characteristic |
|---|---|
| Metabolic | |
| Azotemia | Serum urea ≥36mmol/L (100 mg/dL) |
| Uremic complications | Encephalopathy, pericarditis, bleeding |
| Hyperkalemia | K+ ≥6 mmol/L and/or electrocardiogram abnormalities |
| Hypermagnesemia | ≥4 mmol/L and/or anuria/absent deep tendon reflexes |
| Acidosis | Serum pH ≤7.15 |
| Oligo-anuria | Urine output <200mL/12 h or anuria |
| Fluid overload | Diuretic-resistant organ edema (that is, pulmonary edema) in the presence of acute kidney injury |

Gibney N, Hoste E, Burdmann EA, Bunchman T, Kher V, Viswanathan R, Mehta RL, Ronco C: **Timing of initiation and discontinuation of renal replacement therapy in AKI: unanswered key questions.** *Clin J Am Soc Nephrol* 2008, **3**:876-880.

# RENAL Study entry criteria

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To Consider RRT:

- Oliguria (urine output <100 ml in 6h)
- Potassium >6.5 mmol/L
- pH <7.2
- Urea >25 mmol/L
- Creatinine >300 $\mu$ mol/L
- Clinically significant organ edema

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# VA NIH ATN Study

To Consider RRT:

- Urea ≥ 21 mmol/L
- Volume overload
- Persistent hyperkalemia
  - (K+ > 6.2 mEq/L or ECG changes)
- Severe metabolic acidosis
  - (pH < 7.20 or $tCO_2$ < 15 mEq/L)
- Uremic signs or symptoms

# 1970



THE JOURNAL OF TRAUMA
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## A CONTROLLED EVALUATION OF PROPHYLACTIC DIALYSIS IN POST-TRAUMATIC ACUTE RENAL FAILURE

JOHN D. CONGER, M.D.

*From the Hemodialysis Unit, Veterans Administration Hospital, and Department of Medicine, University of Colorado Medical Center, Denver*

### INTRODUCTION

Evidence has been presented in the past several years that intensive dialysis is beneficial in improving the survival of patients with acute renal failure (6, 13, 14, 17, 21, 23, 25). However, all of these studies have a similar inherent defect: survival data before the advent of dialysis or in the relatively early years of dialysis are compared to those from more contemporary periods. It is possible that factors other than the frequency of dialysis, such as improved

related shutdown will likely have poorer survival results (4, 26) than reports in which there are a large number of medically related renal failure patients (5, 12).

We recently carried out a prospective study to evaluate specifically the value of dialysis treatment programs of differing intensities in the treatment of acute renal failure, designed to eliminate the aforementioned variables. Patients with similar degrees of trauma and catabolism with associated acute renal failure were

9 patient pairs (17 oligo-anuric) – 'Early' BUN 50mg/dl 20% Mortality
'Late' BUN 120mg/dl 64% Mortality

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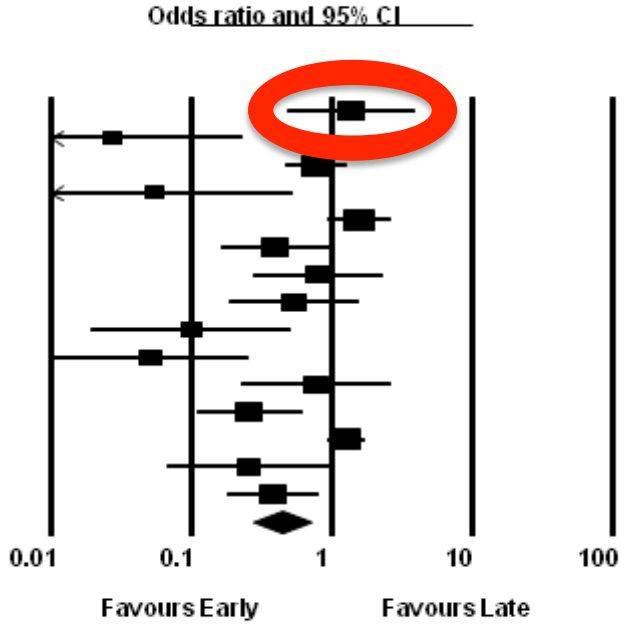
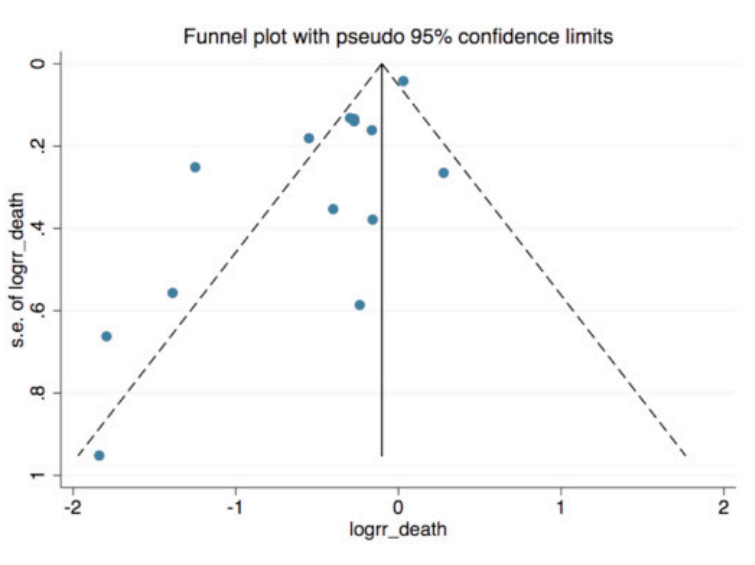
# A comparison of early versus late initiation of renal replacement therapy in critically ill patients with acute kidney injury: a systematic review and meta-analysis

Karvellas *et al. Critical Care* 2011, **15**:R72
http://ccforum.com/content/15/1/R72

Constantine J Karvellas[1], Maha R Farhat[2], Imran Sajjad[3], Simon S Mogensen[4], Alexander A Leung[5], Ron Wald[6], Sean M Bagshaw[1*]



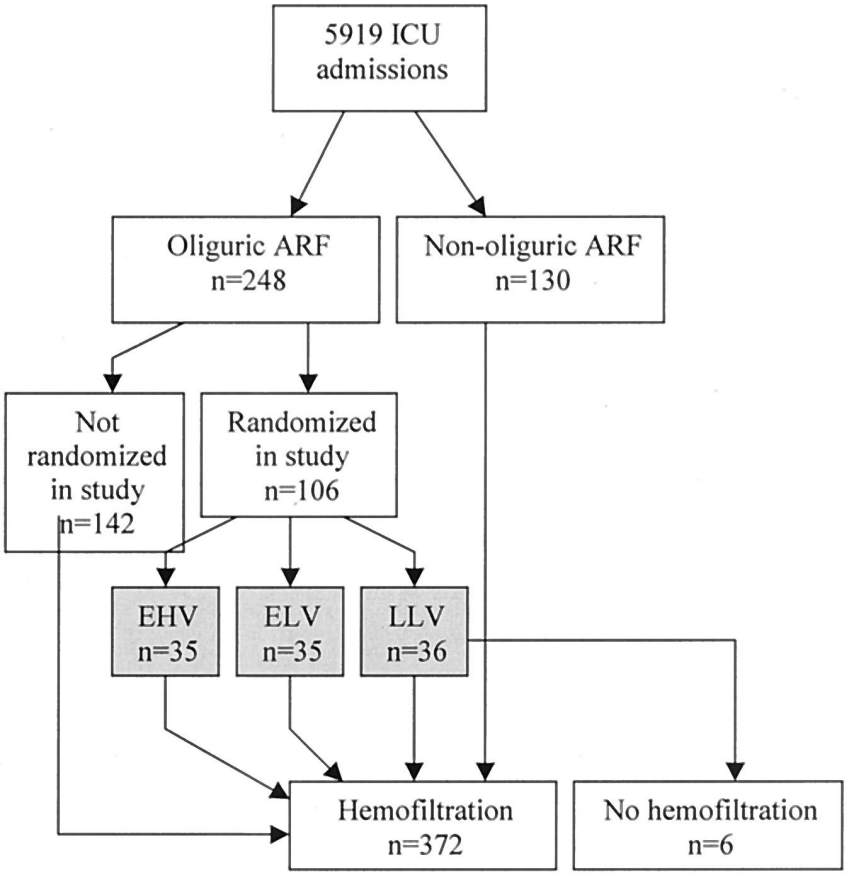




*In the absence of novel evidence from a multi-centric suitably-designed randomized trial, conclusive treatment recommendations on the optimal time to initiate RRT remain uncertain.*

*Future investigation must be targeted at defining acceptable "early" RRT criteria…*

# Effects of early high-volume continuous venovenous hemofiltration on survival and recovery of renal function in intensive care patients with acute renal failure: A prospective, randomized trial

Catherine S. C. Bouman, MD; Heleen M. Oudemans-van Straaten, MD, PhD; Jan G. P. Tijssen, MD, PhD; Durk F. Zandstra, MD, PhD; Jozef Kesecioglu, MD, PhD




Crit Care Med 2002 Vol. 30, No. 10 p. 2205

## Inclusion criteria

1) Urine output of <30 mL/hr for >6 hrs, despite aggressive fluid resuscitation), hemodynamic optimization with dopamine or dobutamine, phosphodiesterase inhibitors or norepinephrine *and* the administration of high dose diuretics (>500 mg of furosemide infusion in 6 hrs)
2) Creatinine clearance of <20 mL/min, calculated from a 3-hr urine portion
3) Mechanical ventilation;

