
 Critical Care Medicine

Acute Kidney Injury: Management and Interventions

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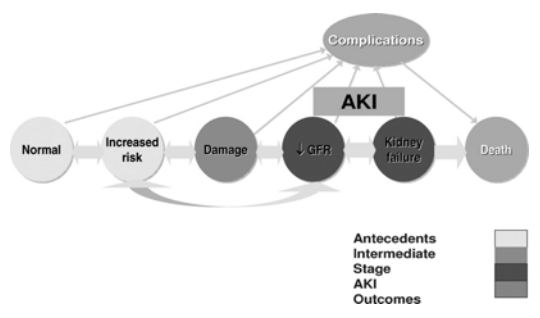
Disclosure

I have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

Affiliation/Financial Interest: Member Expert Panel

Name of Organization: Gambro

Acute Kidney Injury

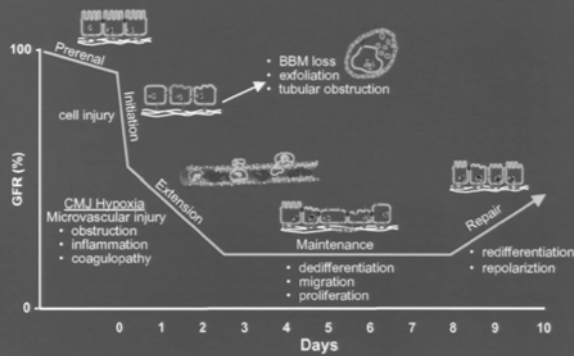


Antecedents
 Intermediate Stage
 AKI
 Outcomes

Outline

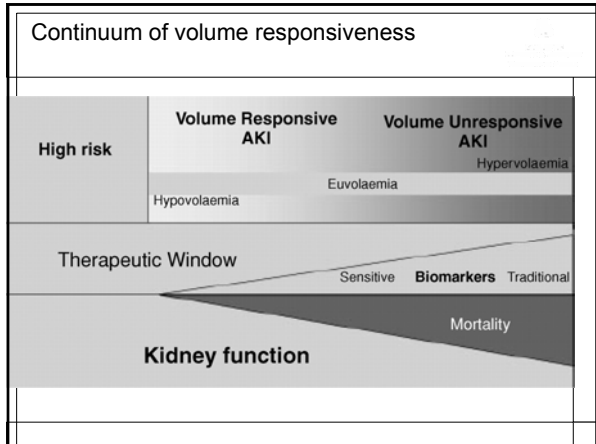
- Volume responsive AKI
- Diuretics
- Vasopressors
- Vasodilators
- Peritoneal dialysis
- Intermittent hemodialysis
- CRRT
- Renal assist device

Phases of AKI



Volume responsive AKI (pre-renal)

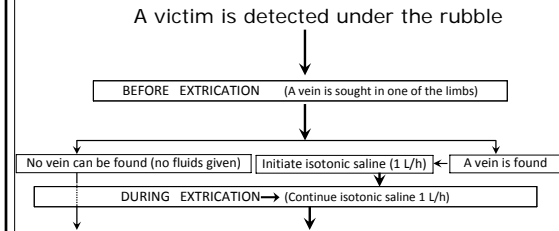
- Volume responsive (pre-renal) AKI is functional and by definition not associated with any additional histopathological change.
 - A consequence of decreased renal perfusion, which leads to a reduction in glomerular filtration rate (GFR).
 - The key management issue is whether appropriate fluid resuscitation will improve or restore renal function.
- Pre-renal AKI (volume responsive) and ischemic ATN may occur as a continuum of the same pathophysiological process.
- Together account for 75% of the causes of AKI.



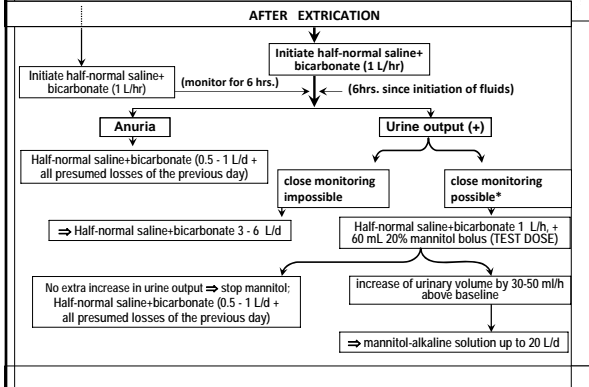
- ### Assessment of volume responsiveness
- Cannot assess volume responsiveness just using static pressure measurements
 - Give volume and assess response
 - Urine output
 - BP, pulse pressure variation
 - Change in CVP, PCWP
 - Change in CO/CI – Starling curve
 - Echocardiography, Doppler
 - How much volume? Over what time?
 - Depends on clinical scenario
 - Consider straight leg raising (M. Pinsky)



