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 guidance (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 practitioners
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 Patient’s 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 for Primary AV Fistulae
   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

- Initiative 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
Provided by the Medical Library.
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
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...
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
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 ($P = 0.005$)).

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

ESRD Costs in Billions

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<th>Year</th>
<th>Total Costs</th>
<th>Non-Medicare Costs</th>
<th>Medicare Costs</th>
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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.

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.

Fig 1

- **Autogenous fistula creation rate (%)**
  - Historical control: 61
  - Study group: 73

P = .15
Fig 2

The figure shows a bar chart comparing the autogenous fistula functional maturation rate between a historical control group and a study group. The chart indicates that the study group has a significantly higher rate of maturation, as indicated by the P < .05 value. The number 73 is shown for the historical control group, and 57 for the study group.
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
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
Loop forearm graft
Brachio-cephaliac and brachio-basiliac transposition AVF
Brachio-axillary graft
Once bridges are burned

- Exotic accesses
REDUCING
Catheter Dependency
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