CONTROVERSES ET ACTUALITÉS EN CHIRURGIE VASCULAIRE
CONTROVERSIES & UPDATES IN VASCULAR SURGERY
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Hemodialysis Vascular Access in Children

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Disclosure

Deepa Chand, MD, MHSA

I have the following potential conflicts of interest to report:

- ☐ Consulting
- ☒ Employment in industry
- ☒ Shareholder in a healthcare company
- ☐ Owner of a healthcare company
- ☐ Other(s)
- ☐ I do not have any potential conflict of interest

Pediatric Data: NAPRTCS 1996

Table 6 HD access

		n (682)	%
A. Access type			100.0
1. External percutaneous catheter		504	75.7
Subclavian vein		386	
Jugular vein		78	
Femoral vein		37	
Single lumen		23	
Double lumen		478	
2. External arteriovenous shunt		4	0.6
3. Internal arteriovenous fistula		76	11.4
4. Internal arteriovenous graft		82	12.3
Autologous vein		3	
Bovine graft		1	
PTFE graft		74	
Other graft		0	
B. Locations for shunts fistulae, and grafts		78	100.0
	Upper arm	24	30.8
	Lower arm	44	56.4
	Thigh	10	12.8

PTFE, Polytetrafluoroethylene

- Central venous catheters (CVC) used in 76% of children on chronic HD vs 11% AVF and 12% AV grafts.
- Lower arm was most frequently used site for long term access.

Lerner GR et al. Pediatr Nephrol 1999].

NAPRTCS 2004: 8 Years Later…….

EXHIBIT 9.4
HEMODIALYSIS ACCESS

	N (2393)	% (100)
External Percutaneous Catheter	1899	79.4
Subclavian vein	1174	
Jugular vein	629	
Femoral vein	80	
Single lumen	62	
Double lumen	1821	
External Arteriovenous Shunt	7	0.3
Internal Arteriovenous Fistula	281	11.7
Internal Arteriovenous Graft	206	8.6
Autologous vein	7	
Bovine graft	1	
PTFE graft	190	
Other graft	4	
Locations of Shunts, Fistulae, and Grafts	152	100.0
Upper arm	36	23.7
Lower arm	97	63.8
Thigh	19	12.5

Prevalence Data

- External catheter usage is not decreasing
  - 76% 1996 vs. 79% in 2004
- Subclavian vein usage is decreasing
  - 77% 1996 vs. 62% in 2004
- Internal jugular usage is increasing
  - 15% 1996 vs. 33% in 2004

Neu AM et al (Peds Neph 2002):

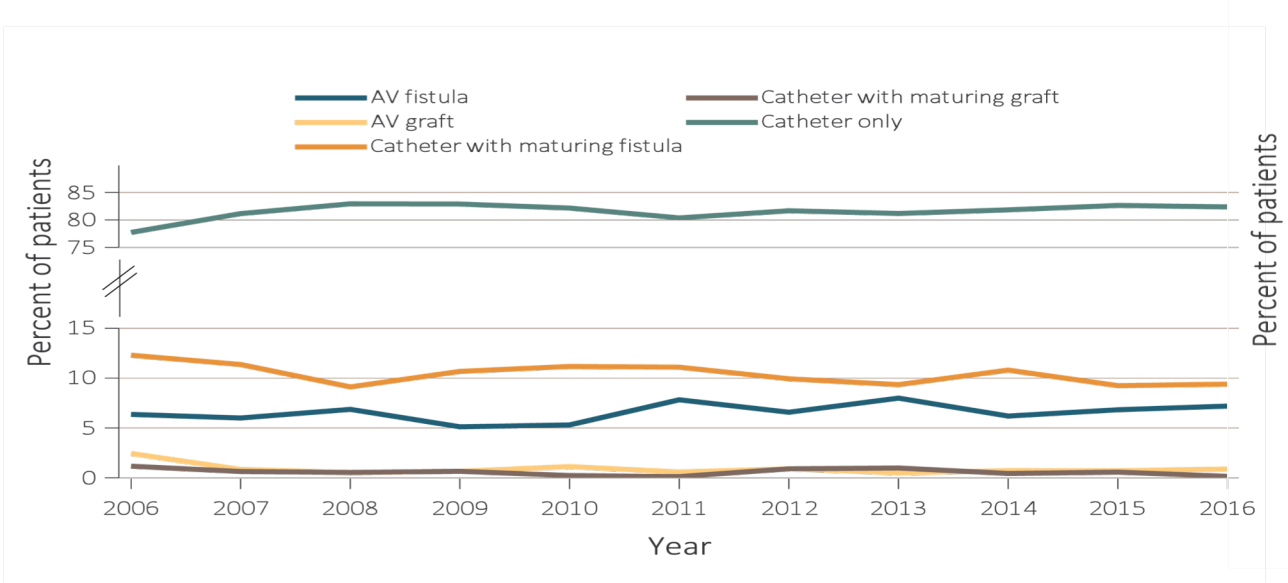
- Odds of using a jugular CVC instead of a subclavian has increased by 24% per year from 1992-2000