# Bouman 2002

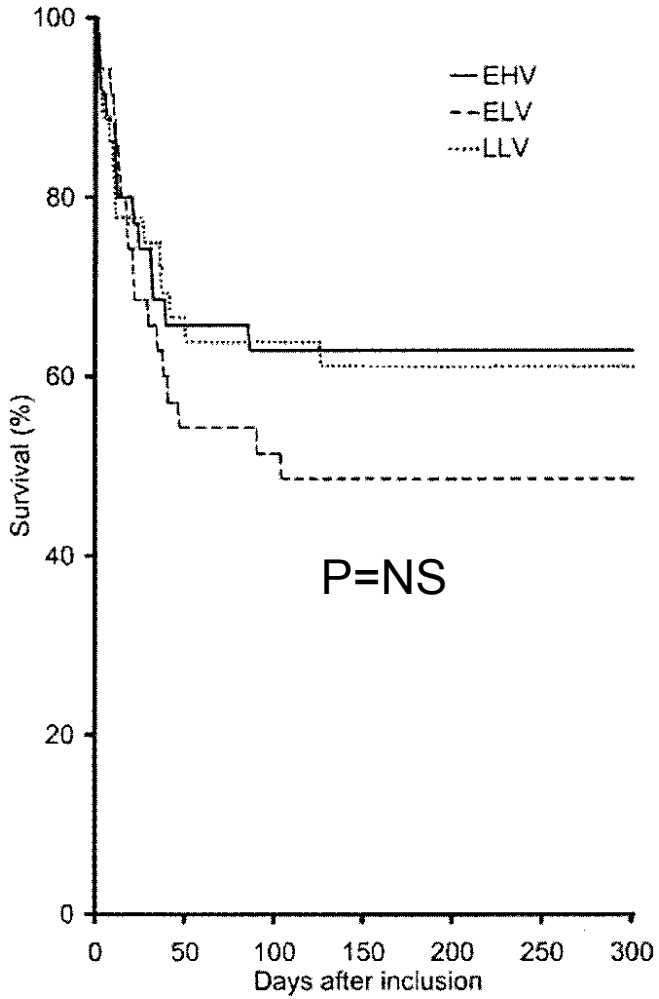



Table 2. Hemofiltration treatment characteristics

| | EHV ($n$ = 35) | ELV ($n$ = 35) | LLV ($n$ = 30) |
|---|---|---|---|
| Hours between $T_{incl.}$ and first hemofiltration session | 6.0 (3.0–9.7) | 7 (5.0–10.0) | 41.8 (21.4–72.0)[a] |
| Urea before first CVVH, mmol/L | 16.3 (13.7–20.6) | 17.1 (14.4–23.5) | 37.4 (22.0–41.4)[a] |
| Filtration rate, mL/kg/hr | 48.2 (42.3–58.7)[b] | 20.1 (17.5–22.0) | 19.0 (16.6–21.2) |
| Hours on hemofiltration | 68.5 (28.0–140.8) | 94.0 (53.0–181.5) | 69.5 (28.3–157.7) |
| Filter life span, hrs | 13.6 (7.8–22.8) | 16.1 (9.0–38.8) | 24.3 (14.0–44)[a] |

# What is early?

- Time from AKI diagnosis

- Level of Uraemia at RRT

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# CREATININE
## – Conflicting Retrospective Evidence

**Higher** Creatinine **Better** Prognosis (>300µmol/L)

- Bagshaw *J Crit Care 2009; 24: 129–140*
- Ostermann *Crit Care 2009; 13: R175*

**Lower** RIFLE **Better** Prognosis

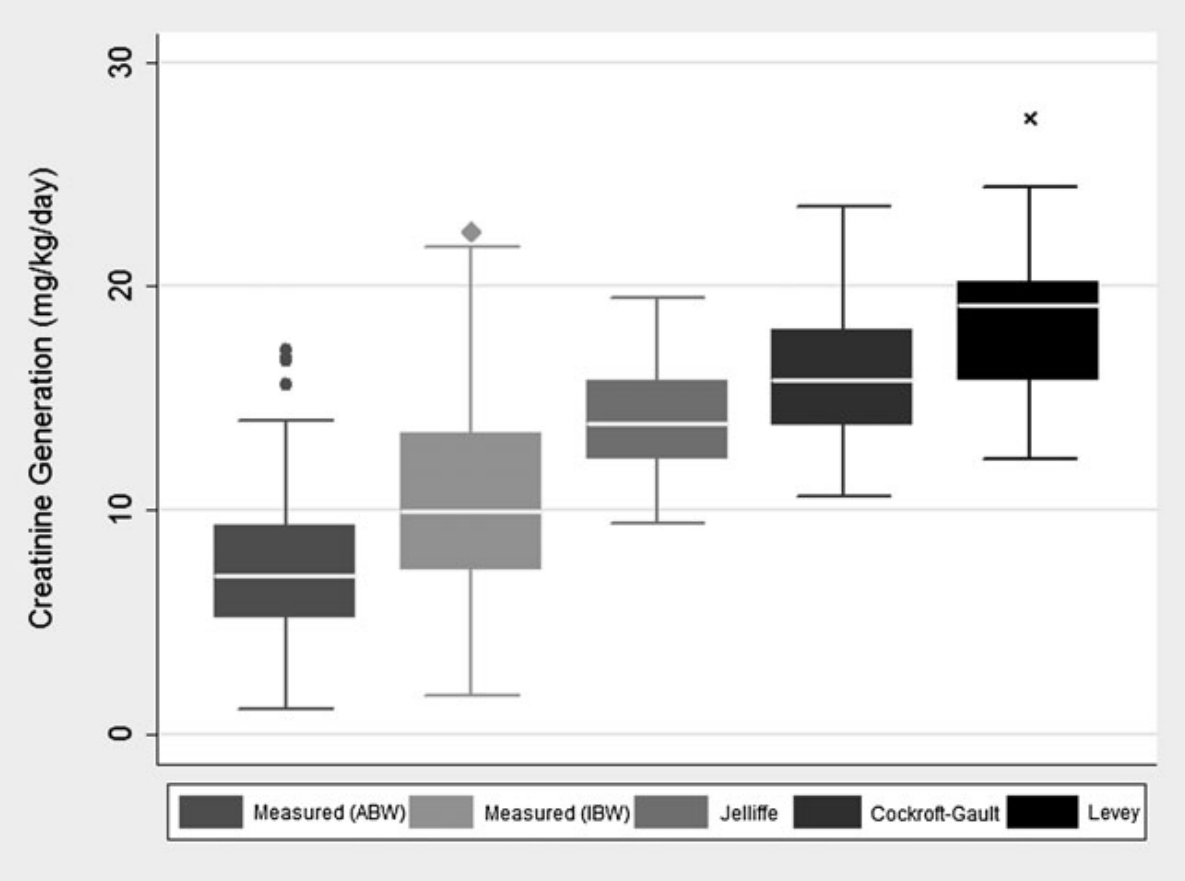
- Shiao *Crit Care 2009; 13: R171*

**Similar** prognosis across RIFLE categories

- Chou *Crit Care 2011; 15: R134*

# Creatinine generation is reduced in patients requiring continuous venovenous hemodialysis and independently predicts mortality

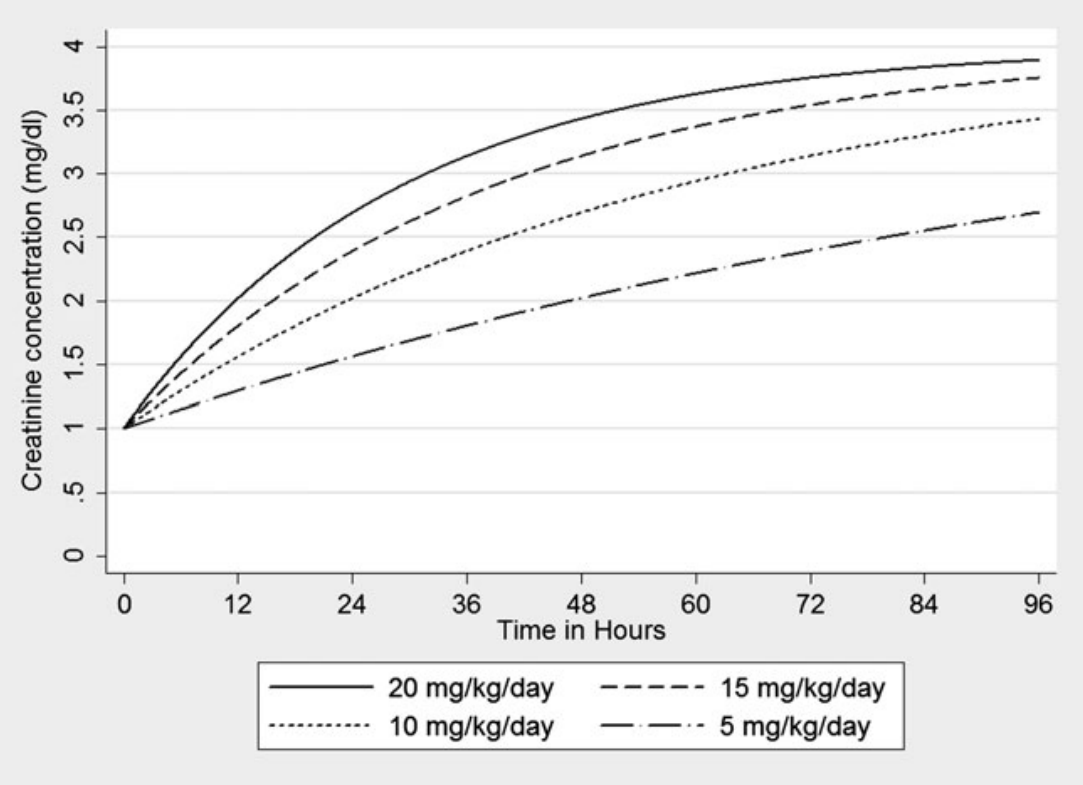
Francis P. Wilson, Jessica M. Sheehan, Laura H. Mariani and Jeffrey S. Berns



# Creatinine generation is reduced in patients requiring continuous venovenous hemodialysis and independently predicts mortality

Francis P. Wilson, Jessica M. Sheehan, Laura H. Mariani and Jeffrey S. Berns

| Risk factor | OR | 95% CI | P |
|---|---|---|---|
| Full multivariable model | | | |
| Creatinine generation rate (per 5 mg/kg/day less) | 2.61 | 1.26–5.39 | 0.01 |



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# Urea

- Improved outcome with commencement at lower Urea in most but not all retrospective analyses.
  - *Ostermann NDT 2012*

- < 36 mmol/L
- < 27 mmol/L
- < 29 mmol/L
- < 21 mmol/L

?

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# Urine Output

- Sustained oliguria or refractory fluid overload
  - < 500–600 mL/24 h
    - *Ostermann NDT 2012*
- Fluid overload at commencement of RRT is associated with adverse outcomes
  - *Payen 2008*
  - *Bouchard 2009*

# Diuretics?

- Mehta et al. JAMA. 2002;288:53
  - 4-center, retrospective analysis of patients referred for nephrology consults (1989 - 1995; n = 552)
  - Prior diuretic use significantly increased risk of death or non-recovery of renal function (odds ratio 1.77; 95% CI 1.14 - 2.76).
- Uchino et al. Crit Care Med. 2004;32:1669 –77
  - 52-center, 1743 ICU patients.
  - No differences in mortality, or renal recovery
    - Odds ratio 1.22 (p = 0.15)
  - However, no benefit associated with diuretics.

