

Everything you want to know about children and CKD

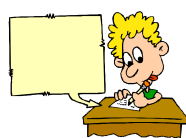
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Well maybe just what we can fit in this talk before lunch.....

Disclosures

- ▶ Research support from
 - ▶ Retrophin, Inc
 - ▶ Bristol- Meyers-Squibb
 - ▶ Glaxo-Smith-Kline

No direct financial support or advisory board responsibilities



Objectives:



Review Care Issues for Children with Chronic Kidney Disease

Causes of CKD

Demographics of ESKD

Treatment Options

NUTRITION/GROWTH

IMMUNIZATIONS

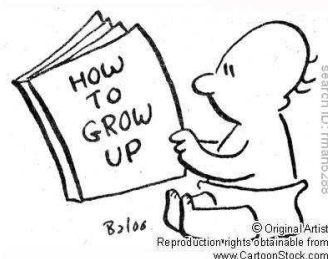
PSYCHOSOCIAL/DEVELOPMENTAL

TRANSITION TO ADULT CARE



Children are Really not Little Adults

	Children	Adults
Hypertension	Secondary	Primary
CKD	CAKUT	Diabetes Hypertension
eGFR	Schwartz	MDRD
Nephrotic Syndrome	Minimal Change	Membranous



What about Blood pressure?

- ▶ 7 y/o healthy child
- ▶ Here for Annual visit
- ▶ No complaints
- ▶ Blood Pressure is 122/82



JNC 8 Recommendations & Definitions

Patient Subgroup	Target SBP (mm Hg)	Target DBP (mm Hg)
≥ 60 years	<150	< 90
< 60 years	<140	< 90
> 18 years with CKD	<140	<90
> 18 years with diabetes	<140	<90

CKD = chronic kidney disease; DBP = diastolic blood pressure; SBP = systolic blood pressure

James PA, et al. *JAMA*. 2013 Dec 18. [Epub ahead of print]

Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	SBP or DBP Percentile
Normal	<90 th percentile
Prehypertension	90 th percentile to <95 th percentile, or BP > 120/80 up to <95 th percentile
Stage 1	95 th percentile to the 99 th percentile plus 5 mmHg
Stage 2	>99 th percentile plus 5 mmHg

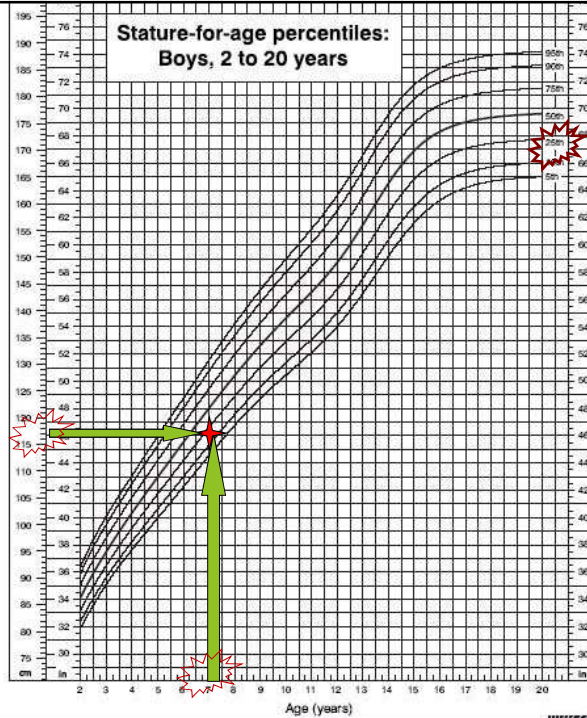
National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents 2004



Example:

7 year old boy
117 cm tall
Initial BP: 122/82

Statcoder.com
Stat Growth-BP
Ver 2.51



Blood Pressure Levels for Boys by Age and Height Percentile

Age, y	BP Percentile	SBP, mm Hg										DBP, mm Hg				
		Percentile of Height										Percentile of Height				
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th	
1	50th	80	81	85	87	88	89	34	35	37	38	39	39			
	90th	94	95	99	100	102	103	49	50	52	53	53	54			
	95th	98	99	103	104	106	106	54	54	56	57	58	58			
	99th	105	106	110	112	113	114	61	62	64	65	66	66			
2	50th	84	85	88	90	92	92	39	40	42	43	44	44			
	90th	97	99	102	104	105	106	54	55	57	58	58	59			
	95th	101	102	106	108	109	110	59	59	61	62	63	63			
	99th	109	110	113	115	117	117	66	67	69	70	71	71			
3	50th	86	87	91	93	94	95	44	44	46	47	48	48			
	90th	100	101	105	107	108	109	59	59	61	62	63	63			
	95th	104	105	109	110	112	113	63	63	65	66	67	67			
	99th	111	112	116	118	119	120	71	71	73	74	75	75			
4	50th	88	89	93	95	96	97	47	48	50	51	51	52			
	90th	102	103	107	109	110	111	62	63	65	66	66	67			
	95th	106	107	111	112	114	115	66	67	69	70	71	71			
	99th	113	114	118	120	121	122	74	75	77	78	78	79			
5	50th	90	91	95	96	98	98	50	51	53	54	55	55			
	90th	104	105	108	110	111	112	65	66	68	69	69	70			
	95th	108	109	112	114	115	116	69	70	72	73	74	74			
	99th	115	116	120	121	123	123	77	78	80	81	81	82			
6	50th	91	92	96	98	99	100	53	53	55	56	57	57			
	90th	105	106	110	111	113	113	68	68	70	71	72	72			
	95th	109	110	114	115	117	117	72	72	74	75	76	76			
	99th	116	117	121	123	124	125	80	80	82	83	84	84			
7	50th	92	94	95	97	99	100	55	55	56	57	58	59			
	90th	106	107	109	111	113	114	70	70	71	72	73	74			
	95th	107	108	113	115	117	118	74	74	75	76	77	78			
	99th	117	118	120	122	124	125	82	82	83	84	85	86			

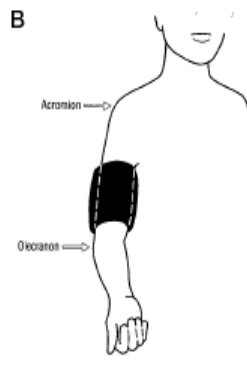
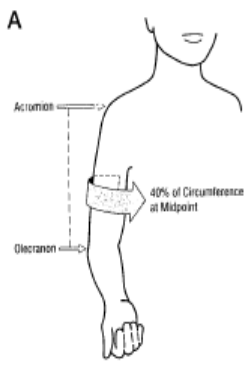


This 7 y/o child is actually hypertensive with a blood pressure of 122/82!

BOO!

Is the hypertension real?

Correct BP Measurement



Acromion

Olecranon

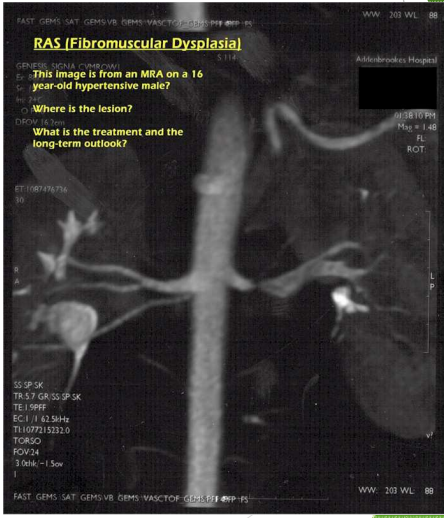
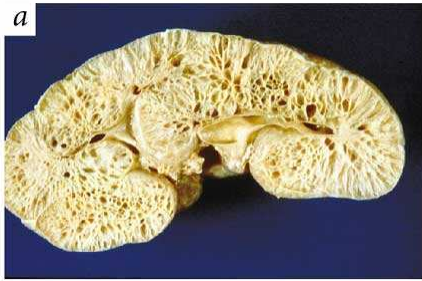
40% of Circumference at Midpoint

