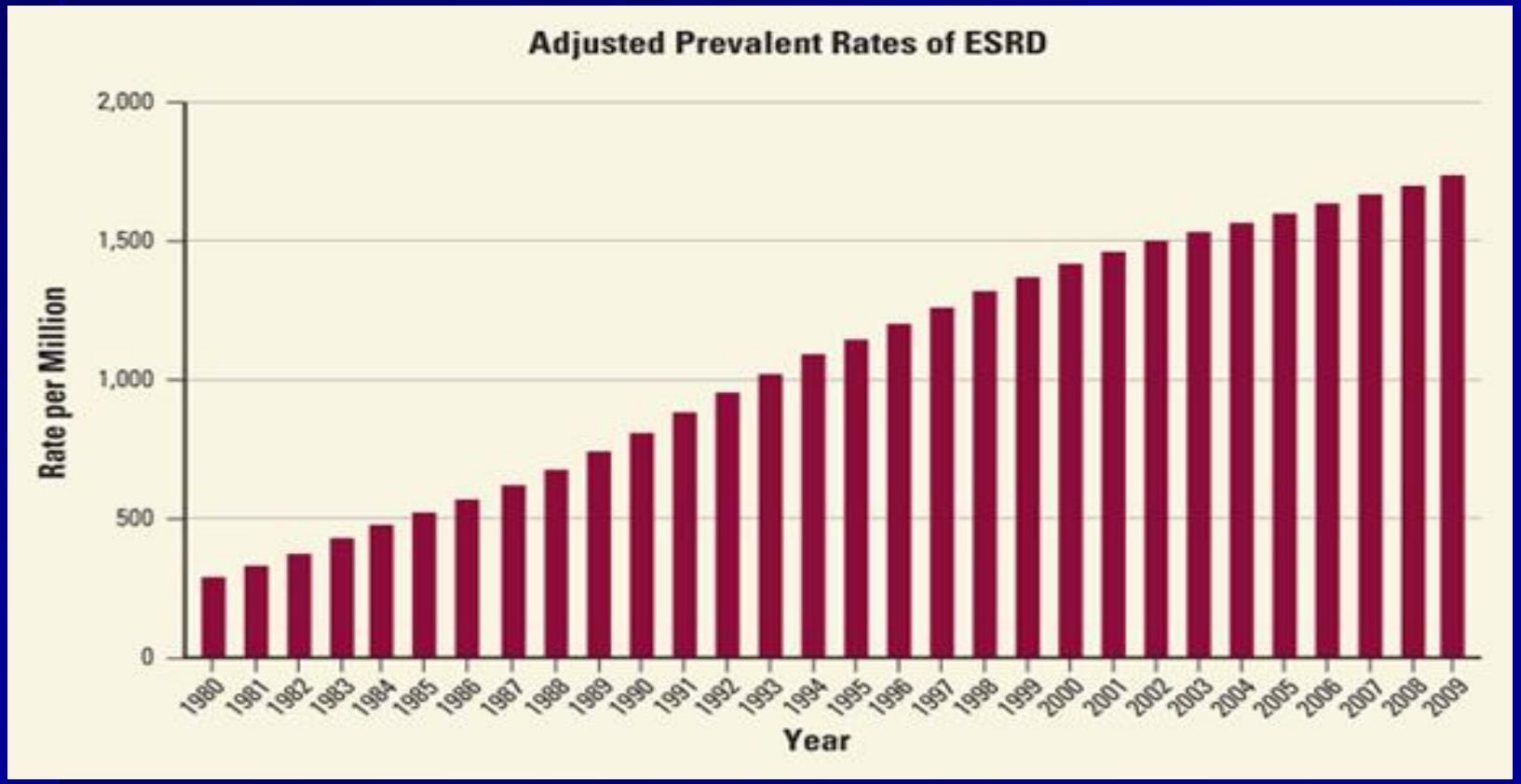
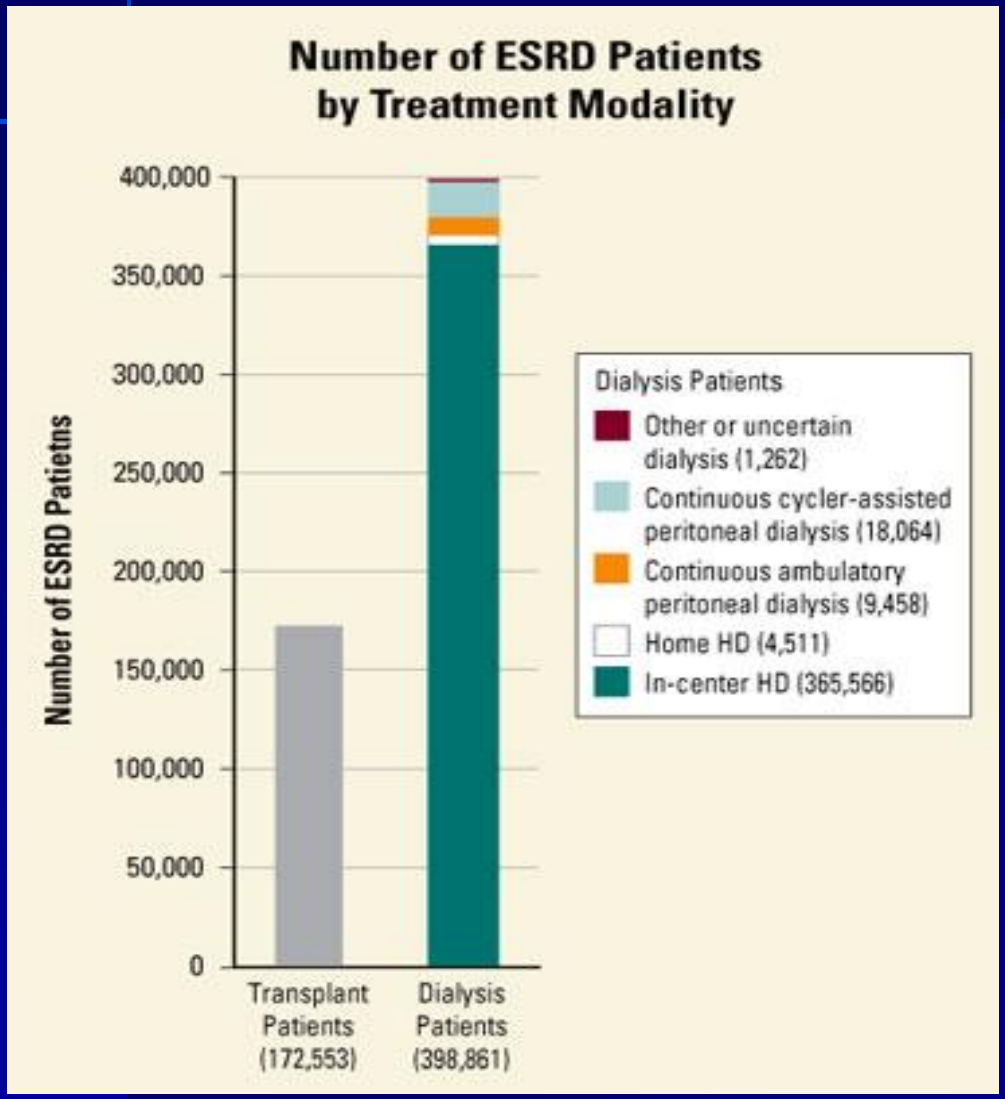
Hemodialysis Access Basics: A Vascular Surgeon's Perspective

Garietta Falls, MD
Assistant Professor, Dept of Surgery
Boonshoft School of Medicine/Wright State University

- End Stage Renal Disease
  - By end of 2009, over 871,000 people being treated for ESRD
  - 600 % increase since 1980



Hemodialysis



- Treatment for end stage renal disease
- Vast majority on some form of hemodialysis (approximately 370,000 people)

Vascular Access

- Immediate/short term
  - Catheter
  - Non-tunneled
    - anticipate less than 3 weeks usage
      - Common ones: Mahurkar, Quinton
      - 11-14 French
      - Inserted at bedside
  - Tunneled
    - less than 6 months or failure of surgical access
    - Common ones: Palindrome, Dura Flow
    - Inserted under fluroscopic guidence (OR, endo suite, etc)
- Long term
  - Arterio-venous fistula
    - Direct connection between artery and vein
  - Arterio-venous "graft"
    - PTFE or other prosthetic material
    - Cadaver vein

National Kidney Foundation/Kidney Disease Outcomes Quality Initiative guidelines (NKD/KDOQI)

- Different aspects of care including hemodialysis, nutrition, anemia, and vascular access
- First published in 1997; updated in 2006
  - Attempt to give evidence-based guidance to health care practioners

KDOQI guidelines for vascular access

- **I. Patient Evaluation Prior to Access Placement**
  Guideline 1: Patient History and Physical Examination Prior to Permanent Access Selection
  Guideline 2: Diagnostic Evaluation Prior to Permanent Access Selection
  Guideline 3: Selection of Permanent Vascular Access and Order of Preference for Placement of AV Fistulae
  Guideline 4: Type and Location of Dialysis AV Graft Placement
  Guideline 5: Type and Location of Tunneled Cuffed Catheter Placement
  Guideline 6: Acute Hemodialysis Vascular Access—Noncuffed Catheters
  Guideline 7: Preservation of Veins for AV Access
  Guideline 8: Timing of Access Placement
  Guideline 9: Access Maturation

  II. Monitoring, Surveillance, and Diagnostic Testing
  Guideline 10: Definition of Terms
  Guideline 11: Monitoring Primary AV Fistulae for Stenosis
  Guideline 12: Recirculation Methodology, Limits, Evaluation, and Follow-Up

