Competency assessment in CRRT – core curriculum. G07

San Diego 2011
Hilton Bayfront

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Austin Hospital
RMIT University
Australia
Heamofiltration – Continuous Renal Replacement Therapy (CRRT) in ICU now for more than 25 years!

1996

...more frequent use, multiple patients...

2010
CRRT in Nursing schools?

- ? Content/hours for ARF & CRRT
- Not yet considered ‘life support’
- Loose link to clinical setting
- Hospital focus ⇒ machine training
- Assessment & credentialing undeveloped
- No clear curriculum for CRRT
Undergrads: Oliguria not useful on a ward....

- So what about a surrogate?

- **Blood pressure**, a routine ward nursing observation

- But is it done?
Oliguria and blood pressure: management flow chart

Is there a reason for the reduction/in BP or U.O.?  
- No
- Yes → Dr consult / diagnosis

Is the patient blood pressure, & U.O. low?  
- No, BP OK..
- Yes

Is the catheter blocked or bladder full?  
- Yes → Fluid bolus IV 3.0 ml/kg
- No → Diuretic

Unblock – ? Catheter in  
- Urine > 0.5 mls/kg/hr
Post grad content - ICU

Post grad ICU subject hrs

- Resp
- ECG
- Pt care
- pH/Elec/fluids
- CVS
- Neuro
- Shock
- GIT
- Renal
- Endocrine
- Sepsis
- Other
- Coag / Haem.
CRRT nursing

- Often the sickest patients
- Nursing collaborative models vary
- Medical support also variable
- Safety reliance on machine design
- Learning by trial and error
- Mistakes occur
Fluids and fluids balance errors...

- Barletta J. et al 2006

- Survey of pediatric programs
- 31 responded
- 18 med. errors, 2 fatal....!
- 2 – Heparin prep.
- 16 – prep. / mixing of fluids
Fluids and fluids balance errors...

- FDA notification. Aug. 23rd 2005 & Feb 2006...
  www.fda.gov/cdrh/safety
  - Incorrect use of Prisma machine with excessive fluid removal
  - Failure of nurse to resolve alarm – ‘incorrect weight change detected’
  - Estimated 9 deaths, 11 serious injuries
CRRT in elderly patient
K+ in dialysate – 53.6 mmol/L
Na+ - 5.9 mmol/L

Central production pharmacy
Error continued despite a 4 step check process
My ICU – incident monitoring

- 5 hrs CVVHDF, no bicarbonate
- pH 7.36 to 7.23
- Nurse did not add bottle
- 2 part bag now
- Additive label used
Suggested key Curriculum: CRRT

A.R.F. and critical illness

Theory of solvent and solute removal

Techniques for CRRT

Fluids and fluid balance

Anticoagulation

Machines and E.C. circuit

Patient care
What is the ‘world’ doing with ARF in ICU?
Major Findings: Incidence

- Severe ARF in 1738 of 29,269 patients screened (5.7%)
- 30% have CKD before ICU admission
- RRT is applied commonly (4.3%)
- Mortality is high: 60.3%
- Dialysis dependence at hospital discharge for survivors: 13.8%
Renal Blood flow: ~ 25% of the cardiac output
1250 ml/min
(but Kidneys only 0.4% of body weight)
Strong relation b/w RBF and GFR
Functional units.

Glomerulus & Bowman’s Capsule structures

http://www.youtube.com/watch?v=glu0dzK4dbU
Kidney functions: Summary

- Removal of metabolic wastes, ‘foreign chemicals’
- Water balance and electrolyte balance
- Regulation of osmolarity
- Acid – base balance (pH)
- Arterial pressure regulation
- Secretion, metabolism, hormone excretion
The kidney and disease.

- Acute glomerular nephritis
- Diabetic nephropathy
- Cystic Kidney disease
- Nephrotic syndrome
- Tubular diseases - damage
Acute kidney injury - failure.

GFR stops

No urine output
Tubular epithelial response to ischaemia, toxins (injury and repair)

Acute Kidney Injury (AKI).

- Acute renal failure – many definitions
- New term – AKI, encompasses the entire spectrum of the syndrome, minor changes in function to need for renal replacement therapy.
- ‘RIFLE’ criteria provides a uniform definition of AKI
RIFLE criteria

ADQI, Crit Care 2004 (8) 204-212
Figure 2

Validation of RIFLE

Uchino and Bellomo et al Crit Care Med. 34(7) 2006
Acute Renal Failure….Management.

- Fluid resuscitation.
- BP maintenance. MAP > 75 mmHg.
- Nutrition - protein rich.
- Electrolyte control.
- Correction of acidosis, anaemia, infection.
- Modify drugs that are nephrotoxic.
- Stress ulcer prophylaxis.
- Renal replacement therapy. Early and aggressive.
Renal Replacement techniques

- Peritoneal dialysis
- Haemodialysis
- Continuous Renal Replacement Therapy (CRRT) Hemofiltration
History of Dialysis

Cellulose and acetate used in the food and packaging industry.

Strong, tolerates pressure and could be sterilised.