Acromion

Olecranon

What Causes HTN in Children?
Renal Parenchymal and Renal Vascular Disease: 75%

a



RAS (Fibromuscular Dysplasia)

FAST: GEMS: SAT: GEMS:VB: GEMS: VASCTOP: GEMS:V: 88

WWW: 203 WL: 88

Adribrinko's Hospital

GENES: GENA: 10/09/09

ET: 87

This image is from an MRA on a 16 year-old hypertensive male?

Where is the lesion?

What is the treatment and the long-term outlook?

ET: 1087476736

SS: SP: SK

TR: 5.7 GR: 35: SP: SK

TE: 1.9999

EC: I: II: 62.54Hz

TL: 10721532.0

TORSO

POV: 24

3.00Hz: -1.5ov

WWW: 203 WL: 88

FAST: GEMS: SAT: GEMS:VB: GEMS: VASCTOP: GEMS:V: 88

www.nature.com/arpkd

Table 1. Most Common Causes of Hypertension by Age Group

< 1 Month

- Renal arterial thrombosis
- Coarctation of the aorta
- Congenital renal disease
- Bronchopulmonary dysplasia

> 6 Years to 10 Years

- Renal parenchymal disease
- Renovascular disease
- Essential hypertension

>1 Month to <6 Years

- Renal parenchymal disease
- Coarctation of the aorta
- Renovascular disease

> 10 Years to 18 Years

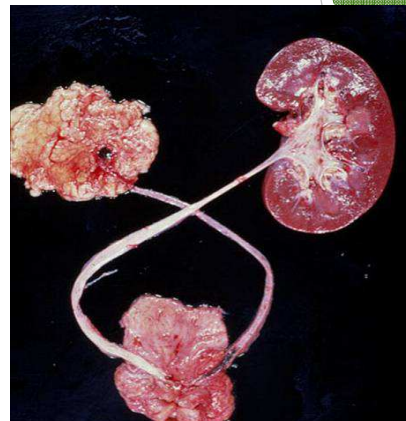
- Essential hypertension
- Renal parenchymal disease
- Renovascular disease

Biggest Burden of Pediatric CKD

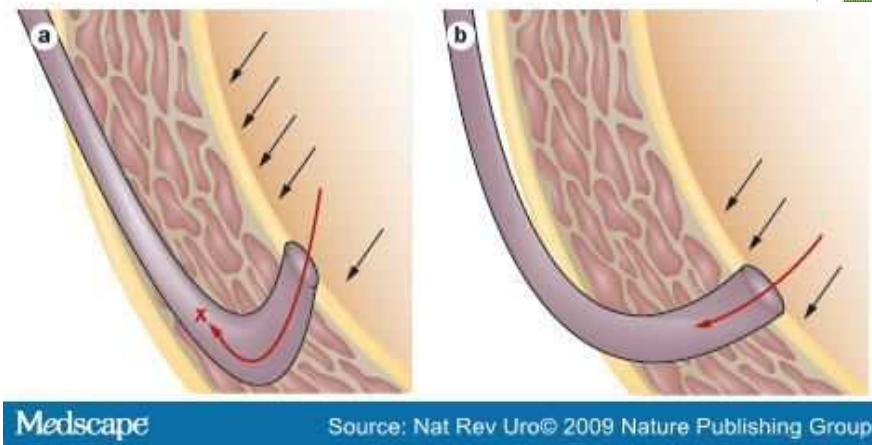
- ▶ Obstructive Uropathy is the most common cause of ESKD/CKD in males less than 4 years of age.
- ▶ CAKUT (Congenital Anomalies of the Kidneys and Urinary Track) accounts for about 1/3 of all ESKD in pediatrics