  III. Prevention of Complications: Infection
  Guideline 13: Infection Control Measures
  Guideline 14: Skin Preparation Technique for Permanent AV Accesses
  Guideline 15: Catheter Care and Accessing the PatientÌs Circulation

- **IV. Management of Complications: When to Intervene**
  Guideline 16: Managing Potential Ischemia in a Limb Bearing an AV Access
  Guideline 17: When to Intervene—Dialysis AV Grafts for Venous Stenosis, Infection, Graft Degeneration, and Pseudoaneurysm Formation
  Guideline 18: When to Intervene—Primary AV Fistulae

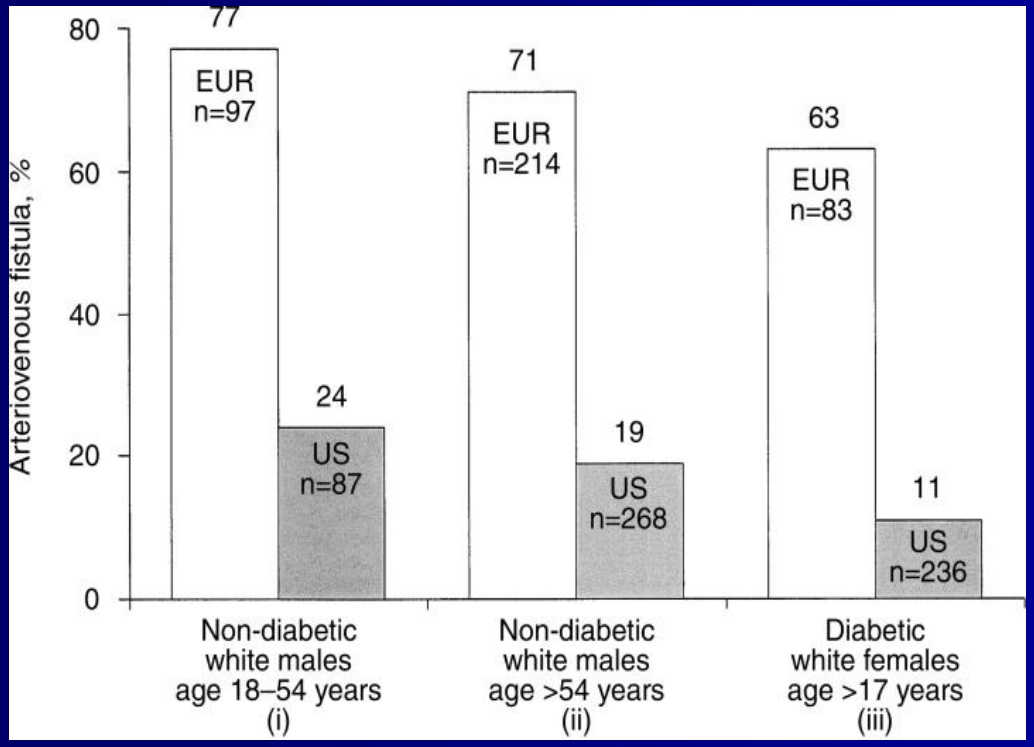
- **V. Management of Complications: Optimal Approaches for Treating Complications**
  Guideline 19: Treatment of Stenosis Without Thrombosis in Dialysis AV Grafts and Primary AV Fistulae
  Guideline 20: Treatment of Central Vein Stenosis
  Guideline 21: Treatment of Thrombosis and Associated Stenosis in Dialysis AV Grafts
  Guideline 22: Treatment of Thrombosis in Primary AV Fistulae
  Guideline 23: Treatment of Tunneled Cuffed Catheter Dysfunction
  ]Guideline 24: Treatment of Infection of Dialysis AV Grafts
  Guideline 25: Treatment of Infection of Primary AV Fistulae
  Guideline 26: Treatment of Infection of Tunneled Catheters
  Guideline 27: Treatment of PSA of Dialysis AV Grafts
  Guideline 28: Aneurysm of Primary AV Fistulae

  VI. Potential Quality of Care Standards
  Guideline 29: Goals of Access Placement—Maximizing Primary AV Fistulae
  Guideline 30: Goals of Access Placement—Use of Catheters for Chronic Dialysis
  Guideline 31: Center-Specific Thrombosis Rate
  Guideline 32: Infection Rate
  Guideline 33: Primary Access Failure Rate—AV Grafts
  Guideline 34: Primary Access Failure Rate—Tunneled Catheters
  Guideline 35: Primary Access Failure—Native AV Fistulae
  Guideline 36: Cumulative Patency Rate of Dialysis AV Grafts
  Guideline 37: Cumulative Patency Rate of Tunneled Cuffed Catheters
  Guideline 38: Cumulative Patency Rate of Primary AV Fistulae

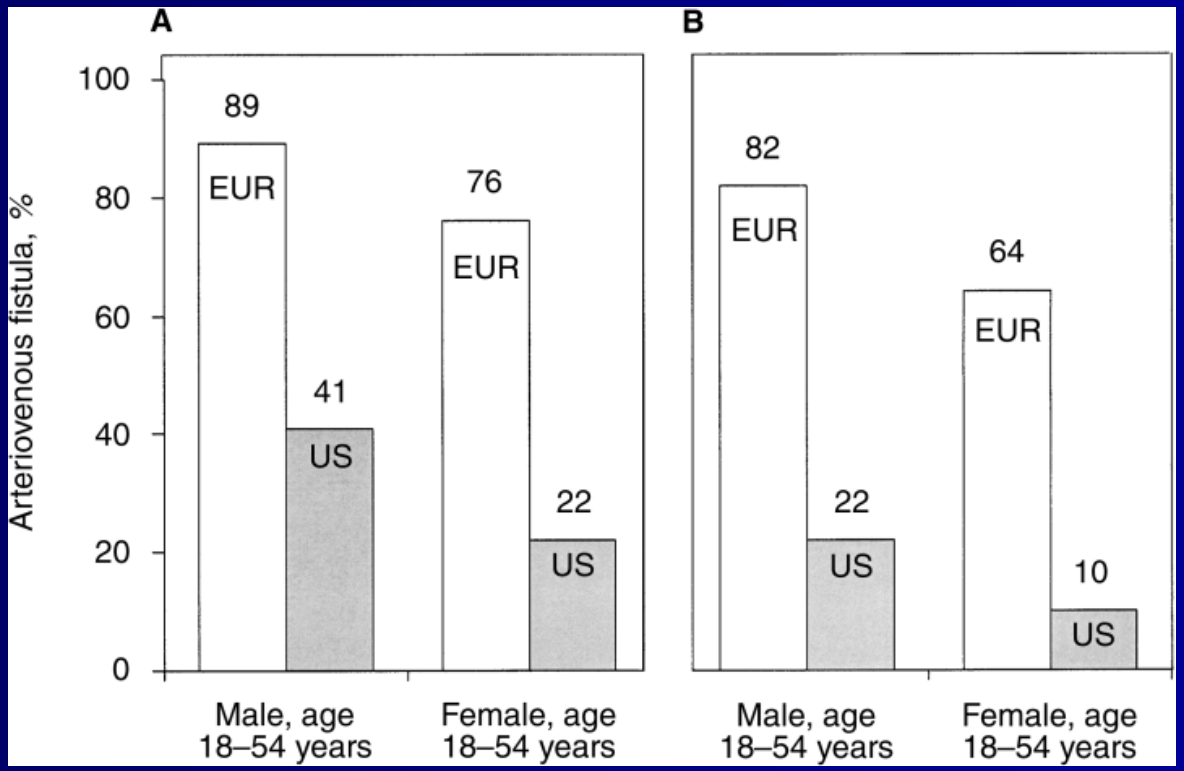
Fistula First, Catheter Last

- Initiaitive began in 2006(?) to increase fistula utilization in all appropriate patients
  - Follow DOQI guidelines
  - Meet CMS goal to have 66% of HD patients using AVF

