با نام و یاد خدا
COMPARISON OF RENAL RRT MODES

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RENNAL REPLACEMENT THERAPY

- Peritoneal Dialysis
- Acute Intermittent Hemodialysis
- Continuous Hemofiltration
  - SCUF
  - CVVH
  - CVVHD
  - CVVHDF
SELECTION FOR HD/PD/CRRT

• Clinical condition
• Lifestyle
• Patient competence
• Affordability
• Availability
PERITONEAL DIALYSIS

- The process takes place inside the body.
- A tube (Tenckhoff catheter) is inserted into the abdominal cavity.
- Special dialysis fluid is drained into the abdomen.
- Excess waste and water pass from the blood into the fluid and after a few hours the fluid is drained out.
INTERMITTENT HEMODIALYSIS (IHD)

- Oldest and most common technique

- Primarily diffusive treatment: blood and dialysate are circulated in countercurrent manner
  - Also some fluid removal by ultrafiltration due to pressure driving through circuit

- Best for removal of small molecules

- Typically performed 4 hours 3x/wk or daily
CONTINUES RENAL REPLACEMENT THERAPY (CRRT)

• Defined as

  – “Any extracorporeal blood purification therapy intended to substitute for impaired renal function over an extended period of time and applied for or aimed at being applied for 24 hours /day.”
SOLUTE REMOVAL MECHANISMS IN RRT

• Diffusion
  • transmembrane solute movement in response to a concentration gradient
  • importance inversely proportional to solute size

• Convection
  • transmembrane solute movement in association with ultrafiltered plasma water ("solvent drag")
  • mass transfer determined by UF rate (pressure gradient) and membrane sieving properties
  • importance directly proportional to solute size
DIFFUSION

- Movement of **Solutes** from an area of **higher** concentration to an area of **lower** concentration
- Dialysis uses a semi permeable membrane for selected diffusion

**Diffusion**: The movement of solutes from a higher to a lower solute concentration area.
ULTRAFLTRATION

- Movement of **FLUIDS** through a membrane caused by pressure gradient
- Positive, negative and osmotic pressure from non-permeable solutes

**Ultrafiltration**: The movement of fluid through a membrane caused by a pressure gradient.
CONVECTION

• Movement of **SOLUTES** with a water flow, “solvent drag”.

*Convection*: The movement of solutes with a water-flow, “solvent drag”, e.g., the movement of membrane-permeable solutes with ultrafiltered water.
CLEARANCE: CONVECTION VS. DIFFUSION
RATE LIMITATIONS OF VOLUME REMOVAL

Extra-Vascular Compartment  Vascular Compartment

BP
IMPROVED VOLUME REMOVAL WITH SLOWER ULTRAFILTRATION RATES

Extra-Vascular Compartment  Vascular Compartment

BP Stable
CRRT FOR METABOLIC CONTROL

![Graph showing BUN levels over time for IHD and CRRT methods.](image-url)
CONTINUES RRT

• Better preservation of cardiovascular function and maintenance of hemodynamic stability
• Prevents the surge in intracranial pressure associated with intermittent therapies- hence useful in neurosurgical patient and acute liver failure.
• Effective in clearance of middle molecules
• Useful in removal of immunomodulatory substances in sepsis like endotoxin, interleukin-1, etc
• Permits protein rich nutritional support with a neutral nitrogen balance preventing protein malnutrition
• Clinical benefits
  – Better survival
  – Better renal recovery
CONTINUES RRT

• Specific patient populations who may benefit from CRRT
  – Hemodynamic instability
  – Combined acute renal and hepatic failure
    • Improved CV instability and intracranial pressure
  – Acute brain injury
    • Decreased cerebral edema
INTERMITTENT RRT

• **Practicality and flexibility**
  – Uses same machines as chronic HD
  – Multiple pts per day
  – Easier to mobilize pts

• **Less expensive than CRRT (by about ½)**

• **Fewer bleeding complications**
  – CRRT requires continuous anticoagulation

• **Less filter clotting**

• **Superior solute clearance**, more rapid removal of toxins (due to higher flows)
INTERMITTENT RRT

• Specific patient populations benefitting from IRRT:
  – High bleeding risk
    • after recent surgery
  – Acute treatment of hyperkalemia, rhabdomyolysis, poisoning, tumor lysis syndrome
DOES CRRT OFFERS BETTER ACUTE KIDNEY INJURY OUTCOMES?