CAKUT

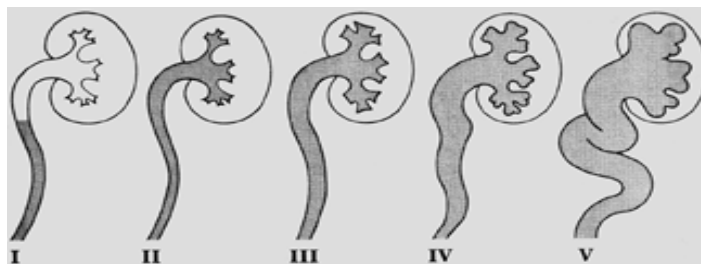
- ▶ Renal dysplasia
- ▶ Renal hypoplasia
- ▶ Renal aplasia
- ▶ Multicystic Dysplastic Kidney
- ▶ Ureteropelvic Junction Obstruction
- ▶ Vesicoureteral reflux
- ▶ Ectopic ureters
- ▶ Ureteroceles
- ▶ Polycystic kidney disease
- ▶ Posterior Urethral valves



Vesicoureteral Reflux



Vesicoureteral Reflux (VUR)



- ▶ Best evaluated by voiding cysturethrogram (VCUG).
- ▶ Grade I - Ureter only
- ▶ Grade II - Ureter, renal pelvis, calyces without dilatation
- ▶ Grade III - Dilatation or tortuosity of ureter and/or dilated pelvis
- ▶ Grade IV - Shape of calyces maintained but dilated
- ▶ Grade V - Gross dilatation of collecting system
- ▶ Management may include prophylactic antibiotics or surgical intervention



Voiding Cystourethrogram (VCUG) showing Grade II reflux on the left and Grade 4 on the right

POSTERIOR URETHRAL VALVES

- Only occurs in males
- 1/5,000 male births
- Accounts for 20% of all childhood end-stage renal failure

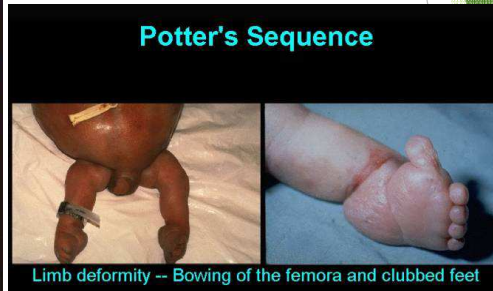
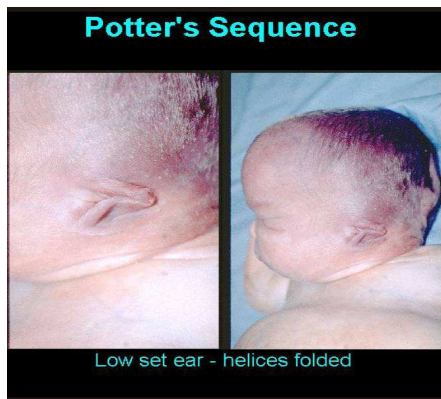


← *Dysplastic kidneys*

← *Dilated urinary tract*

← *Malformed bladder*

Potter's Sequence



Rosenberg ER, Bowie JD. AJR 1984;142:485

Other Common Kidney Diseases in Children

- ▶ Nephrotic Syndrome
- ▶ Cystic/Hereditary/Congenital
- ▶ Glomerulonephritis
- ▶ Vasculitis
- ▶ Acquired Diseases

