Attaining and Maintaining Dialysis Access

Louise Moist MD, MSc
Professor of Medicine and Epidemiology
Kidney Clinical Research Unit
Division of Nephrology
Schulich School of Medicine and Dentistry Western University
London, Ontario, Canada
Objectives

1. To review the current practice in vascular access
2. To review the risk and benefit of each access type
3. Identifying barriers and facilitators to the optimal access
4. Management of access complication
Dialysis Access
Patients’ Life Line for a Lifetime

- **Fistula**
  - Superior survival
  - Patient + access
  - Fewer interventions
  - Fewer complications
  - Less costly

- **AV-Graft**
  - Minimal failure to mature
  - Can use within 3 weeks
  - Patency similar to AVF if consider the FTM rate of AVFs but more interventions

- **CVC**
  - High rate of morbidity/mortality
  - 51% first year mortality when only CVC used!
  - Sepsis related hospitalizations
  - CV events and death related to sepsis
Access Type and Mortality

**Catheters = Inferior Survival**

**CANADA:** Moist, L. et. al, CJASN, 2008

**AUSTRALIA/NEW ZEALAND:** Polkinghorne K. et al, JASN, 2004

AVF vs catheter P < 0.008
AVG vs catheter P < 0.05

Brad C. Astor et al. JASN 2005;16:1449-1455
Trends in Vascular Access

- Improving AVF rates
- Catheter rates still high

Fistula First Dashboard
Right Access Right Patient

Individual Decision for each patient

Consider
- Age
- Life expectancy
- Risk of FTM, infection clotting
- Preference
Patient Case: Mother
34 year old Female:
ESKD 2° GN
PD ineligible
On Tx list 2-5 yr wait
7 y o daughter & husband
Works from home
VALUES:
Independence
Role as Mother/Wife/Entrepreneur
Home Hemo
Access??
Patient Case: Grandmother

82 year old Female: ESKD, DM / CAD / PVD, "Vision,
Lives with Grandson, wife, 3 children (in basement)
VALUES:
Independence (no bother)
Safety / Security
Human Connection
In center Hemo
Access??
Life Line for LIFE
Patient Journey

Transplant

Peritoneal Dialysis

Hemodialysis

CVC 0
AVG 2
AVF

months

0 1
4 1
6 2

0 1
1 2
2
Evaluation for AV Access Creation

Eligibility Criteria

• No consensus or standard
• Consider patient’s expected mortality, need for dialysis, risk of complication related to VA, center specific expertise and wait time.

Steps for an AVF evaluation

• History and physical
  • Prior central venous catheter
  • Swelling or collateral veins in neck, arms, chest
  • Cardiac implantable electronic device (CIED)
  • Arterial evaluation to ensure adequate blood flow and an intact dual blood supply to the hand.

• Vessel mapping US, venography
  • Standard use prior to AV access creation
Evaluation for AV Access Creation

• Arterial and venous requirements
  • Unobstructed inflow to the AVF
  • Arterial diameter 2.0 mm  Venous diameter of e2.5 mm for a fistula and > 4mm for a graft

• Surgical considerations for access
  • Timely access to experienced surgeon
  • 4-6 week follow up

• Hemodynamic consequences of AVF creation
  • Increased cardiac output
  • Decreased systemic peripheral resistance
  • Increased sympathetic activity with increased contractility, heart rate and stroke volume

• Pulmonary HTN and Vascular Access
  • High CO from AVF contributes to pulmonary hypertension
PATIENT FACTORS TO CONSIDER

Obesity
Diabetes
Median age
Venous injury
Calcifications
Abnormal veins

BUT

Patient involvement in decision-making is required.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>+3</td>
</tr>
<tr>
<td>Age &gt;65</td>
<td>+2</td>
</tr>
<tr>
<td>PVD</td>
<td>+3</td>
</tr>
<tr>
<td>CAD</td>
<td>+2.5</td>
</tr>
<tr>
<td>Caucasian</td>
<td>-3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

FAILURE TO MATURE (AVF) RISK SCORE

C Lok, et al. JASN, 2006 Nov;17(11):3204-12
C Lok et al; ASN 2011 (unpublished)

Cavanaugh K et al; CJASN 2009 May;4(5)950-956
Goldstein M et al; AJKD 2004 44 (4) 706-714
Failure to Mature (AVF) Risk Score