Not far fetched goal

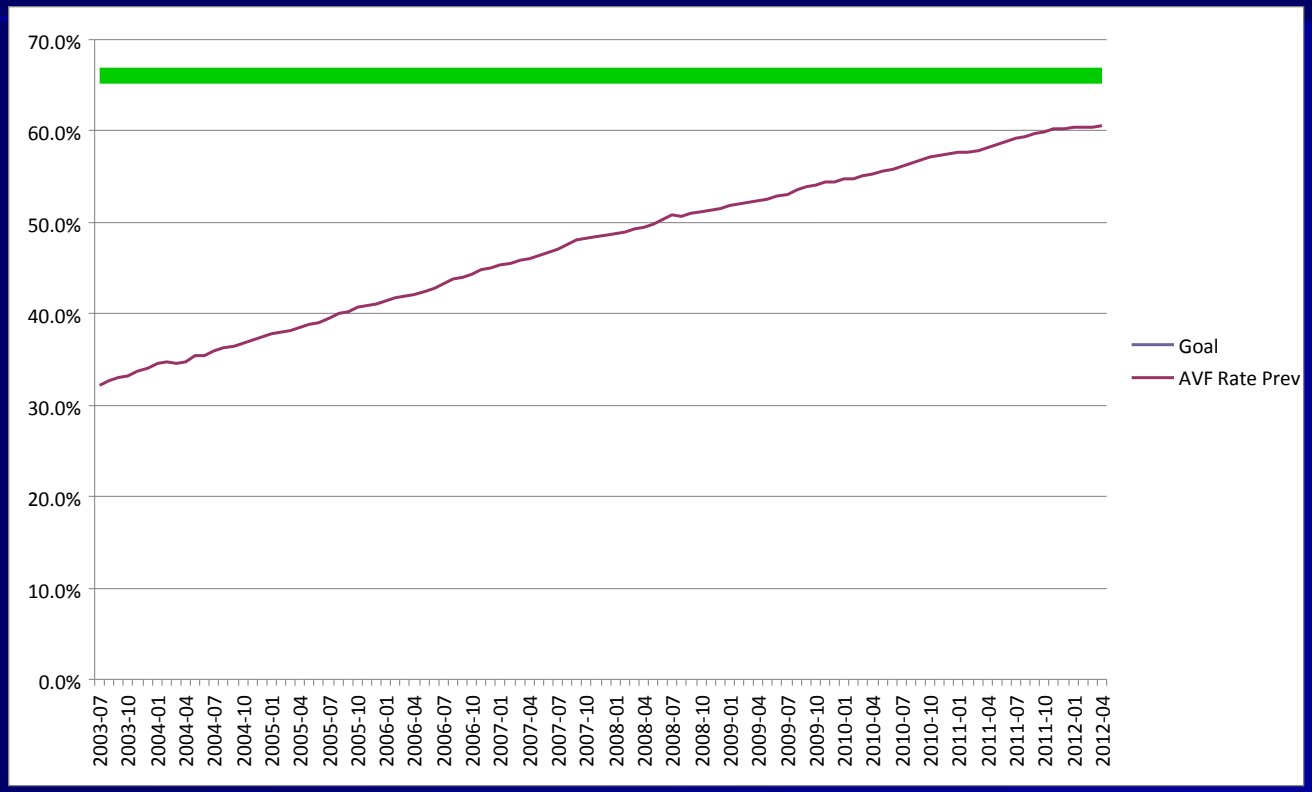


Arteriovenous fistula (AVF) use among incident patients in Europe (EUR) and the United States (US) for three different patient groups. The percent of white patients, who were new to HD and using an AVF at study start was determined for the three groups. Values of n refer to the total number of patients in the particular subgroup.



Arteriovenous fistula (AVF) use among prevalent patients in Europe (EUR) and the United States (US) for patient groups (*A*) without diabetes, peripheral vascular disease, (PVD), and coronary artery disease (CAD). (*B*) Patients with diabetes, PVD, and/or CAD. The percent of patients using an AVF at the time of study enrollment in a cross-sectional sample of patients was determined for the two subgroups shown.

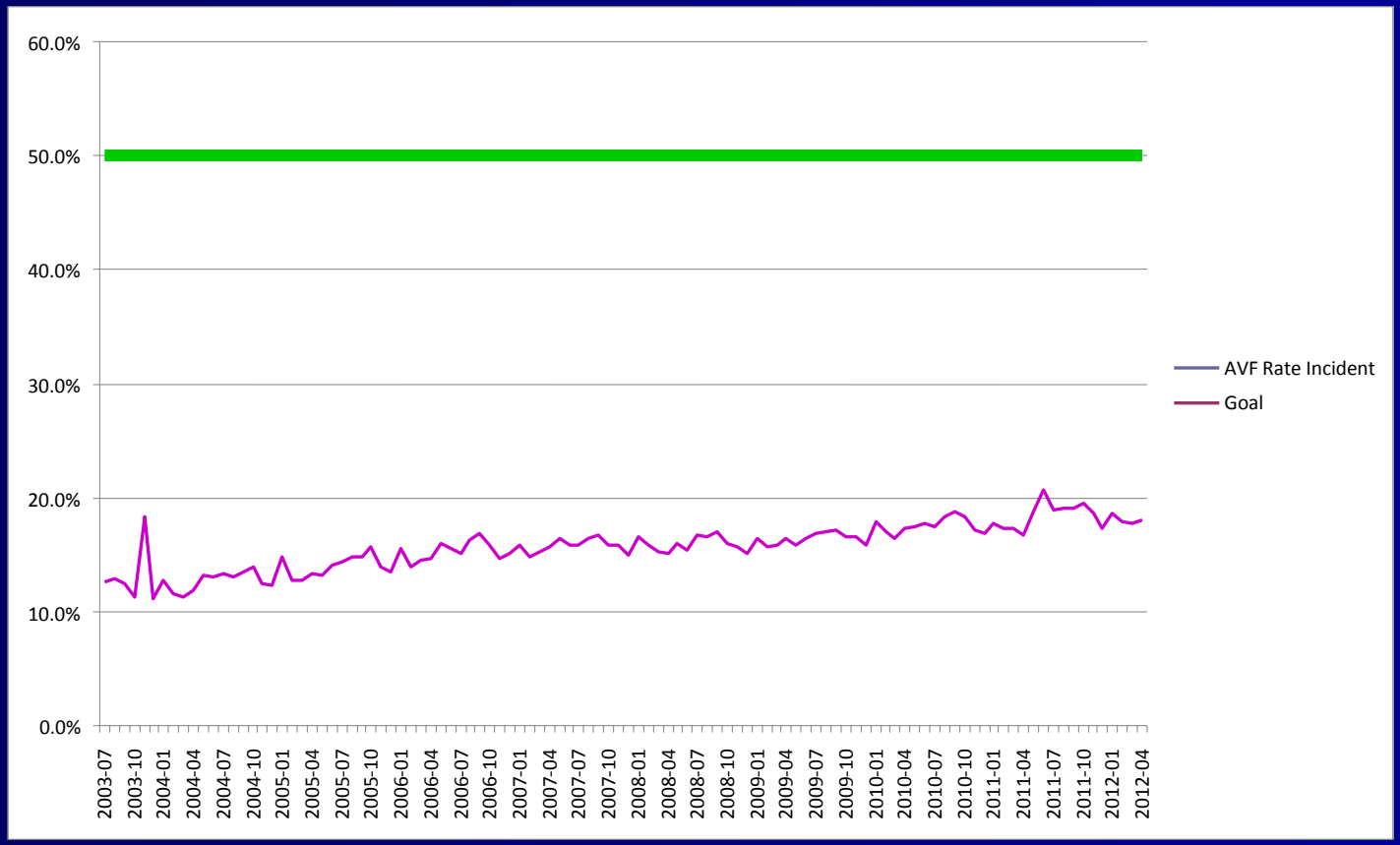
Dismal fistula utilization rates in US initially…



Prevalent AVF Use Rate by Network, July 2003 - April 2012

From FistulaFirst website

However not doing well with patients new to HD



Incident AVF Use Rate by Network, July 2003 - April 2012

From FistulaFirst website

Good goal

- Fistula first
- How to optimize patient's vascular access?
  - Accepting truths
    - Fistulas better than grafts
    - Limited life span of access

Definitions:

- Primary patency
  - Time from creation to first intervention/failure
- Primary Assisted patency
  - Total life span regardless of intervention
- Secondary patency
  - Total life span of fistula/graft that has become occluded and re-opened

Every access has a limited life span

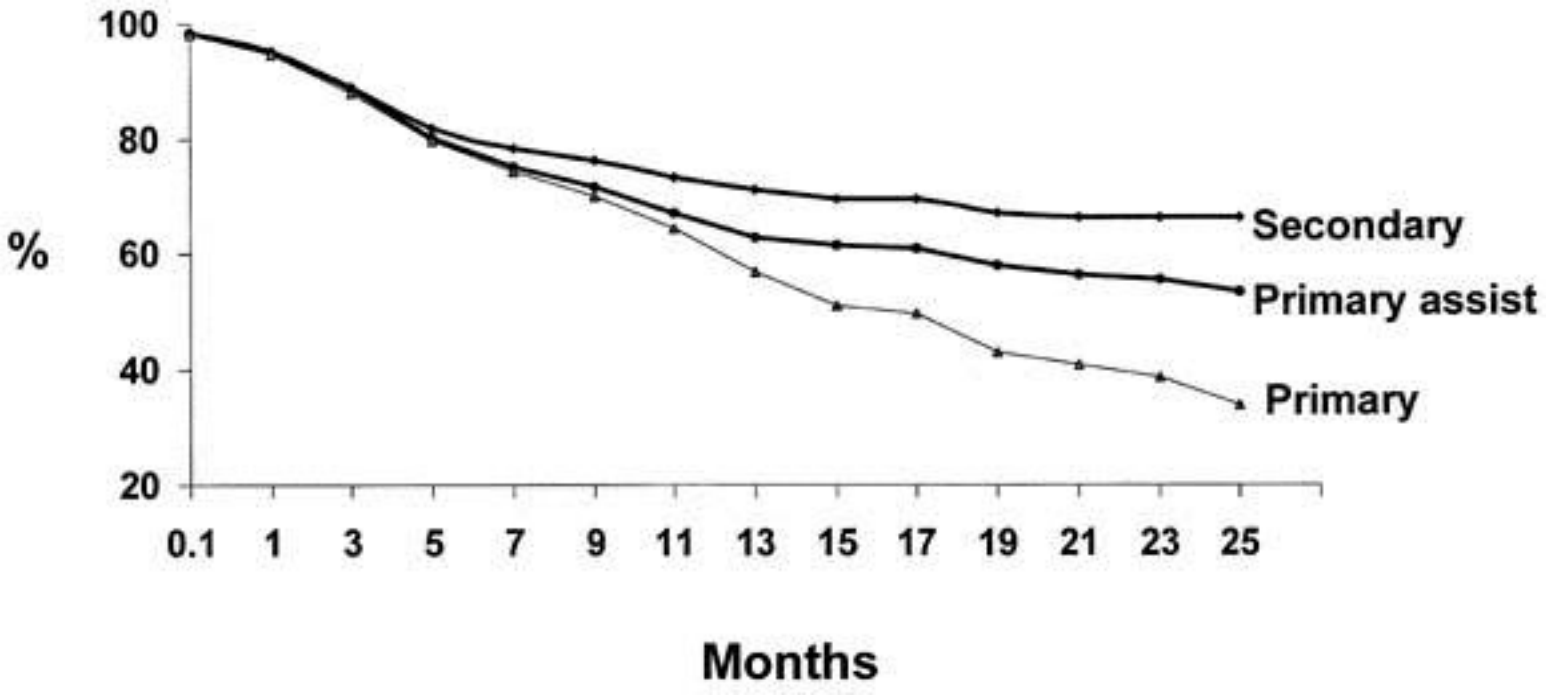


Fig. 1 Cumulative primary (12 months, n = 162; 24 months, n = 53), primary-assisted (12 months, n = 162; 24 months, n = 55), and secondary success (patent and effective dialysis; 12 months, n = 162; 24 months, n = 72) for all 466 vascular access procedures...