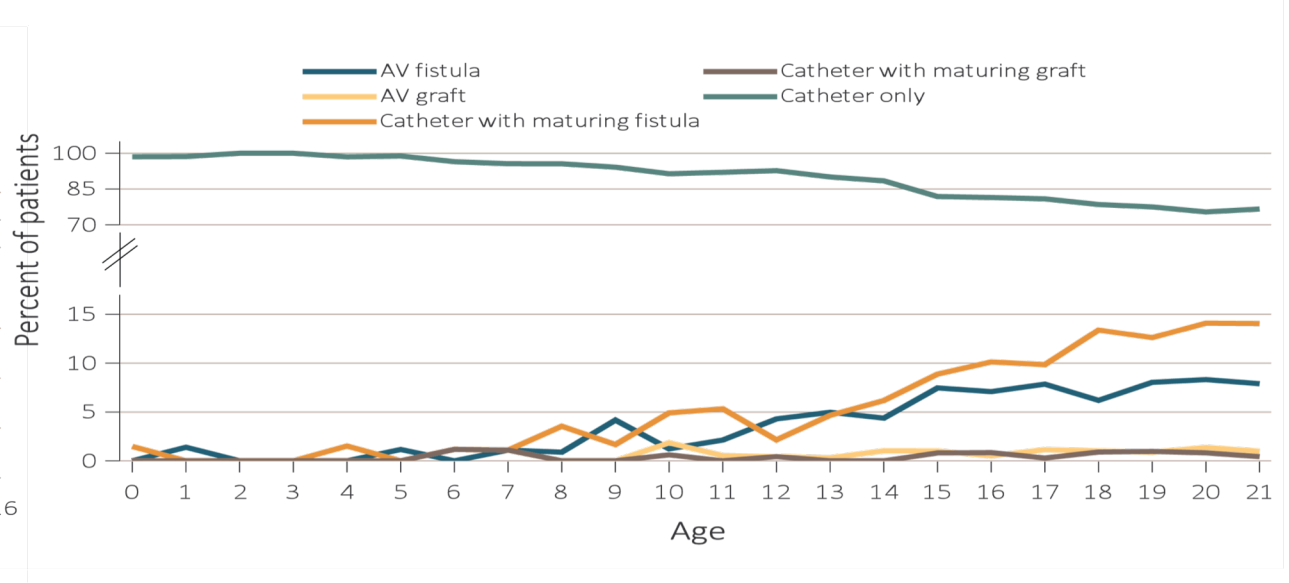
FISTULAFIRST
National Vascular Access Improvement Initiative

- CMS and ESRD networks launched in 2003 to achieve targets (AVF >65%, CVC <10%) in adults through change concepts and process improvement.
- 2005 IPPFI launched
- NKF KDOQI 2006 Update: Clinical Practice Recommendations: Vascular Access in Pediatrics

So, how are we doing now?