Early fluid administration in crush victims

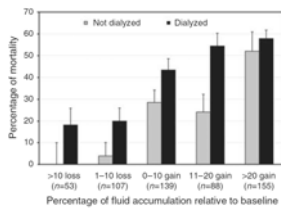


Early Fluid Administration in Crush Victims



Avoid fluid overload

- Septic AKI often not fluid responsive
- Many studies in children and adults showing:
 - Increased morbidity
 - Skin breakdown
 - Pulmonary edema
 - Prolonged mechanical ventilation
 - Abdominal compartment syndrome
 - Increased AKI
 - Decreased renal recovery
 - Increased mortality
- With fluid overload > 10%

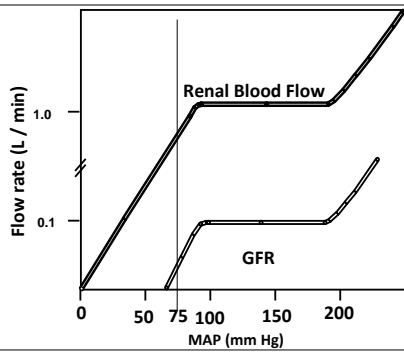


Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury
Oliver Richard¹, Sharon B. Sankar², Glenn M. Chertow³, Jonathan Horowitz⁴, T. Alp Aksoy⁵, Paul P. Fugère⁶ and Ravindra L. Mehta⁷, Program to Improve Care in Acute Renal Disease (PICARD) Study Group

Diuretics in AKI

- Majority of patients being assessed for volume responsiveness develop some degree of fluid overload.
- Diuretics in AKI?
 - Not harmful
 - 92 patients, torasemide, furosemide
 - Shilliday IR et al. Nephrol Dial Transplant 1997;12: 2592-96
 - 1100 patients, furosemide, metolazone
 - Uchino S et al. Crit Care Med 2004;32:1669-77
 - Meta-analysis
 - Kwok M, Sheridan DJ. BMJ 2006;333(7565) 420
 - Harmful
 - 326 patients furosemide, bumetanise, metolazone, HCTZ
 - Mehta R et al. JAMA 2002;288:2547-53

Normal renal vascular autoregulation



Norepinephrine

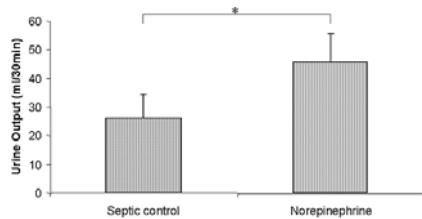


Figure 3. Histogram showing the effect of norepinephrine infusion on urine output in septic sheep compared with placebo septic controls. Norepinephrine infusion nearly doubled urine output.

Norepinephrine vs. terlipressin in HRS



Journal of Hepatology 47 (2007) 499–505

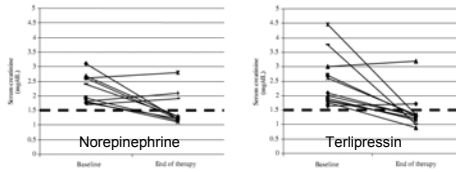
Journal of
Hepatology

www.elsevier.com/locate/jhep

Noradrenalin vs terlipressin in patients with hepatorenal syndrome: A prospective, randomized, unblinded, pilot study

C. Alessandria*, A. Otobrelli, W. Debernardi-Venon, L. Todros, M. Torrani Cerenzia,
S. Martini, F. Balzola, A. Morgando, M. Rizzetto, A. Marzano

Division of Gastroenterology and Hepatology, San Giovanni Rotondo Hospital, Teramo, Italy

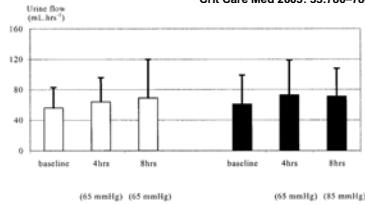


Effect of MAP increase in AKI in septic shock

Increasing mean arterial pressure in patients with septic shock: Effects on oxygen variables and renal function*

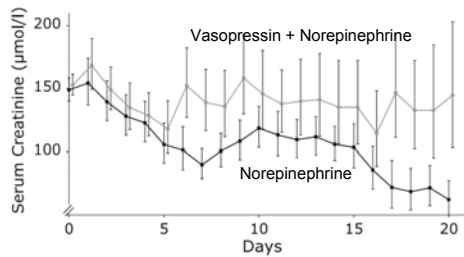
Aurélien Bourgoin, MD; Marc Leone, MD; Anne Delmas, MD; Franck Garnier, MD; Jacques Albanèse, MD;
Claude Martin, MD, FCCM