Kalman et al Journal of Vascular Surgery Volume 30, Issue 4 1999 727 - 733

Primary patency AV fistula v graft

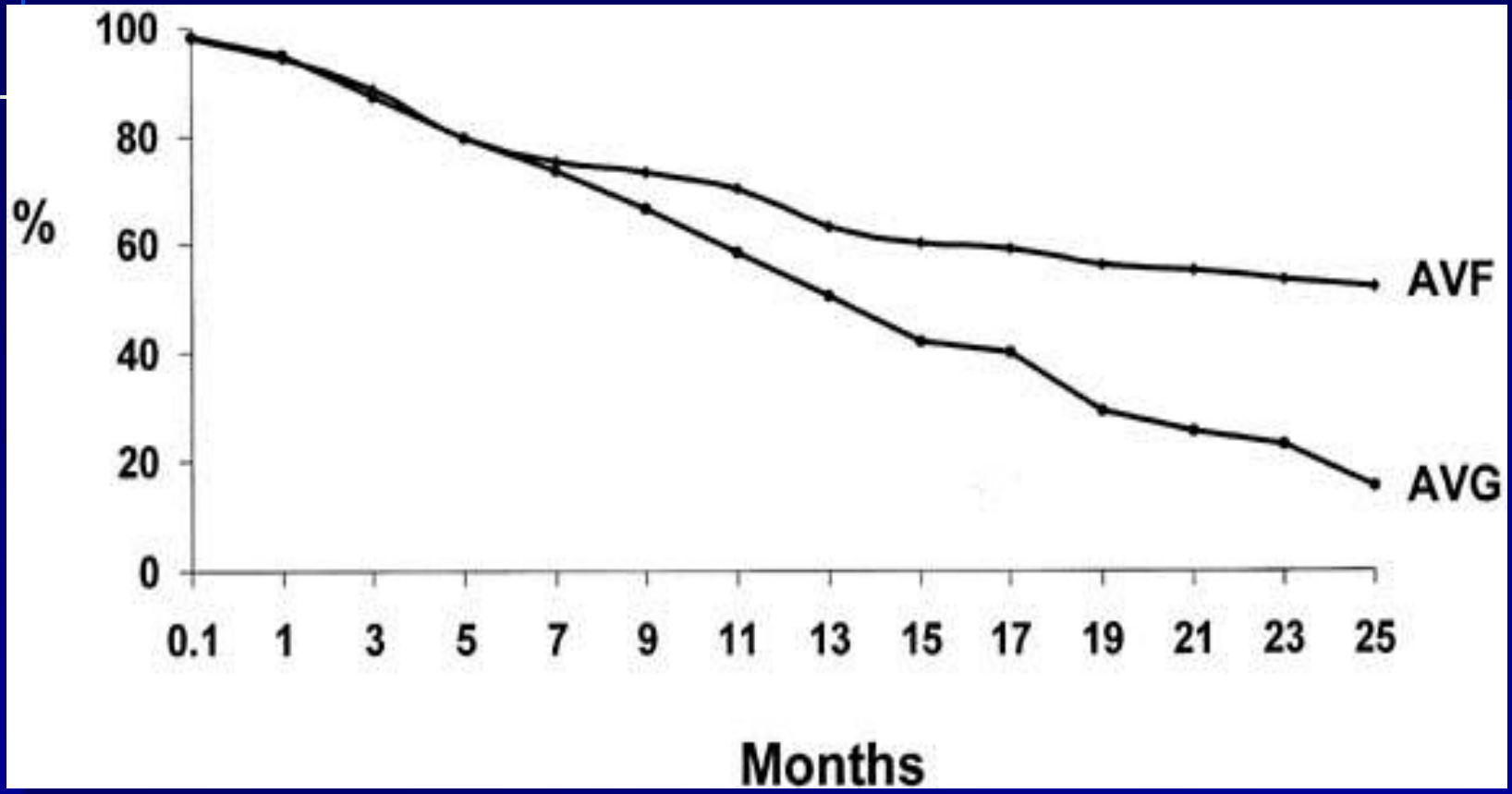
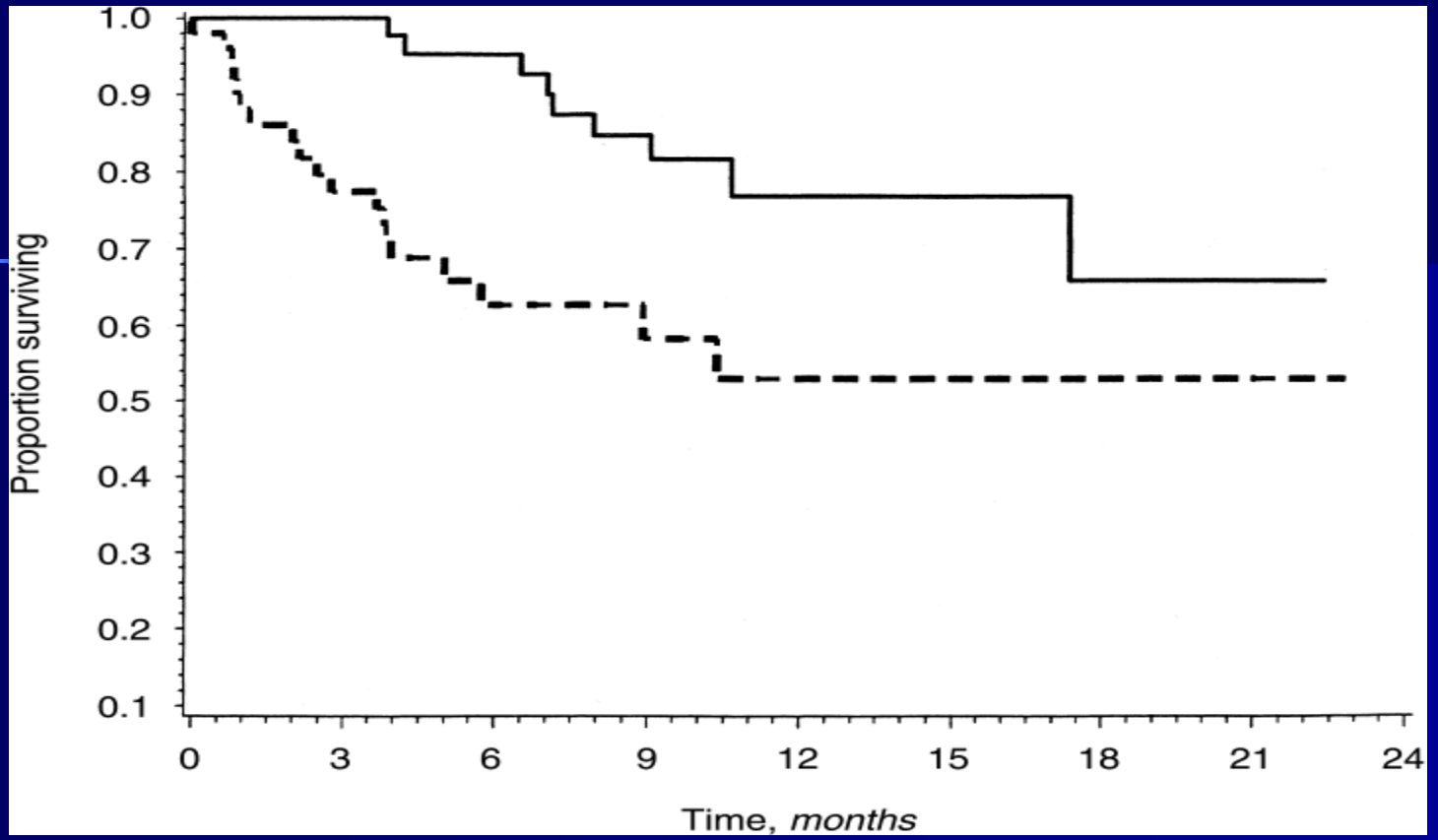


Fig. 2 Cumulative primary success for arteriovenous fistulae (12 months, n = 90; 24 months, n = 40) vs arteriovenous grafts (12 months, n = 72; 24 months, n = 15; only data with an SE less than 10% are shown).

