Pediatric ESRD

Overview:

Besides USRDS and UNOS/SRTR, the major data source in US / Canada is NAPRTCS which is a privately funded multicenter study that tracks (and has performed randomized trials) transplant, CRI, and Dialysis patients in children.

Each offers overlapping and unique data, none are complete

ESRD in Children: Incidence

Incidence Rate Per Million Population (Year 2013):

Age 0-21 years: 15.3

Subgroups
Age 0-4 years: 10.4
Age 5-9 years: 6.6
Age 10-13 years: 10.4
Age 14-17 years: 18.6
Age 18-21 years: 32.4
Age 55-59 years: 603 (for comparison)

Cumulative 15.3

ESRD in Children Due to PKD

Incidence Rate Per Million Population (year 2013):

Age 0-21 years: 0.7

Subgroups
Age 0-4 years: 0.7
Age 5-9 years: -
Age 10-13 years: -
Age 14-17 years: 1.1
Age 18-21 years: -
Age 50-54 years: 18.4 (peak age group)

Cumulative 0.7

USRDS 2015 Report (up to year 2013)
Data Source: Special analyses, USRDS ESRD Database. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis and continuous cycling peritoneal dialysis. All consists of hemodialysis, peritoneal dialysis, uncertain dialysis, and transplant. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.
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Figure 8.1 Number of December 31 point prevalent ESRD pediatric patients (aged 0–21 years), by modality, 1996-2013

Data Source: Special analyses, USRDS ESRD Database. Includes incident pediatric ESRD patients in the years 2003-2012, surviving the first 90 days after ESRD initiation and followed from day 90. Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Figure 8.3 One-year adjusted all-cause hospitalization rates in incident (new yearly) pediatric patients (aged 0-21 years), by modality, 2003-2007 and 2008-2012
Figure 8.6 1-Year adjusted all-cause mortality rates in incident pediatric patients with ESRD, by modality, 2003-2007 & 2008-2012: Transplant is generally MUCH better than dialysis)

Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Figure 8.6 One-year adjusted all-cause mortality rates in incident (new yearly) pediatric patients with ESRD, by age 2003-2007 and 2008-2012

Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.
Figure 8.13 Trends in pediatric transplantation, by patient transplant counts and kidney transplant waiting list times, 1996-2013

Data Source: Reference Tables E2, E3, and special analyses, USRDS ESRD Database. The waiting list count provides the number of pediatric candidates aged 0-21 years on the Organ Procurement and Transplantation Network kidney transplant waiting list on December 31 of each year for first and subsequent kidney alone or kidney plus pancreas transplantation. Candidates listed at more than one center on December 31 are counted only once. There are no data available for median waiting list time for patients with prior transplants listed after 2010. Abbreviations: Tx, transplant.

Figure 8.2 Trends in ESRD modality at initiation, by patient age 1996-2013

Data Source: Special analyses, USRDS ESRD Database. Includes incident ESRD patients in the years 1996-2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.
Dialysis:

Hemodialysis (blood filtering)

Peritoneal Dialysis (in the abdominal cavity)

Miracle Treatments Nobody Wants to Need
Dialysis History

William Kolff (Netherlands): 1st artificial kidney 1943

First dialysis in the US: 1947 (at Mount Sinai NYC, but not without some resistance there), brought by Kolff

Hemodialysis was advanced in the 1960’s in Seattle

Early rationing of care was required: dialysis by committee

1970’s: Medicare / full government coverage

By 2008 costs were > 30 billion/year, about 8% of Medicare per USRDS 2010

Life Magazine, Nov 9, 1962
First child with peritoneal dialysis Toronto 1978

Technique further developed, became more commonplace in the early 1980’s

The New England Journal of Medicine

CONTINUOUS AMBULATORY PERITONEAL DIALYSIS IN CHILDREN

Comparison with Hemodialysis

Michele Baum, M.D., David Powell, M.D., Saale Cavin, R.N., Tarlack McDaid, B.S.N.,
Kathy McHenry, M.P.H., Hensin Mar, B.S., and Donald Potter, M.D.

Abstract. The clinical and biochemical effects of continuous ambulatory peritoneal dialysis in 20 children and of hemodialysis in 16 children were compared over a 2½-year period. Statistically significant differences between the treatment groups included higher hematocrit, higher serum calcium, carbonate, and cholesterol levels, larger intake of calories and protein, and lower systolic blood pressure and rates of transfusion in the patients receiving continuous ambulatory peritoneal dialysis. These patients had more complications than the patients receiving hemodialysis, but hospitalization rates in the two groups were similar. The cost of continuous ambulatory peritoneal dialysis was $19,000 per patient-year; the cost of hemodialysis was $24,000 per patient-year. There were four treatment failures with continuous ambulatory peritoneal dialysis and one with hemodialysis. Patients treated with both forms of dialysis preferred continuous ambulatory peritoneal dialysis.

We conclude that continuous ambulatory peritoneal dialysis is an important alternative to hemodialysis in children.

Hemodialysis

**Connection Types**

1. **Catheter**
   - A tube inserted into a vein in the neck, chest, or leg.

2. **Fistula**
   - A surgically created connection of an artery to a vein.

Blood is pumped out of a patient’s catheter or fistula into the blood line.

**Dialyzer**

Blood flows into the dialyzer, where impurities, salt, and excess fluid are drawn into the dialyzer solution.

Cleansed blood is returned.

