

# Transitioning RRT modalities

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**I have no actual or potential conflict of interest in relation to this program or presentation.**



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## Renal replacement therapy for AKI: a black box

When to start?  
What to use?  
How much to give?



How to assess recovery?  
When to transition?  
When to stop?

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## Objectives for this session:

1. Review goals of renal replacement therapy
2. Discuss rationale for transitioning modalities
3. Discuss "Transitional" modalities – Hybrid therapy
4. Discuss determination of when to discontinue RRT

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## Treatment goals for AKI

- Maintenance of fluid and electrolyte balance
- Solute control - uremia
- Provision of adequate nutrition
- Correction of reversible factors causing AKI
- Appropriate medication dosing
- Avoidance of nephrotoxins

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## Provision of renal support



### DEMANDS

Fluid Balance  
Electrolyte homeostasis  
Acid Base balance  
Uremic solute clearance

### DEMAND / CAPACITY RATIO

IF DEMANDS EXCEED  
CAPACITY  
INITIATE RENAL  
SUPPORT

IF CAPACITY CAN  
MEET DEMAND  
DISCONTINUE RENAL  
SUPPORT

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### Choosing CRRT vs Intermittent therapies

- Cardiovascular stability
- Tolerance of volume management
- Uremic/ solute control in highly catabolic patients

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### Factors influencing discontinuation of therapy

- Hemodynamic status
- Urine output
- Volume requirements
- Logistical characteristics:
  - Circuit clotting
  - Staff availability
  - Cost

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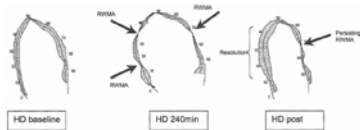
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### Dialysis and cardiovascular stability



N=8  
Randomized crossover study of prevalent HD pts  
with hypotension

Selby et al AJKD 2006

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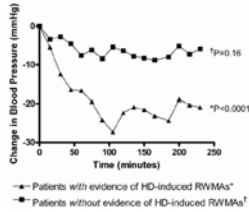
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## Dialysis and cardiovascular stability

- 70 prevalent HD pts



	OR
UF 1 L	5.1
UF 1.5 L	11.6
UF 2L	26.2
SBP↓10	1.8
SBP↓20	3.3

Burton et al CJASN 2009

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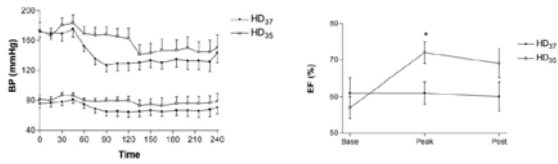
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## Dialysis and cardiovascular stability: Cool dialysate



N= 10  
Cross over design 2 weeks at each temperature

Selby et al CJASN 2006

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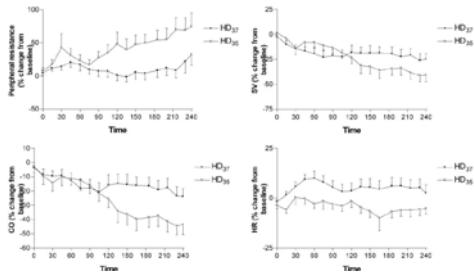
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## Dialysis and cardiovascular stability: Cool dialysate



Selby et al CJASN 2006

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What is the role of hybrid therapies in this discussion?

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What are hybrid therapies?

- Sustained low efficiency dialysis (SLED)
- Extended daily dialysis (EDD)
- Sustained low efficiency diafiltration (SLED-f)
- Slow continuous dialysis (SCD)
- Prolonged intermittent renal replacement therapy (PIRRT)

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Hybrid therapies: advantages

- Uses standard HD machines
  - Lower cost of equipment and disposables
  - Convenient
- Provides slower solute and fluid removal
- Avoids inconvenience of interruptions to therapy for diagnostic tests or out of unit procedures
- Slower solute and fluid removal – single compartment urea kinetics
- High dosing achievable

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## Hybrid therapies: operating characteristics

	Kumar	Marshall	Marshall	Berbece	Salahudeen
Hours/day	7.5	12	8	8	"continuous"
Days/week	6-7	6-7	4-7	6	7
Pump speed (ml/min)	200	100	300	200	200
Dialysate flow (ml/min)	300	200	200	350	100
Replacement (ml/min)			100	17	

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## Hybrid therapies: ATN study operating characteristics

Table VIII-6  
Management of Sustained Low-Efficiency Dialysis (SLED)

Treatment Schedule	Conventional Therapy Arm	Intensive Therapy Arm
	3x/week	6x/week
	<i>Conventional and Intensive Therapy Arms</i>	
Hemodialyzer:	Synthetic hollow-fiber membranes	
Blood Flow Rate:	200 mL/min, prescribed by primary treating team	
Dialysate Flow Rate:	100 - 300 mL/min, prescribed by primary treating team	
Dialysate:	Bicarbonate buffered, electrolyte composition prescribed by primary treating team	
Ultrafiltration:	Prescribed by primary treating team	
Anticoagulation:	Prescribed by primary treating team	
Treatment duration:	5 - 16 hours	
Initial Prescribed spKt/V:	1.4	
Target Delivered spKt/V:	1.2 - 1.4 per treatment, monitored 3x/week for the first 2 weeks and at least weekly thereafter	

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## Hybrid therapies: Dialysate

- on line generation: RO treated tap water
- "Ultrapur" cold sterilization using ultrafilters

Treatment duration	Potassium (meq/L)	Bicarbonate (meq/L)	Calcium (meq/L)
< 8 hours	3	28-32	1.5-2.5
> 8 hours	4	24-28	1.5-2.5