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# Other entry criteria - Biomarkers

ClinicalTrials.gov

**Standard Versus Accelerated Initiation of Dialysis in Acute Kidney Injury (STARRT-AKI) -** NCT01557361

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# STARRT-AKI – Standard RRT

- Standard RRT initiation The trial team will ask that the clinical team to *consider* RRT initiation if there are:
- Criteria for persistent AKI (serum creatinine has not declined by more than 50% from value recorded at time of eligibility)

AND

- At least one of the following indications for RRT initiation:
  - Serum potassium ≥6.0 mmol/L, or
  - Serum bicarbonate ≤ 10 mmol/L, or
  - Evidence of severe respiratory failure, based on a PaO2/FiO2 <200 and bilateral infiltrates on the chest x-ray, or
  - By 72 hours after randomization

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# STARRT-AKI - Entry

- Age ≥ 18 years
- Admission to an intensive care unit
- Evidence of kidney dysfunction
  - (creatinine ≥ 100 µmol/L (women) or ≥ 130 µmol/L (men))
- Evidence of severe AKI defined by at least 2 of the following 3 criteria:
  - A 2-fold increase in serum creatinine during hospitalization or from a known pre-hospitalization baseline
  - Oliguria as defined by total urine output < 6 mL/kg over the preceding 12 hours
  - Whole blood Neutrophil Gelatinase-Associated Lipocalin (NGAL) ≥ 400ng/mL
- Likelihood that an absolute indication for RRT will not arise in the subsequent 24 hours
- Central venous pressure ≥ 8 mmHg

# RRT for All?
# Pre-emptive treatment

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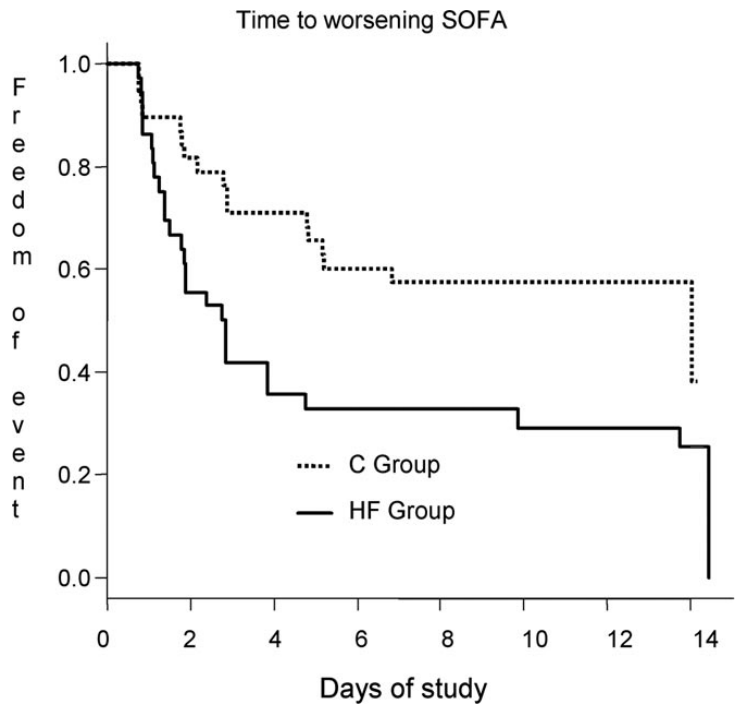
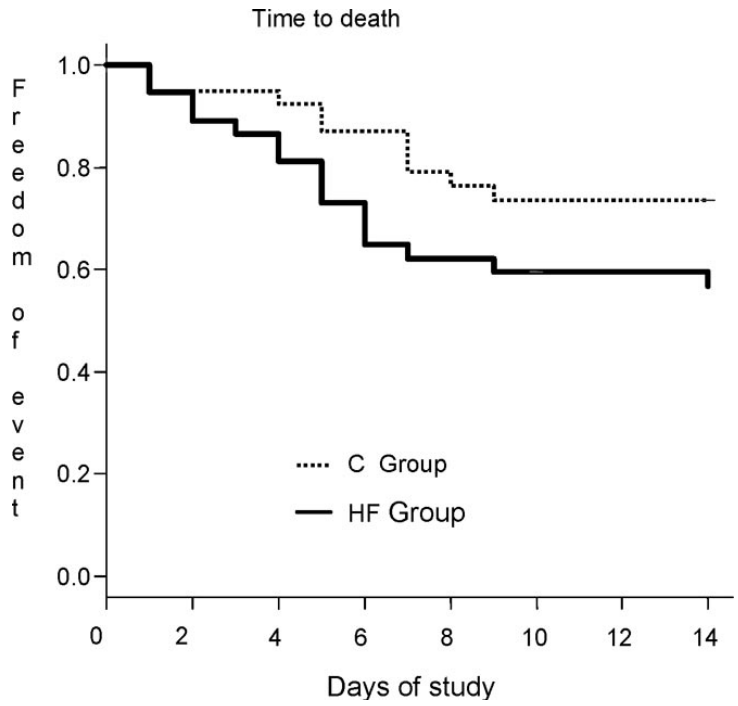
**Impact of continuous venovenous hemofiltration on organ failure during the early phase of severe sepsis: A randomized controlled trial***

Didier Payen, MD, PhD; Joaquim Mateo, MD; Jean Marc Cavaillon, PhD; François Fraisse, MD; Christian Floriot, MD; Eric Vicaut, MD, PhD; for the Hemofiltration and Sepsis Group of the Collège National de Réanimation et de Médecine d'Urgence des Hôpitaux extra-Universitaires



# RRT for all AKI?

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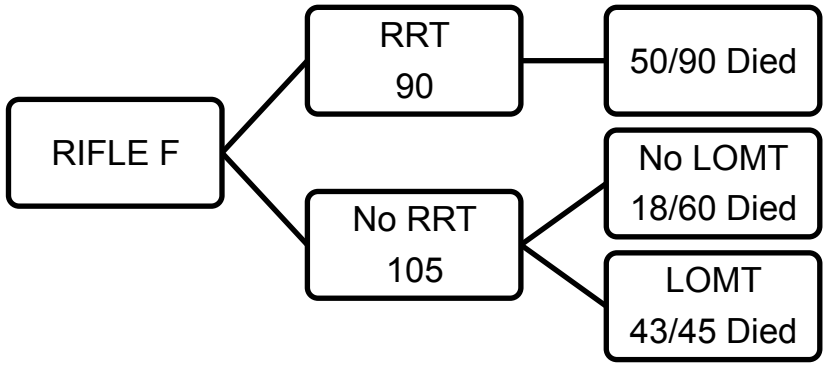
Nephrol Dial Transplant (2012) 27: 947–952
doi: 10.1093/ndt/gfr501
Advance Access publication 8 September 2011

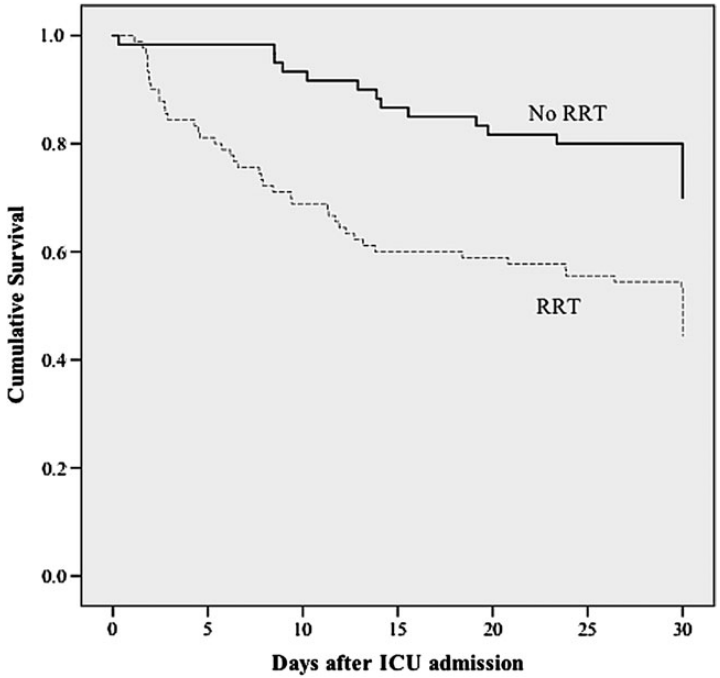
*Original Articles*

NDT
Nephrology Dialysis Transplantation

## Severe acute kidney injury not treated with renal replacement therapy: characteristics and outcome

Antoine G. Schneider[1,2], Shigehiko Uchino[3] and Rinaldo Bellomo[1,2]



# A proposed algorithm for initiation of renal replacement therapy in adult critically ill patients

Sean M Bagshaw[1]*, Dinna N Cruz[2]*, RT Noel Gibney[1] and Claudio Ronco[2]