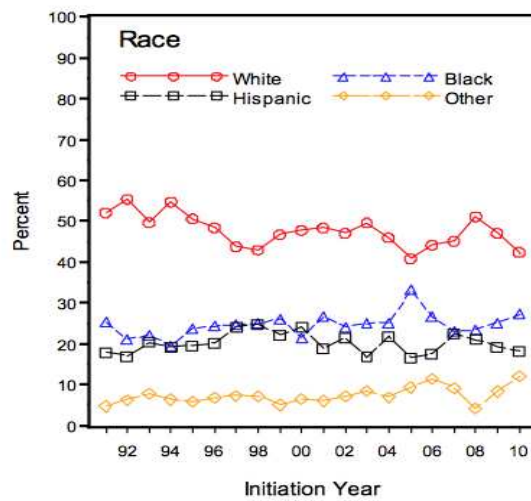
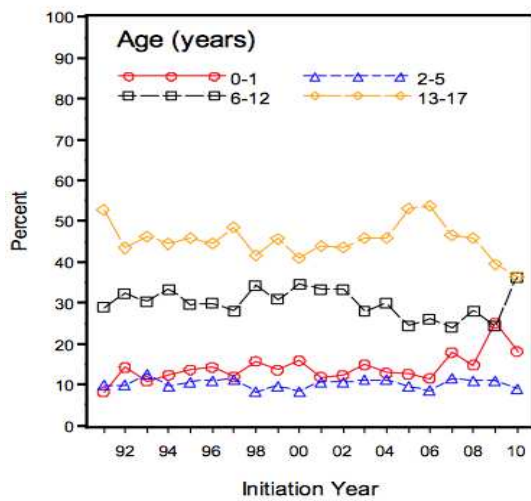
Epidemiology of ESRD in Children

- ▶ 1,398 U.S. children (<19 years of age) diagnosed with ESRD in 2014

	Incidence per million/yr
ESRD	15
Leukemia	40
Congenital Heart Disease	8000

- ▶ 9,721 prevalent U.S. children in 2014

Epidemiology of ESRD in Children

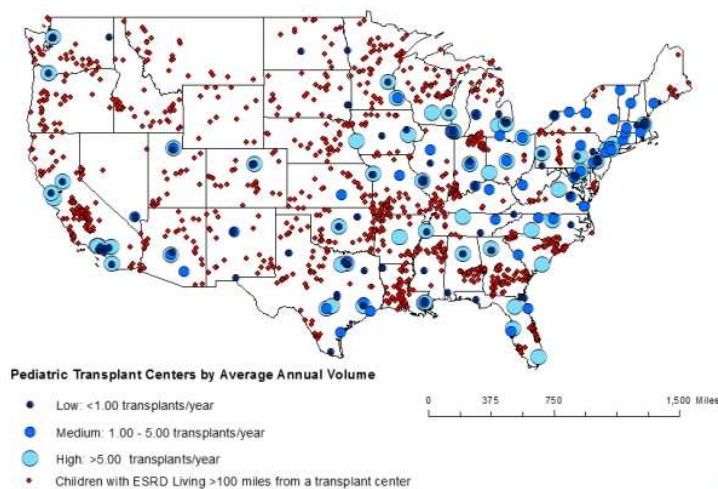


USRDS, 2012

Common Pediatric ESRD Comorbidities

- ▶ 30-40% have >1 non-renal medical comorbidity
 - ▶ **Cognitive dysfunction (15.5%)**
 - ▶ Motor impairment (12.6%)
 - ▶ Ocular abnormality (11.6%)
 - ▶ Cardiac abnormality (9.1%)
 - ▶ Hearing impairment (5.5%)
 - ▶ Pulmonary abnormality (4.2%)
- ▶ 35-40% with growth failure

Location of Pediatric Transplant Centers and Children with ESRD Living >100 miles from Center

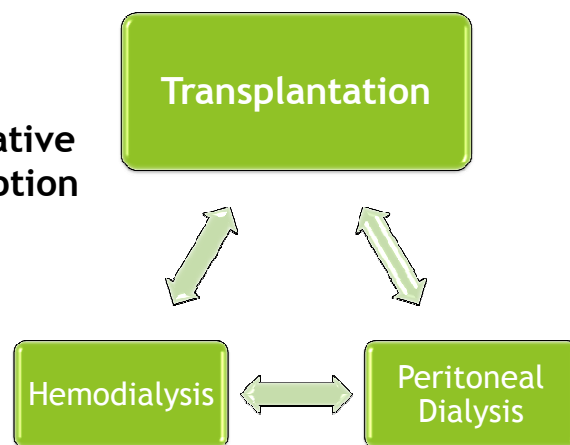


Toro C, Ross M, Wiebe D, Amaral S. Geographic Variability in Access to Transplant Centers for Children with End-Stage Renal Disease. Am J Transplant. 2016;16 (suppl 3).

