Dialysis in children with Endstage Renal Disease

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Objectives

- Define Endstage Renal Disease
  - Indications for Renal Replacement Therapy (RRT)
- Renal Replacement Therapy options
- Technical aspects of RRT
- RRT access types
- Complications associated with RRT
Preparations for RRT should start when estimated GFR declines to less than 30 mL/min per 1.73 m² (CKD stage 4)

- ESRD is a permanent condition that occurs at the final stage – eGFR is 15mL/min per 1.73 m² (CKD stage 5)
- Start dialysis when eGFR is 15mL/min per 1.73 m²
Incidence of ESRD in Children

- ESRD in children is uncommon. Worldwide incidence varies.
- Incidence in Africa remains unclear—> Lack or renal registers.
- Highest incidence of ESRD was in New Zealand → annual rate of 18 per million.
- In United States incidence of ESRD
  - Peaked at 17.5 per million population in 2004
  - Decreased to 13.7 per million children in 2015

In the United Kingdom children on RRT

- Three percent of the total RRT population are less than two years of age
- Twenty eight percent are aged two to eight years,
- Twenty eight percent are 8 to 12 years
- Forty percent percent are 12 to 16 years

Burden Of End-stage Kidney Disease In Sub-Saharan Africa

- This is largely unknown both for adults and more so for children

- About 12–23% of adults in sub-Saharan Africa have CKD and are at risk of developing end-stage kidney disease


Outcomes in adults and children with end-stage kidney disease requiring dialysis in sub-Saharan Africa: a systematic review

Gloria Ashuntantang, Charlotte Osafo, Wasiu A Olowu, Fatiu Arogundade, Abdou Niang, John Porter, Saraladevi Naicker, Valerie A Luyckx

Summary

Background The burden of end-stage kidney disease (ESKD) in sub-Saharan Africa is unknown but is probably high. Access to dialysis for ESKD is limited by insufficient infrastructure and catastrophic out-of-pocket costs. Most patients remain undiagnosed, untreated, and die. We did a systematic literature review to assess outcomes of patients who reach dialysis and the quality of dialysis received.
Renal replacement therapy for ESRD

- Once the kidneys fail, renal replacement therapy by dialysis or transplantation is the only means of survival.

- Studies in the past 5 years show that about 2·3 million and 3·2 million people die yearly as a result of no access to dialysis.

Initiation of HD or Peritoneal Dialysis

- Preemptive transplantation is the preferred RRT
- It has better long-term outcomes
- Initiation of dialysis in children depends on residual renal function, laboratory values, psychosocial factors.
- Estimation of glomerular filtration rate using modified Schwartz formula used in deciding when to initiate dialysis
Initiation of HD or Peritoneal Dialysis

- The KDOQI guidelines recommend considering dialysis at an eGFR <15 ml/min/1.73 m²
- Clinical indicators to begin dialysis are: –
  - Anuria, electrolyte disturbance, neurologic consequences of renal failure, pericarditis, bleeding diathesis, refractory nausea or hypertension malnutrition and the side effects of uremia

Preparation of the family

- CKD patients should be enrolled in the renal clinic before the eGFR declines to 30ml/min/1.73 m².
- Parents should be prepared and educated by renal unit team members.
- Information on type of dialysis and insertion of access tubes or lines.
- Information also through booklets and video,
Choosing dialysis

- All patients should be offered a choice of PD or HD
- Peritoneal dialysis should be offered as the first choice of treatment modality for:
  - Children 2 years old or younger
  - People with residual renal function
  - Adults without significant associated comorbidities

- Peritoneal dialysis may preserve residual renal function more effectively than haemodialysis
<table>
<thead>
<tr>
<th>Medical</th>
<th>PD contraindications</th>
<th>HD contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal adhesions</td>
<td>Relative</td>
<td>Extensive history of PVD</td>
</tr>
<tr>
<td>Ostoimes</td>
<td>Absolute</td>
<td>Access problem</td>
</tr>
<tr>
<td>Severe malnutrition</td>
<td></td>
<td>History of coagulation</td>
</tr>
<tr>
<td>Severe nephrotic-range</td>
<td></td>
<td>problems</td>
</tr>
<tr>
<td>proteinuria</td>
<td></td>
<td>Poor cardiac function</td>
</tr>
<tr>
<td>Severe obstructive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lung disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of VP shunt</td>
<td></td>
<td></td>
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<tr>
<td>Upper-limb amputations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe diabetic gastroparesis</td>
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</tbody>
</table>

| Psychosocial            |                      |                               |
| Elderly patient         |                      |                               |
| Poor hygiene            |                      |                               |
| Blindness               |                      |                               |
| Inability to maintain   |                      |                               |
| sterile technique       |                      |                               |