Crit Care Med 2005; 33:780–786



Conclusion: No renal benefit

Vasopressin (+Levophed) vs. Levophed



AVP n = 53 45 12 4 3
NE n = 53 34 10 4 3

Gordon A et al. Intensive Care Med 2010; 36:83–91

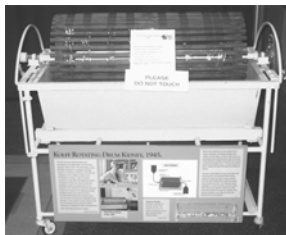
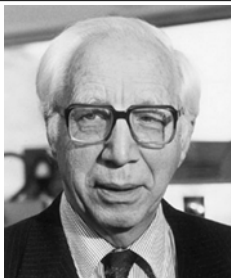
Renal vasodilators

- Dopamine
 - In experimental animals and healthy human volunteers, "renal" or "low" dose dopamine (<5 µg/kg of body weight/min) increases RBF and, to a lesser extent, GFR.
 - No evidence that dopamine can prevent or alter the course of ischemic or nephrotoxic AKI.
 - May cause tachycardia, cardiac ischemia and skin necrosis with extravasation.
- Fenoldopam
 - highly selective dopamine type 1 agonist that preferentially dilates the renal and splanchnic vasculature.
 - Studies show variable results in preventing or reducing incidence of AKI and RRT especially when given early.
 - May cause hypotension.

Renal support

- Peritoneal dialysis
- Intermittent hemodialysis
- Continuous renal replacement therapy
- Hybrid therapies
 - SLED
 - CPDA
- Renal assist device

Willem Kolff 1911-2009



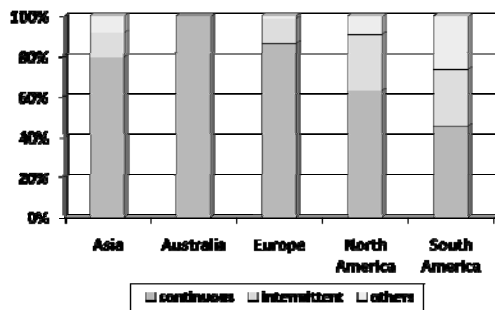
The main aim of my endeavours has always been to restore people to an enjoyable existence. If it's not enjoyable, it should not be done.
- W.J Kolff, 2003 -

Classical indications for dialysis

Oliguria: urine output <200 mL in 12 h
 Anuria: urine output <50 mL in 12 h
 Hyperkalaemia: potassium concentration >6.5 mmol/L
 Severe acidaemia: pH <7.0
 Azotaemia: urea concentration >30 mmol/L
 Uraemic encephalopathy
 Uraemic neuropathy/myopathy
 Uraemic pericarditis
 Plasma sodium abnormalities: concentration >155 mmol/L
 or <120 mmol/L
 Hyperthermia
 Drug overdose with dialysable toxin

Lameire N et al. Lancet 2005; 365: 417–30

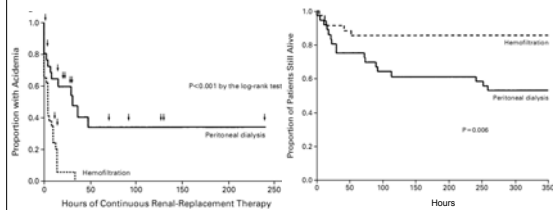
Mode of RRT: Differences across continents



Peritoneal dialysis vs Hemofiltration

HEMOFILTRATION AND PERITONEAL DIALYSIS IN INFECTION-ASSOCIATED ACUTE RENAL FAILURE IN VIETNAM

NGUYEN HOAN PHU, M.D., TRAN TRINH HEN, M.D., NGUYEN THI HOANG MAI, M.D., TRAN THI HONG CHAU, M.D.,
 LY VAN CHUONG, M.D., PHAM PHU LOC, M.D., CHRISTOPHER WINEARLS, D.Phil., M.B., JEREMY FARRAR, M.B., D.Phil.,
 NICHOLAS WHITE, M.D., D.Sc., AND NICHOLAS DAY, B.M., B.Ch.