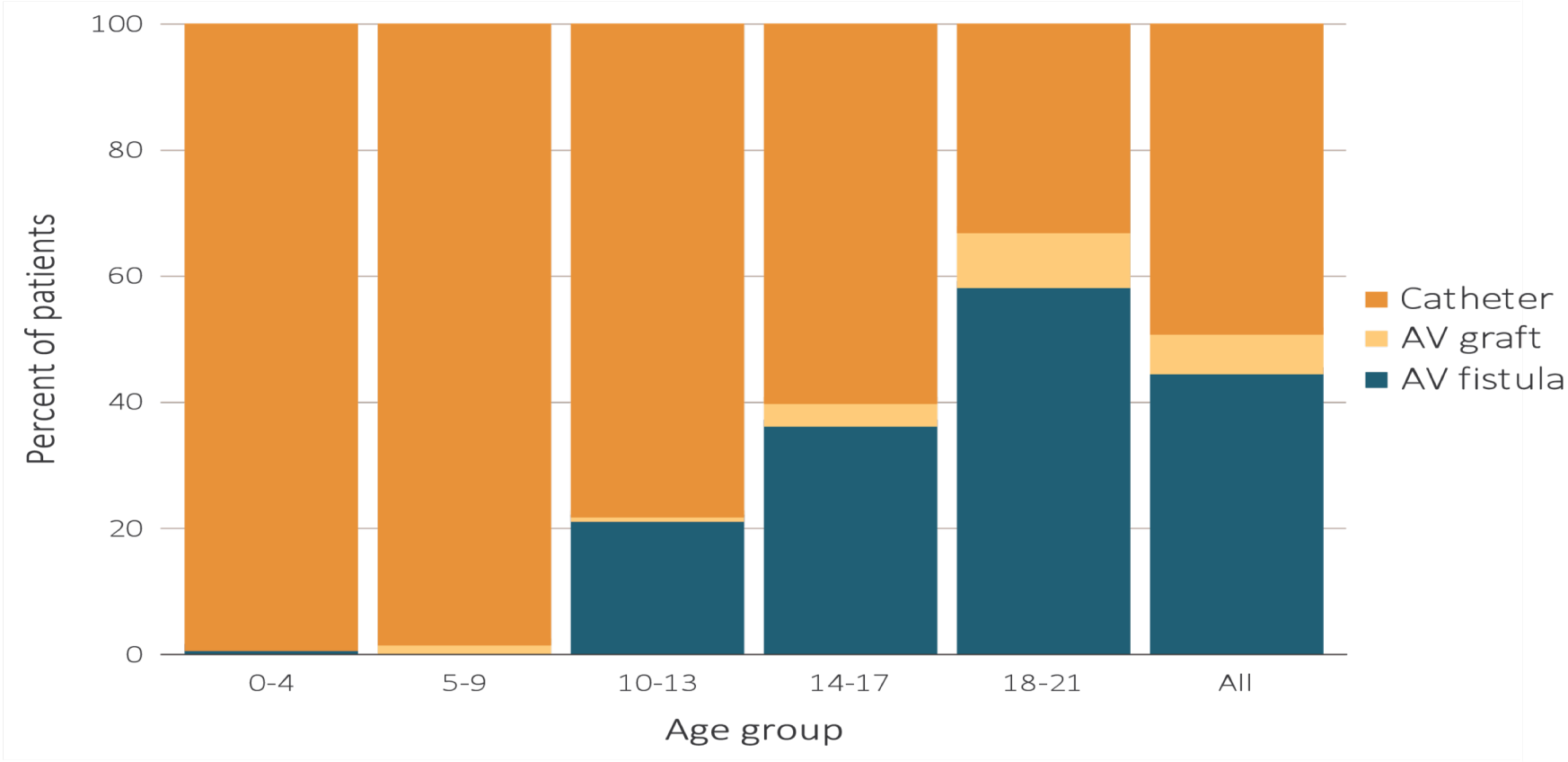
Vascular access type at initiation of incident pediatric hemodialysis patients by year and age, 2006-2016





Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2006-2015. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease. 2018 Annual Data Report Volume 2 ESRD, Chapter 7

Distribution of vascular access type in prevalent pediatric hemodialysis patients



*Data Source: Special analyses, CROWNWeb clinical extracts for May 2017. Hemodialysis patients initiating treatment for ESRD at least 90 days prior to May 1, 2017, *who were <22 years old as of May 1, 2017, and who were alive through May 31, 2017; Catheter=any catheter use; fistula and graft use shown are without the use of a catheter.* 2018 Annual Data Report Volume 2 ESRD, Chapter 7