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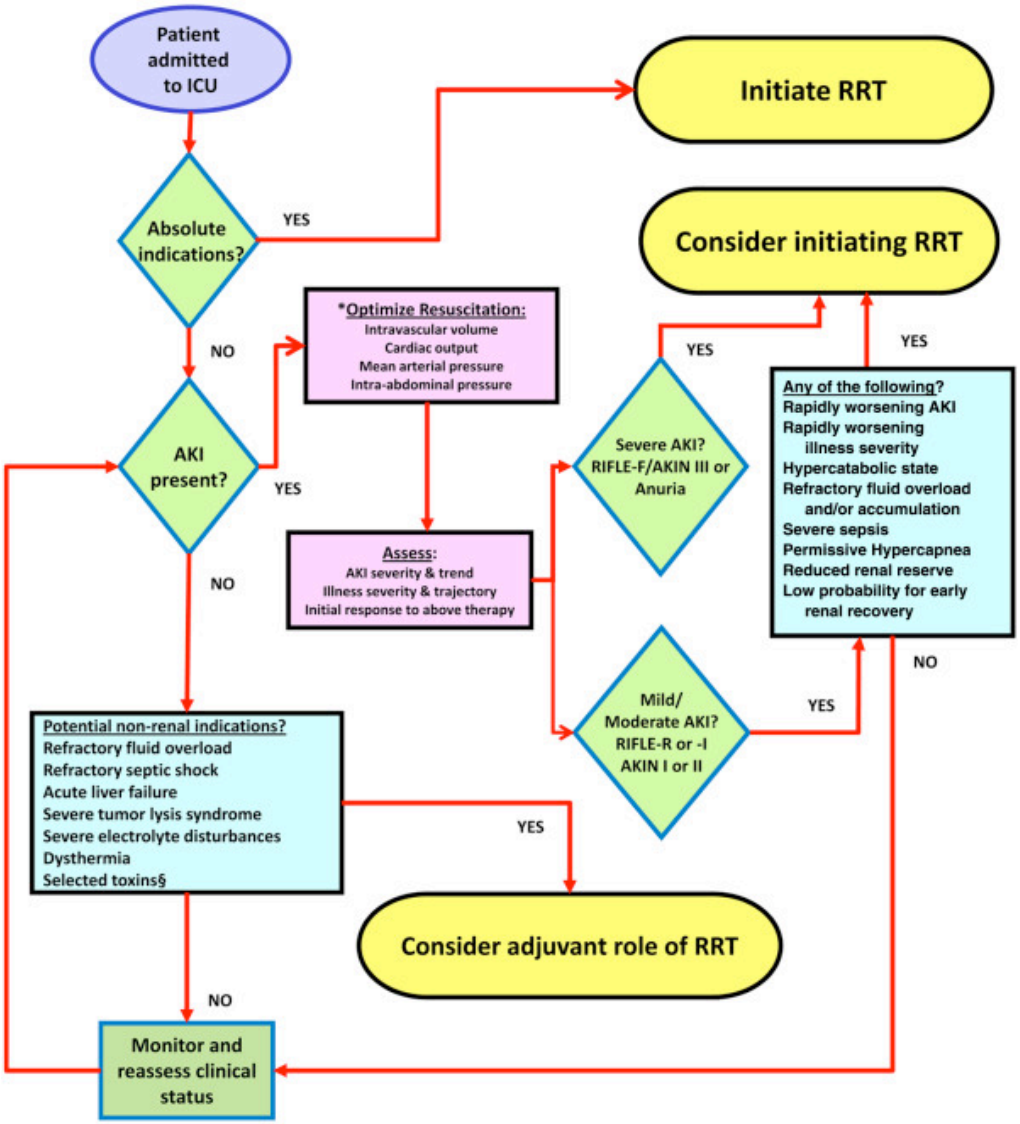
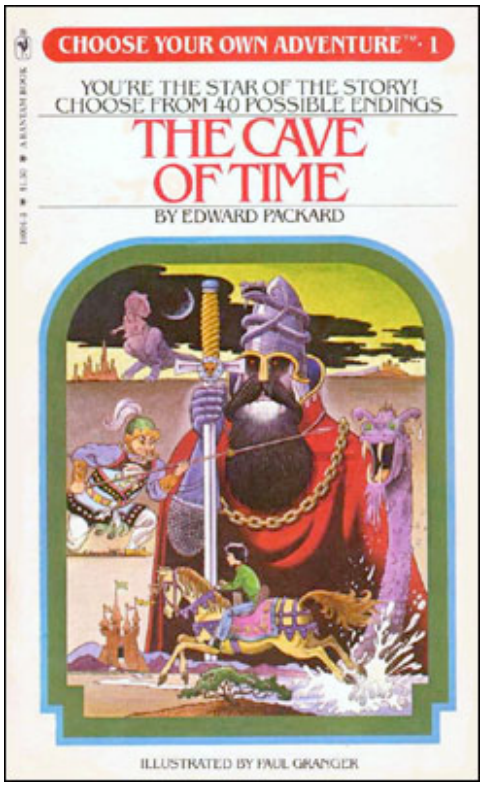
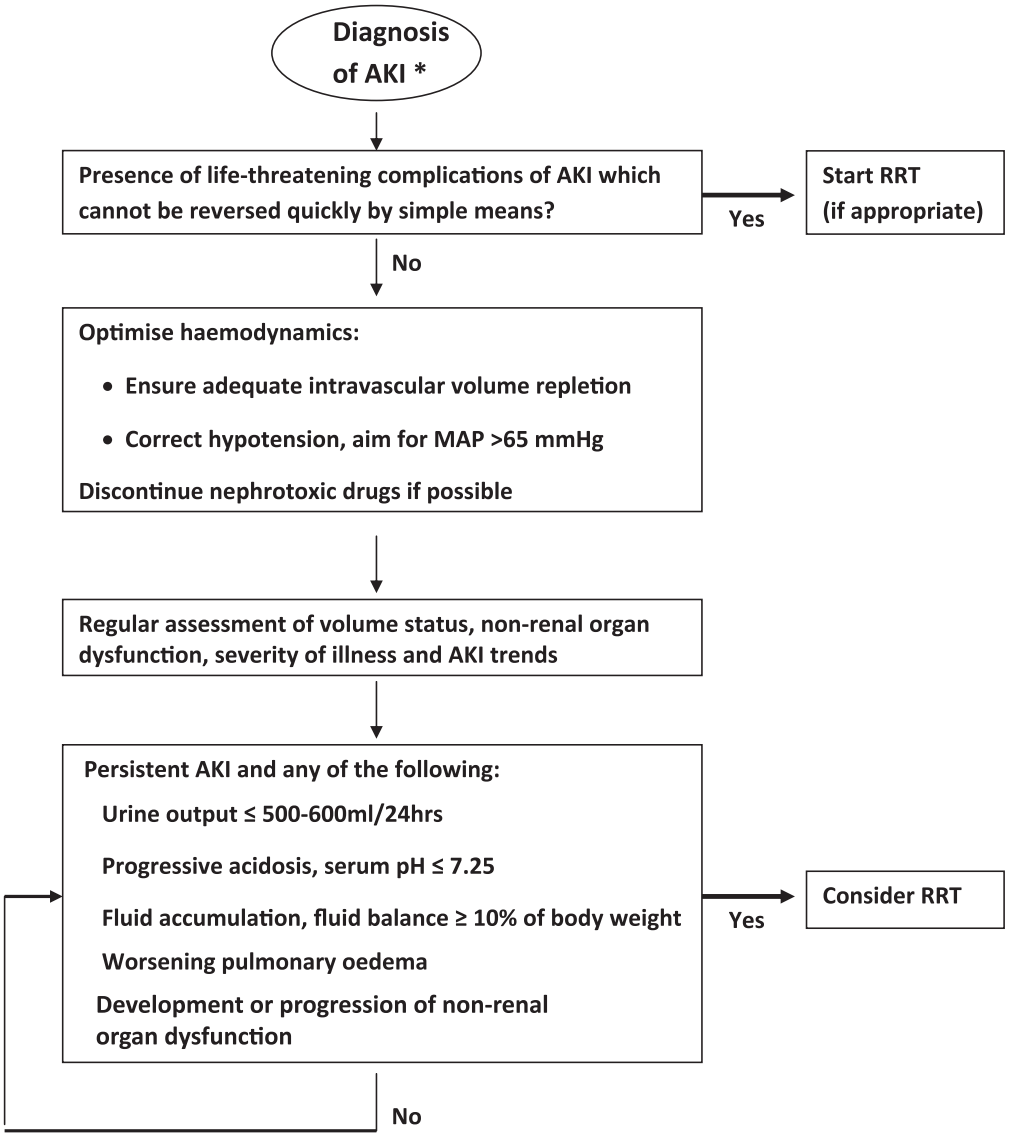


# Renal replacement therapy in critically ill patients with acute kidney injury—when to start

Nephrol Dial Transplant (2012) 27: 2242–2248

Marlies Ostermann, Helen Dickie and Nicholas A. Barrett



# Starting RRT

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- Start in anticipation of Absolute Indications
- Consider severity and likely course of patient's illness
- Oliguria is better than biochemistry (500ml/d)
- Anticipate and avoid fluid overload with early RRT if necessary
- You can use diuretics to modify *Fluid Balance* but this should not delay RRT
- If diuretics are given then Serum Urea may be a trigger for RRT in the absence of oliguria (>25??)
- Can hold off if 'all is well'

# Dose of RRT - Questions

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- How low can you go?

- Can too much be bad for you?

- Does one size fit all?

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The NEW ENGLAND JOURNAL of MEDICINE

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

## Intensity of Continuous Renal-Replacement Therapy in Critically Ill Patients

The RENAL Replacement Therapy Study Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

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

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

The VA/NIH Acute Renal Failure Trial Network*

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# Dose studies for AKI

| Characteristic | VA/NIH ATN study | RENAL study |
|---|---|---|
| *n* | 1,124 | 1,508 |
| Age (years) | 59.7 | 64.5 |
| Male (%) | 70.6 | 64.6 |
| Weight (kg) | 84.1 | 80.7 |
| CKD classification (%)*<br>0–2<br>3a<br>3b<br>4<br>5 | <br>61.0<br>21.1<br>11.0<br>Excluded<br>Excluded | <br>68.6<br>9.7<br>10.4<br>11.3<br>Excluded |
| Sepsis (%) | 63.0 | 47.9 |
| Mechanical ventilation (%) | 80.6 | 73.9 |
| Illness severity score | APACHE II: 26.4‡ | APACHE III: 102.4‡ |

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| |  |  |
|---|---|---|
| Modalities of RRT | CVVHDF, SLEDD or IHD | CVVHDF |
| RRT prior to randomization (%) | 64.3‖ | 0¶ |
| Commenced on CRRT (%) | 69.7 | 100 |
| CRRT mode | Pre-dilution CVVHDF | Post-dilution CVVHDF |
| CRRT high-dose effluent target (ml/kg per h) | 35 | 40 |
| CRRT low-dose effluent target (ml/kg per h) | 20 | 25 |
| Time from ICU admission to first study RRT (days) | 6.7 | 2.1 |
| Urea concentration prior to first RRT (mmol/l) | 23.8 | 24.2 |
| Achieved dose with high-dose CRRT (ml/kg per h) | 27.1§ | 33.4 |
| Achieved dose with low-dose CRRT (ml/kg per h) | 17.5§ | 22 |
| Duration of study RRT in ICU (days) | 13.1 | 6.1 |
| Daily urea level on high-dose CRRT (mmol/l) | 11.7 | 12.7 |
| Daily urea level on low-dose CRRT (mmol/l) | 16.8 | 15.9 |

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

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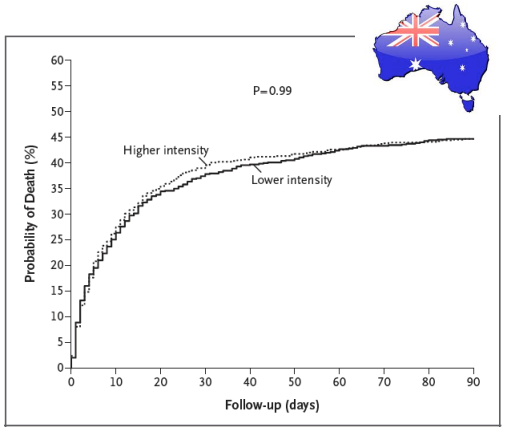


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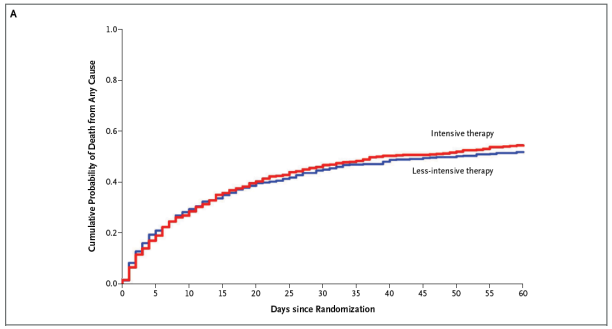
# Intensity of Renal Support in Critically Ill Patients with Acute Kidney Injury