N Engl J Med 2002;347:895-902

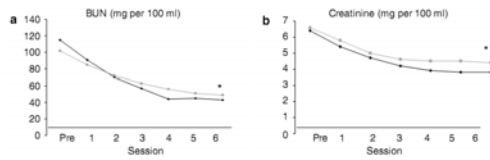
HVPD vs IHD

High volume peritoneal dialysis vs daily hemodialysis: A randomized, controlled trial in patients with acute kidney injury

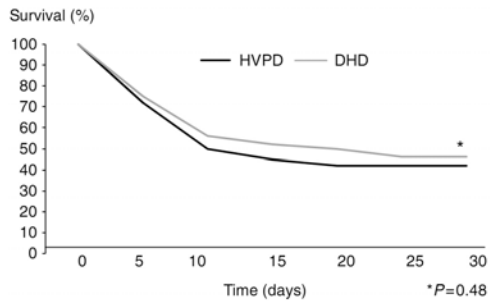
Kidney Int 2008;73:S87-S93

DP Gabriel¹, JT Caramori¹, LC Martin¹, P Barretti¹ and AL Balbi¹

¹Department of Internal Medicine, University Hospital, Botucatu School of Medicine, São Paulo State University (UNESP), Botucatu, SP, Brazil

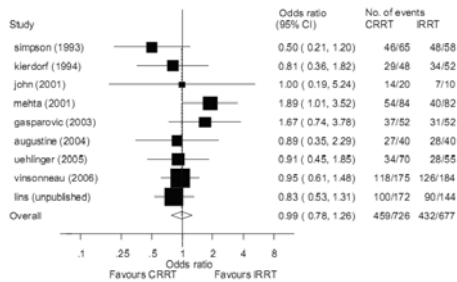


HVPD vs CVVH



Gabriel DP et al. Kidney Int 2008;73:S87-S93

IHD vs. CRRT: Survival



Bagshaw S et al. Crit Care Med 2008;36:610-617

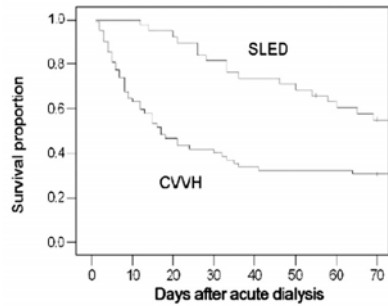
NSARF Study

	CVVH (n = 63)	SLED (n = 38)	P value
Interventions at the first dialysis session			
IE*	5.7 ± 5.3	3.0 ± 3.6	.016
Ventilator	57 (90.5%)	28 (73.7%)	.046
NPO	41 (65.1%)	18 (47.4%)	.097
Diuretics	56 (88.9%)	32 (84.2%)	.548

*IE = [(dopamine + dobutamine) + [milrinone x 15] + [epinephrine + norepinephrine + isoproterenol] x 100] in µg/kg/min.

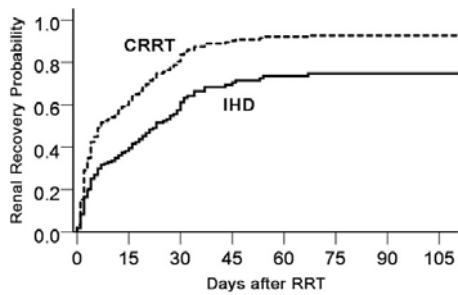
Wu V et al Am J Surg 2009 epub

NSARF survival outcomes



Wu V et al Am J Surg 2009 epub

NSARF study renal recovery



Lin Y et al. Am J Surg 2009; 198, 325-332

CLINICAL RESEARCH | www.jasn.org

Efficacy and Safety of Renal Tubule Cell Therapy for Acute Renal Failure

James Tumlin,* Ravinder Wali,[†] Winfred Williams,[‡] Patrick Murray,[§] Ashita J. Tolwani,^{||} Anna K. Vinnikova,[¶] Harold M. Szerlip,** Jiuming Ye,^{††} Emil P. Paganini,^{‡‡} Lance Dworkin,^{§§} Kevin W. Finkel,^{|||} Michael A. Kraus,^{¶¶} and H. David Humes***

J Am Soc Nephrol 2008;19:1034-1040

Table 1. Patient characteristics

Demographic Characteristic	RAD (n = 40; %)	CRRT Alone (n = 18; %)
Age (yr, mean [SD])	60.9 (13.7)	64.3 (12.3)
Male	72.5	72.2
White	57.5	88.9
Disease cause		
infection/trauma	37.5	33.3
after cardiac surgery	20.0	16.7
after vascular surgery	15.0	16.7
chronic liver disease	2.5	5.6
other (multifactorial)	25.0	27.8