Kalman et al. **A practical approach to vascular access for hemodialysis and predictors of success**
Journal of Vascular Surgery Volume 30, Issue 4 1999 727 - 733



Primary (unassisted) survival of all useable fistulas (solid line) and grafts (dashed line). **Primary survival is the time between graft placement and the first salvage procedure (thrombectomy, angioplasty or surgical revision (*P* = 0.005).**

Allon et al. Kidney Int. 2001 Nov;60(5):2013-20

Primary assisted patency AV fistula v graft

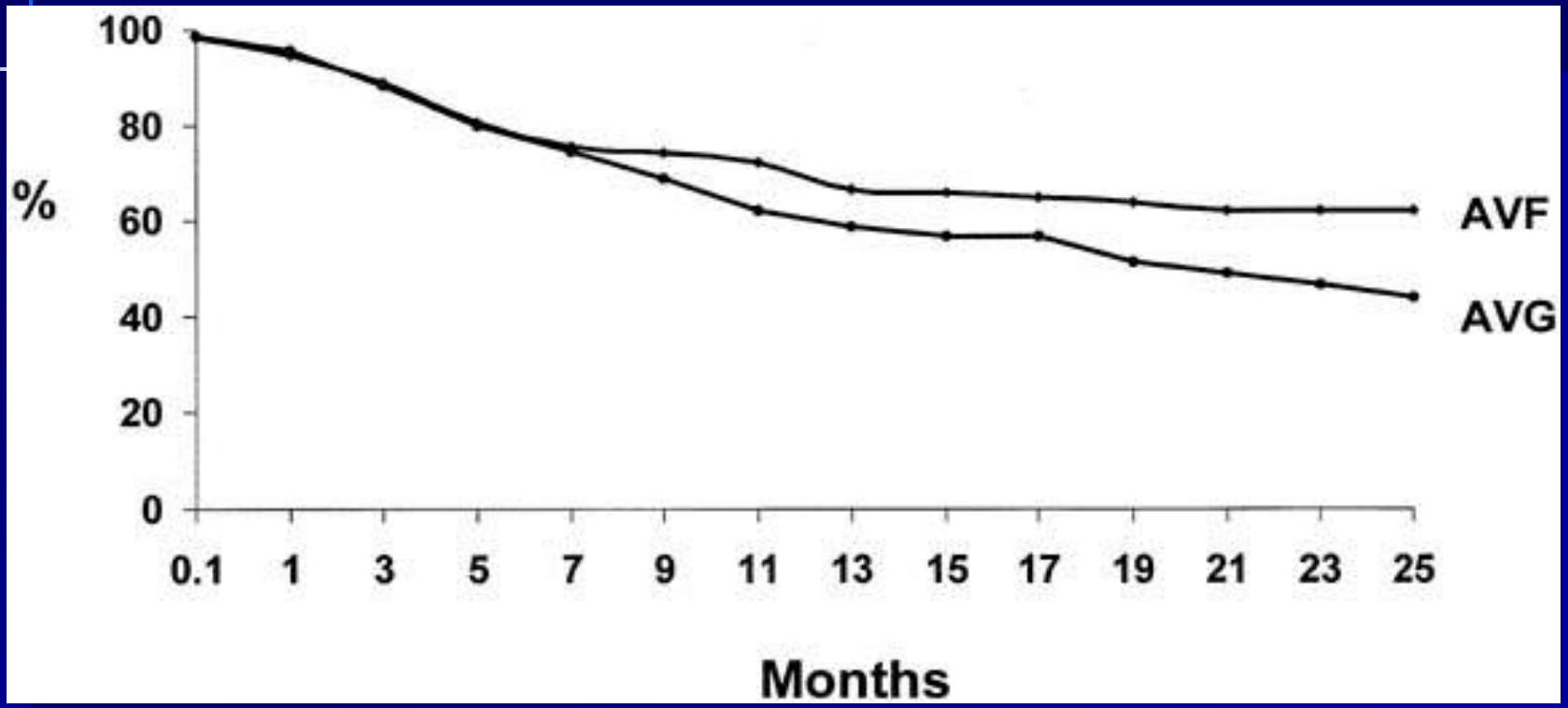
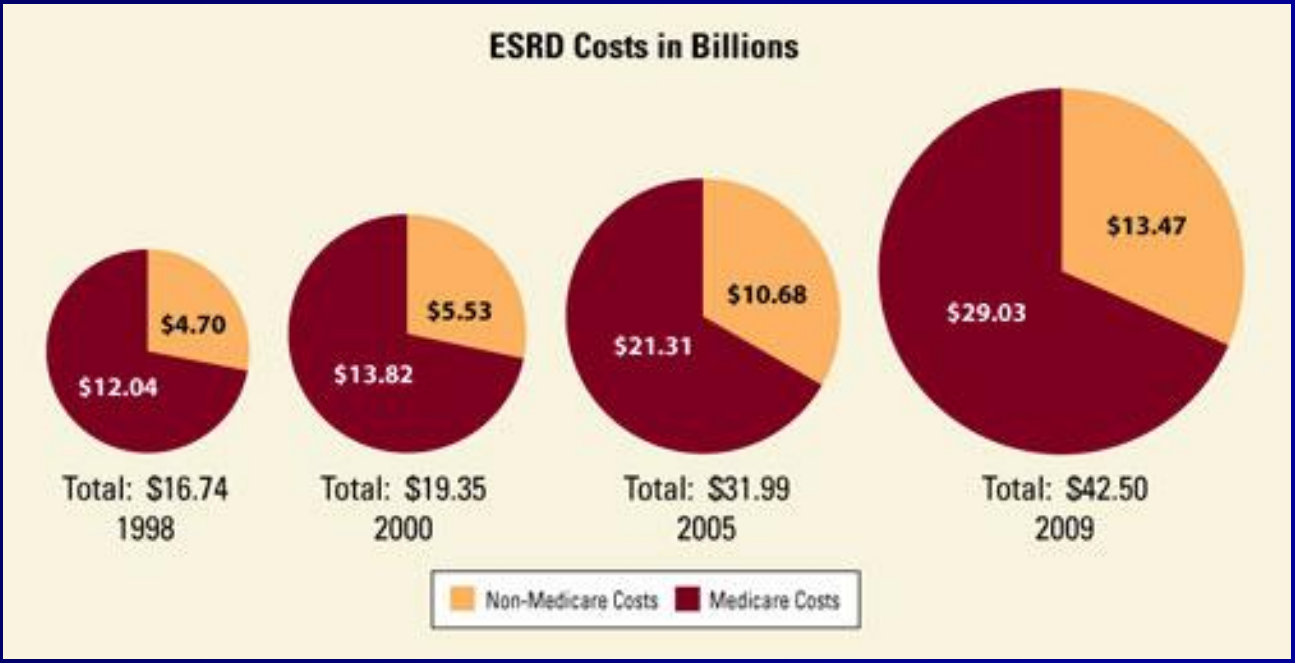
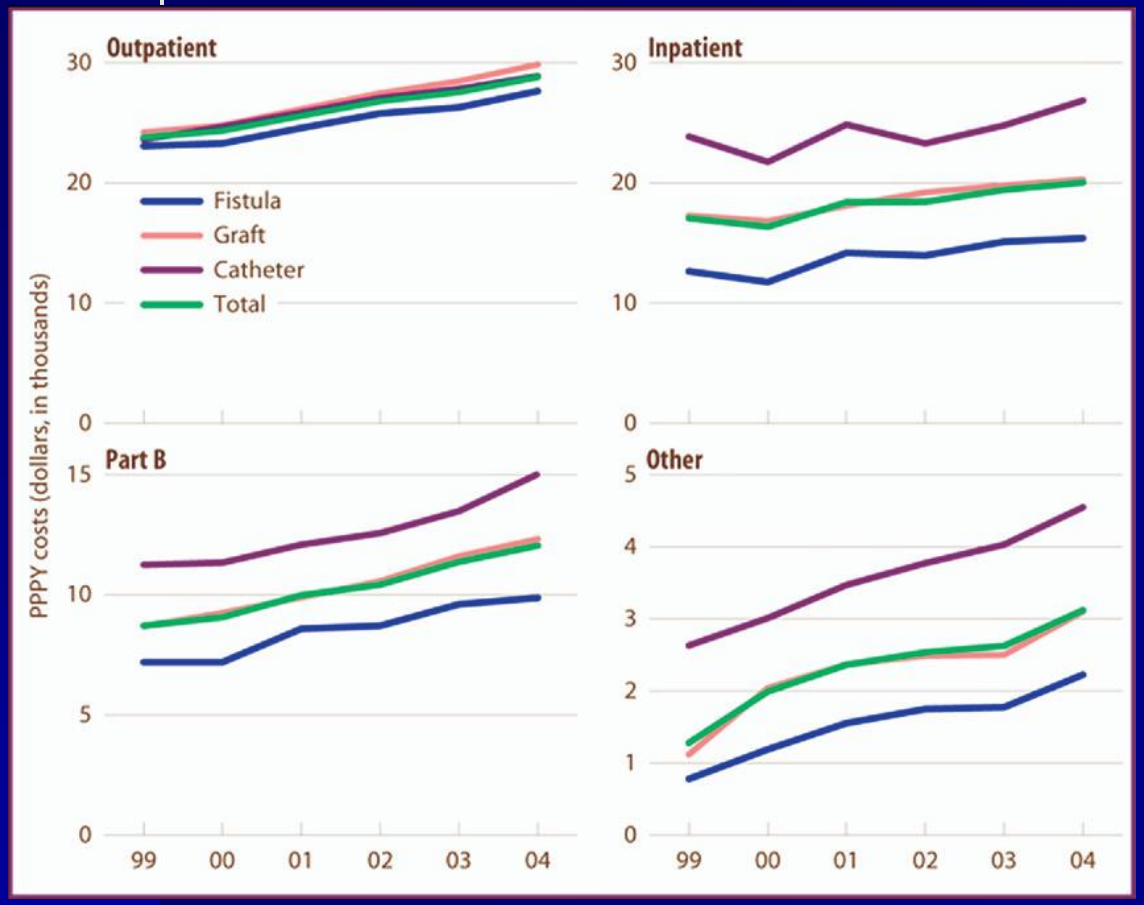


Fig. 3 Cumulative primary-assisted success for arteriovenous fistulae (12 months, n = 90; 24 months, n = 47) vs arteriovenous grafts (12 months, n = 72; 24 months, n = 17; only data with an SE less than 10% are shown).