Heparin, a blood thinner, is added to prevent clotting.
Potassium, Phosphorus, Salt, and Fluid is Restricted

Phosphorus binders are needed
(dialysis doesn’t remove phosphorus so well)

Dairy
Chocolate
Beans / legumes / nuts
Types of grains
Some fruits / veggies
(tomatoes, berries, strawberries)
(Bananas →)

Poor appetite is frequent
And not just because the food
Choices are low
Hemodialysis

**Advantages:**
“Fast” for emergencies
Usually in a dialysis center, with nursing, 3 per week
Home dialysis options

**Disadvantages:**
Discomfort / cramping can occur
More fluid, dietary restrictions
More clinic / hospital visits and transit time
Day-to-day changes in fluid and blood pressure status

**Issues:**
Catheter or fistula/grafts requires “surgery”
Modified activities / bathing
Risk of Infection, clotting
Difficult to do for infants
Peritoneal Dialysis
Same thing, backwards

Peritoneal Dialysis

**Advantages:**
More feasible for infants
Done at home, nightly (mostly) (fewer clinic visits)
Less fluid restriction
Less potassium restriction

**Disadvantages:**
Some people have poor “membrane transport”
Some people don’t feel comfortable, or feel “full”

**Issues:**
Catheter is placed by a surgeon
Modified activities / bathing
Risk of Infection, membrane “failure”
Home environment must be suitable
Kidney Transplantation
**History**

Dialysis became available in the 1940’s
1954 1st transplant surgery in Boston
Between identical twins Ronald & Richard Herrick
Joseph Murray surgeon (Nobel in Medicine 1990)
Donor (Ronald) died in 2010 at age 79
Recipient (Richard) died 8 yrs post transplant

Cyclosporine approved 1983

**Compatibility: Blood Type Issues**

Same rules of transplant compatibility exist as for blood donation.

**O:**    Donate to anybody, accepts only O
**A:**    Donate to A, accept from A or O
**B:**    Donate to B, accept from B or O
**AB:**   Donate to AB, accept from anybody

The exception is subtype A2, which can be transplanted into a type B or O recipient.

*ABO incompatible transplant is feasible with more immunosuppression*
Compatibility: “Tissue Type” Issues

Every donor & recipient’s HLA A, B, and DR is typed. Degree of compatibility is expressed as “out of 6 antigens” since each person has one from each parent. DQ and others (C, DQA, Bw, DP) are done, not generally “used” but may be important.

Non-HLA antibody testing is sometimes done also.

<table>
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<th>example</th>
<th>A</th>
<th>B</th>
<th>DR</th>
<th>DQ</th>
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<tr>
<td>Donor</td>
<td>2/31</td>
<td>39/71</td>
<td>4/8</td>
<td>Probably important</td>
</tr>
<tr>
<td>Recip</td>
<td>2/68</td>
<td>39/53</td>
<td>4/8</td>
<td>Probably important</td>
</tr>
</tbody>
</table>

Compatibility: Antibodies Against Human Tissue

Each recipient is also tested for antibodies against HLA (like being “immunized” against human tissue types).

Non-HLA antibody testing is sometimes done also.

Most children will have NO antibodies, but some will.

Possible causes of “sensitization” include prior transplantation, pregnancy, blood transfusions.

Degree of sensitization (amount and strength of antibodies) can make it more difficult to find donors even if the tissue types are “compatible”
Compatibility: Crossmatching
Older Tests and Newer Tests

Tissue type and blood type aside, the possibility of incompatibility and rejection still exists even in excellent matches.

The “proof” that donor and recipient are compatible is derived from a process called crossmatching,

“Do the cells from recipient and donor get along?”

Older: “classic” testing: okay
Newer: Flow crossmatch, also antibody testing

Surgery Basics

JAMA Vol. 294 No. 21, December 7, 2005
Small children and infants have the kidney attached to the aorta, more in the middle of the belly because there is not enough space in the hip area.
Immunosuppression

There are multiple theories about transplant immunosuppression and the search for full “tolerance” continues.

“Standard” immunosuppression is a balancing act between preventing rejection and allowing infections, tumors, and medication toxicity.

Transplant centers often think of risk in degrees
- Lower risk, standard risk, or higher risk of rejection.
- Allows some “personalization” of immunosuppression.

Immunosuppressing Medications

- **Steroids** = corticosteroids (like prednisone)
- Tacrolimus or Cyclosporine (“calcineurin inhibitors”)
- MMF (mycophenolate mofetil): inhibit white blood cells
- Sirolimus / everolimus: block immune signals

Antibodies against white blood cells
- Anti-thymocyte globulin, Alemtuzumab: very broad
- Basiliximab: more specific
- Rituximab B cells
Immunosuppression Trends

Graft Survival: Medical Progress

SRTR 2012 report (most recent for this item)
Graft Survival: Medical Progress

SRTR 2012 report (most recent for this item)
Kidney Removal at Time of Transplant

Individual decisions based on size, function, and complications of the PKD kidneys.

For most young children with very large kidneys, one or both are removed through the same incision for transplant either to make room for a transplant or for comfort.

Under those conditions, nephrectomy may actually reduce recovery time.

For older children or adults, this is an option among others (kidney removal before or after transplant) where less invasive techniques may be available. Especially if the transplant is to be in the inguinal (hip) area.

ARPKD: Kidney vs Liver + Kidney Tx

Liver transplant should be considered if there is severe liver disease. This would be apparent from specific findings like severe portal hypertension, cirrhosis, biliary (liver) infections.

In the absence of severe liver disease, many individuals with ARPKD who have enjoyed very successful kidney-only transplant.
ADPKD and Kidney Donation

Potential family donors need to be tested for ADPKD

The age of the person is important...

Rules of thumb...
  - No cysts on a sonogram by age 40 = no ADPKD
  - No cysts on MRI by age 25-30 = no ADPKD

Genetic testing is sensitive and specific but only if the specific mutation in the family is known.

ARPKD and Kidney Donation

A parent or a sibling who is a carrier is considered safe to be a donor as long as everything else is okay
Thank You!