The VA/NIH Acute Renal Failure Trial Network*



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# Dose – I Don't Care

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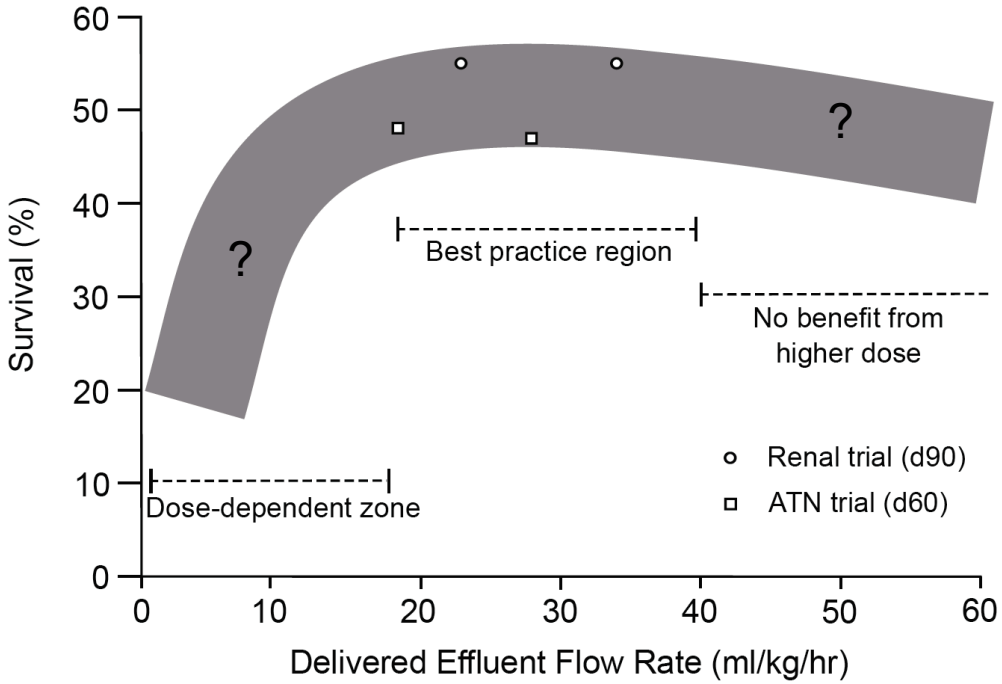
# Dose-response




| | VA/NIH ATN study | RENAL study |
|---|---|---|
| Achieved dose of CRRT (high dose) | 27.1 mL/kg per hour[b] | 33.4 mL/kg per hour |
| Achieved dose of CRRT (low dose) | 17.5 mL/kg per hour[b] | 22 mL/kg per hour |

# What is dose?

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- Urea and small molecule clearance
- Only measures one aspect of RRT
- Effluent flow rate approximates a Urea clearance or 'quasi GFR' measure for CRRT
- Dose response relationship?

# How low can you go?

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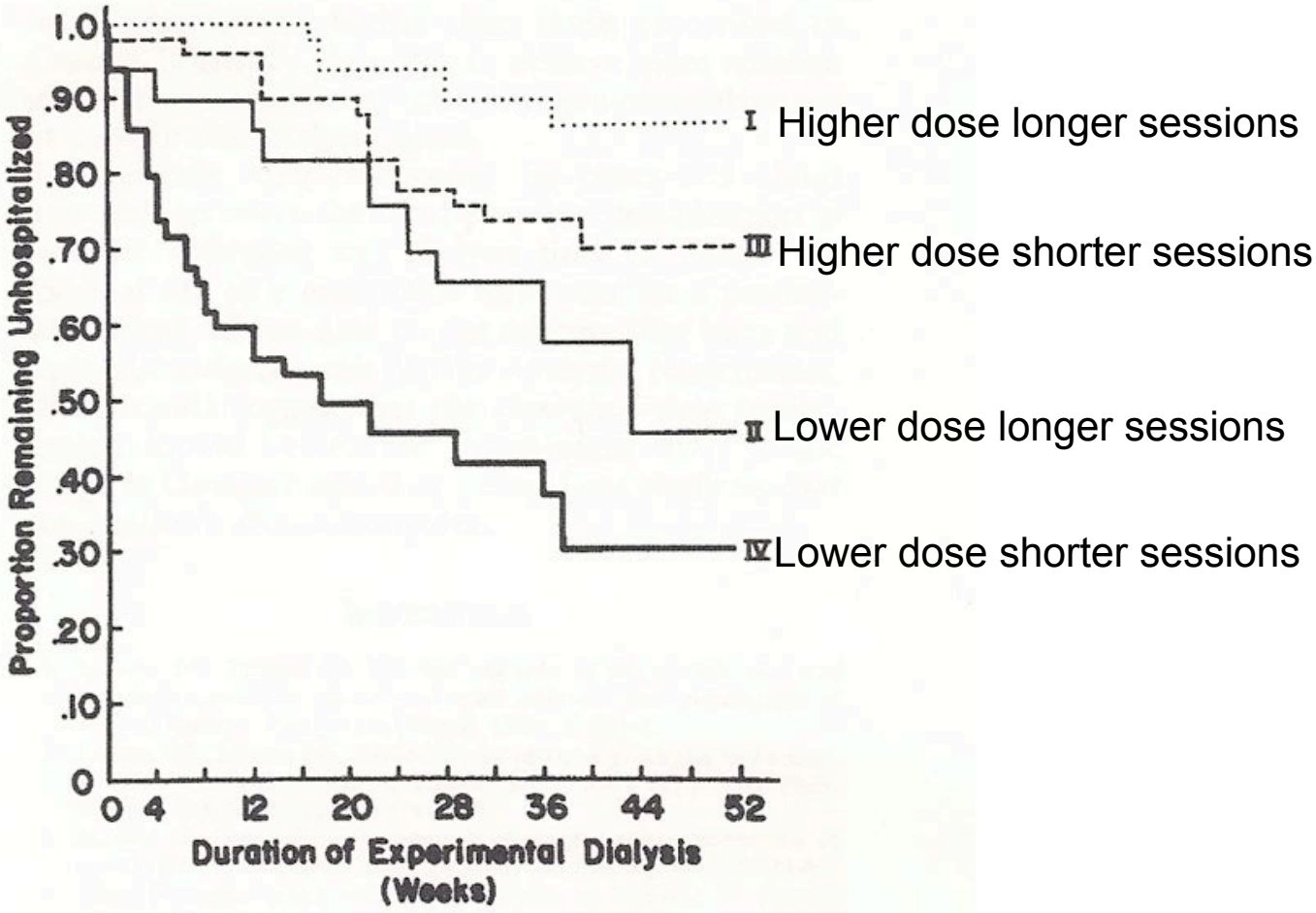
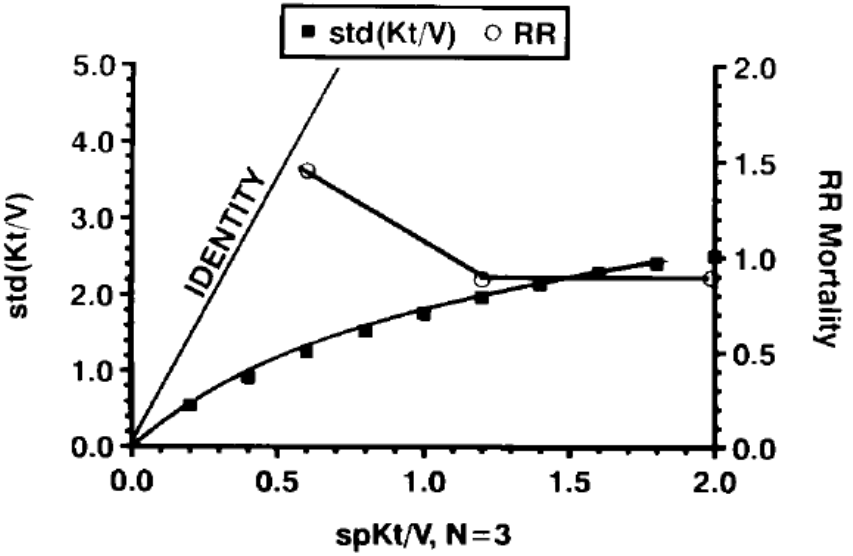
- Where is the inflection point of the D-R curve?
- What is the relationship between prescribed and delivered dose in trials and the real world?
- How do we ensure high quality CRRT is delivered?

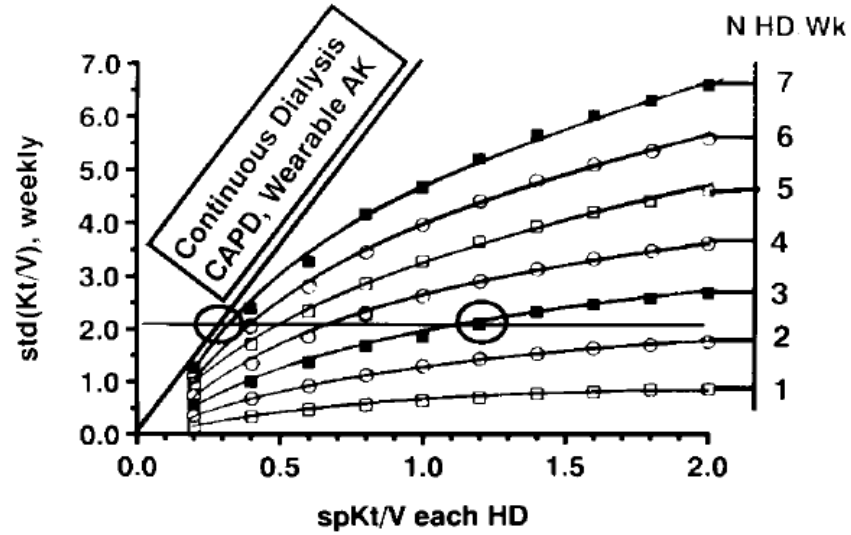
# What happens if you give very little RRT?