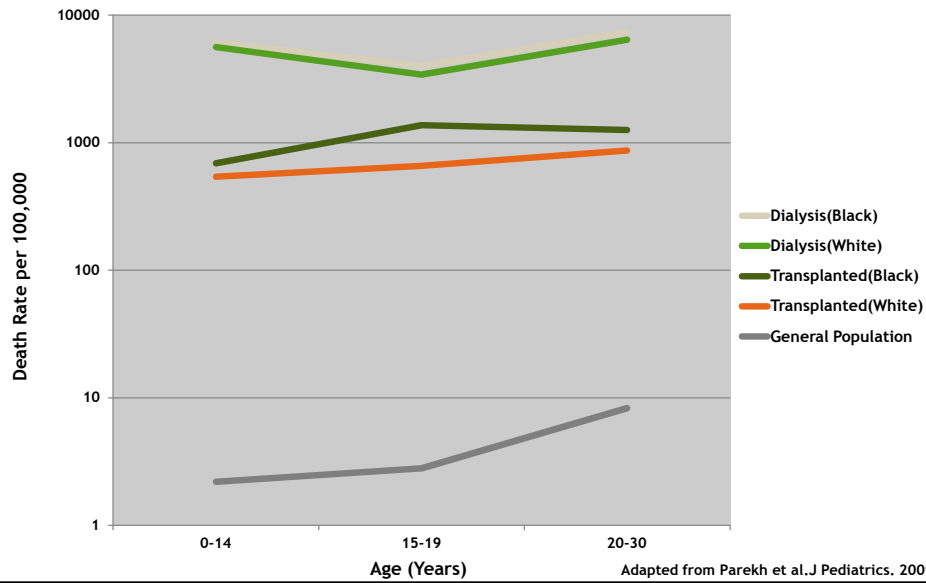
Renal Replacement Therapies

Renal Replacement Therapy in Children

And yes,
supportive/palliative
care is also an option
to consider



Mortality in Pediatric CKD



Renal Transplantation in Children



- ▶ Definitive form of RRT for children
- ▶ Preemptive transplant when possible

Renal Transplantation in Children

- ▶ Recipient
 - ▶ 12 months/10kg
 - ▶ Patient and family must be able to comply with meds and follow-up
 - ▶ Stable social/home environment

Donors

- ▶ Living Donor
 - ▶ Shorter waiting time/ischemic time
 - ▶ Closer matches
 - ▶ Better graft survival/overall outcomes
- ▶ Deceased Donor
 - ▶ Advantage given to pediatric patients on waiting list

Is there a Plumber in the House?

- ▶ Many pediatric diseases are associated with bladder dysfunction
 - ▶ Posterior urethral valves
 - ▶ Severe vesico-ureteral reflux
 - ▶ Other obstructions
- ▶ Dysfunctional voiding
- ▶ Inadequate bladder emptying

Advantages of Hemodialysis in Children

- ▶ Immediately available therapy
- ▶ Trained providers performing treatment with close monitoring (3 times per week)
- ▶ Relief of treatment responsibility for families