PD = peritoneal dialysis; HD = hemodialysis; PVD = peripheral vascular disease; VP = ventriculoperitoneal.
The Two Kinds of Peritoneal Dialysis:

- Continuous Ambulatory Peritoneal Dialysis (CAPD) CAPD is "continuous," machine-free

- Automated Peritoneal Dialysis (APD) APD differs from CAPD in that a machine (cycler) delivers and then drains the cleansing fluid. Usually done at night.
CAPD

- Fresh dialysis solution
- Clamp
- Disposable tubing
- Drain bag
- Transfer set
APD
Selection criteria for ESRD children for the HD program

- Majority of infants and small children with ESRD receive preemptive renal transplant or PD
- Reasons for haemodialysis should be considered when there is:
  - Extensive abdominal surgery or peritoneal membrane failure.
  - Social environment not optimal for home peritoneal dialysis.
  - Large adolescents with low permeability peritoneal membranes.
  - Return to dialysis after a failed renal transplant.
  - Presence of a VP shunt.
Initial blood screening before initiating Haemodialysis

- Blood for urea/electrolytes and creatinine and haemogram
- Screen for blood borne viruses
- Obtain consent for screening for blood borne viruses
  - HIV–Elisa
  - Hepatitis B & C → HBsAg and HCV
VASCULAR ACCESS

- Good vascular access very important for successful HD.
- Three forms of vascular access in children are:
  - Subcutaneously tunneled central venous catheters (CVCs)
  - Native arteriovenous (AV) fistulas
  - Synthetic AV grafts
- Tunneled CVCs may malfunction or become infected, often needing replacement
- Best form of access is an AV fistula
Catheter size for hemodialysis according to the weight of the child

<table>
<thead>
<tr>
<th>Weight of child (kg)</th>
<th>Catheter gauge (Fr)</th>
<th>Catheter length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double lumen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 to 12</td>
<td>8</td>
<td>12 or 18</td>
</tr>
<tr>
<td>10 to 25</td>
<td>10 or 12.5</td>
<td>12 or 19</td>
</tr>
<tr>
<td>15 to 30</td>
<td>10 or 12.5</td>
<td>19 or 28</td>
</tr>
<tr>
<td>&gt;25</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>&gt;30</td>
<td>12 or 13.5</td>
<td>23 or 26</td>
</tr>
<tr>
<td>&gt;40</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>Single lumen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>6.5</td>
<td>29 or 32</td>
</tr>
<tr>
<td>&gt;10</td>
<td>10</td>
<td>36 or 40</td>
</tr>
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Temporary hemodialysis catheter

Exit site at surface of the skin

Inserted in the jugular vein

Tip located at junction of SVC and right Atrium
Tunneled hemodialysis catheter

- Dacron cuff
- Catheter tunnel
- Exit site
- Inserted in the jugular vein
- Tip located at junction of SVC and right Atrium
Aterio–Venous Graft

Diagram showing the structure of an arterio-venous graft.
Type of Dialyzers for Paediatric HD

- Dialyzer used in children are a hollow fiber design
  - minimizes blood volume
  - provides reliable and predictable solute clearance and ultrafiltration coefficients

- Dialyzer is selected as follows:
  - Based on the child’s body surface area
  - Type of hemodialysis (eg, standard or hemodiafiltration [HDF]).

- The surface area of the dialyser should large to optimize clearances but should not exceed child’s BSA

- Dialyzer surface areas range from 0.25 m² up to 1.7 m² and above
Type of Dialyzers for Paediatric HD
Biochemistry

- Dialysate should be bicarbonate based
- Renalyte should be selected based on the patient’s biochemistry, reviewed each session
- Sodium setting should be standardised at 140.
Dialysis Machine - Specific Feature For Pediatric Haemodialysis Machines

- Precise control of ultrafiltration volumetric assessment
- Capable of low blood flow speeds
- Ability to use lines of varying blood volumes
- Measure and remove very small amounts of fluids
- Continuous blood volume monitoring during the session
- Buffered bicarbonate
- Specific material available for babies/infants
Dialysis Machines
Needles for AV Fistulas
Pediatric Haemodialysis Prescription