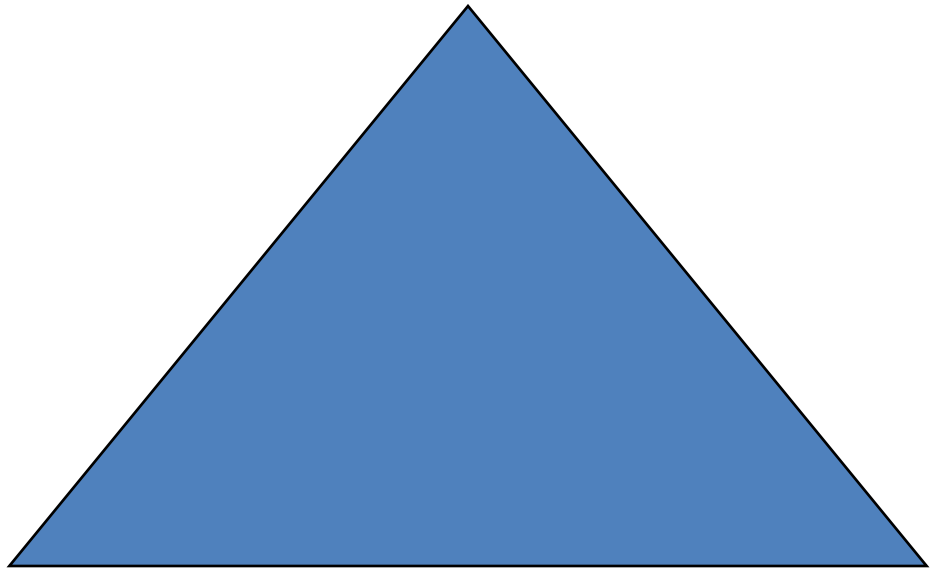
HD Access in the Pediatric Patient

1284 Prevalent Pediatric patients (< 18 yrs) on HD as part of 2001-2003 Clinical Performance Measures (CPM) Project: 41% AVF/AVG; 59% CVC (755 pts)

- Dialysis centers listed reason for catheter as "Transplant Scheduled"-10.1% (83 pts)
- 69% transplanted by 1 yr (median 115 days)

So despite "scheduled", 31% not transplanted by 1 year

Transplant:



Hemodialysis

Peritoneal Dialysis

Dialysis Facility

Experience level (post-training):
- <5yrs 43%
- 5-10 years 22%
- 11-20 years 16%
- > 20 years 19%

When was surgical referral made?
- CKD stage 4: 73%
- CKD stage 5: 22%

Who was referral made to?
- Vascular surgeon 33%
- Pediatric surgeon 27%
- Transplant surgeon 29%

* 65% had a dedicated access surgeon.

Imaging studies prior to surgical referral:
- Venography 34%
- Doppler ultrasound 27%
- Deferred to surgeon 27%

Monitoring
- Physical Exam 74%
- Venous pressure monitoring 26%
- Ultrasound dilution 9%

Following DOQI guidelines:
- Yes 46%
- No 13%
- Unknown 38%

Barriers to AVF placement:
- Patient/parent resistance
- Impending transplant
- Patient age, poor vasculature

Proceduralist

Experience level (post-training):
- <5yrs
- 8 (22%) 5-10 years
- 6 (16%) 11-20 years
- 7 (19%) > 20 years

Formal AVF training?
- Yes 50%
- No 50%

Imaging studies ordered:
- Venography 50%
- Doppler ultrasound 75%
- Physical Examination 42%
- MRV 8.3%

Surgical adjuncts used:
- Loupe magnification 50%
- Operating microscope 0%

Preferred access site:
- Radiocephalic 42%
- Brachiocephalic 17%
- Transposed Brachiobasilic 8.3%
- “Thigh” 8.3%

Following DOQI guidelines:
- Yes 56%
- No 11%
- Unknown 33%

Barriers to AVF placement:
- Patient/parent resistance
- Impending transplant
- Patient age, poor vasculature

- Communication problems existed with surgeons, interventional radiologists, and nephrologists.
- 93% of dialysis facility staff stated they would change practice patterns based on the IPFFI intervention.
- 12% of surgeons stated they would alter practice patterns.