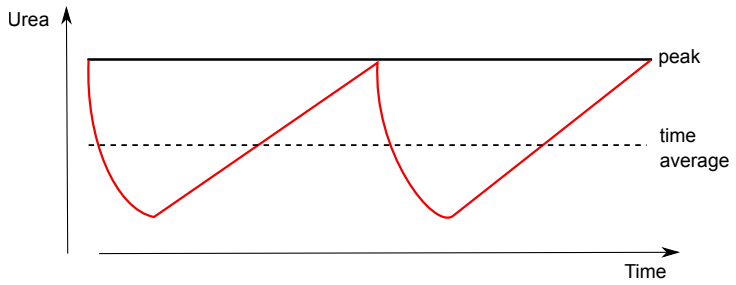


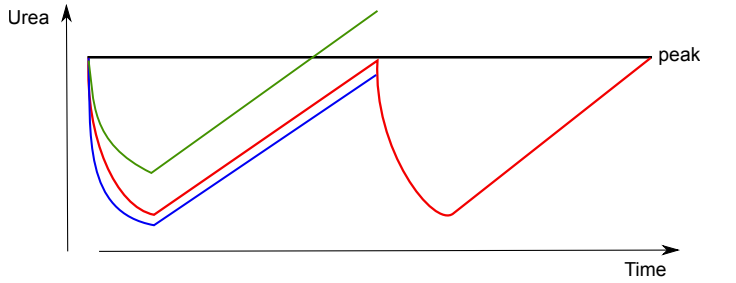


Effect of the Hemodialysis Prescription on Patient Morbidity — Report from the National Cooperative Dialysis Study N Engl J Med 1981; 305:1176-1181




Weekly Std(Kt/V) 2.1 ~ 11ml/min clearance

~ 9 ml/kg/hr

Nephrol Dial Transplant (1998) 13 [Suppl 6]: 10–14

ESTABLISHED IN 1812 DECEMBER 9, 2010 VOL. 363 NO. 24

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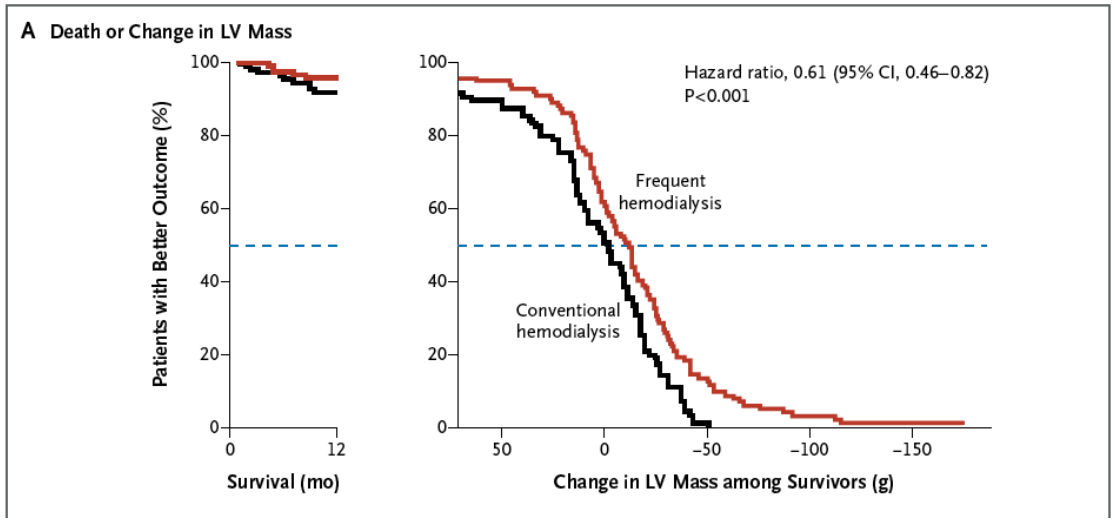
# In-Center Hemodialysis Six Times per Week versus Three Times per Week

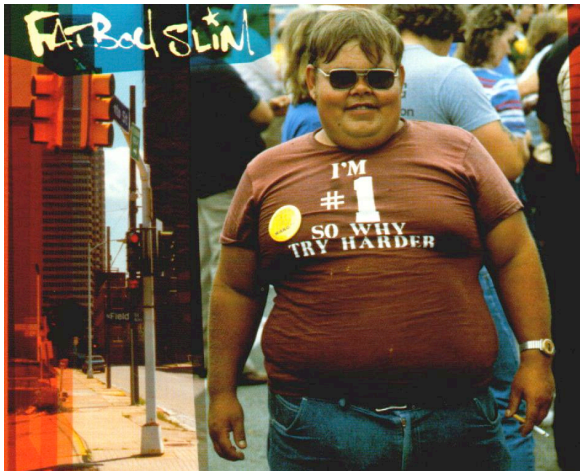
The FHN Trial Group*




~9ml/kg/hr ~15ml/kg/hr

| Variable | Conventional Hemodialysis (N=120) | Frequent Hemodialysis (N=125) | Ratio of Means (Frequent vs. Conventional) | P Value |
|---|---|---|---|---|
| $Kt/V_{urea}$‡ | | | | |
| Total weekly standard | 2.57±0.26 | 3.60±0.57 | 1.40 | <0.001 |
| Dialysis weekly standard | 2.49±0.27 | 3.54±0.56 | 1.42 | <0.001 |

# Dealing with weight?




- ATN
  - EXCLUDED bw >120kg
  - Effluent flow rate in each group will be based upon pre-morbid body weight. In obese patients (>30% above ideal body weight) calculations will be based on *adjusted body weight*, calculated as ideal body weight plus 25% of the difference between ideal and actual weight.
- RENAL
  - EXCLUDED body weight is <60 kg or >100kg

# "You can't always get what you want"

– even in an RCT

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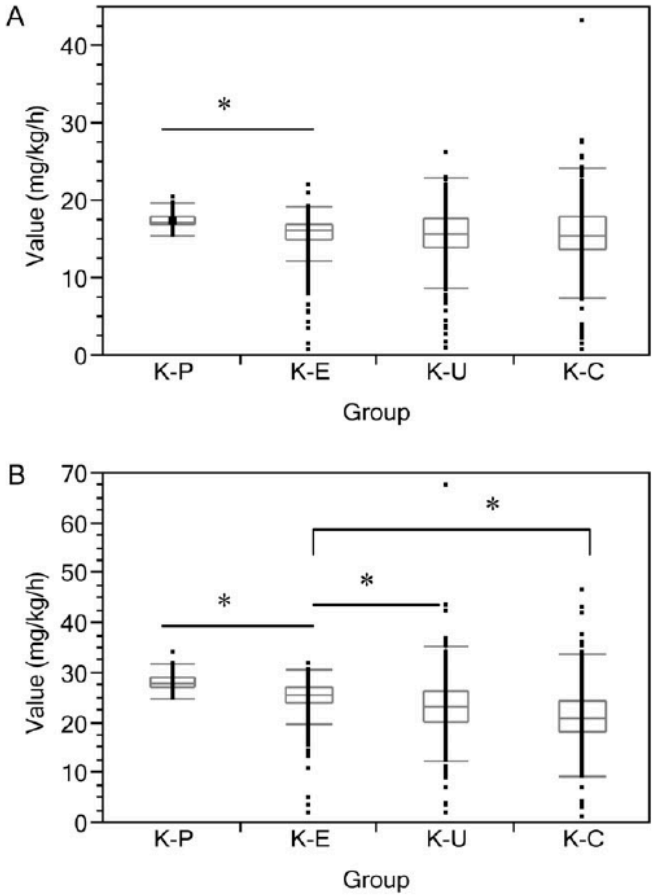
**Table 2.** CVVHDF clearance comparisons

| | Standard dose (20 mg/kg/h) | High dose (35 mg/kg/h) | P |
|---|---|---|---|
| Prescribed clearance ($K_P$) | 17.62 ± 0.96 | 28.10 ± 1.44 | <0.001 |
| Estimated clearance ($K_E$) | 15.79 ± 2.47 | 25.10 ± 3.16 | <0.001 |
| Urea clearance ($K_U$) | 15.55 ± 3.07 | 23.31 ± 5.30 | <0.001 |
| Creatinine clearance ($K_C$) | 15.67 ± 3.88 | 21.62 ± 5.5 | <0.001 |

Nephrol Dial Transplant (2012) 27: 952–956



# RENAL Study doses achieved

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| | Higher Intensity<br>Q1 Median Q3 / n(%) | Lower Intensity<br>Q1 Median Q3 / n(%) | P value[1] |
|---|---|---|---|
| Days of study treatment | 2.00 3.00 7.00 | 2.00 3.00 7.00 | 0.35 |
| Daily effluent (ml/kg/hr) | 29.83 36.31 39.51 | 19.72 23.38 24.98 | <0.001 |
| Percent of dose delivered | 0.75 0.91 0.99 | 0.79 0.94 1.00 | <0.001 |

# Can you have too much of a good thing?

- Even 35ml/kg/hr will probably only achieve a CKD stage 4 GFR equivalent.
- CRRT isn't native renal function.
  - No tubular function
- Abrupt changes in solutes and electrolytes may be harmful.

# Adverse Effects in RENAL/ATN

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**Table 4. Summary of Complications Associated with Study Treatment.**

| Complication | Higher-Intensity CRRT | Lower-Intensity CRRT | P Value |
|---|---|---|---|
| Hypophosphatemia* | | | |
| No. of patients/total no.(%) | 461/708 (65.1) | 396/733 (54.0) | <0.0001 |
| No. of episodes | 1495 | 1059 | — |
| Hypokalemia* | | | |
| No. of patients/total no. (%) | 168/718 (23.4) | 180/737 (24.4) | 0.34 |
| No. of episodes | 297 | 308 | 0.93 |
| Arrhythmia | | | |
| No. of patients/total no. ( %) | 303/722 (42.0) | 337/741 (45.5) | 0.18 |
| No. of episodes | 545 | 617 | 0.27 |
| Arrhythmia requiring treatment | | | |
| No. of patients/total no. (%) | 240/722 (33.2) | 267/741 (36.0) | 0.26 |
| No. of episodes | 388 | 413 | 0.71 |
| Arrhythmia causing hemodynamic instability | | | |
| No. of patients/total no. (%) | 200/722 (27.7) | 181/741 (24.4) | 0.15 |
| No. of episodes | 299 | 257 | 0.10 |
| Disequilibrium | | | |
| No. of patients/total no. (%) | 3/722 (0.4) | 0/743 | 0.08 |
| No. of episodes | 3 | 0 | — |
| One or more other serious adverse events | | | |
| No. of patients/total no. (%) | 4/722 (0.6) | 5/743 (0.7) | 0.77 |
| No. of episodes | 4 | 5 | — |
| Filters used daily — no. | 0.93±0.86 | 0.84±0.81 | <0.001 |