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### Hybrid therapies: Dialysate flow/UF

- Guided by machine characteristics and tolerance to ultrafiltration
- Fresenius 2008H and 4008K machines are capable of delivering dialysate flows less than 300 ml/min
- Standard HD machines can only reduce dialysate flow to 300 ml/min
- Low UF rates can be achieved by infusing saline

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### Hybrid therapies: anticoagulation

- Unfractionated heparin remains most commonly used  
-1000-2000 U bolus followed by infusion of 500u/hr
- Heparin free treatments are also commonly used
- Citrate anticoagulation has also been described using calcium free dialysate

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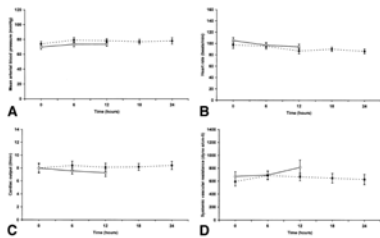
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### Hybrid therapies: Randomized trials



N=39 RCT SLED vs CRRT  
Qb= 200 ml/min  
Time: 11 hours/day

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## Comparison of therapies in HEMODIAFE

Intermittent haemodialysis	Continuous venovenous haemodiafiltration	p-value
Duration of sessions (h)	5-2 (5-5.5)	0.42
Blood flow (ml per min)	275 (275-290)	0.59
Dialysate flow*	500	0.42
Ultrafiltration flow (ml per h)	1278 (1255-1301)	0.95
Net ultrafiltration† (ml per day)	2223 (2143-2295)	0.35
Mean urea (mmol/l)	13.7 (9.5)	0.95

\*Data are mean (SD) or mean (SD), †ml per min in the intermittent haemodialysis group and ml per h in the continuous venovenous haemodiafiltration group. †Mean volume lost per day of treatment.

Table 2: Treatment modalities

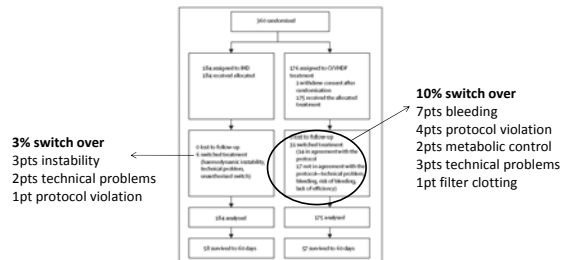
Intermittent haemodialysis (n=354)	Continuous venovenous haemodiafiltration (n=372)	p-value
Hypertension†	27 (8%)	0.42
Bleeding event†	12 (3%)	0.59
Thrombocytopenia	22 (6%)	0.42
Hypoglycaemia	12 (3%)	0.42
Hypocalcaemia	13 (4%)	0.72
Hypothermia	30 (9%)	0.005
Acidytosis	18 (5%)	0.35
Catheter infection	2 (1%)	0.95

†Data are number (percentage). ††Hypotension episodes were recorded from initiation until end of trial (replacement therapy). Hypertension events at least one hypertensive episode during follow-up. †Bleeding events were reported only when transfusion was needed.

Table 3: Adverse events according to treatment group

Vinssonau et al Lancet 2006

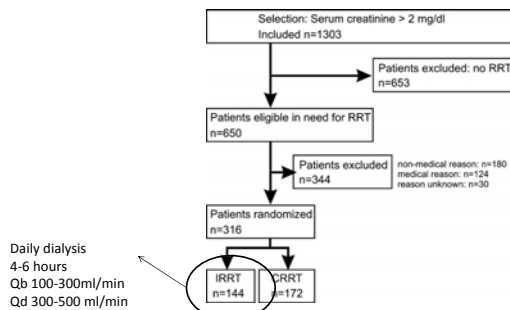
## Randomized Trials: Hemodiafe



Acceptable switchovers:  
 Resolution of MODS (LODS score < 5 x 72 hrs)  
 After 3 weeks of CRRT

Vinssonau et al Lancet 2006

## Hybrid therapies: SHARF Study



Lins et al NDT 2009

## Hybrid therapies: SHARF Study

### CROSSOVERS DURING STUDY

- 11 pts IRR to CRRT for HD instability
- 12 patients CRRT to IRR for coagulation problems

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## Cost considerations for hybrid therapies

	SLED	CRRT citrate	CRRT heparin
Supply cost/day	69.75	402.80	334.95
HD RN cost	168.75	37.50	37.50
Total cost /day	238.50	440.30	372.45
Total cost / week	1431	3089	2607

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## Factors influencing discontinuation of renal replacement therapy

- Urine output
- Evidence of improved solute clearance

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## Prediction of Discontinuation: BEST Kidney study

	All patients	Success	Repeat RRT	P
Number of pts	1006	313	216	
Age	66	66	64	Ns
Male	65.8	69.6	67.6	Ns
CKD %	28.1	26.5	39.8	<0.05
Creatinine	292	300	366	<0.05
Urea	23	22	27	<0.05
Urine output ml/6hr	100	160	100	<0.05

Uchino CCM 2009

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## ATN study: discontinuation criteria

- Urine output > 30ml/hr based on 6 hour urine collections for CrCL
- Clearance studies 3x/wk
- > 20ml/min considered sufficient to d/c renal replacement therapy

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## Recommendations

- Transition from CRRT when factors supporting your decision to use it have resolved
  - Unstable hemodynamics
  - Fluid balance/volume management
- Consider hybrid therapies as both first line and transitional therapies in your renal support program
- Discontinue RRT when factors supporting your decision to start RRT have resolved
  - Solute clearance (serum creatinine)
  - Urine output > 400-500 cc/day

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