Overall failure rate = 45%, High risk group failure rate = 70%

- Low (0-2.0)
- Mod (2.0-3.0)
- High (3.1-7.9)
- Very High (>8.0)

C Lok, et al. JASN, 2006 Nov;17(11):3204-12
# Fistula Complications Patency

<table>
<thead>
<tr>
<th></th>
<th>Lower Arm</th>
<th>Upper Arm</th>
<th>&lt;65 years</th>
<th>65+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Failure</td>
<td>28%</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Patency (1 Yr)</td>
<td>55%</td>
<td>65%</td>
<td>37%</td>
<td>27%</td>
</tr>
<tr>
<td>Secondary Patency (1yr)</td>
<td>68%</td>
<td>70%</td>
<td>64%</td>
<td>59%</td>
</tr>
</tbody>
</table>

Complications of Fistula

Infections/1000 fistula days
• all infections: 0.17 events
• bloodstream infection: 0.09 events
• vascular access site infections: 0.4 events

Ischemic Steal
• rate 0.05 events/1000 fistula days

Thrombosis
• rate of 0.27 events/1000 fistula days

Al-jaishi AA: *Patency and complications of the arteriovenous fistula*. Western University; 2013:81-88.
Consequence of Cannulation Injury and Infiltration

(Courtesy Dr. Lok with permission)
Catheters Last
Are AVGs acceptable?

• Retrospective review (3 years)
• 494 patients, 655 accesses
• 390 AVF, 265 AVG
• AVG fared worse in assisted primary patency BUT superior secondary patency as compared to AVF
• In patients with limited life expectancy, AVG may be an acceptable alternative to AVF

Lok, C.E. and Moist, L. et. al, CJASN, 8: 810; 2013
Vascular Access Events in Frequent Hemodialysis


Table 2. Description of all repairs and losses, considering all accesses used during both trials.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional</th>
<th>Daily Trial</th>
<th>HR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVF/AVG§</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients (n)</td>
<td>106 (79/28)</td>
<td>114 (90/28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total follow-up (yr)</td>
<td>87.9 (67.1/20.8)</td>
<td>95.8 (76.9/18.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Repairs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angioplasty</td>
<td>21 (11/10)</td>
<td>28 (14/14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stent placement</td>
<td>2 (2/0)</td>
<td>2 (1/1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>10 (3/7)</td>
<td>22 (5/17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical revision</td>
<td>5 (3/2)</td>
<td>14 (7/7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall rate (per 100 patient-yr)</td>
<td>43</td>
<td>69</td>
<td>1.68 (1.13–2.51)</td>
<td>0.011</td>
</tr>
<tr>
<td>Losses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stenosis/thrombosis</td>
<td>8 (5/3)</td>
<td>13 (5/8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutureosis/thrombosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>2 (0/2)</td>
<td>2 (0/2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Otherc</td>
<td>1 (1/0)</td>
<td>3 (2/1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>4 (2/2)</td>
<td>2 (1/1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall rate (per 100 patient-yr)</td>
<td>17</td>
<td>21</td>
<td>1.21 (0.61–2.39)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Catheters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional</th>
<th>Daily Trial</th>
<th>HR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>34</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total follow-up (yr)</td>
<td>20.8</td>
<td>18.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repairs (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrin sheath stripping</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair broken component</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Losses (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor flows/thrombosis</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Additional Losses, but More Repairs

Monitoring of AV Access Physical Exam

**Palpation**

**Temperature Change**
- Warmth = ? infection
- Cold = ↓ blood supply

**Thrill**
- Palpation can be started at the anastomosis
- Thrill diminishes evenly along access length
- Change can be felt at the site of a stenosis; becomes “pulse-like” at the site of a stenosis

**Auscultation**
- Listen to entire access
- Note changes in sound characteristics (bruit):
  - well-functioning AVF: continuous, machinery-like bruit on auscultation
  - An stenotic AVF may have a discontinuous and pulse-like bruit rather than a continuous one—and also may be louder, high-pitched or “whistling”
- Louder at stenosis than at anastomosis
## Access Surveillance

