Hypotension
extracorporeal circuits
Deterioration during HDF

- Pt c/o SOBOE after 1 hour
- hypoxic
- hypertensive
  - lung crackles to mid zone
Sudden collapse on dialysis

80 year old man recently switched from PD to HD following peritonitis due for discharge home after dialysis today

- Patient felt dizzy < 5 min starting dialysis
- sudden hypotension
  - BP unrecordable
  - PaO2 2.24 kPa PaCO2 6.34 kPA
- unconscious
- cardiac arrest
Heparin reactions

Contact coagulation pathway

-very charged membrane

C3a ← C3
C5a ← C5

bradykinin ← HMW↑ kininogen

plasma kallikrein

plasma prekallikrein

XII

XIIa

XI

XIa
Granule containing PF4

Heparin containing site

ADP

\( \alpha \) granule containing PF4

Fc\( \gamma \)IIa receptor

HIT-Ab

Heparin-PF4 complex conformational change

Free heparin

Endothelial cell

Heparan sulphate

HIT-Ab binds to platelets

Activates endothelium

Releases microparticles (tissue factor)
Pseudo-pulmonary embolism

acute alveolar shaddowing due to interstitial lung oedema secondary to HIT
Volume management with RRT for AKI

- Maintenance of fluid balance
  - Isovolemic patient
  - Isonatraemic balance

- Avoiding complications
  - Hypovolaemia
  - Negative sodium balance
  - Hypervolaemia
  - Positive sodium balance
What are the effects of different RRT modalities on fluid balance?

- **IHD**: acute loss of plasma volume
  - ultrafiltration rate > refill rate
  - decrease in plasma osmolality and subsequent shift of fluid into extravascular compartments
  - Thermal balance
- **For IHD-induced hypotension:**
  - Preventative measures
  - Therapeutic options
What are the effects of different RRT modalities on fluid balance?

- Convective modalities: better hemodynamic stability
  - More stable plasma osmolality
  - Sodium balance
  - Cooling effect
- CRRT: cohort and retrospective studies suggest preserved diuresis and greater renal recovery than IHD (grade 4)
**How much UF is needed?**

### Nutrition
- 30 kcal/kg.day
- 75 kg = 2250 kcal

1000 ml αα10%
- 750 ml glucose 40%
- 350 ml lipid 20%

+ iv meds infusions

Around 3 l/day

### RRT modality

- **CVVH/CVVHDF**
  - Intermittent
  - 3 x 4 h
  - 5 x 4 h
  - 7 x 4 h
  - 7 x 8 h

### UF rate required anuric patient

- 2400 ml/day
  - 100 ml/h

- 5600 ml/HD
  - 1400 ml/h

- 3360 ml/HD
  - 840 ml/h

- 2400 ml/HD
  - 600 ml/h

- 300 ml/h
UF and ↓ BP during HD

Ronco et al Nephrol Dial Transplant 1990

Ultrafiltration rate ml/min.kg

St Orsola Vincenza HD pts effect of UF rate

* p < 0.05
Daily dialysis for AKI

Schiffl et al NEnglJMed 2002

Univ München
160 AKI pts
80 pts each gp
mean (SD)
*p < 0.05

alt die HD
daily HD

% mortality
days to renal recovery
Hours of observation

- Body Weight Variation (Kg)
- Blood Volume Variation (%)
- Mean Art. Press. (mmHg)
Sodium balance in AKI

Low sodium enteral feeds

- **nepro**
  - 8.7 mmol/can
  - 3.7 mmol/100 ml

- **clinutren**
  - 7.0 mmol/carton
  - 3.5 mmol/100 ml

- **fresubin**
  - 58 mmol/l bag
  - 5.8 mmol/100 ml
Slope RBV with UF
Thermal effects

DeVries et al JASN 1997  Maastricht

Arterial blood pressure mmHg

UF + HD
cold dialysate

warm HF
cold HF

Time (min)

0 30 60 90 120 150 180
Hypotension in pts with AKI

- CRRT
- Haemodialysis

- % treatments with ↓ BP

French ICU Study Group on ARF Prospective Multicenter Dialysate Na + 10 mmol/l 35°C
Hemodiafe dialysis

- $[\text{Na}^+]_D$ 10 mmol/l $> [\text{Na}^+]_P$
- Dialysate Temp 35°C
- Duration – mean time $> 5$ hours
Fluid Imbalance

- **Positive**
  - Insufficient fluid removal
  - Fluid Gain
  - Absolute volume (Total Uf)

- **Negative**
  - Relative Volume (Uf rate)
Machine errors

Most machines do not stop the treatment after multiple overrides of the “fluid balance error” alarm. However, some machines force the operator to stop the therapy after a number of repeated alarms.
Recovery from AKI

Does RRT delay renal recovery?

- complications
  - frequency
  - severity
- clinical significance

Prospective randomised controlled trials
Renal recovery

- Patient factors
  - age
  - co-morbidity
  - pre-existing renal disease
  - etiology of renal failure
Determinants of renal recovery

Augustine et al AmJKidDis 2004

Urine output % day 3/day 1
Urine output day 1 /ml
ΔMAP on dialysis

Case Western Univ Hospitals
Cleveland
80 AKI pts
95% CL
* p < 0.05
Renal autoregulation

Kelleher et al AmJPhysiol 1984

Renal blood flow ml/min

control

3 weeks

1 week

rat model

time from ischemic insult

mean arterial pressure mmHg

90 100 110 120
BEST: Recovery from dialysis dependence
Progression to ESRD following AKI, by CKD Status

- Total: 28.2%
- CKD: 13.4%
- Non CKD: 7.6%

Himmelfarb 12th CRRT San Diego 2007
Renal support for AKI

Summary

- Prevention of hypotension
  - ↑ dialysate Na+
  - ↑ IHD time and frequency
  - cooled dialysate
  - ultrapure dialysate
  - bicarbonate dialysate
  - volumetric machine
  - dialyzer