Tumlin J et al. J Am Soc Nephrol 2008;19:1034–1040,

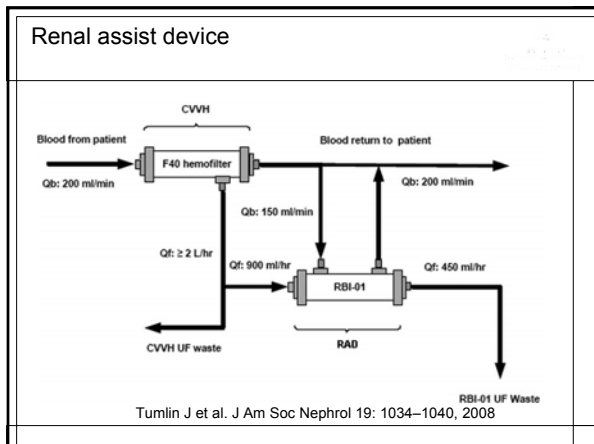
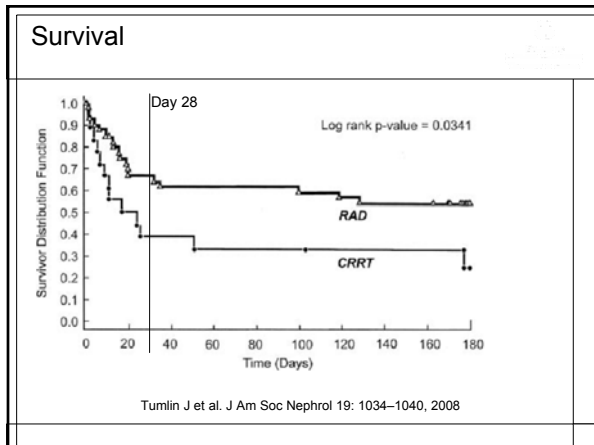


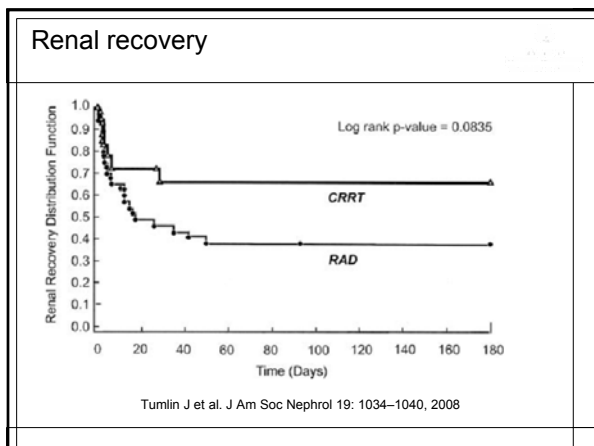
Table 4. All-cause mortality by day 28 by number of organ failures

No. of Organ Failures	RAD (Deaths/Total Patients)	CRRT Alone (Deaths/Total Patients)
1	0/0	0/1
2	0/3	1/3 (33.3%)
3	2/10 (20.0%)	4/7 (57.1%)
4	6/17 (35.3%)	2/3 (66.7%)
5+	5/9 (55.6%) ^a	4/4 (100%)

^aExcludes one patient with unknown status.

Tumlin J et al. J Am Soc Nephrol 19: 1034–1040, 2008





Future

- Timing and targeting of interventions guided by
 - Biomarkers
- Improved volume status monitoring
 - ECHO
 - Doppler
 - PICCO
- Improved renal support
 - More accurate volume removal
 - New membranes

Thank you for your attention!



Relief of renal tract obstruction

- **Postrenal AKI**
- Caused by an acute obstruction that affects the normal flow of urine out of both kidneys.
- The blockage causes pressure to build in all of the renal nephrons.
- The high fluid pressure ultimately causes the nephrons to shut down.
- The degree of renal failure corresponds directly with the degree of obstruction.
- Postrenal AKI is seen most often in elderly men with enlarged prostate glands that obstruct the normal flow of urine.

Postrenal ARF Causes

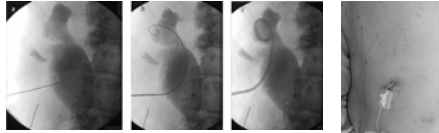
- Bladder outlet obstruction due to an enlarged prostate or bladder calculus
- Bilateral ureteric calculi in both ureters or in patients with one kidney
- Neurogenic bladder (overdistended bladder caused by inability of the bladder to empty)
- Renal injury
- Retroperitoneal fibrosis

Diagnosis and Management

- Ultrasound
 - Hydronephrosis



- Insertion of nephrostomy tube(s)



Ureteric stent

- Cystoscopy
 - Removal of bladder stone
 - Insertion of ureteric stent(s)