Sausage casing membrane; Identified by William Thalhimer for a dialysis membrane
The Allis Chalmers Company
Rotating drum Artificial kidney in
Milwaukee, Wisconsin

Vertical drum Artificial Kidney by Westinghouse Corporation, USA

History of Dialysis
Different settings: CRRT and IHD

Dialysis clinic - outpatients  Intensive Care - inpatients
Peritoneal Dialysis

Diagram showing the process of peritoneal dialysis with labels for bag containing dialysis solution, internal organs, peritoneal catheter, peritoneal cavity, disconnect tubing, drain line, dialysis fluid, bloodstream, peritoneal membrane, and drain.
Membrane is main ‘engine’ for CRRT.

Membranes for CRRT

- Potting agent
- Membrane casing
- Pore holes
- Blood space
- Membrane fibre
- Membrane housing
- Port for Dialysate or Filtration
- Blood tubing connection
Membrane structure

Fiber cross section; sponge structure.

Fibers

Outer side wall of different Polysulfone, arylethersulfone & polyamide-s membranes
Exchange of wastes across membrane by concentration gradients…

Plasma water removal with wastes dissolved in the water…
CVVH — plasma water removal & replacement (convection)
CVVHD(F) - diffusion & convection

Dialysate

Diafiltrate

Blood Pump

Heater

Replacement Fluids
Renal Support Technique

Intensity

Convection + Diffusion

Diffusion
IHD, CVVHD

Convection
CVVH

Duration

Fluid Balance

Solute Clearance
Fluids

- Provide a fluid replacement for plasma water removed – convection (CVVH)
- Provide a fluid for solute (waste) removal – diffusion (CVVHD)
- Correct electrolytes and acid base bal.
## Commercial fluids: Australia

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CRRT solutions

- Lactate solution
- Acetate solution
- Bicarbonate solution

Liver, Kidney, Skeletal muscle

Bicarbonate - Buffer
Fluids settings - examples

- Fixed rates – how to achieve fluid loss
- Increase fluid removal or decrease fluid replacement?
- Anticoag volumes
- Patient balance and machine balance?
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Goals of anticoagulation

- Maintain *patency* and function of extracorporeal circuit
- Minimise *activation* of coagulation factors or platelets
- Avoid *complications*
  - Bleeding
  - Drug specific
- Intentionally *anticoagulate* patient when indicated
Anticoagulation

Nil

- Optimize circuit ‘mechanics’

Systemic

- Heparin (UF)
- LMWH
- Heparinoids
- Thrombin antagonists
- Platelet inhibitors
- Combinations of above

Regional

- Heparin & Protamine
- Citrate & Ca^{++}
What are the Alternatives?

- Unfractionated heparin (UFH)
- Citrate / calcium (‘RA’)
- Heparin / protamine (‘RA’)
- Low molecular weight heparins (LMWH)
- Prostaglandins
- Others
  - Hirudin, Nafamostat
- None!
- Non thrombogenic circuits and filters
# Anticoagulation around the world

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<th>Method</th>
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<td>LMWH</td>
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<td>(hirudin 9, prostacyclin 7, danaparoid 2)</td>
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- 54 hospitals, 23 countries (Sept 2000 – Dec. 2001)

Uchino et al. 2005, BEST kidney study, JAMA, 2005, 294 (7): 813-8
Fibrin Thrombus
International Normalised Ratio (INR)

- Prothrombin time is used for the detection of coagulation factor deficiencies due to Vit K deficiency and liver disease (II, VII, IX & X).
- Prothrombin time (PT) depends on II, VII and X.
- The result for the prothrombin time is expressed as a ratio (clotting time for patient plasma divided by the time for control plasma).
Activated Partial Thromboplastin Time (APTT)

- deficiency in factors VIII, IX, XI, XII
- Heparin interferes with the coagulation cascade at this point so APTT is useful in monitoring the effectiveness of the infusion
CRRT programs: Core curriculum Summary.

- Curriculum for CRRT needs to be defined
- Need to introduce into nursing schools
- Topics in sequence
- Many methods for providing 'core content'
- Background and 'theory' vital for practical
Teaching in sequence ....Abstract to concrete...theory to practice

Theory

Simulation

Supervised experience
1 Day CRRT update and basics

ICU staff Study day – CRRT
ICU lecture theatre, ICU level 2
Thursday December 16th · 2010

0830 - 0930  Renal physiology and ARF in critical illness

0930 - 1030  RRT : therapy modes and application
1030 - 1100  T break
1100 -1200  RRT : Anticoagulation

1200 - 1300  RRT : Fluids and fluid balance
Ian Baldwin
1300 - 1400  Lunch break

1400 - 1500  Machine review & Priming Infomed (group 1)
Machine review & Priming Prismaflex (group 2)

1500 – 1515  T Break
1515– 1600  Panel : ‘Facts’ and ‘Fiction’ using CRRT
Your q’s , our answers......for CRRT
Self scoring for knowledge improvement after 1 day lecture and practical for CRRT: 17 nurses (December 2010)
Difference in knowledge (improvement) after 1 day lecture and practical for CRRT: 17 nurses

(December 2010)
Human – machine interface