**Thrombosis with access blood flow surveillance versus standard care**

<table>
<thead>
<tr>
<th>Study</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fistula</strong></td>
<td></td>
</tr>
<tr>
<td>Sands 1999 F</td>
<td>0.31 (0.04-2.5)</td>
</tr>
<tr>
<td>Sands 1999 F VP</td>
<td>0.25 (0.03-2.06)</td>
</tr>
<tr>
<td>Tessitore 2003</td>
<td>0.43 (0.19-0.96)</td>
</tr>
<tr>
<td>Tessitore 2004</td>
<td>0.37 (0.18-0.75)</td>
</tr>
<tr>
<td>Polkinghorne 2006</td>
<td>1.48 (0.44-5.01)</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>0.47 (0.28-0.77)</td>
</tr>
<tr>
<td><strong>Graft</strong></td>
<td></td>
</tr>
<tr>
<td>Lumsden 1997</td>
<td>1.06 (0.66-1.77)</td>
</tr>
<tr>
<td>Sands 1999 G</td>
<td>0.29 (0.04-1.94)</td>
</tr>
<tr>
<td>Sands 1999 VP G</td>
<td>0.67 (0.22-2.03)</td>
</tr>
<tr>
<td>Smits 2001 A</td>
<td>0.89 (0.25-3.17)</td>
</tr>
<tr>
<td>Smits 2001 B</td>
<td>1.34 (0.71-2.52)</td>
</tr>
<tr>
<td>Ram 2003 DU</td>
<td>0.59 (0.31-1.15)</td>
</tr>
<tr>
<td>Ram 2003 UD</td>
<td>0.80 (0.46-1.37)</td>
</tr>
<tr>
<td>Robbin 2006</td>
<td>1.03 (0.74-1.43)</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>0.94 (0.77-1.16)</td>
</tr>
</tbody>
</table>

Abbreviations: RR, relative risk; CI, confidence interval; F, fistula; VP, venous pressure; G, graft; DU, Doppler ultrasound; UD, ultrasound dilution.

### Access Thrombosis

- Fewer thrombosis in fistula
- No difference in grafts

*Tonelli et al, American Journal of Kidney Diseases, Volume 51, Issue 4, 2008, 630 - 640*
## Access Surveillance

Access loss with access blood flow surveillance versus standard care

<table>
<thead>
<tr>
<th>Study</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fistula</strong></td>
<td></td>
</tr>
<tr>
<td>Tessitore 2003</td>
<td>0.63 (0-2.2)</td>
</tr>
<tr>
<td>Tessitore 2004</td>
<td>0.67 (0.19-2.31)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0.65 (0.28-1.51)</td>
</tr>
<tr>
<td><strong>Graft</strong></td>
<td></td>
</tr>
<tr>
<td>Mayer 1993</td>
<td>1.38 (0.81-2.35)</td>
</tr>
<tr>
<td>Moist 2003</td>
<td>1.01 (0.42-2.43)</td>
</tr>
<tr>
<td>Ram 2003 DU</td>
<td>1.05 (0.49-2.28)</td>
</tr>
<tr>
<td>Ram 2003 UD</td>
<td>0.97 (0.65-1.47)</td>
</tr>
<tr>
<td>Robbin 2006</td>
<td>0.97 (0.65-1.47)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1.08 (0.83-1.4)</td>
</tr>
</tbody>
</table>

Abbreviations: RR, relative risk; CI, confidence interval; DU, Doppler ultrasound; UD, ultrasound dilution.

**Access Loss**

No benefit

Catheter Related Infections

- 37,000 CRB 2008 in HD patients
- 0.6.-6.5 cases/1000 catheter days
- Hospitalizations for bacteremia or septicemia in 2010 ‘51% since 1993
- 1 in 5 patients with infection die within 12 weeks
- Mortality septicemia 4.3 x risk in first 3 mo on dialysis with catheter

1 in 4 patients who get a bloodstream infection caused by S. aureus can face complications such as:
- Endocarditis (infected heart valve)
- Osteomyelitis (infected bone)
- Cost $16,000-$23,000
Prevention of Catheter Related Infection

1. **Surveillance and feedback using NHSN**
2. **Hand hygiene observations**
3. **Catheter/vascular access care observations**
4. **Staff education and competency**
5. **Patient education/engagement**
6. **Catheter reduction**
7. **Chlorhexidine for skin antisepsis**
8. **Catheter hub disinfection**
9. **Antimicrobial ointment**

http://www.cdc.gov/dialysis/collaborative
Path to Appropriate Access

1. Timely Referral to Nephrologist
2. Knowledge Transfer Decision Making
3. Timely Referral to Skilled Surgeon and Radiologist
4. Successful creation and cannulation of AVF
Team Approach to Vascular Access