Cost of caring for ESRD patients



Vascular Accesses are expensive to maintain

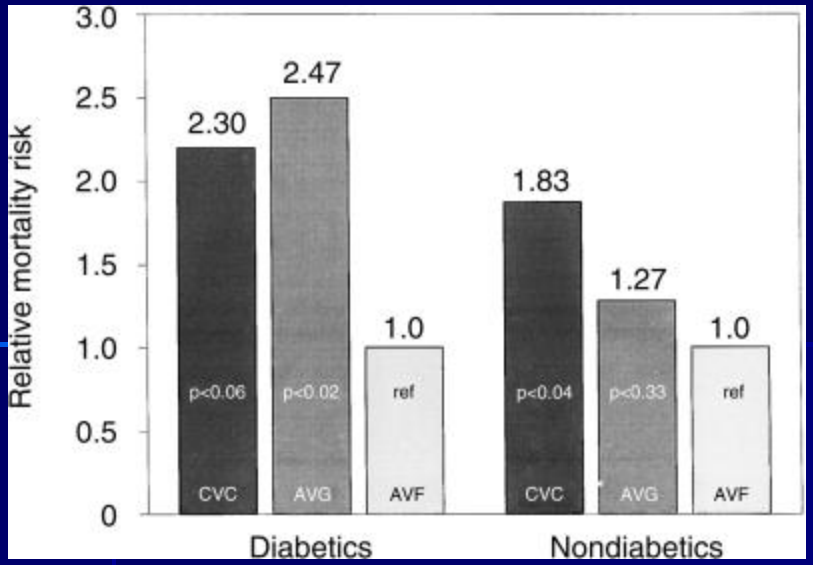


Graph from the US Renal Data System 2006 Annual Data Report shows the increased Medicare expenditures associated with various types of vascular access.

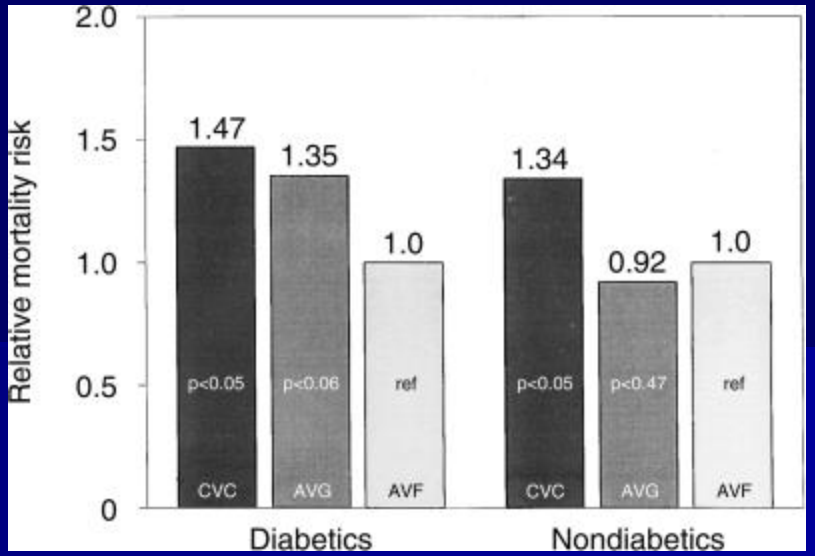
Lacson et al . American Journal of Kidney Diseases, Vol 50, No 3 (September), 2007: pp 379-395

All these patients are sick, but

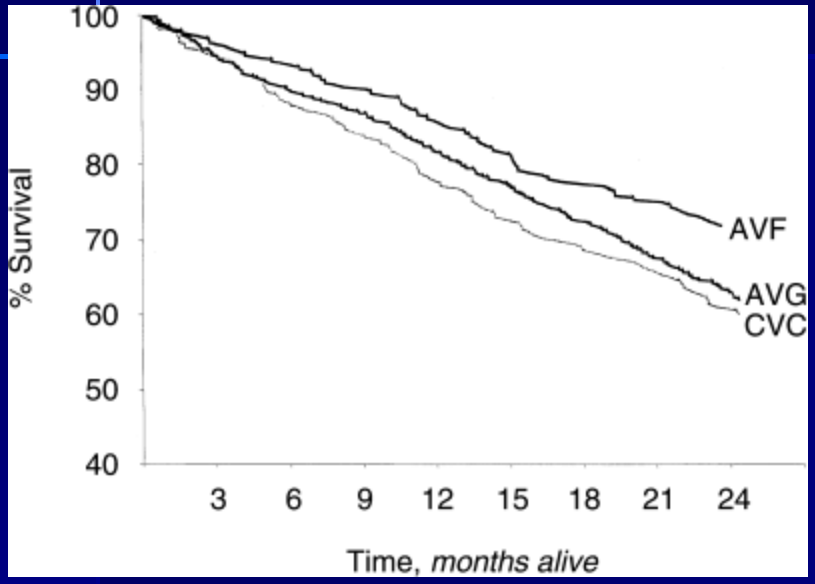
- ESRD patient with fistulas do better



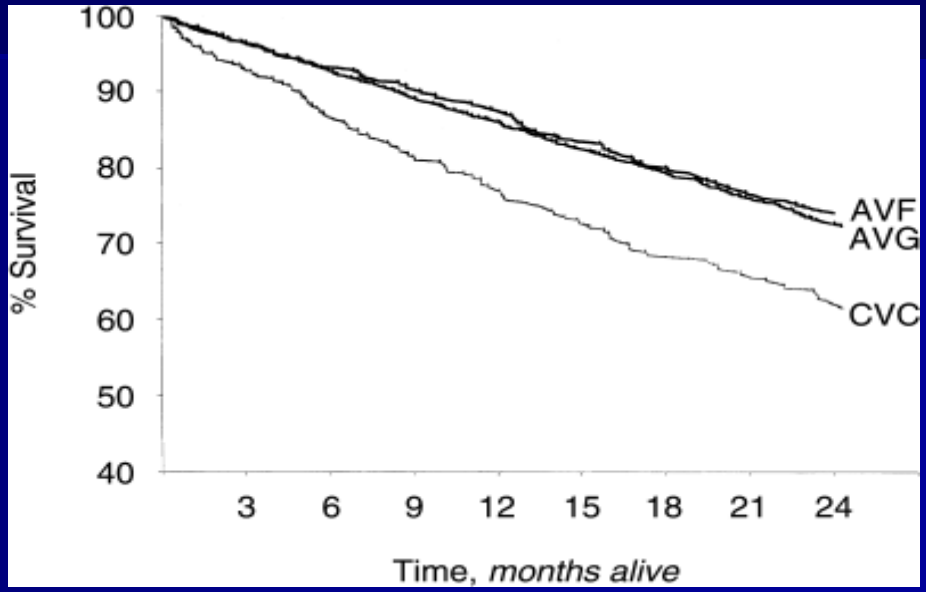
Adjusted* relative risk of death due to infection by VA type and diabetes status. *Adjusted for age, race, gender, BMI, history of smoking, PVD, CAD, CHF, neoplasm, ability to ambulate and education level.



Adjusted* relative risk of death due to cardiac causes by VA type and diabetes status. *Adjusted for age, race, gender, BMI, history of smoking, PVD, CAD, CHF, neoplasm, ability to ambulate and education level.



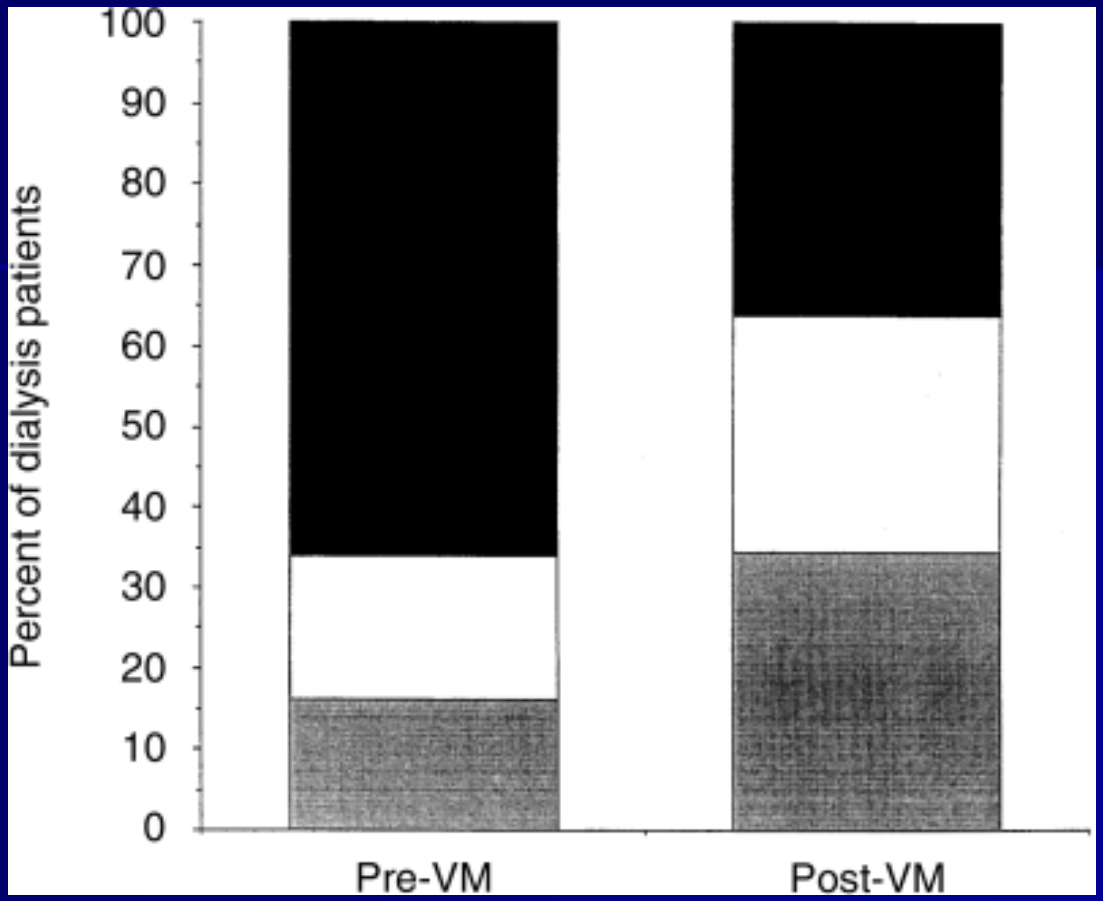
Adjusted patient survival (Cox)* for various vascular access (VA) types [arteriovenous fistula (AVF); arteriovenous graft (AVG); central venous catheter (CVG)] in prevalent diabetic patients. *Adjusted for the average diabetic patient overall (Cox). Covariates in the model included age, race, gender, body mass index (BMI), history of smoking, peripheral vascular disease (PVD), coronary artery disease (CAD), chronic heart failure (CHF), neoplasm, ability to ambulate, and education level.