• Patients with AKI treated with IRRT rather than (CRRT) may be more likely to become dialysis dependent.

• A systematic review and meta-analysis of 23 studies including 7 (RCTs) with 472 patients and 16 observational studies with 3,499 patients concluded that **Overall, initial treatment with IRRT was associated with a 1.7 times increased relative risk for dialysis dependence compared with CRRT.**

• Pooled analyses of the RCTs demonstrated **no significant difference in dialysis dependent rates between the modalities**, but **pooled analyses of the observational studies showed that patients who initially received IRRT had a twofold increased risk of dialysis dependence** compared...
## PERITONEAL DIALYSIS

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Simple to set up &amp; perform</td>
<td>• Unreliable ultrafiltration</td>
</tr>
<tr>
<td>• Easy to use in infants</td>
<td>• Slow fluid &amp; solute removal</td>
</tr>
<tr>
<td>• Hemodynamic stability</td>
<td>• Drainage failure &amp; leakage</td>
</tr>
<tr>
<td>• No anti-coagulation</td>
<td>• Catheter obstruction</td>
</tr>
<tr>
<td>• Bedside peritoneal access</td>
<td>• Respiratory compromise</td>
</tr>
<tr>
<td></td>
<td>• Hyperglycemia</td>
</tr>
<tr>
<td></td>
<td>• Peritonitis</td>
</tr>
<tr>
<td></td>
<td>• Not good for hyperammonemia or intoxication with dialyzable poisons</td>
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</tbody>
</table>
## INTERMITTENT HEMODIALYSIS

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Maximum solute clearance of 3 modalities</td>
<td>• Hemodynamic instability</td>
</tr>
<tr>
<td>• Best therapy for severe hyperkalemia</td>
<td>• Rapid fluid and electrolyte shifts</td>
</tr>
<tr>
<td>• Limited anti-coagulation time</td>
<td>• Complex equipment</td>
</tr>
<tr>
<td></td>
<td>• Specialized personnel</td>
</tr>
<tr>
<td></td>
<td>• Difficult in small infants</td>
</tr>
</tbody>
</table>
CONTINUOUS HEMOFILTRATION

Advantages

- Easy to use in PICU
- Rapid electrolyte correction
- Excellent solute clearances
- Rapid acid/base correction
- Controllable fluid balance
- Tolerated by unstable pts.
- Early use of TPN

Disadvantages

- Systemic anticoagulation (except citrate)
- Frequent filter clotting
- Vascular access in infants
<table>
<thead>
<tr>
<th>Benefits</th>
<th>PD</th>
<th>IHD</th>
<th>CRRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid removal</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Urea and creatinine clearance</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Potassium clearance</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Toxin clearance</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complications</th>
<th>PD</th>
<th>IHD</th>
<th>CRRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal pain</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Bleeding</td>
<td>−</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Dysequilibrium</td>
<td>−</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Need for heparinization</td>
<td>−</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Hypotension</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>−</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Central line infection</td>
<td>−</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Inguinal or abdominal hernia</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Protein loss</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Respiratory compromise</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Vessel thrombosis</td>
<td>−</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

PD, peritoneal dialysis; IHD, intermittent hemodialysis; CRRT, continual renal replacement therapy.
Adapted from Rogers MC: Textbook of pediatric intensive care, Baltimore, 1992, Williams & Wilkins.