Is *Catheter Avoidance* Realistic in Pediatrics?

- Unless patient arrives at end stage, this should be achievable
- Requires timely referral for permanent access
- Requires a vascular access team
  - Vascular access surgeon
  - Radiology for desired preop imaging (Duplex or venography)
  - Coordinated efforts from the medical and surgical team (Pre-op and Post-op)

Reality-It's been done

- Bourquelot et al. first reported the use of microsurgery for creation of AVF in children in 1978 and subsequently reported the use of microsurgery successfully in children under 10 kg in 1981

- Bagolan, et al. 10 yr AVF data from Italy: 112 procedures in 90 children
- Microsurgical creation of Brescia-Cimino (radiocephalic) AVF
- Primary patency rate 81/90; 89% [<15 kg]; 90% [>15 kg]
- Mean age 5.5 yrs (5.5 mos-18 yrs); Mean wt: 28kg (6.5-54 kg)
    - 16% were children <5 yrs; 18% were children <15 kg
- Outcome: 64% patent at 4 years: 70% for those >15 kg and 57% for those < 15 kg

Conclusion: Microsurgery is essential to create AVFs with good results in children

Permanent HD access in children

- AVF:
  - 24 procedures (19 pts)
  - Mean age: 15.1 yrs; Mean weight: 46 kg
  - Site: Radiocephalic (Brescia-Cimino): 22/24
  - Primary failure rate 33.3%
  - No significant difference noted in age or wt of patient when comparing AVF patients with primary failure vs those with functional AVF at 6 weeks
- AVG:
  - 28 procedures (23 pts)
  - Mean age: 13.3 yrs; Mean weight: 41.5 kg
  - Site: Thigh most common (14/28)
  - Primary failure rate 3.6%
  - Access stenosis and infection were higher in AVG vs AVF, but thrombotic episodes were not significantly different.

Conclusion: Children >10 kg, either AVF or AVG should be the goal

**Suggested "early AVF function is probably more dependent on surgical expertise and vessel integrity than vessel caliber"

Sheth et al. [Kidney Int 2002]

But, is surgical technique optimization enough?

What strategies can one use to increase permanent vascular access placement?

IPPFI Initiative

- International Pediatric Fistula First Initiative (IPFFI) as part of MWPNC
- Created to alert Ped Neph, surgeons, and dialysis staff about value of AVF in pediatrics
- Educational DVD around strategies and expectations to increase AVF usage in children; Pre and Post educational survey conducted
- 5 participating centers with 52 surveyed participants
  - Vascular access placed within 3 months in only 35% of patients
    - Interdisciplinary communication problems between Nephrology, Surgery, and IR identified as major barrier
  - Lack of Maturation→ most common reason for not using AVF
  - Routine Vascular access rounds not occurring at any center