Adjusted patient survival (Cox)* for various VA types in prevalent nondiabetic patients. *Adjusted for the average diabetic patient overall (Cox). Covariates in the model included age, race, gender, BMI, history of smoking, PVD, CAD, CHF, neoplasm, ability to ambulate, and education level.

Other challenges to fistula first

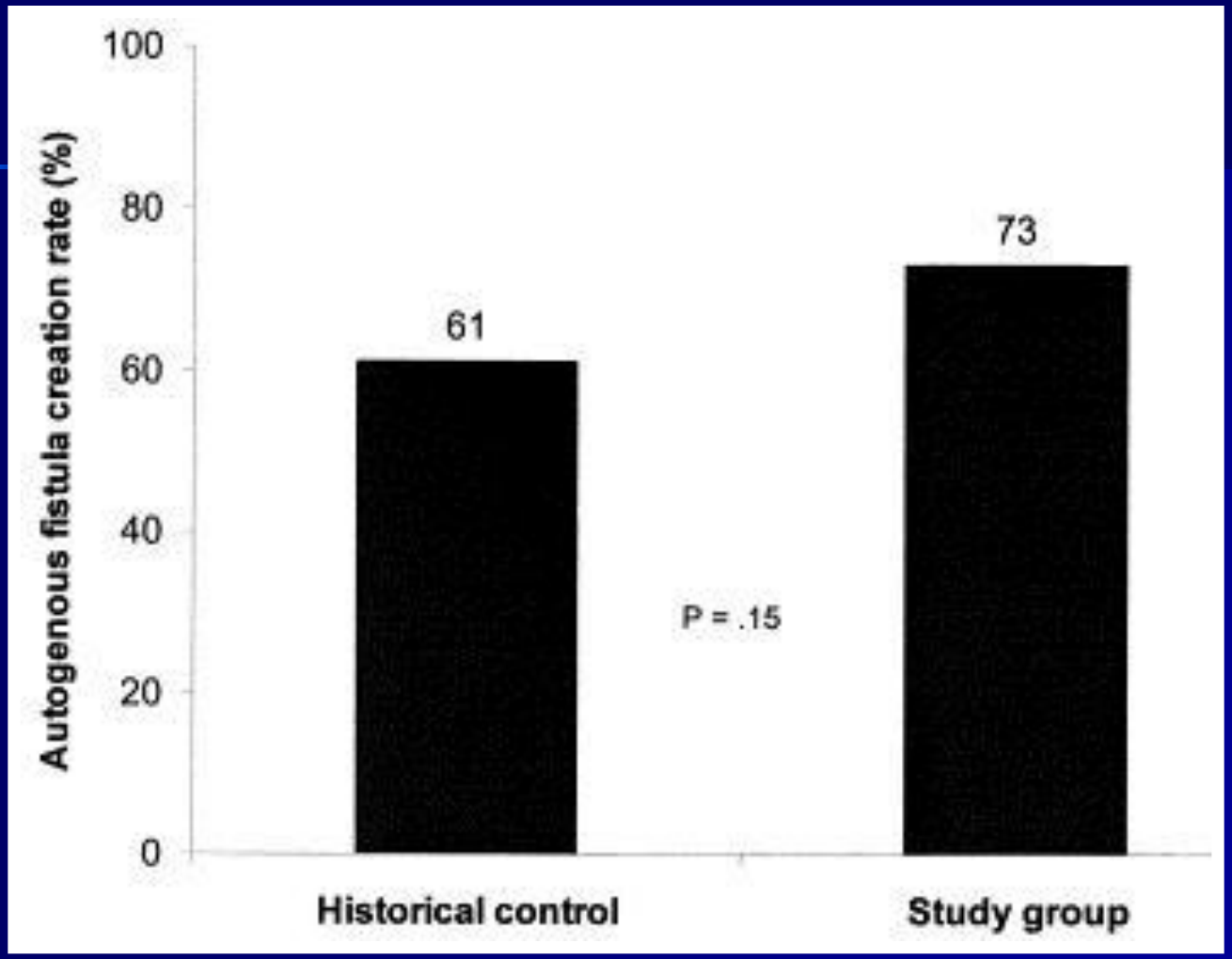
- Delayed maturation or failure
  - Adequate size
  - Adequate flow through fistula
- Maturation issues
  - Up to 50% of new AVF will not mature
  - If not matured after 4-6 weeks, return to surgeon



Outcomes of vascular access procedures performed in the historical period (April 1, 1996 to March 31, 1998) during which physical examination alone was used to guide the surgeons (Pre-VM), and in a subsequent period (November 1, 1998 to March 31, 2000) during which routine preoperative sonographic vascular mapping was used by the surgeons (post-VM; $P < 0.001$ for the comparison). **Symbols are: ( ) fistula not placed; ( ) fistula placed but not adequate; ( ) fistula placed and adequate.**

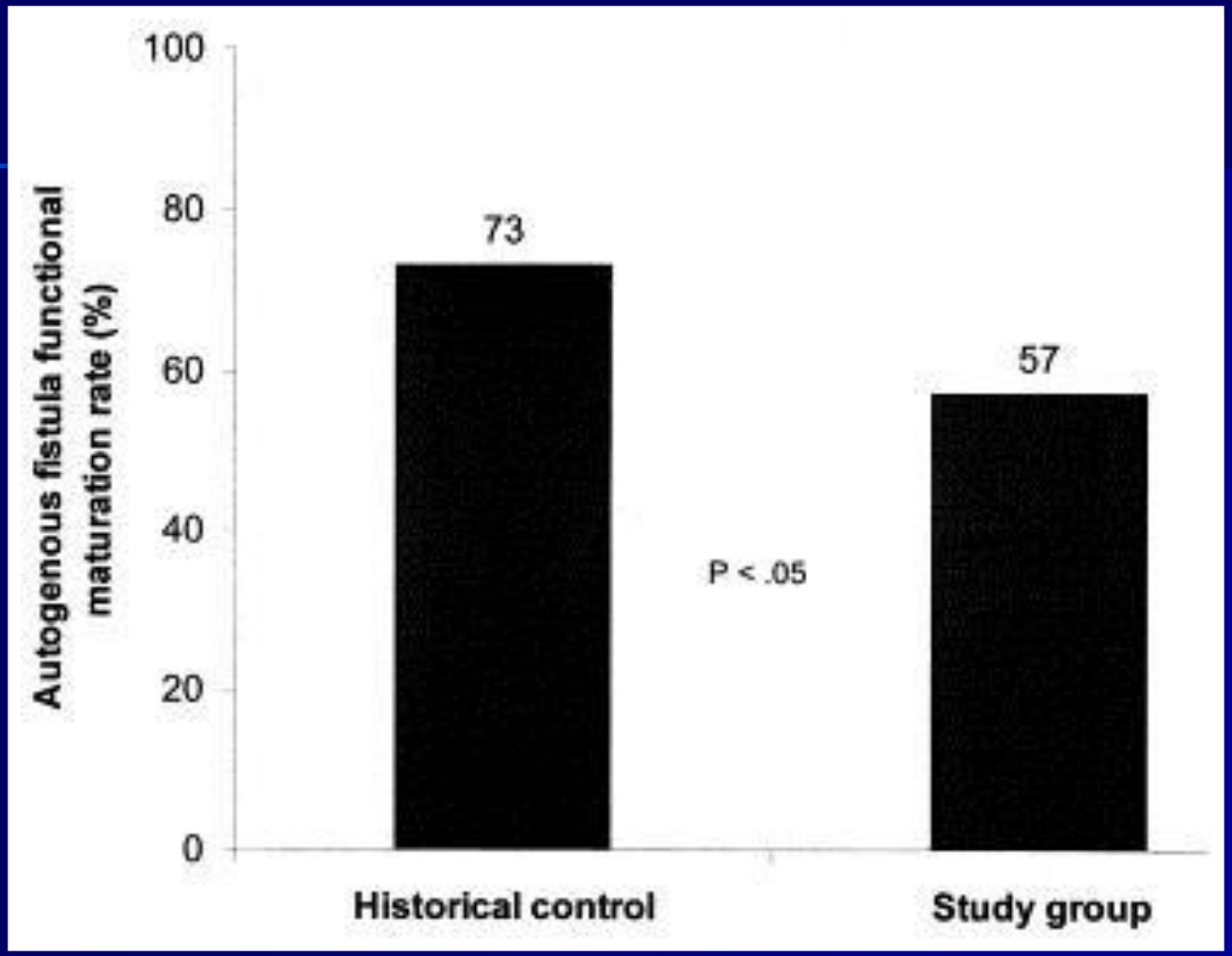
Allon et al. Kidney Int. 2001 Nov;60(5):2013-20

Fig 1



Source: Journal of Vascular Surgery 2003; 38:439-445 (DOI:10.1016/S0741-5214(03)00732-8)