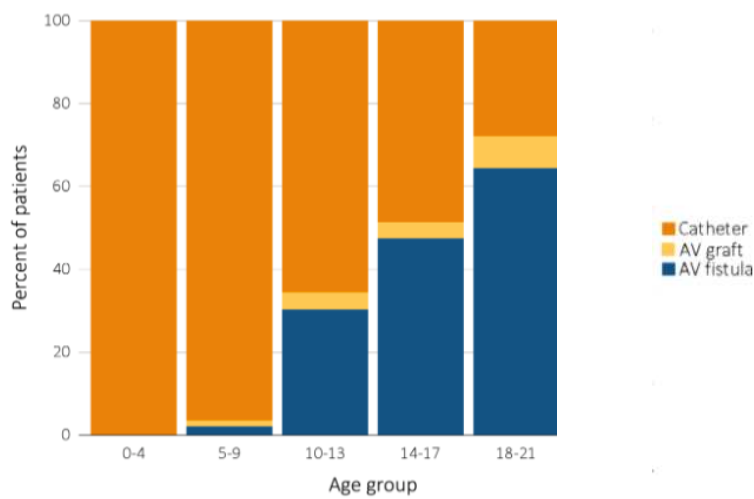
Disadvantages of Hemodialysis in Children

- ▶ Center based, intermittent therapy
- ▶ Requires vascular access
- ▶ Risk of hemodynamic instability
- ▶ Requires more strict adherence fluid/diet restriction
- ▶ Disrupts school/travel schedules
- ▶ Contraindications
 - ▶ Patient size (<1.5-2 kg)



I don't care what day it is.
Four hours is four hours.

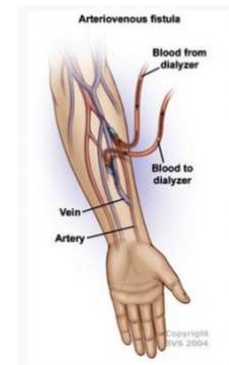
Vascular Access in Children By Age



Vascular Access in Children

- ▶ **AV Fistula most ideal but often not initially feasible**
 - ▶ Access survival rate of 66% at 4 yrs
 - ▶ Mean time to maturation ~4 mths

- ▶ **Double lumen cuffed catheter most feasible**
 - ▶ Access survival rate of ~30% at 1 yr
 - ▶ Median access survival 4-10 mths
 - ▶ Immediately available for use



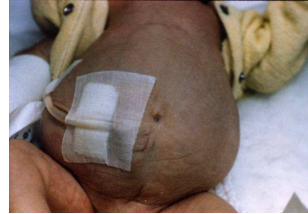
Complications of Vascular Access in Children

- ▶ **Infection!!!**
 - ▶ Exit site infections, tunnel infections, bacteremia
 - ▶ CVC>>AVG>>AVF
 - ▶ CVC infection rate 36% at 6 months
 - ▶ AVF infection rate of 5% at 6 months

- ▶ **Vascular thrombosis**
 - ▶ reported to occur in 9-46% at 1 year
 - ▶ AVG>>AVF>>CVC

Advantages of PD for Children

- ▶ Home based therapy
 - ▶ School and family continuity
 - ▶ Flexibility of treatment schedule
 - ▶ Easier travel
- ▶ Daily therapy
 - ▶ Daily fluid removal
 - ▶ Key in fluid based diets in infants and toddlers
 - ▶ Lower risk of hemodynamic instability
- ▶ Dialysis access
 - ▶ Avoids injury to major vessels



Disadvantages of PD for Children

- ▶ Burden on parents/guardians
- ▶ Home requirements for therapy (space, clean environment, privacy)
- ▶ Infection risks
- ▶ Contraindicated in those with prior abdominal pathology or surgery