- Adequate duration of dialysis: 3–4 h.
- Adequate dialysis dose:
  - start with urea clearance target of 3ml/min/kg.
  - Once stable, higher clearances can be attained.
  - Kt/V minimum target 1.2
- Use bicarbonate dialysis
- Adequate pump speed.
  - Small children: 40–120ml/min
  - Older Children: 140–300ml/min
- Adequate Dialysate flow rate. Qb:Qd = 1:2
1. Heparin initially 50 units/kg/session
   - equal to 10–20 units/kg/hr
   - with a bolus of 10–20 units/kg

On initial treatments activated clotting times should be taken every 30 minutes of treatment and

Dose titrated to keep;
   - ACT at 25% above the patient’s baseline level if patient has clotting problem. (180–220 maximum
   - level)
   - Otherwise ACT at 50% above baseline (180–250 maximum).
Fluid Removal–Ultrafiltration

- The patients target weight should be reviewed every fortnight
- Fluid removal in a dialysis session should not exceed 0.2ml/kg/minute.
- Further fluid can be removed through isolated ultrafiltration or sequential ultrafiltration
- Total fluid removed in a single session should not exceed 10% of patient’s body weight.
- Excessive ultrafiltration is associated with hypotension and exaggerated urea rebound
Renal profile should be performed pre and post dialysis every 2 weeks to assess adequacy of dialysis.

This is used to calculate the UREA REDUCTION RATIO. This should exceed 65%

Pre–Dialysis Serum Biochemistry should be maintained within these levels
Management of Diet, anaemia, Bone Disease

- Adequacy of energy & regulation of protein intake
  - sufficient for growth
  - But regulated to minimise fluctuations in pre-haemodialysis
  - blood urea levels.
- Fluid balance → Intake Restricted to 400–500ml/m^2/day in anuric children
- Electrolytes → Regulate sodium and potassium intake.
- Bone Metabolism → Calcium and phosphorous intake and the use of phosphate binders.
- Adequacy of vitamin and mineral intakes.
Management of anaemia

- Anaemia is a major problem due to the ESRD disease & also due to haemolysis and blood loss during haemodialysis.

- Blood levels should be maintained at
  - Hb 10–12.5 g/dl
  - Ferritin 100–800ng/ml
  - TSats > 20%

- Blood transfusions should be avoided unless the child is very

- Monthly assessment of haemoglobin, ferritin and Transferrin saturation levels.

- Intravenous iron (Venofer) and Erythropoietin Stimulating Agents are given at the end of the HD sessions.
IMMUNISATIONS

- Take a full vaccination history
- Ensure that the child is fully vaccinated
- Hepatitis B vaccination schedule as per the renal unit protocol
Complications of RRT

- **Dialysis process related**
  - Water/volume mediated: hypovolemia
  - Solute mediated: electrolyte shifts, alkalemia
  - Anticoagulation–related: bleeding, low platelets

- **AV access or catheter related**
  - Non–function
  - Infections
  - Steal syndrome (AVF > AVG)
  - High output heart failure (AVF)
  - Central venous stenosis (catheters)
Mortality rates for children on dialysis are higher than in the transplant population.

Five-year survival rate in European children initiating dialysis between 2005 and 2010 was 89.5 percent.

Australia & New Zealand 1963–2002 mortality rates → 4.8, 5.9, and 1.1 per 100 patient years for children receiving haemodialysis, peritoneal dialysis & kidney transplant recipients respectively.

Causes of Mortality in Dialysis

Hemodialysis, 1997-2001
- Cardiovascular
- Infection
- Other
- All

Deaths per 1,000 patient years at risk

Peritoneal dialysis, 1997-2001

Months after day 90

U.S. Renal Data Systems: USRDS Annual Data Report 2005
Long Term management of ESRD children on dialysis

- Transplantation should be arranged as soon as the child is stabilised on dialysis.
- Use a multi-professional approach to inform the child and family.
- When transplantation is not possible due to medical reasons inform the child and family about other long-term options.
- This involves insertion of long term vascular accesses:
  - Perm cath
  - A–V Fistula
- Also preparation of transition to the adult haemodialysis services.
Conclusion

- Start dialysis when eGFR is 15mL/min per 1.73 m²
- Preemptive transplantation is the preferred RRT. It has better long-term outcomes
- Initiation of dialysis in children depends on residual renal function, laboratory values, psychosocial factors,
- All modalities of dialysis can be done on children
- Mortality rates for children on dialysis are higher than in the transplant population
- Transplantation should be arranged as soon as the child is stabilized on dialysis
Thank you