Chand et al. *Hemodial Int* 2015

Effects of Dedicated CKD Clinic on Vascular Access

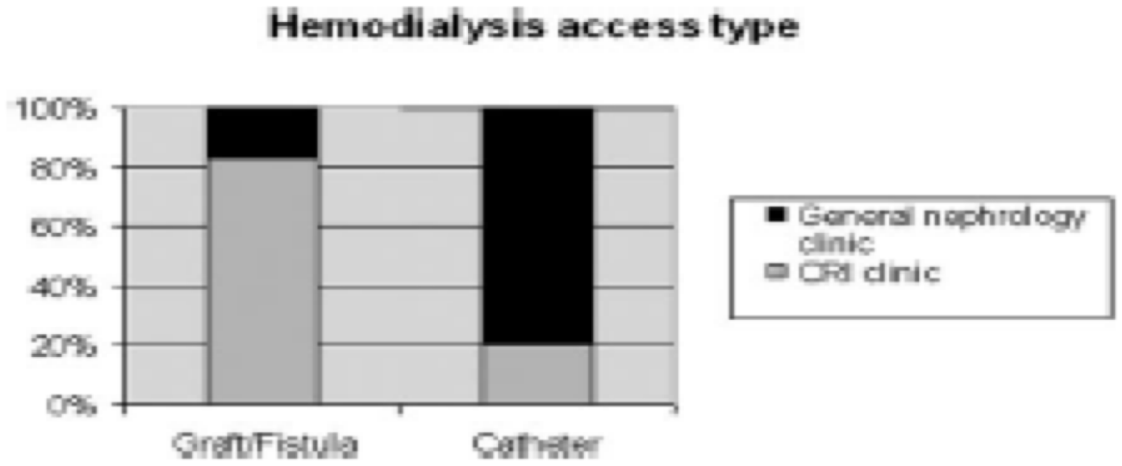


Figure 1. Vascular access types for hemodialysis for patients from the two clinics. Patients in the chronic renal insufficiency (CRI) clinic had a higher percentage of permanent access compared with those in the general nephrology clinic (85.7 *versus* 20%, $P < 0.05$).

Comparison of Gen Neph vs dedicated CKD Clinic

- ESRD Modality : No difference in Pre-emptive Tx or Dialysis modality choice
- Onset of Dialysis: Unscheduled vs Elective
  - Unscheduled: Gen Neph (50%) vs CRI clinic (10.5%)
- Vascular access type at Initiation of HD
  - AVF/AVG: Gen Neph (20%) vs CKD Clinic (85.7%)

Menon et al. *CJASN* 2009

Vascular Access Team can increase AVF in Children

- Dedicated team: Surgeon, Nephrologist, IR, RNs, Child Life specialist
- Achieved approximately 70% AVF rates for children in US at single center

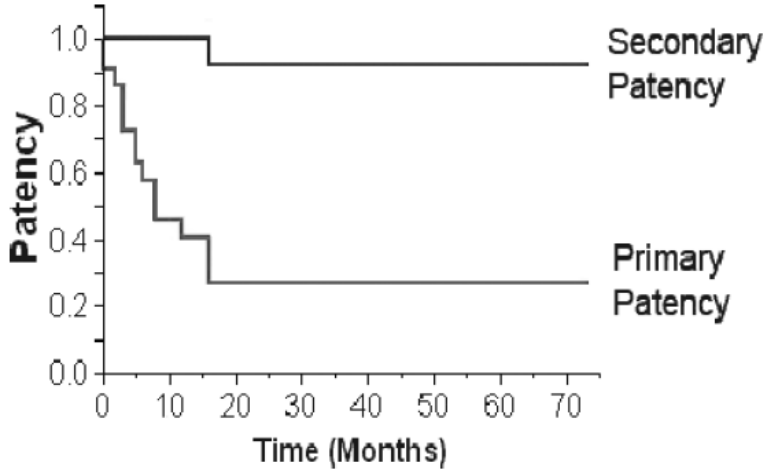


TABLE 3. Outcomes of AVF creation with operating microscope

Patient	AVF site	Arterial size (mm)	Venous size (mm)	Time to maturation (weeks)	No. interventions
1	L RC	1.5	2.5	10	0
2	R TRP BB	1.5	3	8	0
3	L TRP BB	1.5	3	11	1