**Table 4. Summary of Complications Associated with Study Therapy.***

| Event | Intensive Strategy (N=563) | Less-Intensive Strategy (N=561) | P Value |
|---|---|---|---|
| | *no. of patients (%)* | | |
| Any serious adverse event† | 287 (51.0) | 280 (49.9) | 0.72 |
| Not related to study therapy | 207 (72.1) | 202 (72.1) | |
| Possibly or probably related to study therapy | 48 (16.7) | 51 (18.2) | |
| Definitely related to study therapy | 32 (11.1) | 27 (9.6) | |
| Nonfatal only‡ | 137 (47.7) | 128 (45.7) | |
| Catheter-related complications | | | |
| Insertion-related complications | 28 (5.0) | 31 (5.5) | 0.68 |
| Late catheter-related complications | 48 (8.5) | 38 (6.8) | 0.27 |
| Hypotension | | | |
| Requiring vasopressor support | 81 (14.4) | 56 (10.0) | 0.02 |
| Requiring discontinuation of treatment | 55 (9.8) | 49 (8.7) | 0.55 |
| Requiring other intervention | 212 (37.7) | 168 (29.9) | 0.006 |
| Other treatment-related complications | | | |
| Any nonhypotensive complication | 216 (38.4) | 194 (34.6) | 0.19 |
| Electrolyte disturbance | 144 (25.6) | 116 (20.7) | 0.05 |
| Hypokalemia | 42 (7.5) | 25 (4.5) | 0.03 |
| Hypophosphatemia | 99 (17.6) | 61 (10.9) | 0.001 |
| Other | 99 (17.6) | 85 (15.2) | 0.27 |

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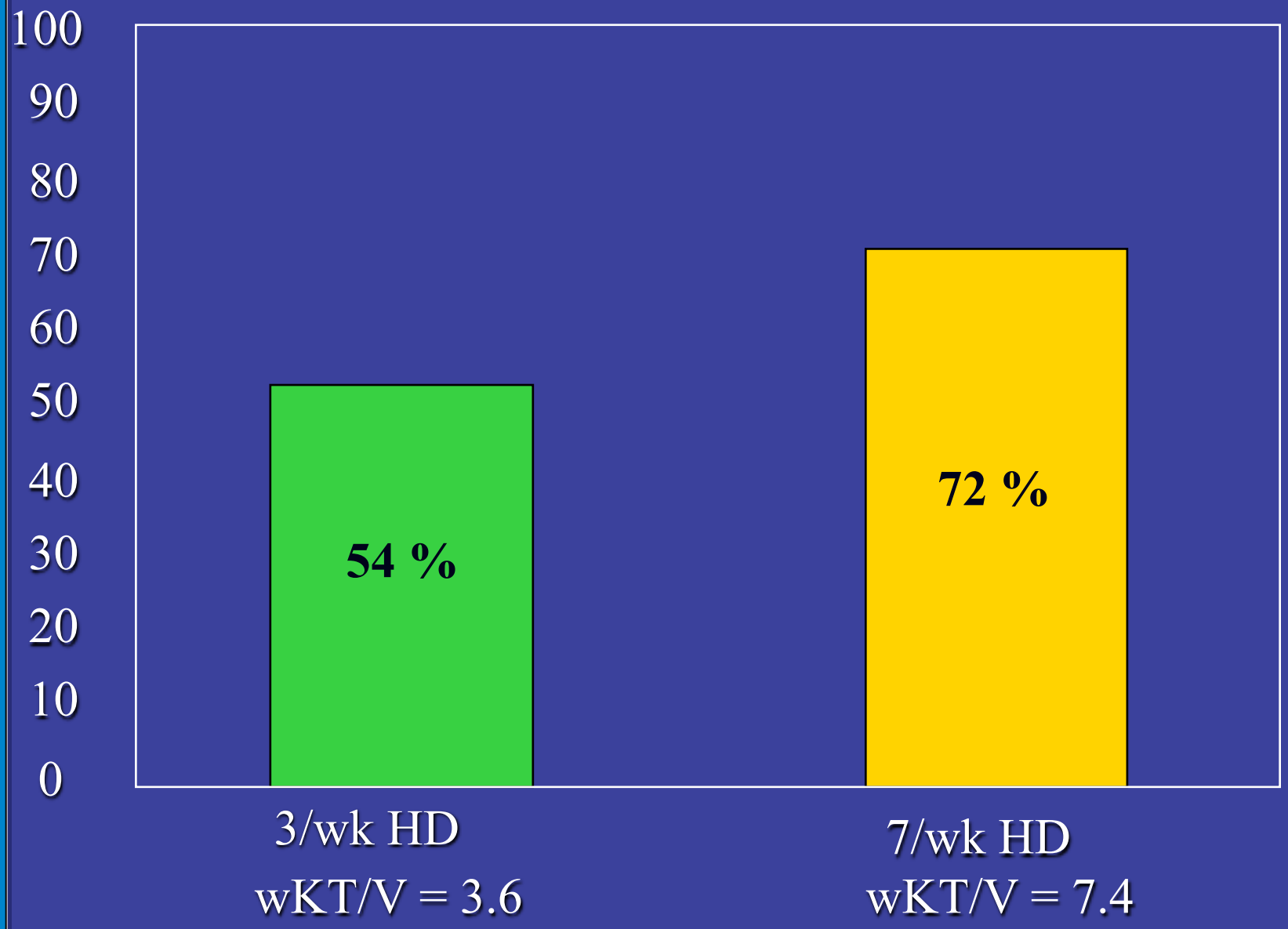
# IHD in AKI - KDIGO

- 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)
- 5.8.3: *We recommend delivering a Kt/V of 3.9 per week when using intermittent or extended RRT in AKI.* (1A)
  - Based on ATN Study low dose with x3/wk IHD
  - I disagree with this recommendation

# IHD for AKI in ATN Study

- Median net fluid balance during the ATN trial was +130 ml per day over the first 14 days
  - To achieve this fluid balance using IHD, around 2 L of ultrafiltration was required per session
  - This indicaties that many patients experienced a considerable degree of pre-dialysis fluid accumulation.
- Isolated ultrafiltration was required for fluid overload in a number of patients receiving less-intensive therapy in the ATN study (219/561 patients)
- 37% of intermittent hemodialysis sessions were complicated by hypotension.




*Shiffl et al. N Engl J Med. 2002;346:305-10.*

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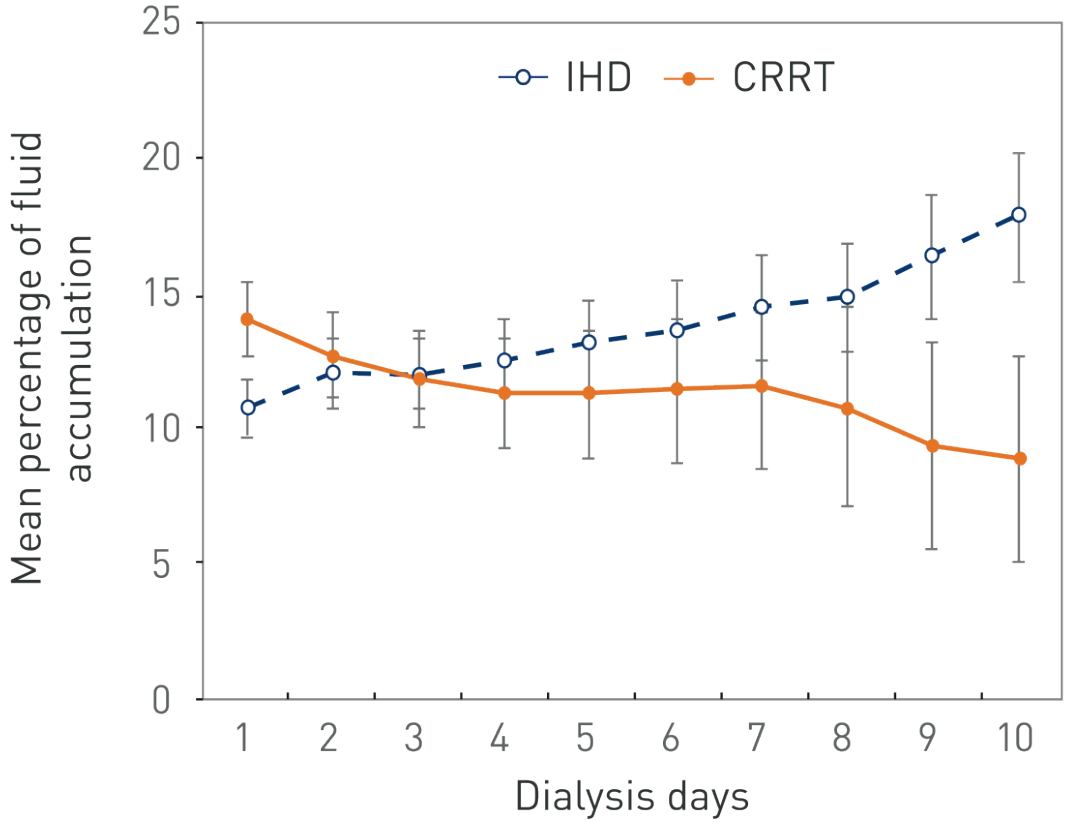
## **Figure 4:** Relationship Between Dialysis Modality and Fluid Accumulation




Bouchard Kidney Int 2009;76:422-7.

ESTABLISHED IN 1812 DECEMBER 9, 2010 VOL. 363 NO. 24

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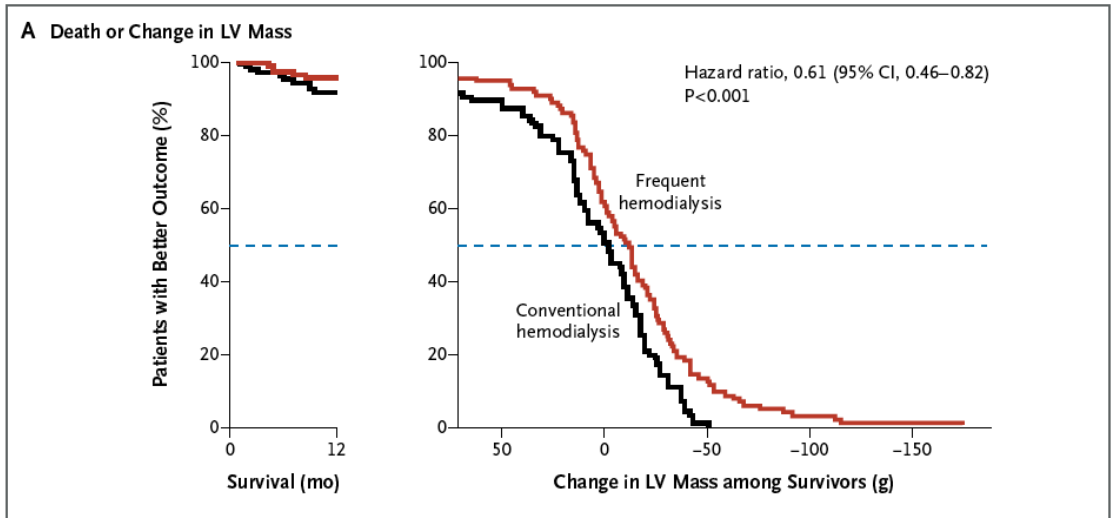
# In-Center Hemodialysis Six Times per Week versus Three Times per Week