Education and CKD

From Nephrons to Neurons

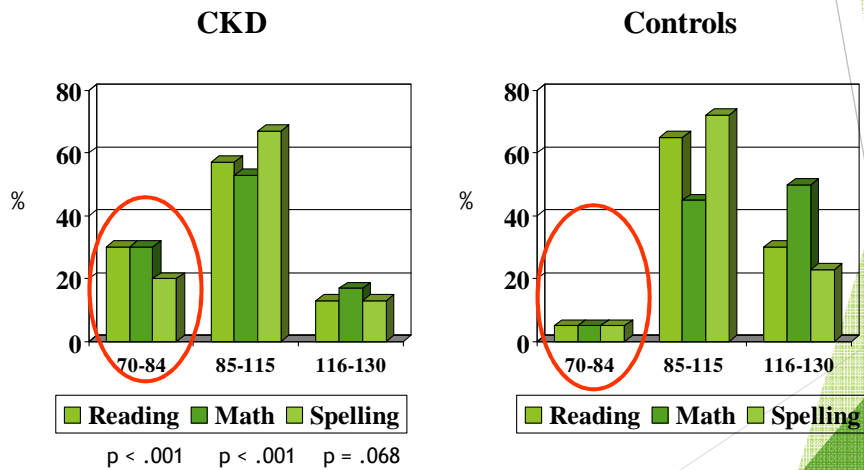
5/29/2017

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Case: 9 year old child with chronic kidney disease since age 5 years. School performance not as good as siblings.

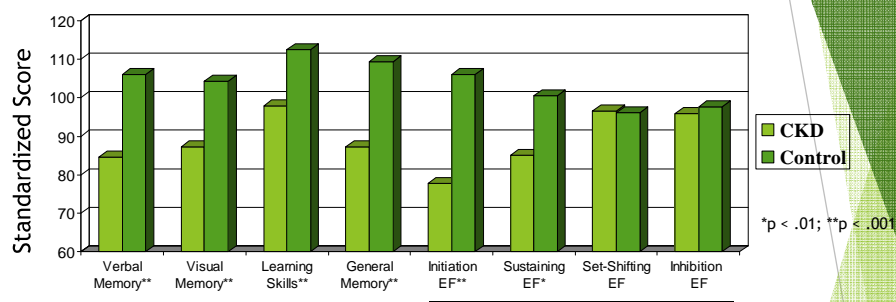
Question: Does CKD impact cognition in children with disease in childhood?

Academic Achievement



Gipson et al. 2005

Memory and Executive Functions



- Children with CKD have universal Memory deficits
- Initiation and Sustaining Executive Functions are impaired
- Difficulty engaging in more complex and rapidly paced activities
- Implications for education techniques

Gipson et al. 2005

Learning in CKD

- **IQ and Academic Achievement track with severity of kidney disease**
- **Access to traditional Learning Disability services will vary by regional approach to model based qualifications**
- **All have opportunity for IEP with “other health impaired” status if enrolled in a public school**
- **These needs should also be considered in our CKD education**

Transition Issues

- ▶ **As survival improves, more children will transition into adult programs**
- ▶ **ESKD teenagers lag the most among all chronic diseases in terms of achieving milestones critical to success in adult life**
- ▶ **Career counseling and vocational guidance very important.**
- ▶ **Insurance issues**

Growth Issues

- ▶ Anorexia
- ▶ Behavioral aversion
- ▶ Acidosis
- ▶ Anemia
- ▶ Renal failure at times of growth spurts
- ▶ Supplement nutrition
- ▶ Monitor closely
- ▶ Correct acidosis
- ▶ Calcium/Phos control
- ▶ Growth hormone therapy

Immunizations

- **Pediatric patients with CKD/Dialysis should receive all the vaccines currently recommended by the standard schedule.**
- **Vaccinate children with CKD /Dialysis with MMR and VZV prior to transplant.**
- **Increased dose or monitoring of response may be necessary. Revaccinate patients without protective antibody titers.**
- **Children on immunosuppressive medications post renal transplant should also receive all standard vaccines except live vaccines [VZV and MMR]**

Final Pearls

- ▶ Children are not little adults
- ▶ Interactions should match developmental age not chronological age
- ▶ Expectations should match those of healthy peers
- ▶ Engage familial support system whenever possible
- ▶ Remember it takes a village

5/29/2017

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UNC Chapel Pediatric Nephrology Team Always happy to hear from our community!



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