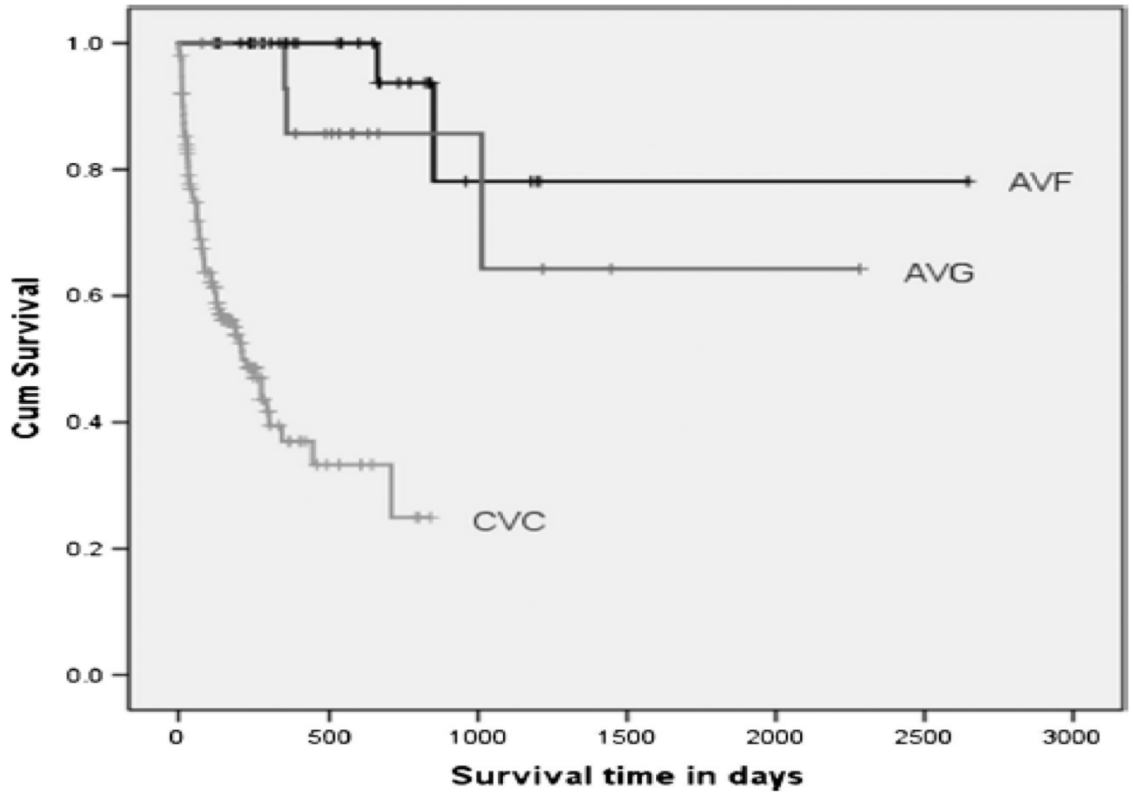
AVF, arteriovenous fistula; L, left; R, right; BC, brachiocephalic; TRP BB, transposed brachiobasilic; RC, radiocephalic.

Chand et al. *Semin Dial* 2009

Reducing central venous catheters in chronic hemodialysis—a commitment to arteriovenous fistula creation in children

Rossana Baracco · Tej Mattoo · Amrish Jain · Gaurav Kapur · Rudolph P. Valentini

Fig. 2 Cumulative (*Cum*) Survival of arteriovenous fistula (AVF) vs. arteriovenous graft (AVG) and central venous catheter (*CVC*). $p<0.001$



Pediatric Nephrol. 2014

Pediatric Vascular Access Summary-Lessons Learned

- Mindset of AVF and AVG should be the HD access in all children
- Preserve vessels (especially in non-dominant arm) in early stage CKD
  - Avoid phlebotomy, IVs and PICC lines
- Identify children with chronic kidney disease who are candidates for hemodialysis at least 6 months before anticipated dialysis date
  - Will allow for revision if AVF is slow to mature
- Doppler exam +/- Venogram of prior to surgical referral
- Discussion with surgeon, RN, (interventional) radiologist pre-operatively

Pediatric Vascular Access Summary-Lessons Learned

- Schedule AVF/AVG on non-dialysis day when intravascular volume likely to be higher, and intraoperative heparin risks lower
- BP medications reduced in immediate pre-op period
- Started on ASA 81 mg one week prior to surgery
- Intraoperative monitoring of BP-aiming for minimum of 90th percentile for age (support with fluids/inotropes if needed)
- Consider intraoperative papavarine to reduce vascular spasms
- Use of loupes/operating microscope

Pediatric Vascular Access Summary-Lessons Learned

- Consider use of dihydropyridine calcium channel blocker
- Observe in hospital overnight to monitor BP, bruit/thrill, and volume status
- Educate family re: fistula care-avoid compression and exercises to support
- Schedule follow up with vascular access surgeon- 2 weeks
- Multidisciplinary rounds within the dialysis unit
- Monitor, monitor, monitor

An organized and committed, multidisciplinary team approach with patient and staff education, proper planning, interdisciplinary communication, and close follow up makes AVF placement in children achievable.

One Happy Dialysis Patient

- Now I am able to swim, shower, and bathe without having to stay in the hospital, undergo multiple surgeries, and get exposed to multiple antibiotics