Fig 2



Source: Journal of Vascular Surgery 2003; 38:439-445 (DOI:10.1016/S0741-5214(03)00732-8)

Primary AV fistulas

- Simple direct AVF
  - Radial – cephalic
  - Brachial – cephalic
  - Proximal radial to median antecubital
- Vein transposition
  - Basiliac vein
    - Forearm or upper arm
  - Cephalic vein
    - Forearm or upper arm
  - Saphenous or femoral veins
- Vein translocation
  - Move vein to another anatomic site

Table modified from
Fistula First materals

AV graft placement

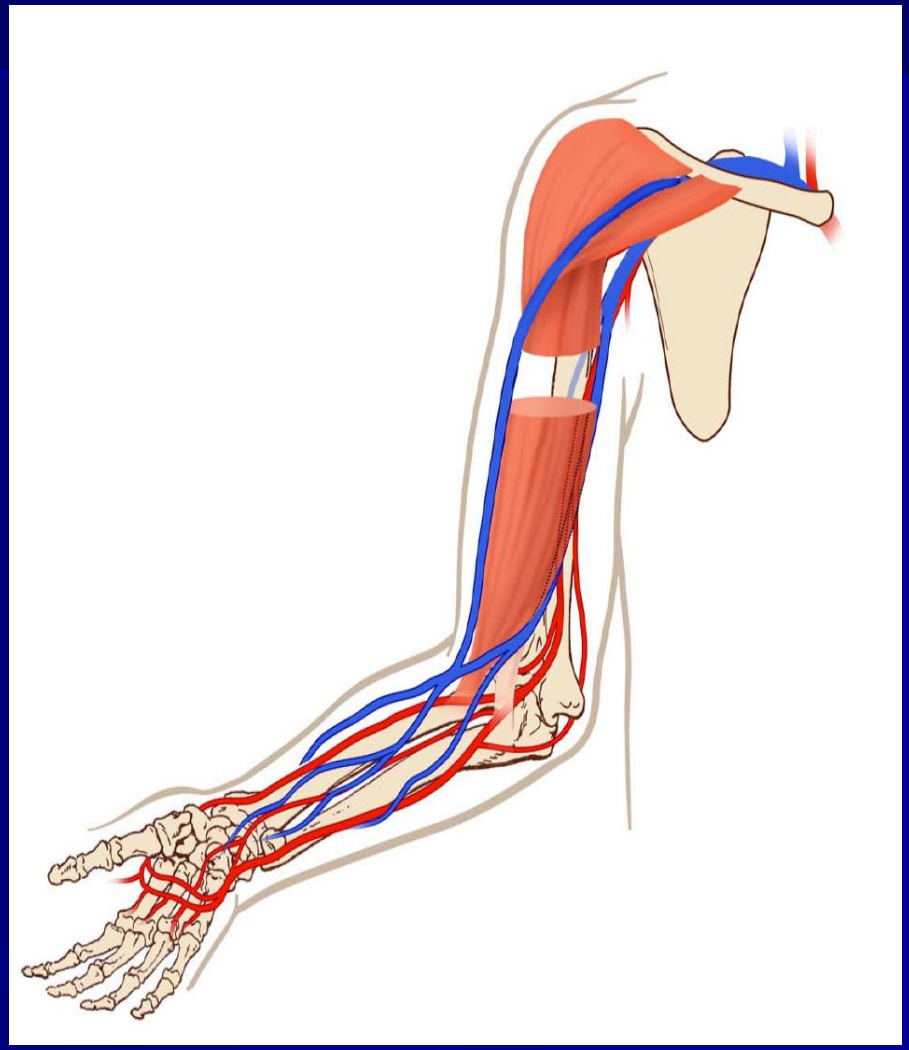
- Limited only by anatomy and your imagination

Guidelines most vascular surgeons use

- Non dominant arm first
- Maximize use of the entire arm
  - Distal to proximal
- Vein preferred but…

My algorithm

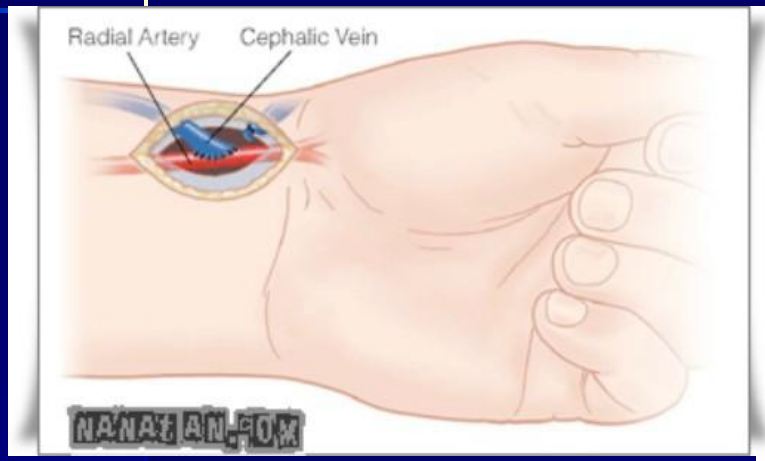
- Radio-cephalic AVF
- Loop forearm graft
- Brachio-cephalic AVF
- Brachio-basilic transposition AVF
- Brachio- axillary graft



Preop evaluation

- Arterial evaluation
  - Size greater than 2 mm
  - Palpable pulse
- Vein evaluation
  - Size greater than 2.5 mm
  - Can be seen through the skin with or without touriquet

Cimino



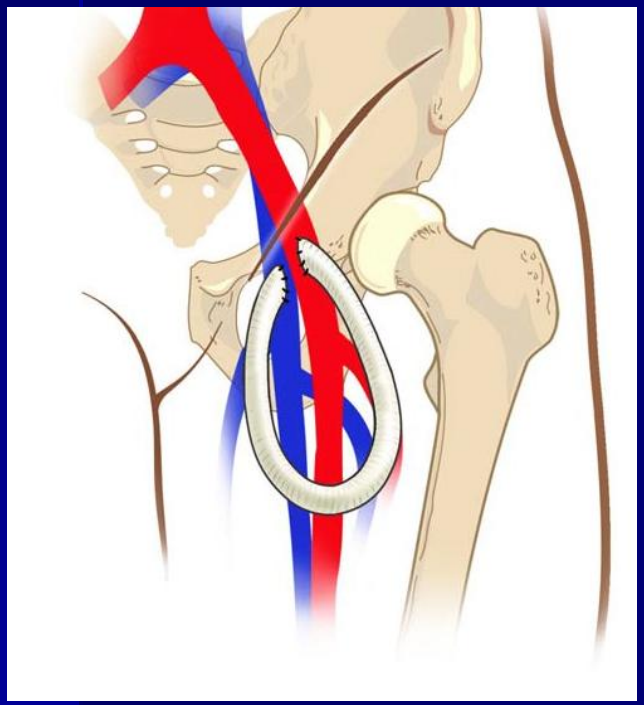
Loop forearm graft

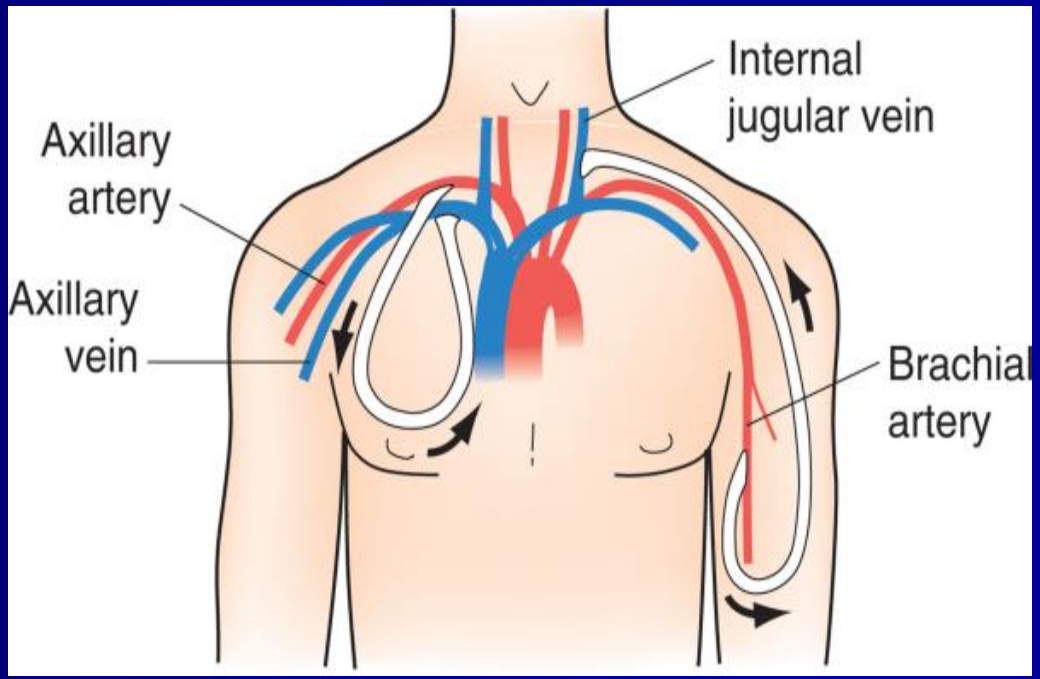
Brachio-cephaliac and brachio-basiliac transposition AVF

Brachio-axillary graft

Once bridges are burned

- Exotic accesses



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Complications of long term access

- Central vein stenosis/arm swelling
- Infection
- Hematoma/bleeding
- Aneursymal degeneration of AVF
- Pseudoaneursym of AV graft
- Steal syndrome

Central vein stenosis

Infection and bleeding

Pseudoaneurysm

Steal syndrome

Aneursymal degeneration