The FHN Trial Group*




~9ml/kg/hr ~15ml/kg/hr

| Variable | Conventional Hemodialysis (N=120) | Frequent Hemodialysis (N=125) | Ratio of Means (Frequent vs. Conventional) | P Value |
|---|---|---|---|---|
| $Kt/V_{urea}$‡ | | | | |
| Total weekly standard | 2.57±0.26 | 3.60±0.57 | 1.40 | <0.001 |
| Dialysis weekly standard | 2.49±0.27 | 3.54±0.56 | 1.42 | <0.001 |

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| | | |
|---|---|---|
| Mortality at day 60 (%) | 52.5 | NR |
| Mortality at day 90 (%) | NR | 44.7 |
| Survivors dependant on RRT at day 28 (%) | 45.2 | 13.3 |
| Survivors dependant on RRT at day 60 (%) | 24.6 | NR |
| Survivors dependant on RRT at day 90 (%) | NR | 5.6 |

70% of patients in ATN study had IHD in ICU at some stage

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# IHD in AKI

- Do CRRT in haemodynamically unstable!
- Daily treatment if evidence of intra-dialytic instability or large fluid removal requirements
- Dosing based of salt and water balance more than Urea
- Risk reduction in renal recovery
  - development of CKD

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# Stopping

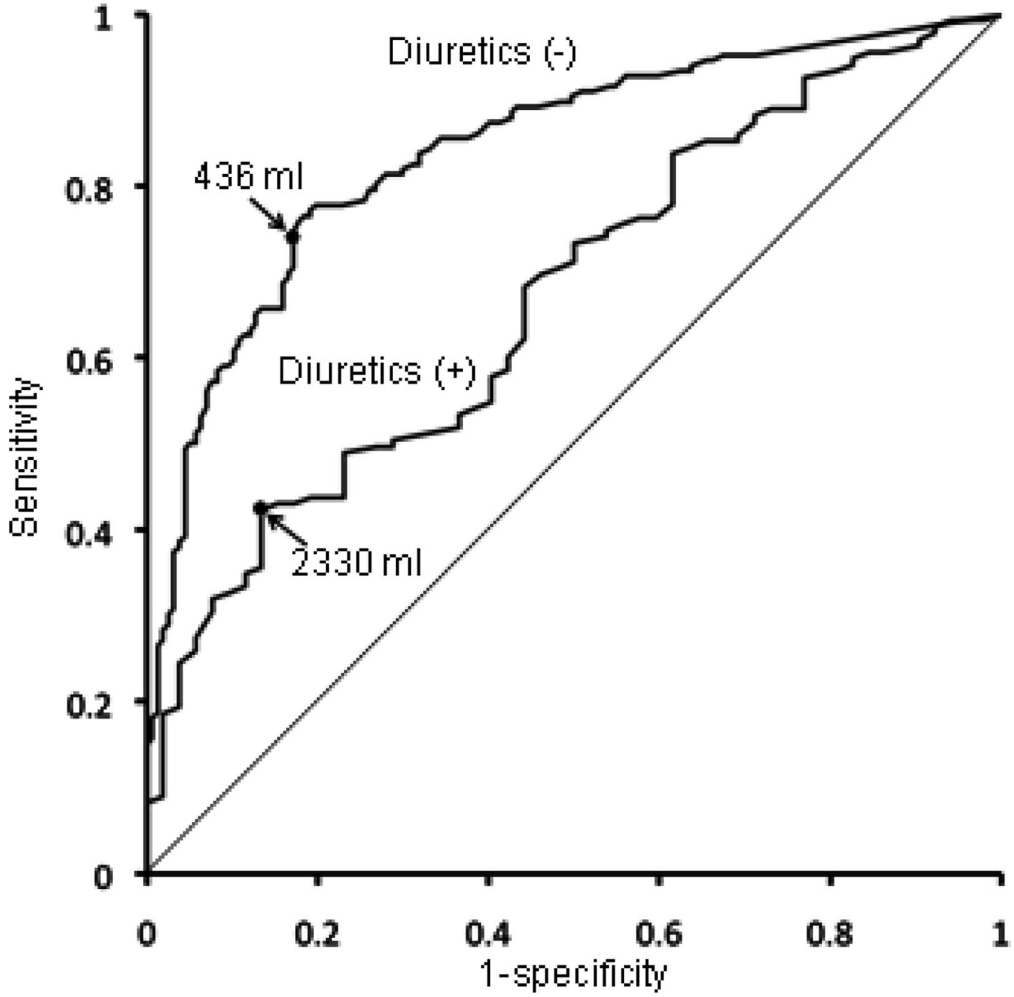

# Discontinuation of continuous renal replacement therapy: A *post hoc* analysis of a prospective multicenter observational study*

Shigehiko Uchino, MD; Rinaldo Bellomo, MD; Hiroshi Morimatsu, MD; Stanislao Morgera, MD; Miet Schetz, MD; Ian Tan, MD; Catherine Bouman, MD; Ettiene Macedo, MD; Noel Gibney, MD; Ashita Tolwani, MD; Heleen Oudemans-van Straaten, MD; Claudio Ronco, MD; John A. Kellum, MD

**Table 4.** Multivariate logistic regression analysis for successful discontinuation of continuous renal replacement therapy

| | Odds Ratio (95% CI) | *p* |
|---|---|---|
| Urine output, 100 mL/day | 1.078 (1.049–1.108) | <.0001 |
| Urine output increased | 3.097 (1.873–5.121) | <.0001 |
| Creatinine, μmol/L | 0.996 (0.994–0.998) | .0005 |
| Chronic kidney disease | 0.534 (0.338–0.844) | .0072 |
| First CRRT period, days | 0.969 (0.947–0.993) | .010 |

CI, confidence interval; CRRT, continuous renal replacement therapy.


Diuretics (-)
436 ml
Diuretics (+)
2330 ml
Sensitivity
1-specificity
0
0.2
0.4
0.6
0.8
1

# Furosemide does not improve renal recovery after hemofiltration for acute renal failure in critically ill patients: A double blind randomized controlled trial*

Peter H. J. van der Voort, MD, PhD, MSc; E. Christiaan Boerma, MD; Matty Koopmans, RN; Mariët Zandberg, MD; Joke de Ruiter, MD; Rik T. Gerritsen, MD; Peter H. M. Egbers, MD; W. Peter Kingma, MD; Michaël A. Kuiper, MD, PhD, FCCP, FCCM

Crit Care Med 2009 Vol. 37, No. 2

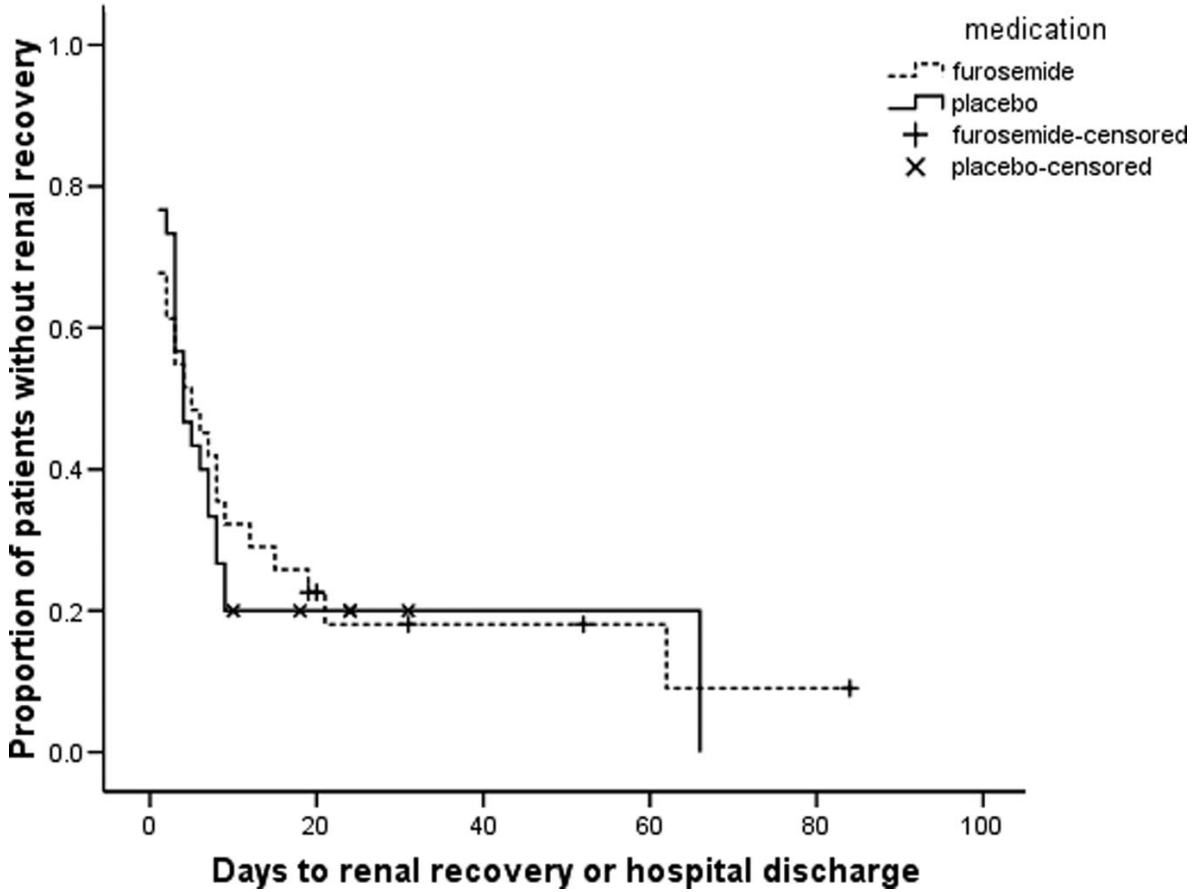



Figure 2. Kaplan-Meier diagram for renal recovery for both study groups. The y-axis starts below 1.0 because of patients who appeared to have a creatinine clearance above 30 mL/min at the start of the study medication.

# Recovery

- Easy!
- Try if UO > ~500ml/day and improving
- Avoid diuretics
  - At least as a decision making tool
- Recovering Patient
  - avoid secondary injury

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# Summary

- Start promptly but in response to clinical indicators
  - Urine output and fluid overload +/- Urea
- Give a dose of > 20ml/kg/hr CRRT to replicate results seen in high quality clinical trials –
  - Leeway to avoid under-dosing
  - No evidence to support higher doses in unselected patients
  - Appropriate weight
  - Inflection point of DR curve not clearly defined
- If using IHD consider need for daily Tx
- Stop if adequate unassisted diuresis